



**CLUSTER**  
**Trading Services**

**UNIT**  
**Engineering**

**DEPARTMENT**  
**Water and Sanitation Engineering**

**PROCUREMENT DOCUMENT**  
**INFRASTRUCTURE**

Documents are to be obtained, free of charge, in electronic format, from the [National Treasury's eTenders website](#) or the [eThekweni Municipality's website](#).

**Contract No: 31300-5W**

**Contract Title: ISIPINGO WASTEWATER TREATMENT WORKS:  
CONSTRUCTION OF FUNCTIONAL IMPROVEMENTS TO  
SELECTED PROCESSES**

**Est. CIDB Grade/ Class: 8 CE or 8 ME**

**CLARIFICATION MEETING AND QUERIES**

**Clarification Meeting: Compulsory Clarification Meeting**

**Meeting Location, Date, Time: Outside the Main Boardroom, Isipingo Wastewater Treatment Works  
on 10 June 2025 at 11h00 (-29.9903, 30.9061)**

**Queries can be addressed to: Project Engineer**  
**The Employer's Agent's: [isipingowwtw@zutari.com](mailto:isipingowwtw@zutari.com)**  
**Representative: Email queries to be sent to [isipingowwtw@zutari.com](mailto:isipingowwtw@zutari.com) by 19 June 2025, response to queries will be uploaded by 26 June 2025.**

**TENDER SUBMISSION**

**Delivery Location: The Tender Box in the foyer of the Municipal Building  
166 KE Masinga Road, Durban**

**Closing Date/ Time: Friday, 04 July 2025 at 11h00**

**FACSIMILE, eMAIL, or POSTED TENDERS WILL NOT BE ACCEPTED**

**Issued by:**

**ETHEKWINI MUNICIPALITY**

**Deputy Head: [Water and Sanitation Engineering](#)**

**Date of Issue: [25/04/2025](#)**

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Tenderer Name:			VAT Registered: Yes No
	Price (excl)	VAT	Price (incl)
Submitted: R		R	R
Corrected: R		R	R

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### **C3.1: PROJECT DESCRIPTION AND SCOPE OF CONTRACT**

#### **STATUS**

In the event of any discrepancy between the Scope of Works and a part or parts of the Specifications, the Bill of Quantities or the Drawings, precedence shall be applied to the Contract as follows:

##### **Civil Works:**

- The Drawings
- The Project Specification
- The Bill of Quantities

##### **Mechanical and Electrical Works:**

- The Technical Datasheets (not applicable to Mechanical Works)
- The Project Specification
- The Bill of Quantities
- The Drawings

#### **C3.1.1 EMPLOYER'S OBJECTIVES**

The Water and Sanitation Department of eThekweni Municipality (EWS) is undertaking an improvement of works at Isipingo Wastewater Treatment Works (WWTW).

The existing Isipingo WWTW currently treats domestic sewage and has a design capacity of 18 Ml/day. Due to aging infrastructure and outdated process technology the plant is not operating at its optimal capacity. Process inefficiencies at selected process units have therefore been identified and need to be addressed.

The Objective of the Employer under this contract is to remediate these process inefficiencies at selected process units, towards improving infrastructure at Isipingo WWTW.

The works described in this contract document covers the Civil, Mechanical and Electrical Works for the functional improvements to selected processes to meet the functional capacity at the Isipingo WWTW.

#### **C3.1.2 OVERVIEW OF THE WORKS**

This Contract Document comprises the Civil, Mechanical and Electrical works for the functional improvements to selected processes at the Isipingo WWTW. The Works mainly comprise of the construction of new inlet works and associated MCC building, refurbishment of the administration building and biofilter pumpstation building, upgrade of the existing biofilter pumpstation (including a new settled sewage sump), a new second class water system (raw water pumpstation, second class water reservoir and pumpstation, as well as associated pipe network), a new temporary sludge stockpile area, refurbishment and remedial work for general civil engineering works such as roads, stormwater, reticulation networks, etc. The works for the abovementioned infrastructure entail civil, mechanical and electrical works.

Should the total constructions costs exceed the Employers available budget, the Employer reserves the right to delay or omit the works, or parts thereof as per provision made in the conditions of contract.

### C3.1.3 SCOPE OF WORKS

#### a) Civil Works:

The civil scope of this Contract is as follows:

1. Inlet Works: The construction of a new inlet works which will accommodate the design flow of 18 Ml/d (average dry weather flow) and a peak wet weather flow of 54 Ml/d. The new inlet works includes a common inlet channel with one (1) trash rack screen, two (2) screen channels with mechanical front raked screens, two (2) bypass channels with manually raked bar screens, two (2) vortex degritters as well as an overflow chamber with a manually raked bar screen.
2. New MCC Building: New building housing all the motor control centres (MCC) for the inlet works and associated pumps.
3. Refurbishment of the Administration Building: Modifications and refurbishment of the existing one (1) storey administration building, which will house the offices of the plant manager, control room, communal area with kitchenette, changerooms and ablution facilities for operational staff.
4. Refurbishment of Biofilter Pumpstation Building and Ablution Block: Internal upgrade of the existing ablution block which entails replacement or refurbishment of all sanitary fixtures and affiliated plumbing, flooring as well as the inclusion of new benches for staff. New brickwork walls are required to enclose the new MCC room as well as new steel columns from the soffit to the sump floor below.
5. Upgrade of the Biofilter Pumpstation: New settled sewage sump (including four (4) individual delivery sumps and a common feeder sump) with an overflow weir, new DN750 concrete pipeline, new DN700 ductile iron suction pipeline, penstock chambers and manhole chambers.
6. Raw Water Pumpstation: New building housing two new (2) self-priming pumps.
7. Second Class Water Pumpstation and Reservoir: New pumpstation for treated effluent reticulation network (second class water) to be used for mechanical equipment and on-site requirements. The pumpstation will also include a square reservoir (above ground).
8. Temporary Sludge Stockpile Area: The construction of a concrete surface bed supported by sufficient layer works.
9. Process Pipework: The interconnecting pipework associated with directing flow through the new structures and the reconfiguration of the existing pipework. It will also include the new overflow pipe from the new inlet works to the existing overflow pipe.
10. Ancillary Structures: The construction of small concrete structures including flow diversion and/or division chambers, flow measurement, distribution boxes, manholes, valve and collection chambers.
11. Demolition and Flow Diversion: Decommissioning and demolition of older process units which are replaced by the proposed scope of works. Flow diversion mainly includes the diversion of the incoming sewage flow from upstream of the new inlet works to the existing inlet works channel, via the new overflow chamber as well as a new overflow pipe and a new diversion chamber.

12. Roads, Stormwater and Cable Ducts: Internal access roads, stormwater drainage and cable routing ducts. Existing stormwater pipes which are affected may be replaced with new pipes pipe sizes vary from standard 375mm Class100D and upwards. New stormwater include 375mm Class 100D, 450mm Class 100D and 200mm HDPVC pipes. Stormwater manholes and field inlets are required to collect stormwater runoff from harden areas. Stormwater concrete channels (precast and cast-in-situ) are required to collected runoff from hardened areas. Grouted stone pitching, chutes and swale are required to manage stormwater runoff in applicable areas of the works and discharge runoff appropriately. Headwalls, aprons and erosion protection mattress are required at outlet locations. Repairs to existing stormwater channels, manholes and covers are required.
13. Site Clearance, General Earthworks and Landscaping: Site clearance, general earthworks and general site landscaping.
14. Second Class Water System: New second class water reticulation network on site to service new inlet works, primary sedimentation tanks, raw sludge tanks, humus tank and the sludge stockpile area.
15. Fencing: Amendment of fencing around sections of maturation ponds.

The above list shall not limit the work to be carried out under this Contract.

**b) Mechanical and Electrical (M&E) Works:**

The M&E works includes the following duties:

- Design
- Manufacture
- Supply
- Delivery
- Storage (if necessary)
- Installation
- Testing
- Commissioning and Trial Operation Period
- Training the Employer's staff in operation and maintenance
- Upholding during the Defects Notification Period.

The Works shall be designed to function safely and effectively in conjunction with the infrastructure provided by others for this project. Where components of the Works are incorporated into structures provided by others, these components shall be designed accordingly.

The M&E scope of this Contract will be as follows:

**The Mechanical works comprises the following:**

**a) New Inlet Works:**

- Trash Rack Screen
- Front Raked Screens
- Hand Raked Screens
- Water Launderers

- Washer Compactors
- Grit Removal Equipment
- Grit Classifiers
- Channel Mounted Sluice Gates
- Skip Dollies for Screenings and Grit
- Second Class Water System Reticulation at the new inlet works (terminating at the various mechanical equipment as necessary)

#### Biofilter Pump Station

- a) Bio Filter Pumps
- b) Wall Mounted Sluice Gates

#### Second Class Water System

- a) Raw Water Pumps
- b) Booster Pumps
- c) Air Compressors
- d) Automatic self-cleaning Filters

#### Sludge Stockpile

- a) Pump Station

#### Other

- a) Pipework and Valves
- b) Lifting Equipment
- c) Operation and Control System
- d) Airconditioning and Ventilation
- e) Site wide safety signage and equipment tagging
- f) Spares
- g) Performance Accepting Testing
- h) Test on Completion
- i) Commissioning
- j) Trial Operation Period
- k) Training
- l) Rectification during Defects Notification Period
- m) Operating and Maintenance Manual

**The Electrical scope comprises the design, supply and installation of the following:**

**The scope of works for the electrical installation is the design, supply, delivery, installation, testing, commissioning and upholding during the trial operation period and the defects liability period of the following equipment and materials:**



- 
- a) 850 kVA continuous power rating power 400 V modified ISO container standby generator, including all required components and accessories
  - b) The following Motor Control Centres (MCCs):
    - Main / Biofilter Pump Station MCC including connecting existing feeders and equipment to the new MCC (MCC01)
    - New Inlet Works MCC (MCC02)
    - Second Class Water MCC (MCC03)
  - c) Various Low Voltage Power cables, installed in ground trenches, PVC ducts and cable ladder.
  - d) Cable Supports for all cable routes.
  - e) Various Field Control stations, including Emergency Stop stations, and Start/Stop/Emergency Stop stations, located within 1 metre of the relevant plant equipment.
  - f) Site Lighting
  - g) Small Power and Lighting for the following buildings and structures:
    - Admin Building
    - Biofilter Pump Station Building
    - New Inlet Works MCC Building
    - New Inlet Works Structure
    - Second Class Water MCC Building
    - Raw Water Pump Station Building
  - h) Smoke detection system for the Admin Building
  - i) Disconnecting, making safe and removal off site of redundant electrical, control and instrumentation equipment and materials
  - j) The following activities shall also be performed by the Contractor:
    - Liaison and coordination with the electrical supply authority, eThekweni Electricity, regarding the electrical supply upgrade change-over and all required shutdowns.
    - Site Harmonic Study Report of impact of all proposed variable frequency drives on the internal reticulation system and at the point of supply.
    - Earthing and Lightning protection.

**The Instrumentation and Control scope comprises the design, supply and installation of the following:**

**The scope of works is to provide the required instrumentation and control systems for the Wastewater Works. In general, the following items are to be supplied but this is not a comprehensive list.**

- a) New SCADA for the entire WWTW comprising of the new MCC's listed above and the existing Chlorine Disinfection MCC (MCC04), including SCADA server and workstation
- b) UPS for SCADA and PLC's

- c) PLCs and I/O
- d) HMI's
- e) Instrumentation, cabling and racking
- f) Instrumentation junction boxes
- g) Dedicated earthing system and Surge protection for the electronic systems
- h) Control room equipment and furniture
- i) CCTV cameras

#### **C3.1.4 DESCRIPTION OF SITE AND CONDITIONS**

The following site conditions shall be taken into consideration:

▪ Altitude above sea level	10-20m mean
▪ Operating Voltage	400V - 3 Phase
▪ Electrical Supply Frequency	50 Hz
▪ Maximum Temperature	45°C
▪ Minimum Temperature	2°C
▪ Maximum Relative Humidity	97%
▪ Corrosion Conditions	Severe
▪ Lightning	High
▪ Rainfall	Summer
▪ Flooding	Means to prevent flooding is required

#### **C3.1.5 SITE ACCESS**

The Isipingo WWTW site is located in Malukazi in the KwaZulu-Natal Province and falls under the eThekweni Municipality's jurisdiction. The general location of the site is on the southern outskirts of the town, approximately 19 km south of Durban and adjacent to the Isipingo River. Refer to the Locality Plan attached in Part C4.1 of the Tender Documents.

The operation of construction vehicles on existing roads or streets shall be limited to traffic with an axle load not exceeding that allowed by the Road Traffic Ordinance of the authority concerned, or any amendment thereof.

The Contractor must note that no additional payment will be made for the construction of temporary access roads to the construction sites, borrow-areas or to the spoil sites, except for payment made under payment item 8.3.2.2 of SANS 1200 A.

The Contractor shall clear any spillage caused by his activities on or near any roads, by whatever means necessary, within 24 hours after such spillage has occurred. No additional payment will be made for the clearance of spillage and all related costs will be deemed to be covered under the relevant items.

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**C3.1.6 NATURE OF GROUND AND SUBSOIL CONDITIONS**

A geotechnical investigation was completed, and the information is included in Part C4.2 for the Tenderer's information. This investigation only comprises test pitting located where new structures shall be located, and any further interpretation of the report is the responsibility of the Contractor.

**C3.1.7 TEMPORARY WORKS**

The Contractor shall be responsible for designing and providing any temporary works required, which shall be approved by a professional engineer or engineering technologist.

Such works and the positioning thereof are to be approved by the Engineer before erection and operation on site.

Such temporary works shall be removed upon completion of the Works and the site of such temporary works re-instated to a pristine condition acceptable to the environmental requirements

**C3.1.8 WORK TO BE CARRIED OUT BY OTHERS (UNDER SEPARATE CONTRACTS)**

It is expected that no works are to be carried out by others, under separate contracts during the contract period.

**END OF SECTION**

**C3.2: ENGINEERING****STATUS**

In the event of any discrepancy between the Scope of Works and a part or parts of the Specifications, the Bill of Quantities or the Drawings, precedence shall be applied to the Contract as follows:

**Civil Works:**

- The Drawings
- The Project Specification
- The Bill of Quantities

**Mechanical and Electrical Works:**

- The Technical Datasheets (not applicable to Mechanical Works)
- The Project Specification
- The Bill of Quantities
- The Drawings

**C3.2.1 DESIGN****Civil Works**

The design responsibilities are as follows:

- a) The Employer is responsible for the design of the Permanent Works as reflected in the Contract Documents unless otherwise stated.
- b) The Contractor is responsible for the design of the Temporary Works (including demolition and diversion) and their compatibility with the Permanent Works.
- c) The Contractor shall supply all details necessary to assist the Engineer in the compilation of the as-built drawings.

**Mechanical and Electrical Works**

The design responsibilities are as follows:

DESIGN PROCESS	RESPONSIBILITY
Concept	Employer responsible
Engineering and layout to tender stage	Employer responsible
Civil design of permanent Works as reflected in the Contract Documents unless otherwise stated	Employer responsible
Temporary works	Contractor responsible for the design of the temporary Works and their compatibility with the permanent Works
As built drawings	Contractor shall supply all details necessary to assist the Engineer in the compilation of the as-built civil drawings and the Contractor shall supply as built drawings for all equipment provided.

DESIGN PROCESS	RESPONSIBILITY
Detailed design of the mechanical and electrical work	Contractor responsible for designing the Works in accordance with the Employer's requirements and tender drawings
Control philosophy/functional design	Contractor responsible for designing the Works in accordance with the Employer's requirements

Design responsibilities are to be read in conjunction with C3.2.4.

### C3.2.2 EMPLOYER'S DESIGN

Refer to Clause C3.2.1. Some provisional sums have been allowed under the Employer's design, of which the works will be designed and quantities together with drawings will be provided to the successful tenderer. These provisional sums include (but are not limited to):

- Removal of unknown existing services not indicated on drawings
- Relocation of existing services not indicated on drawings
- Waterproofing and strengthening to existing chambers or sumps where structural conditions have to be repaired for normal functional purposes
- Supply of maintenance and office equipment/furniture/tools
- Flow diversion works
- Refurbishment and conversion of existing buildings.

### C3.2.3 CONTRACTOR'S DESIGN

#### Civil Works

Where the Contractor is to supply the design of designated parts of the Permanent Works or Temporary Works, he shall supply full working drawings supported by a Professional Engineer's design certificate.

#### Mechanical and Electrical Works

The Contractor's shall be responsible for the design of the mechanical and electrical work. The Contractor's design shall be based on the Employer's requirements and the tender drawings, the existing and future structures and any existing equipment installations and the Contractor shall ensure that the design can be satisfactorily accommodated. All mechanical and electrical designs shall be approved and signed off by professionally registered person (i.e., must be professionally registered with the Engineering Council of South Africa (ECSA)) as per the specific design discipline (e.g., professionally registered person in the mechanical discipline must sign off the mechanical design).

The Contractor shall accommodate actual dimensions and details measured on Site. Any inconsistencies, including any conflict between the Engineer's drawings and the actual dimensions measured on site, shall immediately be drawn to the attention of the Engineer, in writing.

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a) OHS Act

The Contractor is responsible for ensuring that the design of the equipment provided, and the installation of this equipment comply with the Occupational health and Safety Act, Act 85 of 1993 and the 2014 Construction regulations, and the regulations promulgated thereunder. Installations which do not comply shall be corrected by the Contractor at no cost to the Employer.

b) General Safety Requirements

Safety of design is an overriding consideration. Installations which do not comply with the OHS Act shall be corrected by the Contractor at no cost to the Employer.

Equipment which is potentially dangerous shall be designed in accordance with a relevant South African or international Standard which deals with the hazard.

Hazards shall be avoided or guarded to the approval of the Engineer. Nip points shall be guarded. Sharp corners shall be rounded off. Items such as operating handles, supports and protrusions shall be kept clear of access ways or shall be marked clearly.

The Contractor shall cover all unsafe gaps and openings left in structures after installation of the equipment.

Each motor driven device shall be provided with an emergency stop station in an appropriate position.

Trip wires shall be provided along the accessible side/s of moving conveyor belts, chains, etc., irrespective of operating speed and in addition to any guards provided. These shall stop the driving motor when pulled.

c) General requirements

Design shall ensure safety, robust construction, reliability, durability, prevention of avoidable corrosion, neatness, protection of the environment as well as ease of maintenance and operation.

The Contractor's design shall, as applicable, be based on:

- The full range of duties which can be reasonably anticipated
- The maximum pressure or vacuum which can be produced under all conditions including blocked or closed inlet and outlet circuits
- Conservative service and safety factors based on approved standards or laid down in the printed specifications of reputable and approved manufacturers
- Twenty-four hour per day operation (unless specified otherwise)
- A minimum life of 100 000 hours before major part replacement
- Prevention of serious damage from normal operational problems such as blockages, blinding, jamming, seizure, malfunction and, as far as practical, mal operation
- The power and torque transmitted by the driver system under full load and stalled conditions.
- Machines with non-overloading characteristics shall be selected wherever possible, e.g.: motors shall be sized so that they cannot be overloaded by the driven machine.

d) Hazardous Locations

Equipment which is to be installed in areas with hazardous area location zoning for gasses or for dusts in terms of SAN 10108, shall comply with the requirements of that Standard.

e) Fail Safe Operations and Protections

Where damage can occur from normal operational or other foreseeable problems, plant, equipment and systems shall be designed to be fail safe (i.e. shall have built in redundant elements) or shall be fail to safe (i.e. shall return to a safe condition where no further damage can be done in the event of a failure, malfunction, mal-operation, overload and, as far as practical, misuse). All reasonable and economically justifiable protections to prevent or limit damage to plant and equipment, particularly in high-risk situations, shall be incorporated.

Protections shall:

- Be directed at the source of the problem, limit forces to safe levels and act quickly enough to prevent damage (electrical thermal type overloads are inadequate)
- Stop, or prevent from starting, all equipment at risk
- Activate an alarm with a labelled indicator on the control panel, HMI or SCADA mimic whenever a protection operates
- Operate reliably after long inactive periods exposed to corrosive and dirty conditions.

Contractors shall highlight equipment limitations which can be exceeded during operation and cannot be guarded against.

f) Moving Parts

The following general requirements apply to machines and to all equipment with moving parts such as headstocks, extension spindles, swiveling davits, heavy duty hinges, pivots and the like:

- Rotating or swiveling shafts, pins and the like, shall be adequately supported, guided and restrained by lubricated or self-lubricating bearings, collars and/or bushes
- Swiveling joints on linkages and the like shall be of the "universal" or fork and rod type with bearings or bushes fitted to the eyes or forks
- Abrasion resistant materials and slow speed operation shall be used for abrasive applications. (Wastewater and all sludges shall be regarded as abrasive.)
- Susceptibility to fatigue failure shall be minimized by proper design and manufacturing procedures. Sharp changes in section and badly contoured welding shall be avoided especially in components subject to fluctuating stress
- The locking of nuts and pins in position shall be done to the approval of the Engineer
- Wearing parts shall be designed for ease of removal and replacement.

g) Arrangement and Mounting

The design shall take the following requirements into consideration:

- Lifting eyes, lugs, hooks, etc., shall be provided on heavy or large items to facilitate handling
- Castings and fabrications shall have machined pads for seating and shall be mounted on either soleplates or baseplates as appropriate

- Where accurate alignment is required, positioning pins and/or jacking screws shall be provided
- The needs of operation and maintenance including neatness, access, working space, safety, cleaning, adjustment, handling, assembly, alignment, disassembly, removal, etc., shall be accommodated.
- With plant and equipment to be mounted on or against concrete or brick structures built by others, provision shall be made for adjustment in the mechanical design. Any special accuracy requirements must be specified on the Contractor's Documents.

h) Prevention of Corrosion

The Contractor shall review all designs in order to achieve acceptable corrosion protection. Any details which might have a negative effect on the corrosion protection and the future application of coatings are to be brought to the Engineer's attention for a ruling prior to commencement of work.

All items shall be designed to minimize corrosion in the environment in which they will be exposed. Particular emphasis shall be placed on accessibility for surface preparation and the application of coatings. The detailed requirements for corrosion protection are dealt with elsewhere in this document.

Mastics, sealants, insertion rubber or suitable gasket material shall be used to seal unavoidable crevices such as bolted connections.

The design shall ensure that all surfaces to be coated shall be accessible for fettling, blast cleaning, painting and for maintenance of these surfaces. Stainless steel surfaces shall be accessible for pickling and passivation. The use of back-to-back angles, partially open box sections or inaccessible stiffeners shall be avoided. Inaccessible surfaces which cannot be avoided shall be welded closed.

Particular attention shall be paid to the fabrication and inspection requirements for internal weld surfaces in pipework.

All applications associated with wastewater shall be regarded as corrosive and materials of construction shall be selected to suit.

### **C3.2.4 CONTRACTOR'S DOCUMENTS TO BE SUBMITTED FOR APPROVAL**

a) General Requirements

The Contractor's Documents shall comply with the following general requirements:

- A register of all the Contractor's documents shall be kept up to date, and shall be provided with each submission
- Drawings shall be produced from the 3D model and prepared in accordance with the latest issue of SANS 10111. An equivalent international code of engineering drawing practice will also be acceptable
- General Arrangement drawings shall be to A1 size
- Drawings shall be to scale, with both the scale and the drawing being large enough to clearly show all relevant components of the plant and equipment



- In addition to the usual plan and two side elevations, sufficient additional sections shall be included to clearly show the arrangement of all plant and equipment
- Item lists shall be provided on the drawing or on a separate parts list
- Item descriptions shall include the material of construction, quantity and full identification information, including, as applicable, brand name, manufacturer's reference number, model number, size, rating, source, duty, quantity, etc.

b) Required Submissions within 30 days

The Contractor shall submit the following for acceptance within 30 working days from the Commencement Date:

- Programme for The Works in Gantt chart format
- Health and Safety Plan for approval by the Client's appointed Health and Safety Responsible Person
- Copies of insurance policies in respect of the Works, Special Risks and Liability Insurance and evidence of payment of current premiums
- Valid Performance Guarantee
- Organogram and proposed team member CVs

c) Required Submissions in-line with programme

The Contractor shall submit the following for acceptance:

Information Management and Quality Control

- Contractor's document registers
- Model Element Breakdown (MEB)
- Information requirements for each plant element identified in the MEB
- Quality Control Plans for equipment (factory and site)
- Loadings requirements which the lifting gear (including crawl beams, gantries, etc.) will place on other structures
- Contents list for the Operation and Maintenance Manual
- Reporting scope and templates
- Existing Equipment removal, refurbishment and re-installation method statement and program

Models, Layouts and Drawings

- 3D Modelling Plan
- 3D model in IFC format
- Dimensioned layout drawings (from the 3D model) of the installation showing the proposed layout and design of all plant and equipment. Sufficient sections and elevations must be shown so that the relative arrangement of all equipment is clear. This shall be done for all equipment to be supplied under this Contract
- Dimensioned drawings of equipment
- Dimensioned arrangement drawings of all equipment requirements in respect of the building and civil structures
- Civil requirements for the new plinths, sleeves and box outs
- HVAC design and layout drawings

Technical Documents Drawings, Datasheets and Schedules

- 
- Loading requirements for crawl beams, gantries and any other lifting equipment
  - Drawings of pipe support details
  - Piping and instrumentation diagram, indicating items of equipment with final labels/tags, control loops, equipment details and sizes, pipe pressure ratings and diameters, etc
  - The following lists shall be provided and structured according to the model element breakdown (MEB) of the plant. The lists shall contain data related to selection, performance and other important meta data required by the Engineer to approve equipment:
    - Motor and Equipment Schedule
    - Piping Schedule
    - Valve List
    - PLC equipment
    - MCCs
    - Distribution Boards
    - Generator
    - SCADA equipment
    - Building electronic equipment
  - Technical data sheets for all coatings proposed
  - Data sheets giving performance, sizing, physical and general technical data for all equipment.
  - Overall electrical single line diagram
  - LV and C&I Cable schedules
  - LV and C&I Cable Hookup Drawings
  - LV and C&I Cable Loop Drawings
  - LV and C&I Cable block diagrams
  - LV and C&I and data cable route drawings and support system drawings
  - LV (including small power DBs) switchgear general arrangement drawings
  - LV switchgear (including small power DB) single line diagrams per system
  - LV switchgear schematics
  - LV switchgear (including small power DB) panel and door layouts
  - Circuit breaker settings
  - Ground Resistivity Survey and report
  - Earthing designs, earthing SLD and earthing schematics
  - Design documentation as per SANS 1973-1
  - Routine and type test reports for motors
  - Generator diesel tank pipework, fuel lines, general arrangement drawings and plinth requirements
  - Diesel Powered Generator Sets Design and Drawings
  - Dynamic simulation of generator step load start up (on engine and electrical network)
  - Electrical Load flow analysis
  - Electrical Short circuit analysis
  - Electrical Power factor analysis
  - Electrical Harmonics analysis
  - Electrical ETAP model
  - Detailed control architecture drawing
  - Detailed Control philosophy
  - FDS contents list

- Control system functional design specification (FDS)
- Loop diagrams
- Hook-up drawings and mounting bracket details
- Junction box design
- Junction box general arrangements
- SCADA design documentation (as per Std Spec)
- PLC design documentation (as per Std Spec)
- UPS and PSU load calculations and data sheets
- Control Room and server room layout
- Small power and lighting layouts
- Small Power DB designs
- Area lighting layout design
- CCTV, Fire Detection: layouts and network design (including architecture and cable layout)

d) Required Submissions before and during Commissioning of the Works

Prior to commencement of the Tests on Completion and the start of the 2-month Trial Operation Period, the Contractor shall submit:

- Routine and Type test reports for all electrical equipment and motors
- Factory acceptance reports
- Pre-commissioning testing results
- Sign off and acceptance by Contractor's lead Design Engineers of all final design and as-built documents.
- Commissioning plan, indicating the commissioning activities that will take place, including a proposed programme for these activities.
- Operator training plan
- As-Built 3D model
- Two copies of the draft Operation and Maintenance Manual as specified in the Specifications.

e) Required Submissions before, during and after Trial Operation Period

Prior to commencement of the Trial Operation Period, the Contractor shall submit:

- Comprehensive report containing detailed schedules and documentation to record all commissioning tests undertaken and the results of these, demonstrating that the Works have passed the commissioning tests. The data and reports shall be provided from the reporting system with annotation and comments on events to proof that the plant passed the commissioning tests and performance requirements.

During of the Trial Operation Period, the Contractor shall submit:

- Training logs and weekly reports detailing the plant performance, compliance of requirements, problems and equipment failures during the Trial Operation Period (TOP). The TOP reports and data shall be provided from the reporting system (as drawn from the onsite data historian) with annotation and comments on events to proof that the plant operated defect free and according to the Employer's Requirements.

At the completion of the Trial Operation Period, the Contractor shall submit:

- An overall report to summarize performance, problems experienced and how these were addressed.

f) Before Certificate of Practical Completion

Before the Certificate of Practical Completion is issued, the Contractor shall provide an electronic copy and three hardcopies of the approved version of the Installation, Operation and Maintenance Manual. In addition, the Contractor shall provide, on electronic data storage, all drawings supplied in terms of the Required Submissions above, corrected where necessary to be "as built". The 3D model shall be in IFC format and the drawings shall be configured for AutoCAD, or equivalent. The Manual shall comply with the specifications for O&M manuals as detailed in the Specifications.

g) Contents of Control System Functional Design document

The Contractor shall submit a document detailing the Control System (i.e. programmable controllers and operator workstation) functional design, which shall be in the format shown in the following "Table Showing Required Contents List for the Control System Functional Design Specification", and shall provide the information stipulated in this list:

**Required Contents List for the Functional Design Specification**

Item No	Description of Content
<b>1</b>	<b>General</b>
1.1	Contents List
1.2	Introduction
1.3	Drawing List (referring to P&IDs)
1.4	Tag naming convention
<b>2</b>	<b>Control Philosophy</b>
	Plant should be broken down into its various functional units (inlet works, biofilter pump station, second class water system, etc.). For each functional area the following shall be provided:
2.1	Control Modes Description
2.2	Motor List
2.3	Instrumentation List
2.4	Instrumentation Signals
2.5	Output signal during instrument error
2.6	Valve list and Failsafe positions of valves
2.7	Interlocks
2.7.1	Safety Interlocks
2.7.2	Process Interlocks
2.8	Startup/Shutdown Procedures (including for back-up power supply if applicable)
2.9	Duty Selection and Changeover
2.10	Setpoints
2.11	Trended variables
2.12	Variables for Reporting and Logging
2.13	SCADA/HMI display
2.14	Alarms and priority categorization
<b>3</b>	<b>Control Network Architecture</b>
3.1	Description of Control Network

**Required Contents List for the Functional Design Specification**

Item No	Description of Content
3.2	Hardware specifications
3.3	Software specifications
<b>4</b>	<b>Programmable Controllers</b>
4.1	Configuration
4.2	Hardware
4.3	Networks
4.4	IO list
4.5	Protocols
4.6	Functional blocks design and description
<b>5</b>	<b>SCADA/HMI</b>
5.1	Configuration
5.2	Tags List with Tag count
<b>6</b>	<b>SCADA/HMI Mimics (mock ups before programming)</b>
6.1	Plant Overview
6.2	Navigations Bar
6.3	Sub Plant overviews (if applicable)
6.4	Functional Unit Overview
6.5	System Page
6.6	Comms Network (based on network architecture)
6.7	Electrical Distribution and Generation Network
6.8	Instrument Overview Screen
6.9	Symbol Colors
6.7	Process Unit/Drive/Instrumentation/valves Faceplates
6.8	Process sequence pages
6.9	Alarms Page
6.10	PID Control Loops and Set point page
6.11	Reports
6.12	Trending/logging
<b>7</b>	<b>Alarm Management</b>
7.1	Alarm Philosophy
<b>8</b>	<b>Historian</b>
8.1	Configuration
<b>9</b>	<b>Data Warehouse</b>
9.1	Extract Transform Load Procedures
9.2	Data Model
9.3	Data Maintenance Scheduling (e.g. storing, archiving of data and log file)
<b>10</b>	<b>Reporting</b>
10.1	Metric KPI list
10.2	Realtime Visualization
10.3	Report and Dashboard Design (if applicable)
<b>11</b>	<b>Security</b>
11.1	Cybersecurity Design
11.2	Authentication Access Control
11.3	Access Hierarchy

**C3.2.5 APPROVALS AND INSPECTIONS**a) Method statements

The Contractor shall be required to prepare method statements subject to the approval of the Engineer and Client for the installation of equipment on any structures, or prior to the pre-commissioning or commissioning of any equipment.

b) Approvals before Manufacturing and Inspections

All drawings which are to be submitted in terms of the Contract shall be approved in principle by the Engineer before any manufacturing or inspection of manufactured or supplied items commences. Refer to Additional Conditions of Contract Clause 19 (Mechanical and Electrical scope only) for further information in this regard.

c) Quality Control Plans

Quality Control Plans (QCP's) of all manufactured items shall be submitted to the Engineer for approval prior to the start of any manufacturing. The Engineer shall review these QCP's and identify any hold points which he deems necessary for the specific item of equipment. The necessary hold points identified by the Engineer shall be taken into consideration and failure to adhere to any hold points shall constitute a failure of approval and any costs incurred in this regard shall be borne by the Contractor.

d) Inspections

The Contractor shall arrange timeously with the Engineer for any inspections, at least 5 working days in advance. The inspections carried out by the Engineer shall not absolve the Contractor from his responsibilities with regards to the correctness of any of the Works.

**C3.2.6 DRAWINGS**

The Contractor shall use only the dimensions stated in figures on the Drawings in setting out the Works, and dimensions shall not be scaled from the Drawings, unless required by the Engineer. The Engineer will, on the request of the Contractor in accordance with the provisions of the Conditions of Contract, provide such dimensions as may have been omitted from the Drawings.

The Contractor shall ensure that accurate as-built records are kept of all infrastructure installed, relocated or exposed during the Contract. The position of pipe bends, junction boxes, duct ends, and all other underground infrastructure shall be given by either co-ordinates or stake value and offset. Where necessary, levels shall also be given. A marked-up set of drawings shall also be kept and updated by the Contractor. This information shall be supplied to the Engineer's Representative on a regular basis.

All information in possession of the Contractor, required by the Engineer and/or the Engineer's Representative to complete the civil as built/record drawings, must be submitted to the Engineer's Representative before a Certificate of Completion will be issued.

The drawings which are included in Volume 3: Book of Drawings are listed below in order to give an overview of the project. These drawings are for tender purposes and may be amended subject

to the design and equipment offered under this contract.

In the event of any discrepancies in the drawings (or drawings referred in the Bill of Quantities) or conflicting information between EWS standard details and Zutari standard details, EWS standard details shall take precedence.

Civil construction drawings will be issued to the Contractor by the Engineer/Employer on the commencement date to assist the Contractor with planning of the Works as a whole and assist the Contractor with the detailed planning of the Works to be executed in the earlier months of the Contract as stipulated in the approved project programme. The following additional conditions will apply to the issue of construction drawings:

- Construction drawings related to specific structures or buildings which host mechanical and electrical equipment will only be issued to the Contractor for construction once the mechanical and electrical design has been approved. Should the Contractor require the Design and associated drawings by the Engineer/Employer to be amended to accommodate the Mechanical and Electrical Works, the contractor shall provide necessary details (as specified elsewhere, plus any additional details required by the Engineer) in good time (at least two weeks), to allow the Employer's designers adequate time to attend to the design amendments.

No claims for an extension of time and/or additional compensation will be considered or granted by the Employer/Engineer in connection with delays due to the late issuing of amended design details and/or drawings by the Employer, where such delay is a result of the Employer's designers having to amend designs and/or drawings to accommodate the Mechanical and Electrical Works.

- Further drawings detailing steel reinforcement for the concrete structures will be issued to the Contractor in stages to allow the Contractor to undertake construction in accordance with his approved program and will not be available in entirety at commencement of the Works. The Engineer will require good time (at least two weeks, unless otherwise instructed by Engineer) to finalise the respective civil construction drawings. This process will be per structure or building.
- From time to time during the progress of the Works, the Engineer will issue further drawings and details as may be necessary for adequate construction, completion and defects correction of the Works.

DRAWING NUMBER	DRAWING TITLE
<b>A. GENERAL DRAWINGS</b>	
60471/C/GW/001	Existing Site Layout
60471/C/GW/002	Existing Potable Water Network Layout
60471/C/GW/003	Existing Effluent Network
60471/C/GW/004	Existing Services and Survey Layout: 2D Layout
60471/C/GW/005	Existing Services and Survey Layout: 3D Layout
60471/C/GW/006	Scope of Works
60471/C/GW/010	New Site Layout
60471/C/GW/011	Second Class Water System Layout

60471/C/GW/012	Site Establishment
<b>B. BULK EARTHWORKS</b>	
60471/C/GW/100	Earthworks: Biofilter Pump Station Plan and Sections
60471/C/GW/102	Earthworks: Second Class Water System Plan and Sections
60471/C/GW/104	Earthworks: Pump Station Generator Plinth Plan and Sections
<b>C. ROADS &amp; STORMWATER</b>	
60471/C/GW/200	Existing Stormwater Layout
60471/C/GW/201	New Stormwater Layout
60471/C/GW/202	Stormwater and Road Repairs (Sheet 1 of 5)
60471/C/GW/203	Stormwater and Road Repairs (Sheet 2 of 5)
60471/C/GW/204	Stormwater and Road Repairs (Sheet 3 of 5)
60471/C/GW/205	Stormwater and Road Repairs (Sheet 4 of 5)
60471/C/GW/206	Stormwater and Road Repairs (Sheet 5 of 5)
60471/C/GW/207	Swale, Earth Channel & SW Pipe: Long Sections, Cross Sections and Details
60471/C/GW/208	Main Road From Entrance to Drying Beds: Long Section and Cross Sections
60471/C/GW/209	Road From Drying Bed to T-Junction: Long Sections and Cross Sections
60471/C/GW/210	Road From Biofilter to Turning Head: Long Sections and Cross Sections
60471/C/GW/211	Entrance Road: Plan, Long Section and Cross Sections
60471/C/GW/212	Gabion Basket Retaining Wall: Layout and Details
60471/C/GW/213	Temporary Sludge Stockpile: Locality Plan
60471/C/GW/214	Temporary Sludge Stockpile: Layout for Access Road, Platform and Stormwater Sump Details
60471/C/GW/215	Temporary Sludge Stockpile: Access Road Long Section and Cross Sections
60471/C/GW/216	Temporary Sludge Stockpile: Stormwater Sump Rising Main Layout and Long Sections
60471/C/GW/217	New Inlet Works: Stormwater and Skip Dolly Layout
60471/C/GW/219	New Inlet Works: Overflow Pipe Layout and Long Sections
60471/C/GW/220	New Inlet Works: Platform and Access Road Plan and Cross Sections (Sheet 1 of 2)
60471/C/GW/221	New Inlet Works: Platform and Access Road Plan and Cross Sections (Sheet 2 of 2)
<b>D. ZUTARI STANDARD DETAILS</b>	
60471/C/GW/300	Standard Details: Stormwater And Earthworks - Details A - H
60471/C/GW/301	Standard Details: Stormwater And Road Pavement - Details I - O
60471/C/GW/311	Standard Details: Door Schedule
60471/C/GW/313	Standard Details: Structural General Notes & Drawing Standards
60471/C/GW/314	Standard Details: Joint Details for Watertight Concrete
60471/C/GW/315	Standard Details: Typical Masonary Details (Sheet 1 of 2)
60471/C/GW/316	Standard Details: Typical Masonary Details (Sheet 2 of 2)
60471/C/GW/317	Standard Details: Concrete Surface Bed Details
60471/C/GW/318	Standard Details: Typical Concrete Details
60471/C/GW/319	Standard Details: Demolition Notes
60471/C/GW/323	Standard Details: Road Crossing
60471/C/GW/327	Standard Details: MCC Trench Support Details
60471/C/GW/330	Standard Details: Window Schedule
60471/C/GW/331	Standard Details: Anchor Thrust Blocks



60471/C/GW/332	Standard Details: Building Connection and Standpipe Details
60471/C/GW/333	Standard Details: Concrete Joints
60471/C/GW/334	Standard Details: Electrical Duct Manhole
60471/C/GW/335	Standard Details: Fire Hydrant
60471/C/GW/336	Standard Details: Foul Sewer Manhole
60471/C/GW/337	Standard Details: Foul Sewer Rodding Eye
60471/C/GW/338	Standard Details: Gabion Baskets
60471/C/GW/339	Standard Details: Grating & Ladders
60471/C/GW/340	Standard Details: Handrails
60471/C/GW/341	Standard Details: Kerbs
60471/C/GW/342	Standard Details: Manhole for Subsurface Drain
60471/C/GW/343	Standard Details: Pipe Bedding
60471/C/GW/344	Standard Details: Potable Water Network Scour Valve Chamber
60471/C/GW/345	Standard Details: Protection of Existing Services in Roadway
60471/C/GW/347	Standard Details: Shallow Backdrop Manhole
60471/C/GW/348	Standard Details: Stormwater Catchpit Type A1 Inlet Kerb and Cover Slab
60471/C/GW/349	Standard Details: Stormwater Catchpit with Grid Inlet Type B1
60471/C/GW/350	Standard Details: Stormwater Catchpit with Grid Inlet Type C1 and C2
60471/C/GW/351	Standard Details: Stormwater Catchpit Inlet Kerb and Cover Slab
60471/C/GW/352	Standard Details: Stormwater Catchpit Type 1A
60471/C/GW/353	Standard Details: Stormwater Catchpit Type 2A
60471/C/GW/355	Standard Details: Stormwater Gully
60471/C/GW/356	Standard Details: Stormwater Headwall (Sheet 1 of 2)
60471/C/GW/357	Standard Details: Stormwater Headwall (Sheet 2 of 2)
60471/C/GW/358	Standard Details: Stormwater Junction Box
60471/C/GW/359	Standard Details: Stormwater Manhole
60471/C/GW/360	Standard Details: Stormwater Road Take-off and Chute
60471/C/GW/361	Standard Details: Subsurface Drain and Fin Drain
60471/C/GW/362	Standard Details: Subsurface Drainage Collection Manholes
60471/C/GW/364	Standard Details: Air Vents (Sheet 1 of 2)
60471/C/GW/365	Standard Details: Air Vents (Sheet 2 of 2)
60471/C/GW/366	Standard Details: Reservoir Access Hatch (Sheet 1 of 2)
60471/C/GW/367	Standard Details: Reservoir Access Hatch (Sheet 2 of 2)
60471/C/GW/368	Standard Details: Biofilter Pump Station HDPE and CAC Lining
60471/C/GW/369	Standard Details: Waterproofing for Existing Pipes in Chambers
60471/C/GW/370	Standard Details: Flooring Details (Sheet 1 of 3)
60471/C/GW/371	Standard Details: Flooring Details (Sheet 2 of 3)
60471/C/GW/372	Standard Details: Flooring Details (Sheet 3 of 3)
<b>E. CONCRETE STRUCTURES</b>	
60471/C/LI/400	Existing and New Inlet Works: 3D Views
60471/C/LI/401	New Inlet Works: General Arrangement
60471/C/LI/402	New Inlet Works: Layout, Walkway Slabs and Gratings
60471/C/LI/403	New Inlet Works: Concrete Layout, Sections & Details (Sheet 1 of 3)

60471/C/LI/404	New Inlet Works: Concrete Layout, Sections & Details (Sheet 2 of 3)
60471/C/LI/405	New Inlet Works: Concrete Layout, Sections & Details (Sheet 3 of 3)
60471/C/LI/406	New Inlet Works: Roof Layout, Sections and Details
60471/C/LI/407	New Inlet Works: Overflow and Diversion Chambers Layout, Sections and Details
60471/C/LI/408	New Inlet Works: Staircases and Pipe Details
60471/C/LI/414	Existing Inlet Works: Layout, Sections and Details (Sheet 1 of 3)
60471/C/LI/415	Existing Inlet Works: Layout, Sections and Details (Sheet 2 of 3)
60471/C/LI/416	Existing Inlet Works: Layout, Sections and Details (Sheet 3 of 3)
60471/C/LS/421	Biofilter Pump Station: Locality Plan
60471/C/LS/422	Biofilter Pump Station: 3D Views
60471/C/LS/423	Biofilter Pump Station: General Arrangement
60471/C/LS/424	Biofilter Pump Station: Layout, Sections and Details
60471/C/LS/425	Biofilter Pump Station: Manhole Chamber 1 Layout, Sections and Details
60471/C/LS/426	Biofilter Pump Station: Manhole Chamber 2 Layout, Sections and Details
60471/C/LS/427	Biofilter Pump Station: Penstock Chamber 3 Layout, Sections and Details
60471/C/LS/428	Biofilter Pump Station: Flow Meter Chamber Layout, Sections and Details
60471/C/LS/441	New Sewage Settling Sump: 3D Views
60471/C/LS/442	New Sewage Settling Sump: General Arrangement
60471/C/LS/443	New Sewage Settling Sump: Common Sump and Overflow Weir Layout
60471/C/LS/444	New Sewage Settling Sump: Individual Sumps Plan Layout
60471/C/LS/445	New Sewage Settling Sump: Sections and Details (Sheet 1 of 4)
60471/C/LS/446	New Sewage Settling Sump: Sections and Details (Sheet 2 of 4)
60471/C/LS/447	New Sewage Settling Sump: Sections and Details (Sheet 3 of 4)
60471/C/LS/448	New Sewage Settling Sump: Sections and Details (Sheet 4 of 4)
60471/C/SS/451	Temporary Sludge Stockpile Area: 3D Views
60471/C/SS/453	Temporary Sludge Stockpile Area: Slab Layout, Sections and Details
60471/C/SS/454	Temporary Sludge Stockpile Area: Sections and Details
60471/C/GW/458	Final Effluent Measuring Station: Layout, Sections and Details
<b>F. BUILDING WORK</b>	
60471/B/LI/001	New Inlet Works MCC Building: 3D Views
60471/B/LI/006	New Inlet Works MCC Building: Architectural Layout, Sections & Details
60471/B/LI/008	New Inlet Works MCC Building: Structural Layout, Sections & Details
60471/B/GW/021	Admin & Ablution Buildings: 3D Views
60471/B/GW/023	Admin & Ablution Buildings: New Concrete Works
60471/B/GW/025	Admin & Ablution Buildings: Roof Truss Layout
60471/B/GW/026	Admin & Ablution Buildings: Details of Roof Trusses and Sheeting
60471/B/GW/028	Admin & Ablution Buildings: Elevations
60471/B/GW/029	Admin & Ablution Buildings: Finishes Schedule
60471/B/GW/031	Admin & Ablution Buildings: Entrance Plan and Isometric View
60471/B/GW/032	Admin & Ablution Buildings: Architectural General Arrangement
60471/B/GW/033	Admin & Ablution Buildings: Architectural Ceiling Layout
60471/B/GW/035	Admin & Ablution Buildings: Architectural Demolition Layout Structures
60471/B/GW/036	Admin & Ablution Buildings: Architectural Demolition Layout Fixtures

60471/B/GW/037	Admin & Ablution Buildings: Architectural Demolition Layout Roof and Ceiling
60471/B/GW/038	Admin & Ablution Buildings: Architectural Ablution Fixtures
60471/B/GW/043	Admin & Ablution Buildings: Room Schedules
60471/B/GW/044	Admin & Ablution Buildings: 3D View 2
60471/B/GW/046	Admin & Ablution Buildings: New Walkway Section & Details
60471/B/GW/047	Admin & Ablution Buildings: New Entrance Canopy Layout & Details
60471/B/GW/048	Admin & Ablution Buildings: Flooring Layout
60471/B/GW/055	New Generator Plinth: Layout, Sections & Details
60471/B/GW/065	Second Class Water System: Filter Station, Reservoir and Booster Pump Station 3D Views
60471/B/GW/068	Second Class Water System: Filter Station, Reservoir and Booster Pump Station Layout, Sections and Details (Sheet 1 of 3)
60471/B/GW/069	Second Class Water System: Filter Station, Reservoir and Booster Pump Station Layout, Sections and Details (Sheet 2 of 3)
60471/B/GW/070	Second Class Water System: Filter Station, Reservoir and Booster Pump Station Layout, Sections and Details (Sheet 3 of 3)
60471/B/GW/071	Second Class Water System: Reservoir Layout, Sections and Details
60471/B/GW/072	Second Class Water System: Raw Water Pump Station 3D Views
60471/B/GW/073	Second Class Water System: Raw Water Pump Station Elevation Views
60471/B/GW/074	Second Class Water System: Raw Water Pump Station Layout and Sections
60471/B/GW/075	Second Class Water System: Raw Water Pump Station Details
<b>G. PROCESS INSTRUMENT, PROCESS FLOW, AND MECHANICAL DRAWINGS</b>	
60471/M/GW/001	Existing Process Flow Diagram
60471/M/GW/002	New Process Flow Diagram
60471/M/GW/015	Piping and Instrumentation Diagram: Legend
60471/M/LI/016	Piping and Instrumentation Diagram: New Inlet Works (Sheet 1 of 2)
60471/M/LI/017	Piping and Instrumentation Diagram: New Inlet Works (Sheet 2 of 2)
60471/M/LS/018	Piping and Instrumentation Diagram: Biofilter Pumpstation
60471/M/GW/020	Piping and Instrumentation Diagram: Second Class Water System (Sheet 1 of 2)
60471/M/GW/021	Piping and Instrumentation Diagram: Second Class Water System (Sheet 2 of 2)
60471/M/GW/022	Second Class Water System: Filter Station Mechanical Details
60471/M/GW/023	Second Class Water System: Reservoir Mechanical Details
60471/M/GW/024	Second Class Water System: Booster Pump Station Mechanical Details
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### **C3.2.7 HAZOP STUDY**

The Contractor shall conduct a HAZOP study when the P&IDs and Control Philosophy documents have been finalised.

The Contractor shall employ a suitably experienced and independent consultant approved by the Engineer to lead the study in accordance with generally accepted industry practice. The consultant shall provide a report detailing the findings of the study. The study shall be undertaken at a suitable location (with refreshments and high-speed wifi access) once the Contractor's Piping and Instrumentation Diagrams and Detailed Control Philosophy have been approved by the Engineer for this purpose.

The Contractor's P&IDs shall be modified by the Contractor to reflect the decisions reached.

The Contractor's Representative, the Contractor's mechanical design engineer and the electrical design engineer and system integrator, Contractor's specialist designers and OEM support shall be present for the full duration of the study. Representatives of the Employer responsible for planning, design, maintenance, and operation will also be present.

### **END OF SECTION**

### **C3.3: PROCUREMENT**

#### **STATUS**

In the event of any discrepancy between the Scope of Works and a part or parts of the Specifications, the Bill of Quantities or the Drawings, precedence shall be applied to the Contract as follows:

##### **Civil Works:**

- The Drawings
- The Project Specification
- The Bill of Quantities

##### **Mechanical and Electrical Works:**

- The Technical Datasheets (not applicable to Mechanical Works)
- The Project Specification
- The Bill of Quantities
- The Drawings

#### **C3.3.1 PREFERENTIAL PROCUREMENT**

Tenders will be evaluated in terms of the Municipality's Supply Chain Management Policy. Please refer to Part T1.2: Tender Data for the Preferential Procurement Regulations.

#### **C3.3.2 SUBCONTRACTING**

##### **C3.3.2.1 Scope of mandatory subcontract works**

The Contractor may subcontract portions of the Works included in the Contract. Clause 4.4 of the Conditions of Contract makes provision for subcontracting. The Contractor must also comply with requirements for the civil works as stipulated in the Preferencing Points Claim Schedule in Part T2.2.7 of this document.

Where participation credits are claimed by the Contractor in respect of subcontractors, suppliers, manufacturers and/or service providers, the Contractor shall provide evidence that the subcontractors, suppliers, manufacturers and/or service providers are based locally.

##### **C3.3.2.2 Provisional Sums**

Where Provisional Sums have been included in the Bill of Quantities and the work is to be done by a subcontractor, the procedure to be followed is:

- Where monetary allowances for provisional sums or prime costs items have been allowed and the monetary allowance is less than R300 000, the Contractor shall invite three quotations from suitably qualified subcontractors, etc. for the required scope of works. The selection of the subcontractors, etc. shall be approved by the Engineer.
- Where monetary allowances for provisional sums or prime cost items have been allowed and the monetary allowance is greater than R300 000, an open tender process will be followed in respect of a subcontractor for this work, unless otherwise advised and approved by the Employer. If a tender process is followed, the tender will be issued by the Engineer on behalf of the Contractor.

The quotes shall include full technical descriptions as well as a breakdown of prices, which shall be submitted to the Engineer for approval.

#### **END OF SECTION**

### **C3.4: CONSTRUCTION**

#### **STATUS**

In the event of any discrepancy between the Scope of Works and a part or parts of the Specifications, the Bill of Quantities or the Drawings, precedence shall be applied to the Contract as follows:

##### **Civil Works:**

- The Drawings
- The Project Specification
- The Bill of Quantities

##### **Mechanical and Electrical Works:**

- The Technical Datasheets (not applicable to Mechanical Works)
- The Project Specification
- The Bill of Quantities
- The Drawings

#### **C3.4.1 WORKS SPECIFICATIONS (CIVIL WORKS)**

The standards division of the SABS has changed its name and will henceforth publish standards under the name Standards South Africa.

All existing standards are being re-designated as South African National Standards (SANS). This will eventually result in some numbering changes to the existing standards.

Throughout the contract documents inclusive of the above standardized specifications, the terms Scope of Works and Project Specifications are synonymous.

The work specifications comprise some portions of 1200 Standardized Specifications for civil engineering together with project specific specifications as listed below. The Contractor must obtain his own copy of the 1200 Standardized Specifications. The project specific specifications are bound in this document.

All works under the scope of works shall comply with the Project Specifications and the latest relevant SANS, BS or ISO standards where applicable.

##### **C3.4.1.1 Applicable SANS 1200 Standardized Specifications**

The following SANS 1200 Standardized Specifications for civil engineering construction are applicable:

SANS 1200 A	:	General
SANS 1200 C	:	Site clearance
SANS 1200 D	:	Earthworks
SANS 1200 DB	:	Earthworks (pipe trenches)
SANS 1200 DK	:	Gabions and Pitching
SANS 1200 DM	:	Earthworks (roads, subgrade)
SANS 1200 G	:	Concrete (structural)
SANS 1200 GE	:	Precast Concrete (structural)
SANS 1200 H	:	Structural steelwork
SANS 1200 HB	:	Cladding and sheeting
SANS 1200 HC	:	Corrosion Protection of Structural Steelwork
SANS 1200 L	:	Medium-pressure pipelines
SANS 1200 LB	:	Bedding (pipes)

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SANS 1200 LC	:	Cable ducts
SANS 1200 LD	:	Sewers
SANS 1200 LE	:	Stormwater Drainage
SANS 1200 LG	:	Pipe Jacking
SANS 1200 M	:	Roads
SANS 1200 ME	:	Subbase
SANS 1200 MF	:	Base
SANS 1200 MH	:	Asphalt Base and surfacing
SANS 1200 MJ	:	Segmented Paving
SANS 1200MK	:	Kerbing and channelling
SANS 1200MM	:	Ancillary Roadworks

#### **Other Applicable SANS Standardized Specifications**

SANS 10108	:	The Classification of Hazardous Locations and the Selection of Apparatus for Use in Such Locations
SANS 10140-3	:	Identification Colour Marking: Contents of Pipelines
SANS 10400	:	Building Regulations

The term "project specification" must be replaced by "scope of works" wherever it appears in these standardized specifications.

#### **C3.4.1.2 Variations and Additions to the SANS 1200 Standardized Specifications**

Variations and additions to the following SANS 1200 Standardized Specifications listed in C3.4.1.1 are given in Part C3.7.2 (Variations and Additions to the SANS Standardized Specifications) as follows:

SANS 1200 A	:	General
SANS 1200 C	:	Site clearance
SANS 1200 D	:	Earthworks
SANS 1200 DB	:	Earthworks (pipe trenches)
SANS 1200 DK	:	Gabions and Pitching
SANS 1200 DM	:	Earthworks (roads, subgrade)
SANS 1200 G	:	Concrete (structural)
SANS 1200 H	:	Structural steelwork
SANS 1200 HB	:	Cladding and sheeting
SANS 1200 HC	:	Corrosion Protection of Structural Steelwork
SANS 1200 L	:	Medium-pressure pipelines
SANS 1200 LB	:	Bedding (pipes)
SANS 1200 LC	:	Cable ducts
SANS 1200 LD	:	Sewers
SANS 1200 LE	:	Stormwater Drainage
SANS 1200 M	:	Roads
SANS 1200 ME	:	Subbase
SANS 1200 MH	:	Asphalt Base and Surfacing
SANS 1200 MJ	:	Segmented Paving
SANS 1200 MK	:	Kerbing and channelling
SANS 1200 MM	:	Ancillary Roadworks

#### **C3.4.1.3 Variations and Additions to the SANS 1200 Standardized Specifications**

The following Particular Specifications for work not covered by the SANS 1200 Standardized Specifications are given in Part C3.7.3 (Particular Specifications) as follows:

PDB	:	General Building Work
PF	:	Fencing
PP	:	Glass-Reinforced Plastic (GRP) Pipes, Fittings and Joints
PQ	:	General Corrosion Protection
PHA	:	High Density Polyethylene Pipes
WA	:	Concrete Block Pavements
WL	:	Dry-Laid Concrete Block Retaining Walls
PZ	:	Repair Work to Structural Concrete

## **C3.4.2 SITE ESTABLISHMENT**

### **C3.4.2.1 Services and facilities provided by the Employer**

#### **(a) Water sources**

The responsible water supply authority in the area of the Site is the eThekweni Municipality.

Should the Contractor, in complying with his obligations in terms of subclause C3.4.2.2(b): Water, wish to utilise such water supply, he shall himself be responsible for making his own arrangements with the responsible water supply authority for the supply of all water that he may require from such reticulation network for construction purposes as well as for domestic consumption.

If so, required by the responsible water supply authority, the Contractor shall further be responsible, at his own cost, for making or otherwise providing metered connections to the available services at the positions specified by the water authority, as well as for the removal of such connections on completion of the Contract.

No warranty is offered or given by the Employer that the existing available reticulated water supply will necessarily be adequate for the Contractor's purposes nor that such supply is in any way guaranteed.

All charges as may be levied by the responsible water supply authority in respect of water consumed by the Contractor shall be for the Contractor's account and payment to the Contractor in respect thereof shall, in accordance with the provisions of subclause C3.4.2.2(b), be deemed to be included in the sums tendered by the Contractor for the various Preliminary and General items listed in the Bill of Quantities, as well as in the rates tendered by the Contractor for the various other items listed in the Bill of Quantities which require the consumption of water.

The Contractor shall, when reasonably required by the Engineer, produce documentary proof that all amounts as may have become due and payable by the Contractor to the responsible water authority have been promptly paid in full.

#### **(b) Electricity supply**

The responsible electricity supply authority in the area of the Site is the eThekweni Municipality.

Should the Contractor, in complying with his obligations in terms of subclause C3.4.2.2(c): Electricity, wish to avail himself of such supply, he shall, in accordance with the provisions of

subclause C3.4.2.2(c), and at his own cost, be responsible for making his own arrangements with the responsible electricity supply authority for the supply of all electrical power he may require from such reticulation network for construction purposes as well as for domestic consumption.

The Contractor shall, at his own cost, be responsible for making metered connections to the available services at the positions specified by the electricity supply authority, as well as for the removal of such connections on completion of the Contract. A certificate of compliance (according to SANS 10142-1) shall be produced for the construction distribution board before the electrical supply authority switches on power.

No warranty is offered or given by the Employer that the existing available reticulated electrical power supply will necessarily be adequate for the Contractor's purposes nor that its supply is in any way guaranteed.

All charges as may be levied by the responsible electricity supply authority in respect of electrical power consumed by the Contractor shall be for the Contractor's account and payment to the Contractor in respect thereof shall, in accordance with the provisions of subclause C3.4.2.2(c), be deemed to be included in the sums tendered by the Contractor for the various Preliminary and General items listed in the Bill of Quantities, as well as in the rates tendered by the Contractor for the various other items listed in the Bill of Quantities which require the consumption of electricity.

The Contractor shall, when reasonably required by the Engineer, produce documentary proof that all amounts as may have become due and payable by the Contractor to the responsible electricity supply authority have been promptly paid in full.

(c) Excrement disposal

The responsible sewage disposal authority is the eThekweni Municipality.

Should the Contractor, in complying with his obligations in terms of subclause C3.4.2.2(d): Excrement disposal, wish to avail himself of such facility, he shall, in accordance with the provisions of subclause C3.4.2.2(d), and at his own cost, be responsible for making his own arrangements with the responsible disposal authority, and for making such connections he may require to the available services.

If so, required by the responsible sewage disposal authority, the Contractor shall, at his own cost, be responsible for making connections to the available services at the positions specified by the sewage disposal authority, as well as for the removal of such connections on completion of the Contract.

No warranty is offered or given by the Employer that the existing available reticulated water-borne sewage disposal will necessarily be adequate for the Contractor's purposes nor that its operation is in any way guaranteed.

All charges as may be levied by the responsible sewage disposal authority in respect of the disposal of sewage generated by the Contractor shall be for the Contractor's account and payment to the Contractor in respect thereof shall, in accordance with the provisions of subclause C3.4.2.2(d), be deemed to be included in the sums tendered by the Contractor for the various Preliminary and General items listed in the Bill of Quantities.



The Contractor shall, when reasonably required by the Engineer, produce documentary proof that all amounts that may have become due and payable by the Contractor to the responsible sewage disposal authority have been promptly paid in full.

(d) Area for Contractor's site establishment

A specific area in close proximity to or on the Site of the Works will be made available by the Employer to the Contractor for the Contractor's site establishment. The specific area for the Contractor's site establishment will be identified to the Contractor by the Engineer and the Contractor shall have sole use of such area, free of charge, for the duration of the Contract. The Contractor shall use this area only for the purposes of erecting his site offices, workshops, stores and other facilities required for the execution of the Contract. The Contractor shall not use the area nor allow it to be used for any purposes not directly associated with the execution of the Contract.

The Contractor shall be responsible for arranging, at his own cost, for the provision of all services he may require in the area, as well as elsewhere on the Site.

Should the Contractor deem the area made available by the Employer to be inadequate or unsuitable for the Contractor's particular needs, then the Contractor shall be at liberty to make his own arrangements with the owners of other sites which he considers are better suited to his needs; provided always that the use by the Contractor of any area other than that made available to him by the Employer shall be subject to the prior written approval of the Engineer, which approval shall not be unreasonably withheld; and provided further that the Contractor shall have no claim against the Employer in respect of any costs incurred by him, either directly or indirectly in consequence of utilising any area other than that made available to him by the Employer, and which costs exceed those costs allowed for by the Contractor in his Tender. The approval of any area proposed by the Contractor will be subject to the conditions of the Environmental Authorisation received for the Project.

(e) Spoil Site

A designated area within the construction site boundary shall be allowed for as the spoil site, for disposal of spoil material from bulk and necessary excavations.

### **C3.4.2.2 Facilities to be provided by the Contractor**

(a) Facilities for the Engineer

The Contractor shall provide on the Site, for the duration of the Contract and for the exclusive use of the Engineer and/or his Representative (as applicable), the various facilities described hereunder. All such facilities shall be provided promptly on the commencement of the Contract and failure on the part of the Contractor to provide any facility required in terms of this specification shall constitute grounds for the Engineer to withhold payment of the Contractor's tendered Preliminary and General items until the facility has been provided or restored as the case may be. The facilities shall be provided to cater for the following staff complement:

- 1 x Resident Engineer
- 2 x Assistant Resident Engineer

The facilities shall include the following:

(i) Site Offices

The Contractor shall supply and furnish two air-conditioned “Kwikjack” or similar approved (6m x 3m) site offices, internal size of at least 15 m<sup>2</sup> each, with two toilet facilities for the exclusive use of the Engineer and his staff. The toilet facilities shall have connection to water borne sanitation system, shall comprise two separate facilities (i.e., two toilet facilities), each facility with a toilet, hand wash basin and liquid soap dispenser. One of the toilet facilities shall include a urinal. The Contractor must provide four suitable office desks with lockable drawers, six office chairs, four “Barhold” or similar wall-mounted racks with 6 clamps suitable for hanging A0 sized drawings, electric lighting, air-conditioning (minimum 18,000 BTU for each split unit type), minimum one plug per office (15A each), one kettle, one 100 l (minimum) fridges, a microwave oven (28 l, 900 W minimum), a lockable plan cupboard in each office and windows fitted with blinds, burglar bars and fly screens over the openings, for the exclusive use of the Engineer, Engineer’s Representative and assistant. A wash sink, other than the one provided for ablutions, shall be provided for washing of dishes. A concrete floor will be permitted for the office provided that it is covered with linoleum. The roof and walls should be insulated.

The Engineer, the Engineer’s Representative and assistant shall be allowed free use of all the Contractor’s site facilities.

The Engineer, the Engineer’s Representative and assistant shall be allowed free use of survey equipment and assistants to carry out control work as and when required, and the Contractor shall provide all pegs, concrete, tools and other necessary items as well as all necessary labour for excavation, bush clearing, mixing and placing of concrete, as and when required for the control of the setting out of the Works.

The offices shall have a clean and neat appearance throughout. The Contractor shall arrange for the offices and facilities to be cleaned daily.

(ii) Vehicle for the Engineer

Not applicable / not necessary

(iii) Carports

Four shaded carports (6m x 3m wide), with a free draining, wearing course floor. The roof must be built in such a way that a vehicle will always be shielded against the sun throughout the day.

(iv) Site meeting venue

The Contractor shall provide within his own site establishment facilities, a suitably furnished lockable office or other venue capable of comfortably accommodating a minimum of **eighteen (18)** persons at site meetings. This is to include a large boardroom table with chairs, capable of comfortably seating these persons at site meetings. The table is to be large enough to accommodate these persons and also to display A1 sized drawings. The Contractor shall also provide a projector for this site meeting venue. Projection onto the wall of the inside of this site meeting venue will suffice, if this wall is white. If not, a suitable projector screen will need to

be provided. The boardroom shall be equipped with two split wall air conditioning units (18,000 BTU minimum).

In addition, one tea set comprising 1 kettle, eighteen cups and saucers, eighteen teaspoons, two teapots, one sugar bowl and one milk jug shall be provided for use at these site meetings. The Engineer shall be allowed free use of such venue for conducting any other meetings concerning the Contract at all reasonable times when not in use by the Contractor.

(v) Contract nameboards

The Contractor shall provide, erect and maintain **two (2)** contract nameboard at such a position and location as directed by the Engineer, which nameboard shall, unless otherwise specified elsewhere in the Contract, comply with the recommendations for the standard board of the Consulting Engineers of South Africa, with regard to size, painting, decorating and detail, and the requirements described hereunder.

Each nameboard shall be made of tempered hardboard with a thickness of at least 12 mm, so braced on the reverse side as to prevent warping and shall be mounted on two or more, as necessary, firmly planted poles. The painting of the boards shall comply with the relevant requirements of CKS 193, and the colours of the paints shall be an acceptable match to the applicable colours given in SANS 1091.

Before ordering or manufacturing any contract nameboards, the Contractor shall obtain the Engineer's written approval in respect of all names and wording to appear on such contract nameboards.

The Contractor shall keep the contract nameboards in good state of repair for the duration of the Contract and shall remove them on completion of the Contract.

(vi) Survey equipment and assistants

The Contractor shall, for the duration of the Contract, provide the following survey equipment for the use of the Engineer and his staff:

- 1 x 5 meter tape (Stallion or equivalent);
- 1 x 1 meter spirit level;
- 1 x 100 meter Stilon tape measure, with calibration certificate.

Whenever reasonably required by the Engineer, the Contractor shall make available to the Engineer or his representative, the following additional survey equipment:

- 1 upright reading automatic level with tripod;
- 1 metric levelling staff with protective cover bag;
- 6 ranging rods;
- 1  $\pm$  2 kg hammer;
- 1 tacheometer with tripod;
- 1 survey staff for tacheometer;
- 1 Distomat, complete with tripod and fully charged battery.
- 1 no. 2 m DCP

All such survey equipment provided by the Contractor shall be in good condition, properly

calibrated and fit for the purpose and shall be kept fully serviceable at all times by the Contractor at his own cost. The Contractor shall have any defective equipment repaired or replaced at his own cost within 12 hours after notification by the Engineer's staff.

Where required by the Engineer, the Contractor shall at his own cost, promptly arrange for the recalibration of survey equipment provided.

The Contractor shall, in accordance with the requirements of subclause 5.5 of SANS 1200 AB, make available to the Engineer, two (2) survey assistants.

(vii) Telephone facilities

The Contractor shall, for the duration of the Contract, provide the following telephone facilities as specified hereunder, for the exclusive use of the Engineer and his staff:

Telkom Telephones:

Not applicable / not necessary

Cellular Telephones:

The Engineer, Engineer's Representative and assistant will make use of their own cellular telephone on site. Monthly itemized statements will be submitted to the Contractor showing the cost of project related calls for which the Contractor shall reimburse the Engineer, Engineer's Representative and assistant by a method agreed to be appropriate by both parties. The Contractor shall attach the itemized statements to the monthly payment certificate and be reimbursed the cost of the cellular calls.

(viii) Computer facilities

The Contractor shall, for the duration of the Contract, provide the computer equipment together with the software specified hereunder, for the exclusive use of the Engineer and his staff:

- 3 x Dell laptop computers (see hardware specs below)
- 1 x Color Printer with Scanner (including A3 and double sided printing capability) with WIFI/Bluetooth connectivity functionality
- 3 x 23 inch LCD widescreen monitors

Printers shall, unless otherwise approved by the Engineer, be Hewlett-Packard 600 Series DeskJet printers or equivalent compatible. The printer shall be of the 3-in-1 type to perform scanning of documents with a "scan to email" facility, capable of scanning A3 size.

The Laptop Computers shall comply with the following minimum specifications:

- Dell Laptop
- INTEL Core i7 with NVIDIA graphics
- 15.6"HD Widescreen
- NVIDIA Quadro/RTX GPU
- 32 Gigabytes (GB) RAM
- Minimum 500GB available storage
- Carrying case included

- Wireless mouse included

All computer hardware shall be provided complete with the requisite connecting cables and all interfacing devices and software necessary for its efficient operation as an integral system.

The following software shall be properly installed on the computer, and the original license agreements and disks shall be provided to the Engineer for safekeeping:

- Microsoft Windows 11
- MS-Office 365 Professional Plus
- Minimum of 50Mbit/s internet connection (download and upload) with unlimited data per month package (fibre connection), dedicated to the Employer's Staff with no shared connection to the Contractor's Staff)

All computer equipment provided shall be kept fully serviceable at all times by the Contractor. The Contractor shall have any defective equipment repaired or replaced at his own cost within 12 hours after notification by the Engineer's staff. The Contractor shall insure the laptop computers comprehensively, especially against theft (both on-site and off-site).

The computer equipment will revert to the Contractor at the end of the Contract.

(ix) Fax facilities

Not applicable/not necessary.

(x) Electricity supply for the Engineer

All electricity supply to the Engineer's office(s) and laboratory (if applicable), whether provided by the Contractor by way of a reticulated supply from a local authority or other authorised electricity supply, or by way of on-site generators, shall be regulated by the Contractor to within limits such as to prevent damage due to fluctuations in the electrical current supply that may occur to any electrical plant and equipment provided by the Contractor or the Engineer.

The Contractor shall be liable for and pay to the Engineer on demand, all costs that the Engineer may incur in the repair or replacement of any electrical equipment provided by the Engineer on the Site. Reliance by the Contractor on the regulation of the electrical supply by the supplier or on current regulators fitted to generators shall not absolve the Contractor of his liabilities in terms of this subclause and, where appropriate, the Contractor shall provide and install at his own cost, all such electrical current-regulating equipment as is necessary to prevent damage to the said equipment.

(xi) Site Instruction Book

The Contractor shall keep a triplicate book for site instructions on the Site at all times.

(b) Water

The Contractor shall, at his own expense, be responsible for obtaining and distributing all water as may be required for the purposes of executing the Contract, including water for both construction purposes and domestic use, as well as for making all arrangements in connection therewith. The Contractor shall further, at his own expense, be responsible for providing all necessities for procuring, storing, transporting and applying water required for the execution of the Contract, including but not limited to all piping, valves, tanks, pumps, meters and other plant and equipment, as well as for all work and superintendence associated therewith.

The sources of all water utilised for the purposes of the Contract shall be subject to the prior approval of the Engineer, which approval shall not be unreasonably withheld.

The Contractor shall comply with all prevailing legislation in respect of drawing water from natural and other sources and shall, when required by the Engineer, produce proof of such compliance. The distribution of water shall be carried out by the Contractor strictly in accordance with the applicable laws and regulations.

All water provided by the Contractor for construction purposes shall be clean, free from undesirable concentrations of deleterious salts and other materials and shall comply with any further relevant specifications of the Contract. The Contractor shall, whenever reasonably required by the Engineer, produce test results demonstrating such compliance. Water provided by the Contractor for human consumption shall be healthy and potable to the satisfaction of the health authorities in the area of the Site.

No separate payment will be made to the Contractor for the obtainment, distribution and consumption of water, the costs of which will be deemed to be included in the Contractor's tendered rates.

(c) Electricity

The Contractor shall, at his own expense, be responsible for obtaining and distributing all electricity as he may require for the purposes of executing the Contract, including electricity for both construction purposes and domestic use, as well as for making all arrangements in connection therewith.

The distribution of electricity shall be carried out by the Contractor strictly in accordance with the applicable laws and regulations.

No separate payment will be made to the Contractor for the obtainment, distribution and consumption of electricity, the costs of which will be deemed to be in the Contractor's tendered rates and prices.

As part of the operation and training portion of the Contract, the Contractor may use the Employer's existing electricity supply and shall not be charged for reasonable use for the execution of tasks that fall under this Contract.

(d) Excrement disposal

The Contractor shall, at his own expense, be responsible for safely and hygienically dealing with and disposing of all human excrement and similar matter generated on the Site during the course of the Contract, to the satisfaction of the Engineer and the responsible health authorities in the area of the Site.

The Contractor shall further comply with any other requirements in this regard as may be stated in the Contract.

No separate payment will be made to the Contractor in respect of discharging his obligations in terms of this subclause and the costs thereof shall be deemed to be included within the Contractor's tendered Preliminary and General Items.

As part of the operation and training portion of the Contract, the Contractor may make use of the Employer's existing sanitation facilities. The Contractor shall ensure his personnel maintain these facilities in a good condition and shall always adhere to acceptable hygienic standards. The Employer shall reserve the right to revoke access to these facilities for the Contractor's personnel should they fail to adhere to acceptable hygienic standards. Should access to sanitary facilities be revoked, the Contractor shall make alternate arrangements for sanitary use by his workmen.

(e) Security

The Contractor may be exposed to criminal actions, including theft and vandalism, and shall make the necessary security arrangements for the duration of the Contract. The Contractor shall, as a minimum, enclose the entire camp with a security fence. The Contractor shall remove the fencing and shall rehabilitate the camp site areas on completion of the Contract.

**C3.4.2.3 Permits and wayleaves**

The Contractor shall be responsible for obtaining all of the necessary wayleaves, permissions or permits applicable to working near any existing services or other infrastructure on Site and shall abide by the safety conditions imposed by such wayleaves, permissions or permits.

The Contractor shall ensure that all wayleaves, permissions and permits are kept on site and are available for inspection by the relevant service authorities on demand.

The Contractor shall also ensure that any wayleaves in respect of electricity services are renewed timeously every three months.

**C3.4.2.4 Features requiring special attention**

(a) Site maintenance

During progress of the work and upon completion thereof, the Site of the Works shall be kept and left in a clean and orderly condition. The Contractor shall store materials and equipment for which he is responsible in an orderly manner and shall keep the Site free from debris and obstructions.

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(b) Testing and quality control (Civil Works)

(i) Contractor to engage services of an independent laboratory

Notwithstanding the requirements of the Specifications pertaining to testing and quality control, the Contractor shall engage the services of an approved independent laboratory to undertake all testing of materials, the results of which are specified in, or may reasonably be inferred from, the Contract. These results will be taken into consideration by the Engineer in deciding whether the quality of materials utilized and workmanship achieved by the Contractor comply with the requirements of the Specifications. The foregoing shall apply irrespective of whether the specifications indicate that the said testing is to be carried out by the Engineer or by the Contractor.

The Contractor shall be responsible for arranging with the independent testing laboratory for the timeous carrying out of all such testing specified in the Contract, at not less than the frequencies and in the manner specified. The Contractor shall promptly provide the Engineer with copies of the results of all such testing carried out by the independent laboratory.

For the purposes of this clause, an "independent laboratory" shall mean an "approved laboratory" (as defined in SANS 1200, General, subclause PSA 7.2) which is not under the management or control of the Contractor and in which the Contractor has no financial interest, nor which has any control or financial interest in the Contractor.

(ii) Additional testing required by the Engineer

In addition to the provisions of subclause C3.4.2.4(b)(i): Contractor to engage services of an independent laboratory, the Engineer shall be entitled at times during the Contract to require that the Contractor arrange with the independent laboratory to carry out any such tests, additional to those described in subclause C3.4.2.4(b)(i), at such times and at such locations in the Works as the Engineer shall prescribe. The Contractor shall promptly and without delay arrange with the independent laboratory for carrying out all such additional testing as required by the Engineer, and copies of the test results shall be promptly submitted to the Engineer.

(iii) Costs of testing

(a) Tests in terms of subclause C3.4.2.4(b)(i)

The costs of all testing carried out by the independent laboratory in accordance with the requirements of subclause C3.4.2.4(b)(i), above shall be borne by the Contractor and shall be deemed to be included in the tendered rates and prices for the respective items of work as listed in the Bill of Quantities and which require testing in terms of the Specifications. No separate payments will be made by the Employer to the Contractor in respect of any testing carried out in terms of subclause C3.4.2.4(b)(i).

Where, as a result of the consistency of the materials varying or as a result of failure to meet the required specifications for the work, it becomes necessary to carry out additional tests (e.g. re-tests on rectified work and/or



replacement materials), the costs of such additional testing shall be for the Contractor's account.

(b) Additional tests required by the Engineer

The costs of any additional tests required by the Engineer in terms of subclause C3.4.2.4(b)(i): Additional testing required by the Engineer, shall be reimbursed to the Contractor against substitution of the Provisional Sum allowed therefore in the Bill of Quantities; provided always that the costs of any such additional tests ordered by the Engineer, the results of which indicate that the quality of the materials utilised and/or the standard of workmanship achieved are/is not in accordance with the specifications, shall not be reimbursable to the Contractor.

(c) Subcontractors

All matters pertaining to subcontractors (including Nominated Subcontractors) and the work executed by them shall be dealt with directly between the Engineer and the Contractor in the context of all subcontract work being an integral part of the Works for which the Contractor is responsible.

The Engineer will not liaise directly with any subcontractors, nor will he issue instructions concerning the subcontract works directly to any subcontractor.

All matters arising from the subcontract agreements shall be dealt with directly between the Contractor and the subcontractors and the Engineer will not become involved.

Any issues related to payments, programming, workmanship, etc. shall be the concern of the Contractor and the Subcontractor, and the Engineer will not be involved.

(d) Opening up and closing down of designated borrow pits

Measurement and payment for opening up and closing down designated borrow pits, including removing and stockpiling overburden and restoring the Site, shall be made under item 8.3.4(b) of SANS 1200 D. This item applies to all borrow material required under this Contract.

The requirements of subclause 5.2.2.2 of SANS 1200 D regarding the opening up, maintenance and closing down of borrow pits shall be adhered to.

(e) Access to properties

The Contractor shall organise the work to cause the least possible inconvenience to the public and to the property owners adjacent to or affected by the work, and except as hereunder provided, shall at all times provide and allow pedestrian and vehicular access to properties within or adjoining or affected by the area in which he is working.

If, as a result of restricted road reserve widths and the nature of the work, the construction of bypasses is not feasible, construction shall be carried out under traffic conditions to provide access to erven and properties.

Notwithstanding the aforementioned, the Contractor may, with the prior approval of the Engineer (which approval shall not be unreasonably withheld), make arrangements with and obtain the acceptance of the occupiers of erven and properties to close off part of a street, road, footpath or entrance temporarily, provided that the Contractor duly notifies the occupiers of the intended closure and its probable duration, and reopens the route as punctually as possible. Where possible, such streets, roads, footpaths and entrances shall be made safe and reopened to traffic overnight. Such closure shall not absolve the Contractor from his obligations under the Contract to provide access at all times. Barricades, traffic signs, drums and other safety measures appropriate to the circumstances shall be provided by the Contractor to suit the specific conditions.

(f) Employment of local labour (Civil Works)

It is the intention that this Contract should make maximum use of the local labour force that is presently under-employed, specifically for the civil scope of the works. To this end the Contractor shall limit the utilisation on the Contract of non-local employees to that of key personnel only and to employ and train local labour to the extent necessary for the execution and completion of this Contract.

The Contractor shall complete the forms for key personnel in the Returnable Documents to be completed by the Tenderer. That data stated in the above mentioned form will be strictly monitored during the Contract period and any deviations therefrom shall be subject to the prior approval of the Engineer, which approval shall not be unreasonably withheld.

(g) Monthly statements and payment certificates

The statement to be submitted by the Contractor in terms of Clause 6.10.1 of the Conditions of Contract shall be prepared by the Contractor at his own cost, strictly in accordance with the standard payment certificate prescribed by the Engineer, in digital electronic computer format. The Contractor shall submit to the Engineer the digital electronic computer file of the statement.

For the purposes of the Engineer's payment certificate, the Contractor shall subsequently be responsible, at his own cost, for making such adjustments to his statement as may be required by the Engineer for the purposes of accurately reflecting the actual quantities and amounts which the Engineer deems to be due and payable to the Contractor in the payment certificate.

The Contractor shall, at his own cost, make the said adjustments to the statement and return it to the Engineer within three (3) normal working days from the date on which the Engineer communicated to the Contractor the adjustments required. The Contractor shall submit to the Engineer the electronic digital computer file which includes the adjusted statement.

(h) Construction in restricted areas

Working space on the site of works is restricted. The construction method used in these restricted areas largely depends on the Contractor's Plant. Notwithstanding, measurement and payment will be strictly according to the specified cross-sections and dimensions irrespective of the method used, and the rates and prices tendered will be deemed to include full compensation for any difficulties encountered by the Contractor while working in restricted areas. Neither extra payment nor any claim for payment due to these difficulties will be considered.

(i) Notices, signs, barricades and advertisements

All notices, signs and barricades, as well as advertisements, may be used only if approved by the Engineer. The Contractor shall be responsible for their supply, erection, maintenance and ultimate removal and shall make provision for this in his tendered rates.

The Engineer shall have the right to instruct the Contractor to move any sign, notice or advertisement to another position, or to remove it from the Site of the Works if in his opinion it is unsatisfactory, inconvenient or dangerous.

(j) Workmanship and quality control

The onus to produce work that conforms in quality and accuracy of detail to the requirements of the Specifications and Drawings rests with the Contractor in accordance with the Conditions of Contract, and the Contractor shall, at his own expense, institute a quality control system and provide suitably qualified and experienced engineers, foremen, surveyors, materials technicians, other technicians and technical staff, together with all transport, instruments and equipment to ensure adequate supervision and positive control of the Works at all times.

The cost of supervision and process control, including testing carried out by the Contractor, will be deemed to be included in the rates tendered for the related items of work.

The Contractor's attention is drawn to the provisions of the various Standardized Specifications regarding the minimum frequency of testing required. The Contractor shall, at his own discretion, increase this frequency where necessary to ensure adequate control.

(k) Dealing with Water

On completion and submission of every part of the work to the Engineer for examination and measurement, the Contractor shall furnish the Engineer with the results of the relevant tests, measurements and levels to demonstrate the achievement of compliance with the Specifications.

The Contractor shall deal with water on the Site so that the Works are kept sufficiently dry for their proper execution. The Contractor shall:

- a) Prevent flooding of the Works and by the Works
- b) Keep all completed Works properly drained
- c) Not inhibit surface drainage
- d) Manage and dispose of water, which shall include for by-pass arrangements, temporary earthworks, cofferdams, pumping equipment, well-pointing, de-watering equipment etc., and for dealing with all possible flows whether or not the existing flow path is being interfered with during construction
- e) Note that the Contractor under this contract shall be responsible for dewatering of the tanks during installation of mechanical equipment.

The onus to produce work that conforms in quality and accuracy of detail to the requirements of the Specifications and Drawings rests with the Contractor, and the Contractor shall, at his own expense, institute a quality control system and provide suitably qualified and experienced.

**C3.4.2.5 Extension of time due to abnormal rainfall**

“Extension of time due to abnormal rainfall will be calculated in accordance with Clause 5.12.2.2 of the Conditions of Contract.”

**C3.4.3 PLANT AND MATERIALS****C3.4.3.1 Extension of time due to abnormal rainfall**

The Employer shall not supply any plant or materials.

**C3.4.3.2 Materials, samples and shop drawings****(a) Samples**

Materials or work which does not conform to the approved samples submitted in terms of Sub-clause 7.4.1 of the Conditions of Contract will be rejected. The Engineer reserves the right to submit samples to tests to ensure that the material represented by the sample meets the specification requirements.

The costs of any such tests conducted by or on behalf of the Engineer, the results of which indicate that the samples provided by the Contractor do not conform to the requirements of the Contract, shall, in accordance with the provisions of Sub-clause 7.4.4 of the Conditions of Contract, be for the Contractor's account.

**C3.4.4 CONSTRUCTION EQUIPMENT****C3.4.4.1 Requirements for equipment**

The Contractor shall supply all the plant and equipment required and all plant and equipment shall comply with the requirements as stipulated in the Environmental and Occupational Health and Safety Act and the Construction Regulation Act (2014).

**C3.4.4.2 Equipment provided by the Employer**

The Employer shall not supply any plant, material or equipment.

**C3.4.5 EXISTING SERVICES****C3.4.5.1 Known services**

All known existing services are indicated on the drawings (including potable water, irrigation, washwater, sewer pipelines etc.). The Contractor shall be responsible for confirming the location and be responsible for uncovering and protecting services where required. The Contractor shall inform the Engineer immediately if services other than those shown on the drawings are detected.

**C3.4.5.2 Treatment of existing services**

Refer to SANS 1200 A.

**C3.4.5.3 Prevention of contamination of existing works**

Refer to SANS 1200 A.

**C3.4.5.4 Damage to services**

Refer to SANS 1200 A. The Contractor shall repair or arrange to immediately repair any damage to the existing services at his own cost if the damage was caused by the Contractor during the construction process.

**C3.4.5.5 Reinstatement of services and structures damaged during construction**

Refer to SANS 1200 A. The Contractor shall immediately inform the Engineer of any damage to existing services or structures.

**C3.4.6 SITE USAGE AND DEMARCATED WORKING AREAS**

Access to demarcated working areas shall be limited to the Contractor and his personnel. The Contractor shall be responsible to control unauthorized entry to these areas and shall inform the Engineer of any breach of such rules. The site shall be managed and used for its intended purpose.

It must further be noted that when the Isipingo WWTW is under construction and since it is an operational facility, it must perform satisfactory in terms of its effluent standards and the Employer's employees shall require access to all parts of the treatment works for normal or emergency duties and work.

**C3.4.7 OTHER CONTRACTORS**

As discussed in Clause C3.1.8 in Part C3.1 (Description of Works), other contractors are not expected to be present on site during the period of the Contract.

**C3.4.8 CONSTRUCTION RESTRICTIONS, DEMOLITION AND DIVERSION WORKS**

The Contract will be subject to construction restrictions. The aforementioned will need to be considered for programming and planning requirements as stipulated in Clause C3.5.1 (Part C3.5: Management) of this Contract Document.

The Works must at all times during the construction of the Contract, remain operational in such a way so as to at least achieve the treatment performance currently achieved by the existing Works before construction began. This means that an existing process unit (or equipment associated with the process unit) in a treatment step can only be taken offline if that treatment step is not taken offline completely, permanently or with irreversible effects. Guidance from the Engineer can be sought in this respect. Further, where such works is programmed, the Contractor will be required to submit a Method Statement to the Engineer for approval.

Furthermore, once new equipment and process units are brought into operation to replace existing equipment or process units, the new equipment and/or process units may need to remain operation to ensure treatment. Due to the nature of a wastewater treatment plant, it may be necessary to commission equipment/process units at different stages to achieve the development of the treatment process and its parameters. As such, it is noted that the Contractor should expect that

the commissioning of equipment/process units will not occur simultaneously, and that equipment/process unit will be in operation prior to the rest of the works. This does not constitute the Employer taking over the works and the works must be complete in its entirety and the treatment process (including all the necessary ancillaries) operational prior to the Employer taking over.

#### **C3.4.8.1 Demolition Works/Decommissioning Works**

Demolition works/Decommissioning Works (including the removal of existing mechanical and electrical equipment where applicable) will be undertaken as follows and is subject to the construction restrictions as tabulated in the table under item C3.4.8.3 below:

- a) Demolish sections of the existing incoming sewer channel (where the new inlet works will be constructed).
- b) Decommissioning and removal of existing inlet works equipment (e.g. manual coarse screens)
- c) Ancillary items: Demolish relevant items such as lengths of road, existing stormwater, overflow structures, etc.

#### **C3.4.8.2 Diversion Works**

Diversion Works will be undertaken as follows and is subject to the construction restrictions as tabulated in the table under item C3.4.8.3 below:

- a) Incoming raw sewage is to be diverted upstream of the new inlet works to the existing inlet works via the new overflow chamber, new overflow pipe and a diversion chamber.
- b) Incoming sewer main pipe daylighting in the channel upstream of existing inlet works is to be relocated in the channel upstream of the new inlet works.
- c) Diversion of existing on-site sewerage from temporary municipal offices to existing inlet works.
- d) Diversion of existing on-site sewerage from existing administration building and ablution block to a location upstream of the new inlet works.
- e) Diversion of existing unknown pipe crossing existing raw sewage incoming channel to the outside of the construction footprint in areas as required.
- f) Diversion of existing fiber cement pipe from existing humus pumpstation to the existing inlet works to the outside of the construction footprint in areas as required.
- g) Other existing services not shown on drawings (existing electrical cables, mini-sub, irrigation pipelines, process pipeline and rising mains) to be diverted or relocated when causing restrictions in construction areas. Guidance from the Employer's Agent can be sought in this respect. Further, where such works is programmed, the Contractor will be required to submit a Method Statement to the Employer's Agent for approval.

#### **C3.4.8.3 Construction Restrictions**

The Contract will be subject to construction restrictions. The aforementioned will need to be considered for programming and planning requirements as stipulated in Clause C3.5.1 (Part C3.5:

Management) of this Contract Document. The Works must at all times during the construction of the Contract, remain operational in such a way to at least achieve the treatment performance currently achieved by the existing Works before construction began. This means that an existing process unit (or equipment associated with the process unit) in a treatment step can only be taken offline once the new process unit/structure is commissioned. Guidance from the Engineer can be sought in this respect. Further, where such works is programmed, the Contractor will be required to submit a Method Statement to the Engineer for approval.

The Contractor is to note the following construction restrictions for the respective process units:

PROCESS UNITS	CONSTRUCTION RESTRICTION
Decommissioning of existing inlet works	New inlet works to be commissioned as well as diversion of unknown sewer pipe at the existing inlet works channel
Construction of new inlet works	Construction of new overflow chamber, new overflow pipe, and a diversion chamber and diversion of existing unknown pipe crossing existing raw sewage incoming channel
Refurbishment of administration building	Temporary accommodation and ablution facilities for municipal staff must be provided prior to work commencing and relevant diversion works
Refurbishment of biofilter pumpstation and ablution block	
Modifications to existing maturation ponds	Lowering water level of maturation ponds
Lowering water level of maturation ponds	Refurbishment of existing final overflow weir to take place simultaneously during suction pipe installation at the raw water pumpstation

**END OF SECTION**

### **C3.5: MANAGEMENT**

#### **STATUS**

In the event of any discrepancy between the Scope of Works and a part or parts of the Specifications, the Bill of Quantities or the Drawings, precedence shall be applied to the Contract as follows:

##### **Civil Works:**

- The Drawings
- The Project Specification
- The Bill of Quantities

##### **Mechanical and Electrical Works:**

- The Technical Datasheets (not applicable to Mechanical Works)
- The Project Specification
- The Bill of Quantities
- The Drawings

#### **C3.5.1 PROGRAMMING AND PLANNING**

The Construction Programme to be submitted to the Engineer, within 14 days from the commencement date, by the Contractor shall meet the following requirements:

- (a) Be in the form of a bar chart/Gantt chart
- (b) Clearly indicate the start and end dates and duration of all construction activities and identify the critical path.
- (c) Take full cognizance of all the Contractor's risks and obligations in terms of the Contract.
- (d) Indicate key dates in respect of work to be carried out by others.
- (e) Indicate key dates in respect of information to be provided by the Engineer and/or others.

The said Programme and all revisions thereto shall also be provided to the Engineer in electronic format using MS PROJECT software.

The programme shall be updated monthly during the contract period. In addition to the above, a monthly cash flow forecast shall also be submitted to the Engineer.

The Contractor must plan his works and order of work to allow the existing WWTW to operate satisfactorily. **The Construction Restrictions, Demolition and Diversion Works requirements listed in part C3.4.8 must be taken into account in the Programme provided by the Contractor.**

When drawing up his programme, the Contractor shall, take into consideration and make allowance for, inter alia:

- (a) Expected weather conditions and their effects,
- (b) Known physical conditions or artificial obstructions
- (c) Searching for, dealing with and carrying out alterations to the existing services
- (d) Relocation and/or diverting of existing services
- (e) The accommodation of public access and traffic
- (f) The provision and implementation of the health and safety plan in terms of the Construction Regulations, 2014 of the Occupational Health and Safety Act
- (g) Commissioning and making live the new power supply MV system to site, before mechanical and process equipment can be tested (if required).



- (h) Temporary power supply

The following key dates shall apply:

- (a) It is anticipated that the Contract will be awarded within 12 weeks of the tender closing date.
- (b) It is anticipated that the instruction for Commencement of the Works will be within 30 days of the Commencement date as per Clause 5.3.1 of the General Conditions of Contract.
- (c) Handover of the admin building to the Employer for use shall take place 8 months after the commencement date.
- (d) The Contractor shall complete the entire Works within the period stated in C1.2: Contract, Clause 1.1.1.14 as follows:
  - The time for achieving Practical Completion as per Clause 5.3.1 of the Conditions of Contract and inclusive of non-working days referred to in Clause 5.8.1 of the Conditions of Contract and inclusive of special non-working days.

### **C3.5.2 CONTRACTOR'S RESPONSIBILITY IN TERMS OF THE OHS ACT**

The Contractor shall be responsible for complying with the Occupational Health and Safety Act, Act 85 of 1993, and specifically the Construction Regulations 2014 issued in terms of Section 43 of the Act (GNR 84 of 10 February 2014).

The Contractor is referred to Part T1.2 Tender Data and the Health and Safety Specification and the Environmental Management Specification (see C3.6) in this regard.

### **C3.5.3 WORKS NOT TO INTERFERE**

The Contractor is to take cognizance of the fact that the proposed site for the Works is located in close proximity to the industrial area and within the existing WWTW. The Contractor shall ensure that the Works do not affect operations of the aforementioned facilities.

The Contractor is to take cognizance of the fact that the Works is to remain operational during construction and interference with the existing process must be kept to a minimum. The Contractor is also alerted to construction activities on the Works by others. The Contractor shall ensure that:

- (a) The Contractor's site staff shall cooperate with the Employer's staff and other Contractor's and their staff.
- (b) The Employer's rules and requirements for operations are adhered to.
- (c) Site staff is familiar with and comply with the Employer's emergency procedures.
- (d) Activities of the Site staff do not adversely affect the health and safety of the Employer's staff once the Works is put into operation.

### **C3.5.5 UNAUTHORIZED PERSONS**

The Contractor shall keep unauthorized persons from the Works at all times.

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**C3.5.6 MANAGEMENT MEETINGS****C3.5.6.1 Technical Meetings**

Technical meetings shall be held on an monthly basis.

The Contractor shall arrange for the Contractor's project manager and the Contractor's Technical Supervisor to attend these meetings. The Contractor shall also arrange for the Technical Inspector to attend.

The Engineer or his authorized representative will make notes of the decisions taken and hand these to the Contractor within five (5) working days. The Contractor shall attend to these items and shall provide all present with copies of the notes within one working day.

**C3.5.6.2 Site Meetings**

Site meetings shall be held monthly. The Contractor shall arrange for the Contractor's Representative to be present at these meetings. The Contractor shall submit a progress report within 3 days of the next site meeting which shall include but not limited to: updated cashflow, updated programme as contemplated in Clause 5.7.1 (Conditions of Contract), whether or not any progress of the Works has fallen behind programme, including showing percentage complete.

The Engineer will take minutes of these meetings and distribute these to all relevant parties at least one (1) week prior to the next site meeting.

**C3.5.6.3 Health and Safety Meetings**

Health and Safety Meetings shall be held monthly to take place together with the monthly site meetings.

**C3.5.6.4 HAZOP Meeting**

HAZOP Meeting will be called by the Contractor at the commencement of the Contract and prior to installation of mechanical and electrical equipment.

**C3.5.6.5 Defects Notification Period**

The Contractor shall attend meetings during the Defects Liability Period called by the Engineer.

**C3.5.7 KEY PERSONNEL**

The Contractor shall provide a schedule of key personnel, with contact particulars and experience. Please refer to Returnable Schedule T2.2.21 and the Organogram required therein.

**C3.5.8 HEALTH AND SAFETY****C3.5.8.1 Health and safety requirements and procedures**

The Contractor shall be responsible for complying with the Occupational Health and Safety Act, Act 85 of 1993, and specifically the Construction Regulations 2014 issued in terms of Section 43 of the Act (GNR 84 of 10 February 2014).

The Contractor is referred to Part C3.6 Occupational Health and Safety Specification in this regard. Health and Safety Specification is attached hereto, the following shall apply.

- (i) The Contractor undertakes to acquaint the appropriate officials and employees of the Contractor with all relevant provisions of the Act and the Regulations promulgated in terms of the Act.
- (ii) The Contractor undertakes that all relevant duties, obligations and prohibitions imposed in terms of the Act and Regulations on the Contractor will be fully complied with.
- (iii) The Contractor accepts sole liability for such due compliance with the relevant duties, obligations and prohibitions imposed by the Act and Regulations and expressly absolves the Employer from himself being obliged to comply with any of the aforesaid duties, obligations and prohibitions, with the exception of such duties, obligations and prohibitions expressly assigned to the Employer in terms of the Act and its associated Regulations.
- (iv) The Contractor agrees that any duly authorised officials of the Employer shall be entitled, although not obliged, to take such steps as may be necessary to monitor that the Contractor has conformed to his undertakings as described in paragraphs (i) and (ii) above, which steps may include, but will not be limited to, the right to inspect any appropriate site or premises occupied by the Contractor, or any appropriate records or safety plans held by the Contractor.
- (v) The Contractor shall be obliged to report forthwith to the Employer and Engineer any investigation, complaint or criminal charge which may arise as a consequence of the provisions of the Act and Regulations, pursuant to work performed in terms of this Contract, and shall, on written demand, provide full details in writing, to the Employer and Engineer, of such investigation, complaint or criminal charge.
- (vi) The Contractor shall furthermore, in compliance with Constructional Regulations 2014 (Government Gazette 37305 and Regulation Gazette 10113 of 7 February 2014) to the Act acquaint himself with the requirements of the Employer's health and safety specification as laid down in regulation 4(1)(a) of the Construction Regulation 2014, and prepare a suitably and sufficiently documented health and safety plan as contemplated in regulation 7(1)(a) of the Construction Regulation 2014 for approval by the Employer or his assigned agent. The Contractor's health and safety plan and risk assessment shall be submitted for approval, to the Employer or his agent, within 14 days of the Commencement Date and shall be implemented and maintained from the commencement of the Works.

The Contractor shall at all times be responsible for full compliance with the approved plan as well as with the Construction Regulations and no extension of time will be considered for delays due to non-compliance with the abovementioned plan or regulations.

- (vii) The Employer, or his assigned agent, reserves the right to conduct periodic audits, as contemplated in the Construction Regulations 2014, to monitor that the Contractor is compliant in respect of his obligations. Failure by the Contractor to comply with the requirements of these Regulations shall entitle the Engineer, at the request of the Employer or his agent, to suspend all or any part of the Works, with no recourse whatsoever by the Contractor for any damages incurred as a result of such suspension, until such time that the Employer or his agents are satisfied that the issues in which the Contractor has been in default have been rectified.

- (viii) The proposed type of work, materials to be used and potential hazards likely to be encountered on this Contract are detailed in the Parts C3.4 and C3.5, the Bill of Quantities, the Drawings, and in the Employers' health and safety specification (regulation 5(1)(b) of the Construction Regulations 2014), which is contained in the Particular Specifications.

Payment items are included in the Bill of Quantities to cover the Contractor's cost for compliance with the OHS Act and the abovementioned regulations.

#### **C3.5.8.2 Health and Safety Plan**

Without limiting his obligations and liabilities in terms of the Construction Regulations, 2014 of the OHS Act, the Contractor, in his Health and Safety Plan to be submitted in terms of the Contract Data, shall inter alia deal with the safety provisions he will set up in respect of the aspects specified in the Specifications.

The Health and Safety Plan shall be neatly set out in a lever-arch type file, with labelled dividers for each section.

A copy of the approved Health and Safety Plan shall be kept on Site and made available upon request.

#### **C3.5.8.3 Protection of the public and Employer's staff**

The Contractor shall at all times ensure that his operations do not endanger any member of the public, or the Employer's staff.

Open excavations and other hazardous conditions on site shall be barricaded and precautions shall be taken to protect the public from the same in terms of the OHS Act.

As the Works are on operating pump station sites, the Contractor shall take special precautions to prevent access to any danger areas on the Works, e.g. by temporary barricades, notices and/or fencing.

The Contractor shall direct, control, facilitate and safeguard all pedestrian traffic during construction of the Works, provide all notices, and arrange for watching and lighting in accordance with the requirements of the relevant authorities.

#### **C3.5.8.4 Excavations**

Without limiting his responsibility for the safety of his workers in any excavation, the Contractor shall ensure the safety of his workers in trenches and excavations deeper than 1,0 m. in terms of the provisions of the OHS Act. The Contractor may choose to batter excavations to a safe slope if sufficient space is available or adequately shore the excavations.

#### **C3.5.8.5 Working and entering confined spaces**

Confined space is defined in the Occupational Health and Safety Act, Act 85, 1993, as an enclosed, restricted, or limited space in which, because of its construction, location or contents, or any work activity carried on therein, a hazardous substance may accumulate or an oxygen-deficient atmosphere may occur, and includes any chamber, tunnel, pipe, pit, sewer, container, valve, pump, sump, or similar construction, equipment, machinery or object in which a dangerous

liquid or dangerous concentration of gas, vapour, dust or fumes may be present.

(a) Hazardous conditions in confined spaces could be identified as:

*Hazardous atmosphere:*

- Too little or too much Oxygen (too little can cause brain damage and cause the heart to stop and too much increases the risk of fire or explosion)
- Presence of Toxic gases
- Liquids or solids inside the confined space. Liquids may produce hazardous atmosphere when it evaporates e.g. fuel
- Type of work done inside the confined space. Activities can lead to the release of harmful substances e.g. grinding, descaling etc.
- Contamination from outside/adjacent sources. A contaminant could enter the confined space through porous walls, communicating openings e.g. sewers

*Explosive atmospheres:*

- High concentration of Oxygen (>23%),
- Fuel e.g. Acetylene gas from leaking welding equipment;
- Methane gas and hydrogen sulphide produced by rotting organic waste in sewers;
- Hydrogen gas produced by contact between aluminum or galvanized metals and corrosive liquids;
- grain or coal dust;
- solvents such as acetone, ethanol, toluene, turpentine, and xylene which may be introduced into the space through spills) and
- Ignition sources e.g. open flames, welding arcs, chemical reaction, arcing of electrical motors etc.)

*Physical hazards:*

- Loose and unstable material may lead to trapping or burying workers
- Slip, trip and fall hazards
- Falling objects from above
- Moving parts of equipment and machinery
- Electrical shock from defective extension cords, welding cables etc.
- Poor visibility
- Temperature extremes
- Noise
- Risk of drowning
- Rusted railings

(b) Safe work procedures for Confined Spaces shall include:

Only enter confined space after the air has been tested and evaluated by a competent person who has certified in writing that the space is safe and will remain safe for the duration of the work. Where the confined space cannot be certified as safe steps must be taken to ensure that any confined space in which there exists or is likely to exist a hazardous gas, vapour, dust or fumes, or which has or is likely to have, an oxygen content of less than 20 per cent by volume, is entered by an employee or other person only when;

- the confined space is purged and ventilated to provide a safe atmosphere therein and measures necessary to maintain a safe atmosphere therein have been taken; and

- the confined space has been isolated from all pipes, ducts and other communicating openings by means of effective blanking other than the shutting or locking of a valve or a cock, or, if this is not practicable, only when all valves and cocks which are a potential source of danger have been locked and securely fastened by means of chains and padlocks.

In an instance where it's not possible to purge and ventilate the confined space, the following precautions must be taken:

- the confined space is entered only when the employee or person entering is using breathing apparatus of a type approved by the chief inspector and, further, that;
- the confined space has been isolated from all pipes, ducts and other communicating openings by means of effective blanking other than the shutting or locking of a valve or a cock, or, if this is not practicable, only when all valves and cocks which are a potential source of danger have been locked and securely fastened by means of chains and padlocks any employee or person entering the confined space is using a safety harness or other similar equipment, to which a rope is securely attached which reaches beyond the access to the confined space, and the free end of which is attended to by a person referred to in paragraph (c);
- at least one other person trained in resuscitation is and remains in attendance immediately outside the entrance of the confined space in order to assist or remove any or persons from the confined space, if necessary; and
- effective, approved apparatus for breathing and resuscitation is available immediately outside the confined space.

Ensure that everybody vacate the confined space after completion of any work therein. Where the hazardous gas, vapour, dust or fumes are of an explosive or flammable nature, further steps must be taken to ensure that such a confined space is entered only if –

- the concentration of the gas, vapour, dust or fumes does not exceed 25 percent of the lower explosive limit of the gas, vapour, dust or fumes concerned
- where the work to be performed is of such a nature that it does not create a source of ignition; or
- such concentration does not exceed 10 per cent of the lower explosive limit of the gas, vapour, dust or fumes where other work is performed

Employees required to work in confined spaces must be trained and competent in confined space procedures. Working alone in a confined space is not permitted. A Confined Space Entry Permit is required for entry prior to any work performed in a confined space. A suitably trained person must undertake a written risk assessment before carrying out work involving entry into a confined space. The assessment shall take into account the following:

- the nature of the confined space;
- the work required and the methods by which the work can be done;
- the hazards involved and associated risks;
- implementation of control measures;
- the emergency and rescue procedures.

The risk assessment must be signed by all the people involved in the work to be done in the confined space. Communication between people in a confined space must be established as well

as communication with any stand-by staff located outside. Rescue procedures must be established before entry into any confined space which, include a stand-by person. If working under a contractor or Client's entry permit, this must be reviewed by a suitably qualified Health and Safety Specialist person to ensure adequacy of risk assessment, control measures and safe working procedures before entry.

#### **C3.5.8.6 Health and safety specialist**

The Contractor shall employ a health and safety specialist, with suitable and proven qualifications, either on full-time or part-time basis, for the duration of the Contract. This specialist shall assist with the preparation of the health and safety plan, shall provide on-going training for all construction staff (at least 1 hour per week whilst work on site is in progress, in the form of weekly toolbox talks), and shall assist with the upkeep of the health and safety plan and associated regular inspections etc.

The requirement for a weekly presence on Site necessitates that the Health and Safety Specialist be based locally, at least for the period while the Contractor is working on Site (i.e. site establishment, site clearance, earthworks, construction).

#### **C3.5.8.7 Monthly health and safety reports**

The health and safety specialist required in terms of C3.5.8.6 shall submit a report to the Engineer at the monthly site meetings, detailing the state of health and safety on the site over the last month, new risk assessments added, potential new risks, new precautions taken, and summarizing the results of various inspections required in terms of the health and safety plan, etc. If this report is not submitted at each monthly site meeting, the Engineer shall impose a fine of R5000.00 on the Contractor, in each instance.

### **C3.5.9 ENVIRONMENTAL MANAGEMENT**

The Contractor will be responsible for managing his activities so that damage to the environment is minimized, as per the specifications contained within Part C3.6.2: Environmental Management Programme (EMPr).

### **C3.5.10 SUBCONTRACTORS**

The Contractor is responsible for work carried out on his behalf by subcontractors. The Engineer will not liaise directly with such subcontractors, and all problems relating to payments, programming, workmanship, etc., shall be the concern of the Contractor and the subcontractor, and the Engineer will not be involved.

### **C3.5.11 FORMS FOR CONTRACT ADMINISTRATION**

The Contractor shall submit with each monthly statement for payment the following updated returns:

- (a) Project Labour Report
- (b) EME and QSE Contract Participation Expenditure Report
- (c) Targeted Labour Contract Participation Expenditure Report

The Project Labour Report must include details of all labour (including that of sub-contractors) earning less than R200 per day (excluding any benefits) employed on this contract in the month in question.

**END OF SECTION**



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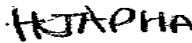
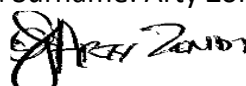
**C3.6: OCCUPATIONAL HEALTH AND SAFETY & ENVIRONMENTAL SPECIFICATIONS**

C3.6.1: Occupational Health And Safety Specification - See attached.

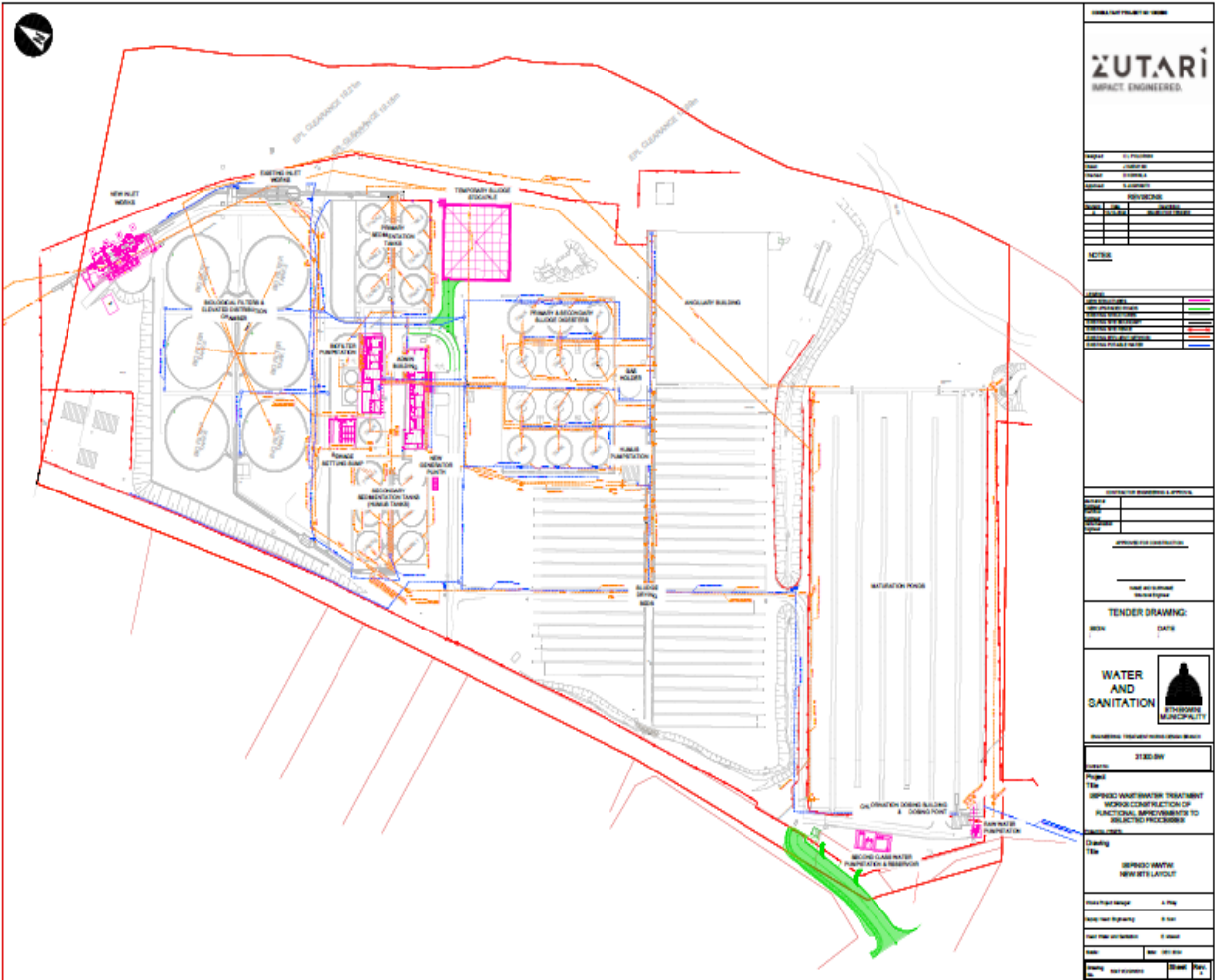
**ETHEKWINI MUNICIPALITY**  
**Occupational Health & Safety Unit**



**Site Specific Health and Safety Specification in terms of 2014  
Construction Regulations 5.1(b)**

Document Title	Site Specific Health and Safety Specification
Client	eThekweni Municipality – Water and Sanitation
Project Name	Isipingo Wastewater Treatment Works: Construction of Functional Improvements to Selected Processes
Contract Number	31300-5W
Compiled by (Safety Officer)	Name and Surname: Hlengiwe Njapha Signature:  Date: 18/02/2025
Approved by (Safety and Risk Manager)	Name and Surname: Arty Zondi Signature:  Date: 18/02/2025
Reference Number	SSHSS 348/02/2025

PROJECT LOCALITY



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## **1.PROJECT DESCRIPTION**

Isipingo Wastewater Treatment Works: Construction of Functional Improvements to Selected Processes

## **2. LIMITATIONS OF LIABILITY**

The Principal Contractor shall enter into a Mandatory Agreement with the Client, as defined in Section 37(2) of the Occupational Health and Safety ACT.

The Principal Contractor shall ensure that each contractor appointed by the Principal Contractor and each sub-contractor appointed by a contractor also into a Mandatory Agreement with the Principal Contractor, as defined in Section 37(2) of the Occupational Health and Safety ACT. These agreements shall be included in the Principal Contractor's H&S File on site and be valid for the duration of the contractors' work on the construction site.

## **3. PURPOSE OF THE CONSTRUCTION H&S SPECIFICATION**

This document defines the minimum management requirement that is to be implemented by the Principal Contractor/Contractor for the management of Health and Safety on any eThekweni Municipality project.

The aim of this document is to present the health and safety aspects that need to be controlled and managed on the project.

This Health and Safety specification identifies and encompasses the working behaviours and safe work practices that are expected of all employees, Vendors and Contractors, Sub-Contractors and Visitors, engaged on construction site.

Providing a guideline to comply with best Health & Safety practices and the Occupational Health and Safety Act 85/1993 as amended, including reference to applicable legislative requirement.

#### 4. PROJECT HEALTH AND SAFETY COST

The Client must ensure that potential Principal Contractor submitting tenders have made adequate provision for the cost of health and safety measures.

The Principal Contractor shall allow in their cost provision for complying with the requirements of this Client Health and Safety Specification; resources for the following H&S controls shall be in place.

	H&S cost item	Description
1.	Full Time Safety Officer	Full Time attendance on site of a SACPCMP registered safety officer from the start of construction until the end of project handover
2.	First Aiders	First Aid training
3.	Competent inspectors (trained, certified, competent)	Statutory inspections of excavations, temporary works, fire extinguishers, lifting equipment, lifting machinery, construction vehicles and mobile plant, portable electrical equipment, Electrical Installation Controller etc.
4	Medical certificate of fitness	Medical examination of all employees and certification of fitness by an Occupational Medicine Practitioner Pre- employment and annual
5	PPE	Standards set for all employees Including community and environment
6	Dust mitigation	To reduce dust exposure to the employees and the public
7	Public protection and barricading	Barricading, shoring and notices
8	Employee facilities	Refer to the Facilities Regulations (drinking water, change facility, personal lockers, and wash facilities, eating facilities, ablution toilets)
9	Traffic management	Traffic controller's training and traffic signage
10	Signage	All construction safety signage required for the project
11	Other	

## 5. SCOPE OF WORK

The civil scope of this Contract is as follows:

1. Inlet Works: The construction of a new inlet works which will accommodate the design flow of 18 Mℓ/d (average dry weather flow) and a peak wet weather flow of 54 Mℓ/d. The new inlet works includes a common inlet channel with one (1) trash rack screen, two (2) screen channels with mechanical front raked screens, two (2) bypass channels with manually raked bar screens, two (2) vortex degritters and an overflow chamber.
2. New MCC Room: New building housing all the motor control centres (MCC) for the inlet works and associated pumps.
3. Refurbishment of the Administration Building: Modifications and refurbishment of the existing one (1) storey administration building, which will house the offices of the plant manager, control room, communal area with kitchenette, changerooms and ablution facilities for operational staff.
4. Refurbishment of Biofilter Pumpstation Building and Ablution Block: Internal upgrade of the existing ablution block which entails replacement or refurbishment of all sanitary fixtures and affiliated plumbing, flooring as well as the inclusion of new benches for staff. New brickwork walls are required to enclose the new MCC room as well as new steel columns from the soffit to the sump floor below.
5. Upgrade of the Biofilter Pumpstation: New settled sewage sump (including four (4) individual delivery sumps and a common feeder sump) with an overflow weir, new DN750 concrete pipeline, new DN700 ductile iron suction pipeline, penstock chambers and manhole chambers.
6. Raw Water Pumpstation: New building housing two new (2) self-priming pumps.
7. Second Class Water Pumpstation and Reservoir: New pumpstation for treated effluent reticulation network (second class water) to be used for mechanical equipment and on- site

requirements. The pumpstation will also include a square reservoir (above ground).

8. Temporary Sludge Stockpile Area: The construction of a concrete surface bed supported by sufficient layer works.
9. Process Pipework: The interconnecting pipework associated with directing flow through the new structures and the reconfiguration of the existing pipework. It will also include the new overflow pipe from the new inlet works to the existing overflow pipe.
10. Ancillary Structures: The construction of small concrete structures including flow diversion and/or division chambers, flow measurement, distribution boxes, manholes, valve and collection chambers.
11. Demolition and Flow Diversion: Decommissioning and demolition of older process units which are replaced by this proposed scope of works. Flow diversion includes the diversion of the incoming sewage flow, upstream of the new inlet works to the existing inlet works, via the new overflow chamber, new overflow pipe and a diversion chamber.
12. Roads, Stormwater and Cable Ducts: Internal access roads, stormwater drainage and cable routing ducts. Existing stormwater pipes which are affected may be replaced with new pipes pipe sizes vary from standard 375mm Class100D and upwards. New stormwater shall be 375mm Class 100D, 450mm Class 100D and 200mm HDPVC pipes. Stormwater manholes and field inlets are required to collect stormwater runoff from harden areas. Stormwater concrete channels (precast and cast-in-situ) are required to collected runoff from hardened areas. Grouted stone pitching, chutes and swale are required to manage stormwater runoff in applicable areas of the works and discharge runoff appropriately. Headwalls, aprons and erosion protection mattress are required at outlet locations. Repairs to existing stormwater channels, manholes and covers are required.



13. Site Clearance, General Earthworks and Landscaping: Site clearance, general earthworks and general site landscaping.
14. Second Class Water System: New second class water reticulation network on site to service new inlet works, primary sedimentation tanks, raw sludge tanks, humus tank and the sludge stockpile area.
15. Fencing: Amendment of fencing around sections of maturation ponds.

The above list shall not limit the work to be carried out under this Contract

**b) Mechanical and Electrical (M&E) Works:**

c)

The M&E works includes the following duties:

- Design
- Manufacture
- Supply
- Delivery
- Storage (if necessary)
- Installation
- Testing
- Commissioning and Trial Operation Period
- Training the Employer's staff in operation and maintenance
- Upholding during the Defects Notification Period.

The Works shall be designed to function safely and effectively in conjunction with the infrastructure provided by others for this project. Where components of the Works are incorporated into structures provided by others, these components shall be designed accordingly.

The M&E scope of this Contract will be as follows:

**The Mechanical works comprises the following:**

a) New Inlet Works:

- Trash Rack Screen
- Front Raked Screens
- Hand Raked Screens
- Water Launderers

- Washer Compactors
- Grit Removal Equipment
- Grit Classifiers
- Channel Mounted Sluice Gates
- Skip Dollies for Screenings and Grit
- Second Class Water System Reticulation at the new inlet works (terminating at the various mechanical equipment as necessary)

#### Biofilter Pump Station

- a) Bio Filter Pumps
- b) Wall

Mounted Sluice

Gates Second

Class Water

System

- a) Raw Water Pumps
- b) Booster Pumps
- c) Air Compressors
- d) Automatic

self-cleaning Filters

Other

- a) Pipework and Valves
- b) Lifting Equipment
- c) Operation and Control System
- d) Airconditioning and Ventilation
- e) Site wide safety signage and equipment tagging
- f) Spares
- g) Performance Accepting Testing
- h) Test on Completion
- i) Commissioning

- j) Trial Operation Period
- k) Training
- l) Rectification during Defects Notification Period
- m) Operating and Maintenance Manual

**The Electrical scope comprises the design, supply and installation of the following:**

**The scope of works for the electrical installation is the design, supply, delivery, installation, testing, commissioning and upholding during the trial operation period and the defects liability period of the following equipment and materials:**

- a) 850 kVA continuous power rating power 400 V modified ISO container standby generator, including all required components and accessories
- b) The following Motor Control Centres (MCCs):
  - Main / Biofilter Pump Station MCC including connecting existing feeders and equipment to the new MCC (MCC01)
  - New Inlet Works MCC (MCC02) Second Class Water MCC (MCC03)
- c) Various Low Voltage Power cables, installed in ground trenches, PVC ducts and cable ladder.
- d) Cable Supports for all cable routes.
- e) Various Field Control stations, including Emergency Stop stations, and Start/Stop/Emergency Stop stations, located within 1 metre of the relevant plant equipment.
- f) Site Lighting
- g) Small Power and Lighting for the following buildings and structures:
  - Admin Building
  - Biofilter Pump Station Building

- New Inlet Works MCC Building
  - New Inlet Works Structure
  - Second Class Water MCC Building
  - Raw Water Pump Station Building
- h) Smoke detection system for the Admin Building
- i) Disconnecting, making safe and removal off site of redundant electrical, control and instrumentation equipment and materials
- j) The following activities shall also be performed by the Contractor:
- Liaison and coordination with the electrical supply authority, eThekweni Electricity, regarding the electrical supply upgrade change-over and all required shutdowns.
  - Site Harmonic Study Report of impact of all proposed variable frequency drives on the internal reticulation system and at the point of supply.
  - Earthing and Lightning protection.

**The Instrumentation and Control scope comprises the design, supply and installation of the following:**

**The scope of works is to provide the required instrumentation and control systems for the Wastewater Works. In general, the following items are to be supplied but this is not a comprehensive list.**

- a) New SCADA for the entire WWTW comprising of the new MCC's listed above and the existing Chlorine Disinfection MCC (MCC04), including SCADA server and workstation
- b) UPS for SCADA and PLC's
- c) PLCs and I/O
- d) HMI's
- e) Instrumentation, cabling and racking
- f) Instrumentation junction boxes
- g) Dedicated earthing system and Surge protection for the electronic systems
- h) Control room equipment and furniture

- CC TV Camera

## **6. COMPENSATION FOR OCCUPATIONAL INJURIES AND DISEASES ACT**

The Principal Contractor, each contractor and each sub-contractor shall submit proof of Good Standing with COIDA Commissioner or a Mutual Association licensed in terms of Section 30 of COIDA, prior to starting any work on site.

A copy of the Letter of Good Standing with COIDA Commissioner must be included in the H&S Plan of each contractor working on the site and must remain updated for the duration of the construction work.

## **7. APPLICATION FOR CONSTRUCTION WORK PERMIT**

The Principal Contractor shall assist the Client in compiling the evidence required by the Department of Labour for the issuing of the Construction Work Permit.

The Principal Contractor shall ensure that the H&S Plan presented for approvals includes:

- Evidence that the Principal Contractor made adequate provision for the cost of H&S measures
- Evidence that the Principal Contractor has the necessary competencies and resources to carry out the construction work safely.
- A copy of the Letter of appointment of the Construction Manager in terms of CR 8(1) + proof of his qualification, competence and registration where applicable.
- Proof of the registration of the Principal Contractors Health & Safety officer with the SACPCMP.

The Principal Contractor shall display the work permit number at the main site entrance. This display must be conspicuous to the satisfaction of the Department of Labor. The permit must be noticeable.

The construction works can only commence once the construction work permit is issued by the Department of Labor.

## **8. MANAGEMENT AND SUPERVISION OF CONSTRUCTION WORK**

### **8.1 Construction Manager**

The Principal Contractor shall appoint a full-time competent person as the construction manager with the duty of managing all construction on the site including the duty of ensuring occupational health and safety compliance.

The Construction Manager must demonstrate competency in relation to work being performed and the ability to manage construction work which may include making all statutory appointments in terms of health and safety.

### **8.2 Construction Health and Safety Officer**

The Principal Contractor shall appoint a full-time competent Construction Health and Safety Officer for the construction work. The Construction Safety Officer shall be full on the construction site for this project.

The Safety Officer shall be registered with the South African Council for the Projects and Construction Management Professions. Proof of competence and registration of the appointed Construction Safety Officer must be included in the H&S Plan.

### **8.3 Construction Supervisor**

A Construction Manager must in writing appoint construction supervisors responsible for construction activities and ensuring occupational health and safety compliance on the construction site. A contractor must, upon having considered the size of the project, in writing appoint one or more competent employees for different sections thereof to assist the construction supervisor contemplated in sub regulation (7), and every such employee has, to the extent clearly defined by the contractor in the letter of appointment, the same duties as the construction supervisor: Provided that the designation of any such employee does not relieve the construction supervisor of any personal accountability for failing in his or her supervisory duties in terms of this regulation.

## **9. PRINCIPAL CONTRACTOR'S HEALTH AND SAFETY PLAN**

The Principal Contractor shall submit a suitable, sufficiently documented and coherent specific health and safety plan based on the Client documented Health and Safety Specification. The health and safety plan shall include but not limited to the following

- Objectives
- Scope of work
- Management of construction and supervision
- Monitoring and review plan
- Sub-contractor management

- Risk Assessment & Written Safe Working Procedures
- Incident Management & First Aid
- Emergency procedures/ plan
- Fire Prevention & Protection
- Public Health and Safety
- PPE Provision
- Health & Safety Signage
- Excavations
- Site establishment
- Soil poisoning
- Existing services
- Construction Vehicles and Mobile Plants
- Hand & Electrical Tool Management
- Construction Employees Facilities
- Health & Safety Policies
- Health and Safety Training & Competencies
- Housekeeping
- Hazardous Chemicals
- Inductions
- Medicals
- Site Security
- Stacking and Storage
- Internal and external Audit
- Inspection Registers
- Toolbox Talks
- Site Establishment
- Asbestos Removal

## **10. HAZARD IDENTIFICATION AND RISK ASSESSMENT**

The Principal Contractor shall before commencement of any construction and during such construction works have risk assessments performed by appointed competent person in writing which forms part of the health and safety plan to be applied.

**The provisions of Regulation 9 of the Construction Regulations shall be followed in every detail.**

## **11. HEALTH AND SAFETY FILE**

The Client must discuss and negotiate with a Principal Contractor the content of the Health and Safety Plan and thereafter finally approve the Health and Safety plan for implementation. The recommended Health and Safety file shall include the following:

- Client Health & Safety Specification
- Principal Contractor Health & Safety Plan
- Letter of good standing
- Section 37.2 Mandatory Agreement
- Contractor appointment letter in terms of CR 5.1(k)
- Legal appointments and competencies (Site manager, Site supervisor, Safety officer, Risk assessor, Incident investigator, Fall protection planner, Temporary work designer, Temporary work supervisor, Electrical installation supervisor)
- Risk Assessments as per scope of work
- Written Safe Working Procedures as per risk assessment
- Incident/Accident Management Procedures
- Award letter from SCM
- Organogram as per appointments
- Copy of OHS Act and COID Act
- Environmental Management Procedures (Dumpsite, Water provision, Ablution, Waste management, Concrete works, Refuelling and spillage management, Hazardous chemicals storage and disposal, Environmental awareness training, No Go Areas, Protection of animals, Site demarcation etc.)
- Health and Safety Induction programme
- Emergency Procedures/ Plan
- Medical Fitness Certificate (Safety Officer, Site manager and Supervisor)
- Toolbox Talks Programme/ Plan
- SHE Policy

## **12. HEALTH AND SAFETY REPRESENTATIVES AND COMMITTEE**

### **Health and Safety Representatives**

- The Principal Contractor shall ensure that Health and Safety Representatives are appointed in writing and exercise their functions as defined in OHSA.
- The Principal Contractor shall elect and appoint a health and safety representative regardless of the number of employees on the site.
- The H&S representative shall at all times be on site and report to the Health and Safety Officer and Construction Manager.

### **Health and Safety Committee**

- The Principal Contractor shall ensure that the H&S committee meets on a monthly basis



- The Principal Contractor's management and each contractor shall be represented at the H&S committee meeting; contractors with more than 20 employees shall have an H&S representative at each committee meeting and each contractor shall have a management member attending each H&S committee meeting

### **13. CLOSE- OUT CONSOLIDATED HEALTH AND SAFETY FILE**

The Principal Contractor shall compile a consolidated H&S file and hand over to the Water and Sanitation Unit. OHS Unit will conduct a project close out using the appropriate checklist before the completion of the project.

### **14. HEALTH AND SAFETY TRAINING**

The Principal Contractor shall ensure that employees are trained on health and safety measures this shall include but not limited to:

- Written Safe Working Procedures
- Risk Assessments
- Health and Safety Plan
- Emergency Management Plan
- Induction
- Toolbox Talks
- MSDS

### **15. INCIDENTS MANAGEMENT & FIRST AID**

All incidents and accidents as per Section of the Act must be reported, recorded and investigated as per General Administration Regulation 8 & 9

Where a fatality or permanent disabling injury or incident occurs on the Construction site, the Client must ensure that the Principal Contractor provides the Provincial Director with a report contemplated in Section 24 of the Act and the report includes the measures that the Principal Contractor intends to implement to ensure a safe construction site.

### **16. HEALTH AND SAFETY AUDITS**

The Client must ensure that periodic health and safety audits are conducted at intervals mutually agreed upon between the Principal Contractor and the Client at least every 30 days, the copy of the health and safety audit report must be provided to the Principal Contractor within seven days after the audit.

## **17. FIRE PRECAUTIONS ON CONSTRUCTION SITE**

The Principal Contractor shall provide suitable fire extinguishers which shall be serviced regularly in accordance with the manufacture's recommendations.

Safety signage shall be prominently displayed in all areas where fire extinguishers are located. The Principal Contractor shall arrange for training of the relevant personnel, in the use of fire extinguishers.

**The provisions of Regulation 29 of the Construction Regulations as well as Regulation 9 of Environmental Regulation for Workplaces shall be followed in every detail.**

## **18. PERSONAL PROTECTIVE EQUIPMENT AND CLOTHING.**

The Principal Contractor shall ensure that every employee is issued with, and wears SANS-approved P.P.E. as per the conducted risk assessment.

Failure to use protective equipment as per the risk assessment shall require disciplinary intervention and this process shall be documented in the induction.

No employer shall in respect of anything which he is in terms of this Act required to provide or to do in the interest of health or safety of an employee make any deductions from any employee's remuneration or require or permit any employee to make any payment to him or to any other person.

**The provisions of Regulation 2 of the General Safety Regulations shall be followed in every detail.**

## **19. OCCUPATIONAL HEALTH AND SAFETY SIGNAGE**

The Principal Contractor shall erect and maintain quality safety signage

The signage shall include but is not limited to:

- The construction work permit number displayed at the entrance
- Access restrictions
- A sign indicating that all visitors must report to the site office and must be accompanied by the Principal Contractor when accessing the site
- The name and telephone number of the responsible person(s)
- Emergency telephone number(s)
- PPE to be worn at the particular site
- When falling objects may occur, relevant barricading and warning signs must be erected

- Excavations, heights structures, temporary structures and all risk areas must be indicated as per the specific methods defined in the H&S Plan.

## **20. DUTIES OF PRINCIPAL CONTRACTORS AND CONTRACTORS**

Contractors and sub-contractors must be given a copy of the H&S specification and any additional specification issued by the Client and shall comply with these specifications integrally. All employers working on the site shall conform to the standard in the CHSS. All the duties of the Principal Contractor in this CHSS equally apply, in full, to contractors of such Principal Contractor and to sub-contractors of such contractors.

The Principal Contractor shall ensure that the comprehensive and updated list of all the contractors and sub-contractors on site includes:

- A reference to the agreements between the parties, including all contractors Section 37(2) agreements with the Principal Contractor
- The type of work being done
- The date of the approval of the H&S Plan
- The date of expiry of the COIDA certificate of good standing
- The date of the last monthly audit

**The provisions of Regulation 7 of the Construction Regulations shall be followed in every detail.**

## **21. PUBLIC HEALTH AND SAFETY**

The site shall at all times be secured to prevent the unauthorized access of persons to construction risk areas.

Appropriate health and safety signage shall be posted and access control to site must be exercised via a single access point.

All members entering the site must indicate in what capacity they are visiting the site.

The access point must be designed and constructed to allow for temporary parking, entry of construction vehicles, entry of personnel transport vehicles and entry of individual workers and other persons.

The principal Contractor shall ensure that each person visiting the site shall be inducted to the site and such abridged induction shall outline the hazards from on-site activities and the precautions to be observed to avoid or minimize those risks

Visitors must only enter when accompanied by a responsible person designated by the Principal Contractor.

## **22. NIGHT; WEEK –END WORK**

No night or weekend work shall be performed unless authorized by the Principal Agent or Lead Engineers

Where week end work is planned the Principal Contractor shall ensure that its construction supervisor is on site, this applies even if only contractors or sub-contractors are working on the site

Where week end work is planned each contractor or sub-contractor shall ensure that its construction supervisor is on site, this applies even if the Principal Contractor's manager or supervisor is on the site.

## **23. CONSTRUCTION EMPLOYEES FACILITIES**

The Principal Contractor shall provide at or within reasonable access of every construction site, the following clean, hygienic and maintained facilities:

- (a) Shower facilities after consultation with the employees or employees representatives, or at least one shower facility for every 15 persons;
- (b) at least one sanitary facility for each sex and for every 30 workers;
- (c) changing facilities for each sex; and
- (d) sheltered eating areas.

**The provisions of Regulation 2, 3, 4, 6, 7, 9 of the Facilities Regulations shall be followed in every detail.**

## **24. STORAGE AND USE OF FLAMMABLE LIQUIDS**

No flammable substances must be stored on site unless these are stored in a flammable store or cabinet approved by the Municipal Chief Fire Officer, no other materials shall be stored in the flammable store or cabinet

Where required the H&S Plan shall include a method statement detailing the safe use, storage, decanting and spill controls for all flammable liquids used and stored on site.

**The provisions of Regulation 25 of the Construction Regulations shall be followed in every detail.**

## **25. HAZARDOUS CHEMICAL SUBSTANCE**

With respect to hazardous chemical substances used, the contractor shall ensure that:

- All MSDS are included in the H&S File
- A HCS risk assessment is included in the H&S Plan

- The safe use, storage, emergency procedures and safe disposal of hazardous substances are addressed in a method statement(s) included in the H&S Plan.
- Proof of competency and signed letters of appointment of the person responsible for chemical handling is included in the H&S File.

Any hazardous chemical substance intended to be applied on site during the project (i.e. after approval of the H&S Plan) shall be subject to an issue-based risk assessment and method statement which must be presented to the Client Agent prior to the substance being introduced on site.

**The provisions of Regulation 3, 5, 7, 8, 9, 9A, 10, 11, 14, 15 of the Hazardous Chemical Substances Regulations shall be followed in every detail.**

## **26. HOUSEKEEPING AND GENERAL SAFEGUARDING ON CONSTRUCTION SITE**

The Principal Contractor shall appoint a person responsible for general housekeeping and stacking and storage of materials and equipment on the entire site.

**The provisions of Regulation 27 of the Construction Regulations shall be followed in every detail.**

## **27. CONSTRUCTION MEDICALS**

A Principal Contractor must ensure that all his or her employees have a valid medical certificate of fitness specific to the construction work to be performed and issued by an Occupational Health Practitioner in the form of Annexure 3.

## **28. STACKING AND STORAGE ON CONSTRUCTION SITE**

A Principal Contractor must, in addition to compliance with the provisions for the stacking of articles in the General Safety Regulations, 2003, ensure that—  
A competent person is appointed in writing with the duty of supervising all stacking and storage on a construction site; Adequate storage areas are provided; There are demarcated storage areas; and storage areas are kept neat and under control.

## **29. INDUCTION AND TOOLBOX PROGRAMME**

No contractor may allow or permit any employee or person to enter any site, unless that employee or person has undergone health and safety induction training pertaining to the hazards prevalent on the site at the time of entry.

A contractor must ensure that all visitors to a construction site undergo health and safety induction pertaining to the hazards prevalent on the site and must ensure that such visitors have the necessary personal protective equipment.

A contractor must at all times keep on his or her construction site records of the health and safety induction training contemplated in sub-regulation (6) and such records must be made available on request to an inspector, the client, the client's agent or the principal contractor. The Principal Contractor must ensure that the toolbox talks are conducted on weekly basis and the training records kept on the safety file.

**DESIGNER COMMENTS ON HEALTH AND SAFETY SPECIFICATION**

## Designer's Health and Safety Checklist

Name and address of Project \_\_\_\_\_

Item and Legal Reference	Y/N	Comment
CR 6(1) (a)  Has the designer familiarized himself with the Construction Regulations 2014 (particularly Regulation 6) and the Safety Standards incorporated into these Regulations?		
CR 6(1) (b)  During the design stage, was the Client's Health and Safety Specifications given due consideration?		
The structural design aspects that could have an effect on the pricing of construction work?		
The geotechnical-science aspects?		
The weight which the structure is designed to safely withstand?		
CR 6(1)(d)  Has the designer communicated all known and anticipated hazards and risks associated with the construction of the designed structure?  Furthermore, has the safe method statement been developed to ensure that construction work is safely executed?		
CR 6 (1) (e)  As far as is reasonably practicable, are the dangerous processes and materials been eliminated or replaced in the design?		

CR 6(1) (f)  Has due consideration been taken during the design stage, for the safe maintenance of the structure after its completion?		
CR 6 (g-i)  Is the designer aware of his/her responsibility to carry out periodic site inspections to ensure that the structure is constructed correctly in accordance with the design?		
CR 6(1) (j)  Have all ergonomic hazards been considered for the lifecycle of the structure (i.e. during construction and after completion)?		

(Please ensure that the checklist is completed in full particularly the comments column)

Name of Designer\_\_\_\_\_

Designer's Title (e.g. Engineer, Architect)\_\_\_\_\_

Signature\_\_\_\_\_

Date\_\_\_\_\_

For Further details please contact [Hlengiwe.Ngubo@durban.gov.za](mailto:Hlengiwe.Ngubo@durban.gov.za), 0784571935.





## ETHEKWINI MUNICIPALITY Occupational Health & Safety Unit

### BASELINE RISK ASSESSMENT

Document Title	Baseline Risk Assessment
Client	eThekweni Municipality – Water and Sanitation
Project	Isipingo Wastewater Treatment Works: Construction of Functional Improvements to Selected Processes
Contract Number	31300-5W
Compiled by (Safety Officer)	Name and Surname: Hlengiwe Njapha Signature:  Date: 11/02/2025
Approved by (Safety and Risk Manager)	Name and Surname: Arty Zondi Signature:  Date: 11/02/2025
Revision Number	BRA 348/02/2025

# **BASELINE RISK ASSESSMENT**

**1. INTRODUCTION:** In accordance with the Occupational Health and Safety Act, (Act 85 of 1993) the Legislator places specific requirements on an Employer. One of these is prescribed in Section 8(i) of the Act where it requires the Employer to ascertain the risks and dangers which may occur within the workplace or section of the workplace and then goes on to establish working procedures or practices.

**2. PURPOSE:** This is conducted to create a benchmark of the potential risks that apply to the whole project or business operation.

**3. SCOPE:** This assessment could be approached on a site, regional or national level concerning any facet of the business operation or process or activity.

## **4. REVIEW AND MONITORING PLAN**

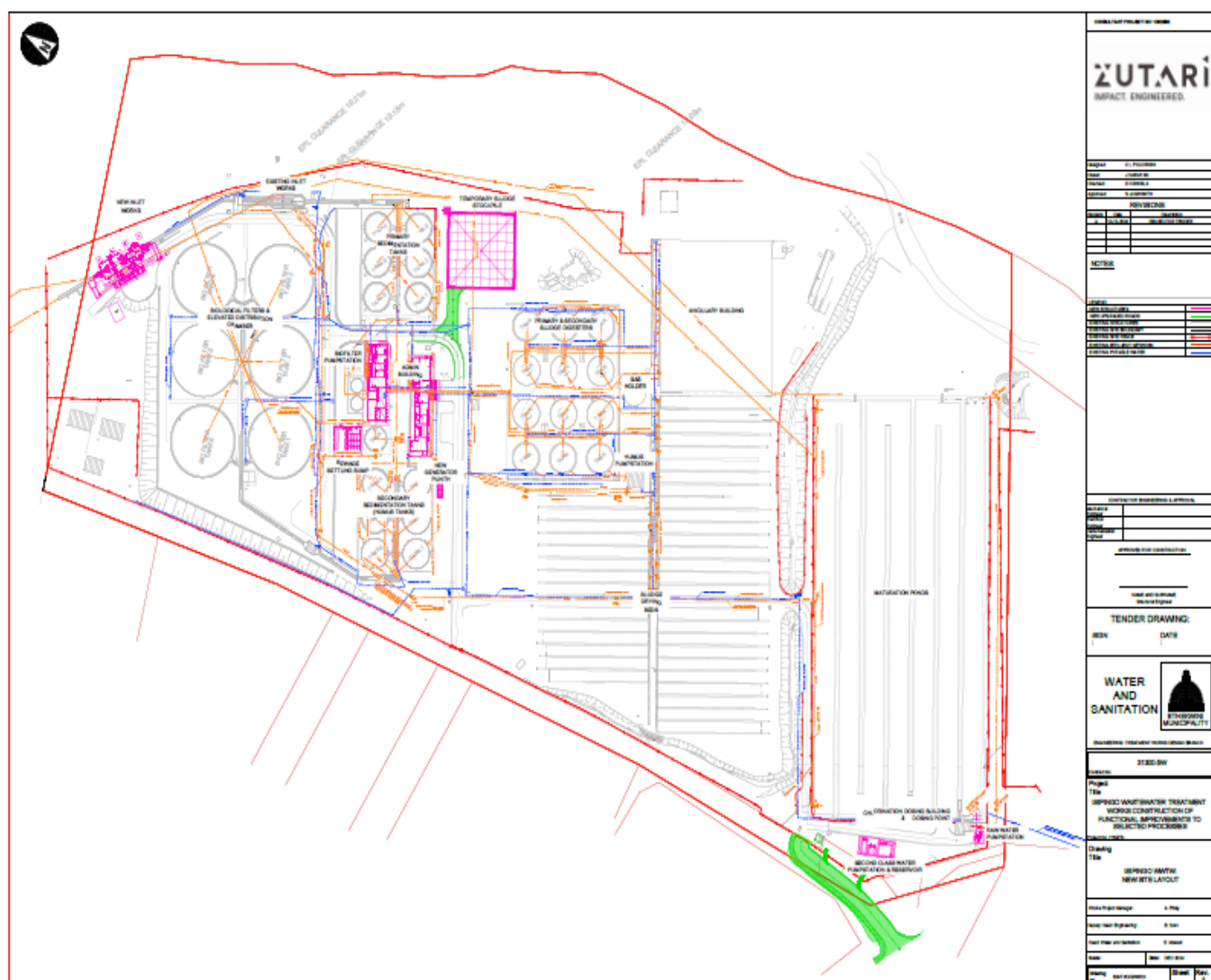
The risk assessment form part of the health and safety plan to be applied on the site and must include the following:

- (a) The identification of the risk and hazards to which persons may be exposed.
- (b) An analysis and evaluation of the risk and hazards identified based on a documented method.

## **5. REFERENCES**

- (a) Tender document number 31300
  - (b) Occupational Health & Safety Act and its Regulation
- © Physical Inspection

# LOCALITY PLAN



## **RISK ASSESSMENTS SCOPE OF WORK**

The civil scope of this Contract is as follows:

1. Inlet Works: The construction of a new inlet works which will accommodate the design flow of 18 Ml/d (average dry weather flow) and a peak wet weather flow of 54 Ml/d. The new inlet works includes a common inlet channel with one (1) trash rack screen, two (2) screen channels with mechanical front raked screens, two (2) bypass channels with manually raked bar screens, two (2) vortex degritters and an overflow chamber.
2. New MCC Room: New building housing all the motor control centres (MCC) for the inlet works and associated pumps.
3. Refurbishment of the Administration Building: Modifications and refurbishment of the existing one (1) storey administration building, which will house the offices of the plant manager, control room, communal area with kitchenette, changerooms and ablution facilities for operational staff.
4. Refurbishment of Biofilter Pumpstation Building and Ablution Block: Internal upgrade of the existing ablution block which entails replacement or refurbishment of all sanitary fixtures and affiliated plumbing, flooring as well as the inclusion of new benches for staff. New brickwork walls are required to enclose the new MCC room as well as new steel columns from the soffit to the sump floor below.
5. Upgrade of the Biofilter Pumpstation: New settled sewage sump (including four (4) individual delivery sumps and a common feeder sump) with an overflow weir, new DN750 concrete pipeline, new DN700 ductile iron suction pipeline, penstock chambers and manhole chambers.
6. Raw Water Pumpstation: New building housing two new (2) self-priming pumps.
7. Second Class Water Pumpstation and Reservoir: New pumpstation for treated effluent reticulation network (second class water) to be used for mechanical equipment and on- site requirements. The pumpstation will also include a square reservoir (above ground).
8. Temporary Sludge Stockpile Area: The construction of a concrete surface bed supported by sufficient layer works.
9. Process Pipework: The interconnecting pipework associated with directing flow through the new structures and the reconfiguration of the existing pipework. It will also include the new overflow pipe from the new inlet works to the existing overflow pipe.
10. Ancillary Structures: The construction of small concrete structures including flow diversion and/or division chambers, flow measurement, distribution

boxes, manholes, valve and collection chambers.

11. Demolition and Flow Diversion: Decommissioning and demolition of older process units which are replaced by this proposed scope of works. Flow diversion includes the diversion of the incoming sewage flow, upstream of the new inlet works to the existing inlet works, via the new overflow chamber, new overflow pipe and a diversion chamber.
12. Roads, Stormwater and Cable Ducts: Internal access roads, stormwater drainage and cable routing ducts. Existing stormwater pipes which are affected may be replaced with new pipes pipe sizes vary from standard 375mm Class100D and upwards. New stormwater shall be 375mm Class 100D, 450mm Class 100D and 200mm HDPVC pipes. Stormwater manholes and field inlets are required to collect stormwater runoff from harden areas. Stormwater concrete channels (precast and cast-in-situ) are required to collected runoff from hardened areas. Grouted stone pitching, chutes and swale are required to manage stormwater runoff in applicable areas of the works and discharge runoff appropriately. Headwalls, aprons and erosion protection mattress are required at outlet locations. Repairs to existing stormwater channels, manholes and covers are required.
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15. Fencing: Amendment of fencing around sections of maturation ponds.

The above list shall not limit the work to be carried out under this Contract

**b) Mechanical and Electrical (M&E) Works:**

c)

The M&E works includes the following duties:

- Design
- Manufacture
- Supply
- Delivery
- Storage (if necessary)
- Installation
- Testing
- Commissioning and Trial Operation Period
- Training the Employer's staff in operation and maintenance
- Upholding during the Defects Notification Period.

The Works shall be designed to function safely and effectively in conjunction with the infrastructure provided by others for this project. Where components of the Works are incorporated into structures provided by others, these components shall be designed accordingly.

The M&E scope of this Contract will be as follows:

**The Mechanical works comprises the following:**

a) New Inlet Works:

- Trash Rack Screen
- Front Raked Screens
- Hand Raked Screens
- Water Launderers
- Washer Compactors
- Grit Removal Equipment
- Grit Classifiers
- Channel Mounted Sluice Gates
- Skip Dollies for Screenings and Grit
- Second Class Water System Reticulation at the new inlet works (terminating at the various mechanical equipment as necessary)

Biofilter Pump Station

- a) Bio Filter Pumps
- b) Wall Mounted Sluice

Gates Second Class Water

System

- a) Raw Water Pumps
- b) Booster Pumps
- c) Air Compressors
- d) Automatic self-cleaning

Filters Other

- a) Pipework and Valves
- b) Lifting Equipment
- c) Operation and Control System
- d) Airconditioning and Ventilation
- e) Site wide safety signage and equipment tagging
- f) Spares
- g) Performance Accepting Testing

- h) Test on Completion
- i) Commissioning
- j) Trial Operation Period
- k) Training
- l) Rectification during Defects Notification Period
- m) Operating and Maintenance Manual

**The Electrical scope comprises the design, supply and installation of the following:**

**The scope of works for the electrical installation is the design, supply, delivery, installation, testing, commissioning and upholding during the trial operation period and the defects liability period of the following equipment and materials:**

- a) 850 kVA continuous power rating power 400 V modified ISO container standby generator, including all required components and accessories
- b) The following Motor Control Centres (MCCs):
  - Main / Biofilter Pump Station MCC including connecting existing feeders and equipment to the new MCC (MCC01)
  - New Inlet Works MCC (MCC02) Second Class Water MCC (MCC03)
- c) Various Low Voltage Power cables, installed in ground trenches, PVC ducts and cable ladder.
- d) Cable Supports for all cable routes.
- e) Various Field Control stations, including Emergency Stop stations, and Start/Stop/Emergency Stop stations, located within 1 metre of the relevant plant equipment.
- f) Site Lighting
- g) Small Power and Lighting for the following buildings and structures:
  - Admin Building
  - Biofilter Pump Station Building
  - New Inlet Works MCC Building
  - New Inlet Works Structure
  - Second Class Water MCC Building
  - Raw Water Pump Station Building
- h) Smoke detection system for the Admin Building

- i) Disconnecting, making safe and removal off site of redundant electrical, control and instrumentation equipment and materials
- j) The following activities shall also be performed by the Contractor:
  - Liaison and coordination with the electrical supply authority, eThekweni Electricity, regarding the electrical supply upgrade change-over and all required shutdowns.
  - Site Harmonic Study Report of impact of all proposed variable frequency drives on the internal reticulation system and at the point of supply.
  - Earthing and Lightning protection.

**The Instrumentation and Control scope comprises the design, supply and installation of the following:**

**The scope of works is to provide the required instrumentation and control systems for the Wastewater Works. In general, the following items are to be supplied but this is not a comprehensive list.**

- a) New SCADA for the entire WWTW comprising of the new MCC's listed above and the existing Chlorine Disinfection MCC (MCC04), including SCADA server and workstation
- b) UPS for SCADA and PLC's
- c) PLCs and I/O
- d) HMI's
- e) Instrumentation, cabling and racking
- f) Instrumentation junction boxes
- g) Dedicated earthing system and Surge protection for the electronic systems
- h) Control room equipment and furniture
- (i) CC TV Camera



## 1. RISK ESTIMATION AND EVALUATION

### RISK CLASSIFICATION USING A RISK SCORE TECHNIQUE

<b>Exposure (E) How frequently does the hazardous event occur</b>		<b>Risk classification</b>
Continuously .....		10
Frequently (daily) .....		6
Occasionally (weekly) .....		3
Unusually (monthly) .....		2
Rarely (few a year) .....		1

<b>Probability (P) The probability of a loss when the hazardous event does occur</b>		<b>Risk classification</b>
Frequent (happens often) .....		10
Probable (quite possible) .....		6
Occasional (unusual, but possible) .....		3
Remotely possible (has happened somewhere) .....		1
Improbable (practically impossible) .....		0.5

<b>Severity (S) Consequences of the hazardous event</b>		<b>Risk classification</b>
<b>Catastrophic</b> many fatalities; or interruption of longer than 2 weeks; or asset or environmental damage (or both) exceeding R100m .....		100
<b>Disaster</b> (few fatalities; or interruption between one and 2 weeks; or asset or environmental damage (or both) exceeding R10m) .....		40
<b>Very serious</b> (one fatality; or interruption of 6 days; or asset or environmental damage (or both) exceeding R100,000 .....		7
<b>Important</b> (temporary disability; or interruption between 6 and 24 hours; or damage exceeding R10,000 .....		3
<b>Noticeable</b> (first aid needed; or interruption of less than 6 hours; damage exceeding R1000) .....		1

<b>Risk classification (Risk score = E x P x S )</b>	
<b>Risk score</b>	<b>Risk classification</b>
Over 400-----5	Very high risk – discontinue operation or activity
200 to 400 ----- 4	High risk – immediate correction needed
70 to 200----- 3	Substantial risk – correction needed
20 to 70----- 2	Possible risk – attention needed
Under 20 ----- 1	Risk accepted

### **BASELINE RISK ASSESSMENT WORKSHEET**

1	Site Access								
	Activity	Hazard	Risk	Risk Evaluation			Risk Score	Risk level	Risk Rank
				E	P	S			
	Accessing the site using construction vehicles or walking to site. Delivering of equipment and material to the site	Excessive speed, head on collusion, employees knocked by moving vehicles. Road blocked off due to community protest. Manual Handling and excessive lifting.	Accidents, damage to equipment or severe injuries or death. Back injuries,	6	6	7	252		4
2	Site Establishment								
	Manual and mechanical clearing of the land. Off-loading and positioning of offices by mobile crane. Fencing. Installation of temporary water supply, electricity, ablution facilities,	Dust, Snakes, Bees & Wasps. Incompetent operator. Poor connection of temporary services.	Poisoned and death. Collision/impacts of mobile lifting equipment loads and dropped loads with process plant, pipe work, electrical cables and people. Water leaks, Electrocution, improper connection	6	6	7	252		4

<b>3</b>	<b>Demolition Work</b>								
	Removal of barrier kerb using tools	Manual handling of equipment and materials Dust Noise Flying objects Defective tools	Manual handling injuries Dust being inhaled/getting into eyes	6	6	3	108		3
4	<b>Removal and Replacement pumps, fittings</b>	Using mushroomed head tools, homemade tools. Falling tools	Multiple injuries, property damage	6	6	3	108		3
<b>5</b>	<b>Existing Services</b>								
	Identify /proving the existing services	Unforeseen hazards	Property to damage Fatalities/injuries	6	6	7	252		4
<b>6</b>	<b>Excavation</b>								
	Mechanical and manual excavation. Back filling mechanical and manual	Manual handling equipment and materials Sun Noise Vibration Inclement weather Unauthorized operator. Machine running out of control. Open excavation.	Manual handling injuries Personal injury/possible disabling injuries. Property to damage Respiratory problem.	6	6	7	252		4

		Dust. Operating mobile plant next to open excavation.							
<b>7</b>	<b>Pipelaying</b>								
	Accessing trenches Pipeline excavations Placement of pipes	Trench collapse, falling objects/material Incorrect lifting of pipes Engulfment of excavation	Personal injuries Manual handling injuries	6	6	7	252		4
<b>8</b>	<b>Backfilling and compaction</b>								
	Compact ground using Whackers, rolling compactors, plate compactors etc	Incompetent operator. Noise. Vibration.	Personal injuries and damage to property. Noise Induce. Hearing loss. Kidney problem. Body pain.	6	6	7	252	4	
<b>9</b>	<b>Brickwork</b>								
	Brickwork and mixing mortar.	Manual handling of blocks. Mortar inhalation. Mortar contact with body.	Injury to hands. Respiratory problem. Skin problems.	6	6	3	108		3
<b>10</b>	<b>Working at height</b>								
	Erection of Scaffolding by a Competent person Use of ladders	Unsafe scaffolding/ trestle scaffolds Falling from height	Unsafe scaffolding could collapse resulting in critical injuries Fatalities	6	6	7	252		4

11	<b>Welding</b> Setting up the welding machine	Sparks from the welding machine Emission smoke Incorrect welding Exposed wire	Burns Respiratory problem Multiple injuries Electrocution	6	6	7	252		4
12	<b>Road Work and Asphalt paving</b>								
	Layer works Applying asphalt Compaction	Nose, dust Inclement weather, including localized flooding Smoking/open fires Vibration (rolling compaction)	Rain causing slippery conditions and localised flooding causing property damage, injury and possible death Heat stroke from being exposed to the sun for too long and sunburn Bush fires caused by cigarette/open fires causing smoke, inhalation possible death	6	6	7	252		4
13	<b>Construction Mobile Plant and Equipment</b>								
	Use of Plant & Equipment on site	Incompetent operator Unsafe plant & equipment.	Personal injuries. Motor vehicle accident. Environmental contamination.	6	6	7	252		4

		Collusion with other vehicles. Petrol and oil spillages.							
<b>14</b>	<b>Emergency Management</b>								
	Development and Implementation of an Emergency Management Plan	Failure to have a basic, site specific emergency management plan. Workers not trained in the Emergency Plan. Insufficient or no emergency equipment or personnel.	Injury or damage to property. Inability to respond to emergencies. Insufficient or no emergency equipment.	6	6	3	108		3
<b>15</b>	<b>Community Risk Management</b>								
	Managing community risk	Failure to adequately monitor and manage the multi-faced social issues.	Violent protests. Injury to employees and property damage.	6	6	3	108		3

<b>16</b>	<b>Subcontractor Management</b>								
	Managing subcontractors	Failure to adequately assess subcontractors S.H.E Management System before work commences and at regular intervals. Inadequate Supervision. Utilizing incompetent Subcontractors.	Injury and non-compliance to legislation. High level of employee unsafe behavior. Accidents and property damage.	6	6	3	108		3

C3.6.2: Environmental Management Programme (EMPr) - See attached.





IN ASSOCIATION WITH INKANYEZI YETHU



NOVEMBER 2024

ENVIRONMENTAL MANAGEMENT PROGRAMME (EMPr)

ISIPINGO WASTE WATER TREATMENT WORKS (WWTW)  
UPGRADE

ETHEKWINI MUNICIPALITY

EVP1469



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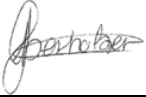
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## SECTION 1: INTRODUCTION, PROJECT AND SITE DESCRIPTION

### 1.1. Background

The eThekweni Municipality intend to upgrade of the Isipingo Wastewater Treatment Works (WWTW) at the location described in the table below.

**Table 1: Location Information**

District Municipality				eThekweni Municipality																				
Local Municipality				eThekweni Municipality																				
Ward				89																				
Area / Town / Village				Isipingo																				
Co-ordinates:				Latitude										Longitude										
	Mid-point			29°59'24.40"S										30°54'21.25"E										
Property Description:				Erf 296 Isipingo Erf 297 Isipingo Erf 298 Isipingo Erf 299 Isipingo Erf 300 Isipingo Erf 301 Isipingo																				
21 Digit Surveyor General's numbers:				N	0	F	U	0	0	0	0	0	0	0	0	2	9	6	0	0	0	2	6	
				N	0	F	T	0	1	5	6	0	0	0	0	0	2	9	7	0	0	0	0	0
				N	0	F	T	0	1	5	6	0	0	0	0	0	2	9	8	0	0	0	0	0
				N	0	F	T	0	1	5	6	0	0	0	0	0	2	9	9	0	0	0	0	0
				N	0	F	T	0	1	5	6	0	0	0	0	0	3	0	0	0	0	0	0	0
				N	0	F	T	0	1	5	6	0	0	0	0	0	3	0	1	0	0	0	0	0

### 1.2. Scope of Work

Prepare a site-specific EMPr to manage and mitigate potential environmental impacts during construction and operations. The provisions of this EMPr are binding on the eThekweni Municipality throughout the life of the Isipingo WWTW.

### 1.3. General Principles and Purpose of This EMPr

The purpose of this EMPr is to guide all relevant personnel on how to operate responsibly to achieve these goals and ensure that the requirements of the legislation are met. This EMPr is a working document and has been generated to ensure that:

- The protection of the environment during the construction and operational phase.
- All emissions to air water and soil are controlled and managed to mitigate their impacts on the environment and surrounding communities.
- Nuisance factors associated with the construction and operational phase are controlled as far as is reasonably possible.
- The correct principles are followed during the lifecycle of the asphalt plant thereby reducing frustrations on the part of the operators when asked to



- comply with the structures of the EMPr and relevant environmental legislation.
- The post-construction clean-up is carried out correctly to avoid environmental impacts and meet the legislated requirements.

This EMPr is subject to change as brought about by variations in the project specification, and any changes must be approved by the relevant authorities.

#### 1.4. Responsibilities

The Project Applicant (eThekweni Municipality) is responsible for:

- Ensuring compliance with the EMPr.
- Ensuring compliance with the provisions for duty of care and remediation of damage in accordance with section 28 of the National Environmental Management Act (NEMA), (No. 107 of 1998) and its obligations regarding the control of emergency incidents in terms of Section 30 of NEMA.
- Notifying the relevant authorities, Department of Economic Development, Tourism and Environmental Affairs (EDTEA) and/or Department of Water and Sanitation (DWS), of any incident as defined in section 30 of NEMA and section 20 of National Water Act (NWA), (No. 36 of 1998).
- Ensuring that the mitigation measures to address environmental impacts identified are carried out by the responsible person.
- Ensuring adherence to safety, health and environment (SHE) standards and ensuring that all activities comply with the EA, WUL and EMPr.
- Mitigating impact on the environment through responsible operation and adherence to the EA, WUL and EMPr.
- Ensuring transparency in their operation and environmental management of the site

The Project Manager or Engineer (Zutari) is responsible for:

- Appointing a qualified contractor and ensuring that they have read and understood the EA, WUL and EMPr.
- Ensuring all work undertaken is per the EA, WUL and EMPr.
- Ensuring adherence to safety, health and environment (SHE) standards and ensuring the construction activities comply with the EA, WUL and EMPr.
- Arranging for the site to be monitored daily to ensure compliance with the EA, WUL and EMPr.
- Overall responsibility and accountability for the site during the construction phase.
- Mitigating impact on the environment through responsible operation and adherence to the EA, WUL and EMPr.
- Ensuring transparency in their environmental management of the site.
- Managing the contractor to ensure that they adhere to the EA, WUL and EMPr and ensuring that all necessary documentation is maintained on-site.
- Ensuring that the contractor has a copy of the EA, WUL and EMPr.

The Site Contractor(s) is/are responsible for:

- Providing a suitable person to operate as Environmental Officer (EO) to undertake the monitoring of the day to day requirements of the EA, WUL and EMPr.
- Operating per the EA, WUL and EMPr and carrying out construction activities with due care and diligence.
- Ensuring that any communications from stakeholders are reported to the Environmental Control Officer (ECO).
- Maintaining relevant documentation for review by the ECO.
- Undertaking the mitigation measures to address the environmental impacts identified.

The Environmental Control Officer (ECO or Independent environment practitioner) is responsible for:

- Conducting regular auditing against the requirements of the EA, WUL and EMPr.
- Liaising directly with the EDTEA and/or DWS and supplying them with copies of the audit reports.
- Liaising directly with the contractor and EO and supplying them with a copy of the audit reports.

### 1.5. Monitoring

The key to a successful EMPr is effective monitoring and review to ensure the effective functioning of the EMPr and to identify and implement corrective measures in a timely manner:

- The EO must be responsible for day-to-day monitoring and reporting. The day-to-day monitoring must be conducted by the EO in conjunction with the contractor and the engineer.
- The ECO must undertake to monitor the site on a monthly basis during construction.
- The ECO must undertake to monitor the site on an annual basis during operation for the lifespan of the WWTW.
- All ECO audit reports must be submitted to EDTEA and DWS Compliance and Enforcement. Paramount to the reporting of non-conformances or incidents is that corrective and preventive action plans are developed and adhered to. Photographic records of all incidents and non-conformances must be retained. Non-compliances identified by the ECO must be resolved within fourteen days of being noted, and incidents that are deemed by the ECO to have a large environmental impact must be resolved immediately.

### 1.6. Applicable Legislation

The iLembe District Municipality must be aware of any compliance issues raised by the ECO and must ensure that the necessary corrective measures are implemented. As per the National Environmental Management Act No 107 of 1998 (Section 28), offending parties may be held financially accountable for any pollution or environmental damage.

The following environmental legislation must be adhered to:

- The Constitution of South Africa (No. 108 of 1996)
- National Environmental Management Act (Act 107 of 1998)
- National Water Act (Act 36 of 1998)
- National Environmental Management: Waste Act (Act 59 of 2008)
- National Environmental Management: Air Quality Act (Act 39 of 2004)
- National Environmental Management: Protected Areas Act (Act 57 of 2003)
- National Environmental Management: Integrated Coastal Management Act (Act 24 of 2008)
- National Forest Act (Act 84 of 1998)
- Environmental Conservation Act (Act 43 of 1996)
- National Environmental Management: Biodiversity Act (Act 10 of 2004)
- National Heritage Resources Act (Act 25 of 1999)
- KwaZulu-Natal Heritage Act (Act 4 of 2008)
- Mineral & Petroleum Resources Development (Act 28 of 2002)

- Occupational Health and Safety Act (Act 181 of 1993)
- Hazardous Substances Act (Act No. 15 of 1973)
- National Building Regulations and Building Standards Act (Act 103 of 1977)
- Relevant local bylaws

This EMPr meets the requirements of the stipulations provided in Appendix 4 of NEMA, 1998 (Act No. 107 of 1998) Environmental Impact Assessment Regulations, 2014 with regards to the content of EMPr. This EMPr has been developed to specifically address the impacts related to this project in each phase of development.

### 1.7. The layout of the EMPr

The EMPr is divided into five sections dealing with an Introduction and description of the proposal and the site, Pre-Construction and Site Set Up, Construction Activities and Post Construction, Rehabilitation and Operation Activities. Sections 4 and 5 provide definitions and records that can be used to record training, incidents, and complaints. Under the construction section, each section deals with a specific aspect of the development, i.e., administration and records. Within these sections, the specific activity is described, and the mitigation action required is provided. The tables have been set up to enable ease of auditing with a section for the EO/SHE officer or ECO to state whether mitigation measures have been put in place and to make a comment about any problems noted.

### 1.8. Project Details

The main work associated with the project is to upgrade the existing Isipingo WWTW. The WWTW currently treats domestic sewage (only) with a design capacity of 18Ml/d. Due to ageing infrastructure and outdated process technology, the plant is not operating at optimal capacity. For this reason, various improvements are required to the plant to increase its functional capacity to ensure the plant can meet its design capacity of 18Ml/d, these include the following (refer to Figures 1 and 2):

#### New Inlet Works, Refurbishment Of Existing And New MCC Room

- A temporary bypass north of the existing channel will be constructed in order to build the new inlet works where the channel width will be increased from 1m to 1.3m.
- Amendments to Existing Inlets Works
  - The existing central parabolic grit channel will be converted into a 1.3m wide rectangular channel.
  - One of the existing parabolic grit channels will be decommissioned and filled in.
  - The remaining parabolic grit channel will be kept for emergency purposes.
  - The existing screens will be removed, and the concrete will be refurbished.
  - The existing inlet works building will be refurbished, to be potentially used for storage.
  - The top of walls and channel floor levels at identified portions of the inlet works will be raised to address the risk of hydraulic concerns.
  - A sewage manhole outside of the site will have its opening raised to address the risk of hydraulic concerns.
- New Inlets Works
  - The new inlet works will have a standard channel width of 1.3m with three forks.
  - Channel 1 will have a manual screen. Channel 1 will have a retractable sluice gate.

- Channels 1 and 2 will each house a covered, mechanical front rake screen. Each mechanical screen will have a dedicated shaftless screw conveyance from a screen to a washer compactor.
- Two vortex degritters and associated grit washer-classifier.
- skips on motorised trolleys to hold grit and screenings
- A new MCC Building for the Inlet works.
- The existing turning circle will be redesigned as a concrete hardstand which will be able to accommodate the manoeuvres of the skip truck.

#### **Civil And Structural Upgrade Of The Administration Building**

- Replacement of all sanitary fixtures and new ablution facilities for the staff.
- A new tiled floor finish will be adopted, with new suspended ceilings furnishing the building.
- New independent strip footings to support new brick walls
- New timber roof trusses.
- New Lintols to support openings in existing brickwork.
- A new concrete framed entrance canopy, strapped to the existing eaves beam.
- The internal room configuration will change, achieved by the demolition of existing walls and the addition of new internal brickwork walls and some drywall partitions.
- Pavers that surround the administration building will be removed and replaced by an apron slab.

#### **Civil And Structural Upgrade Of The Structural Biofilter Pump Station**

- Refurbishment of the internal fixtures and flooring and a complete roof replacement.
- New brickwork walls to enclose the MCC room.
- The existing crawl beam will be re-furbished and reused for the upgrade,
- The flooring to the Biofilter pump station will be non-slip acid-resistant epoxy, and the concrete substrate will be refurbished

#### **Upgrade Of The Biofilter Pump Station And Newly Settled Effluent (Biofilter) Sump**

- Phase 1
  - Replacement of the pumps in the existing biofilter PS with new pumps to supply 48 Ml/d and keep the existing PS pipework and delivery pipeline to the distribution tower.
  - Construction of a new sump to accommodate the design capacity of 48 Ml/d while keeping the existing sump for redundancy purposes (i.e. cleaning/maintenance). The new sump shall be designed such that it can be used in future to accommodate the active volume required for the full design capacity of 72 Ml/d under Phase 2.
  - New manhole chamber and pipeline to connect the WWTW to the new sump.
  - New suction pipeline from the new sump to the existing suction line.
  - Installation of penstock valves to accommodate the decommissioning of existing infrastructure and introduction of new infrastructure to the scheme.
  - Installation of flow meter on the delivery pipeline.
  - Construction of a new MCC room in the existing pump station building and a new generator room outside the building.
- Phase 2
  - Construction of a new larger biofilter PS when the WWTW reaches its full design capacity of 72 Ml/d (PWWF).



- Replacement of the existing delivery pipeline with a new delivery pipeline from the new biofilter PS with a larger diameter to accommodate the PWWF of 72 Ml/d.
- Reconfiguration of the new sump constructed under Phase 1 to accommodate the active volume requirements under Phase 2.
- Construction of a new MCC room for new PS under Phase 2.

### **Second-Class Water System**

- Two self-priming pumps will be installed on a hardstand
- A new filtration system.
- A square, concrete reservoir (above ground).
- A pump station to hold a multistage booster pump set to maintain a pressure of 6 bar throughout the network.
- The existing fence will be amended to include this within its perimeter.

### **Temporary Sludge Stockpile Area**

- A concrete surface bed sloped to the edges in a 1.5% slope.
- A rainwater collection sump, with a sump pump to drain the rainwater to the inlet works.

### **Flow Measurement At The Treatment Works Outfall**

- Relocate ultrasonic level sensor position from the chlorine dosing weir to the final weir.

### **Refurbishment Of Specific Road Segments**

- Approximately 385m in length of the existing roads will be regraded and surfaced to promote stormwater drainage. This length equates to approximately 2000m<sup>2</sup> of asphalt surfacing and granular base layer.

### **Remediation Of Problematic Stormwater Areas.**

- New 375mm dia Stormwater pipeline from existing concrete channel next to Biofiltration
- New 450mm dia. Stormwater pipeline from new channel next ancillary building.
- New rectangular concrete channels.
- New stone pitching and outlet chutes.
- New Stormwater catchpit and field inlets.
- Earth channel rehabilitation.
- New grassed swales.
- Existing Channel repairs.
- Replacement of solid catchpit/inlet covers.
- Headwall and outlet erosion protection.
- Subsoil Drainage.



Figure 1: Master Layout For The Isipingo WWTW

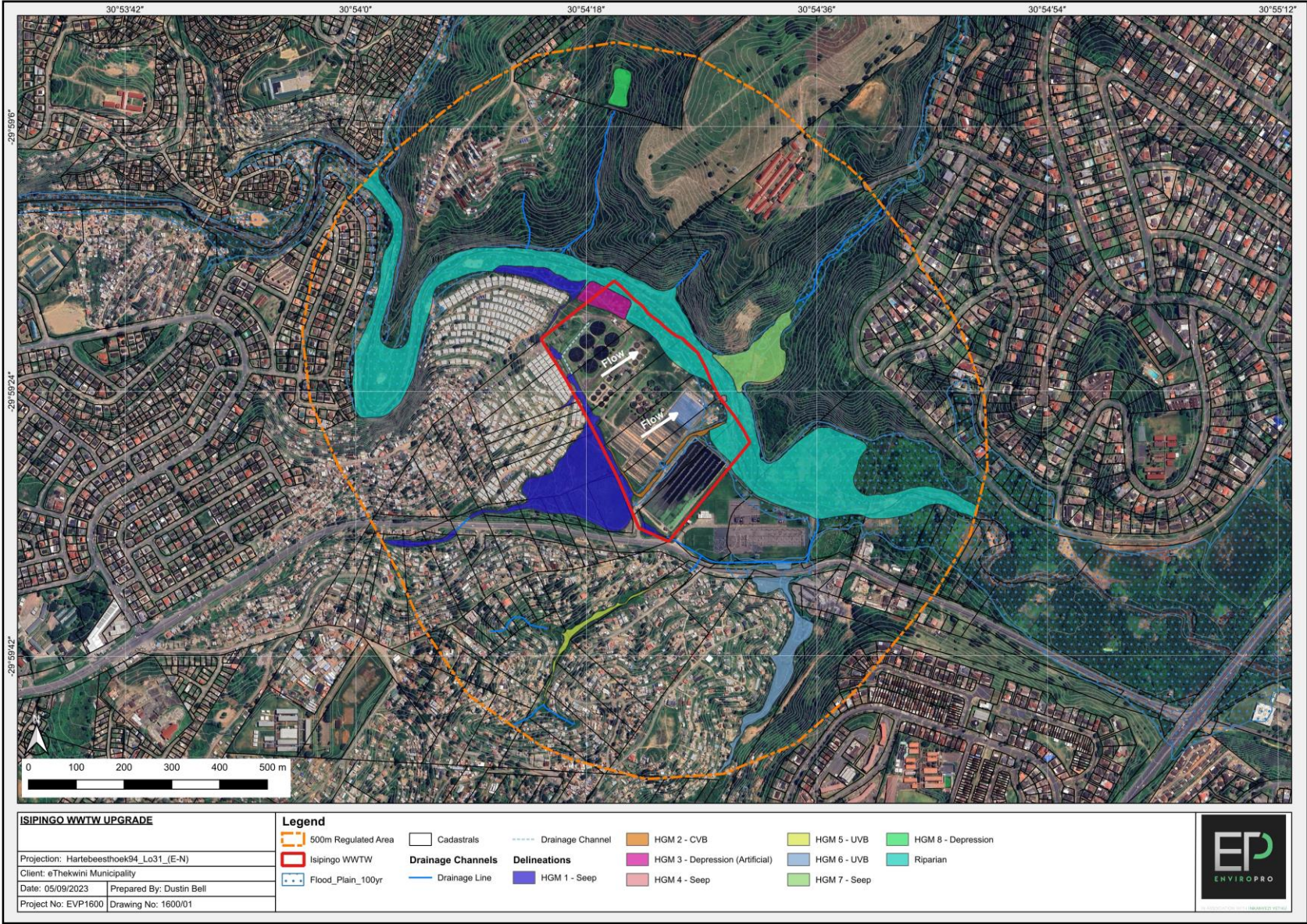
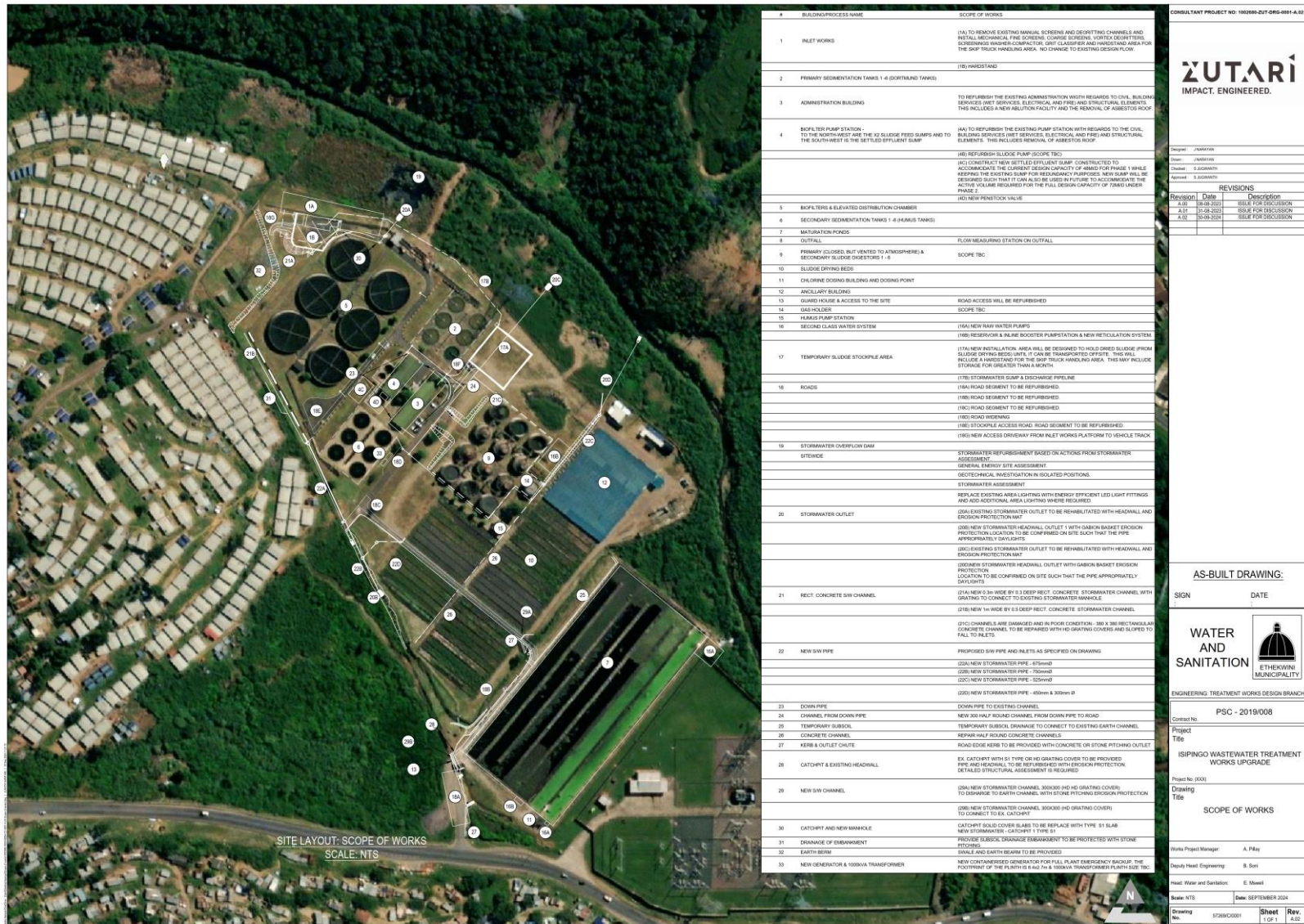




Figure 2: Scope Of Works For The Isipingo WWTW



### 1.9. Table of Responsibilities

This is to state that the undersigned have received a copy of the Environmental Management Plan (EMPr) developed for this site by *EnviroPro* dated November 2024. Any contravention of the EMPr must be recorded, and corrective action must be carried out. Any changes to the EMPr must be approved by the *Environmental Control Officer (ECO)*, the consultant *EnviroPro* and the relevant authority. Such changes are to be made in writing, and a record must be maintained.

The undersigned do hereby agree to abide by the structures of the Environmental Management Plan (EMPr) and accept responsibility for ensuring adherence to the Construction EMPr as it relates to the following areas:

Table of Responsibilities				
Job description / title	Scope of work or area of responsibility i.e., camp drainage, construction camp, housekeeping etc.	Responsible person (Name)	Signature	Date

**1.10. Names and Telephone Numbers of Contact Persons**

The following list of contacts must be printed and made clearly visible on the site.

Contact List			
Designation	Organisation	Name	Contact number
Applicant	eThekweni Municipality	Shalina Ramnund	031 311 8657
Engineer/Project Manager	Zutari	Samista Jugwanth	031 575 5500
Independent Environmental Practitioner	EnviroPro	Dustin Bell	031 765 2942
Environmental Control Officer			
Environmental Authority (Enforcement & Compliance)	EDTEA	-	033 347 1820
Environmental Authority (Enforcement & Compliance)	DWS	-	031 336 2700
Wildlife Related Incident	Ezemvelo KZN Wildlife	-	033 845 1999
Heritage Resources	AMAFA	-	033 394 6543
Fire Emergency	Fire Department	-	10111
Crime Emergency	Police	-	10111

### 1.11. Fines/Penalties

Fines/penalties will apply to the Contractors responsible for the maintenance or repair work, should they fail to comply with the provisions of the EMPr and WUL. Penalties for non-compliance need to be discussed with the Contractor on appointment. The Contractor must make every effort to ensure that staff members comply with the EMPr, and enforce non-compliance penalties. Allowances must be made for the contractor to rectify all non-compliances, prior to issuance of penalties/fine.

The Contractor will comply with the requirements of this EMPr on an ongoing basis, any failure on their part to do so will entitle the Project Manager, in consultation with the ECO to certify the imposition of a fine. The value of the fine will be agreed between the Project Manager and ECO based on the nature, extent and duration of the offence and subsequent environmental damage and will be within the confines of the contractual arrangements. Such penalties shall be payable in addition to any remediation costs for correction of environmental damage as a result of noncompliance to this EMPr, that will also be for the Contractor's account. Time penalties may also be awarded by the contract's manager where the contractors do not comply. These details are to be included into the contracts.

The Contractor is deemed NOT to have complied with the EMPr if:

- a) Within the boundaries of the site, site extensions and haul/ access roads there is evidence of contravention of the EMPr confirmed and verified by the ECO;
- b) Environmental damage ensues due to non-compliance of EMPr requirements;
- c) The Contractor fails to comply with corrective or other instructions issued within a specific time;
- d) The contractor fails to comply with a site instruction given by the Engineer based on the ECO report;
- e) The Contractor fails to respond adequately to complaints from the public in line with requirements of this EMPr; and
- f) Legal action is instituted against the proponent in terms of Environmental laws.

## SECTION 2: CONSTRUCTION MITIGATION MEASURES

### 2.1. Site Camp, Storage & Handling of Hazardous and Non-Hazardous Materials & Stockpiling

Activity	Mitigation Measure	Responsible Person	Compliant (Yes / No)
Location & Establishment of the construction camp	<ul style="list-style-type: none"> <li>The construction camp must be marked out with the approval of the ECO.</li> </ul>	CON	
	<ul style="list-style-type: none"> <li>The site camp must be located within the WWTW property.</li> <li>The site camp must be located on a flat transformed portion of land.</li> <li>Do not set up the construction camps within 25m of any watercourse.</li> </ul>	CON	
	<ul style="list-style-type: none"> <li>The site camp must be demarcated and fenced off to prevent illegal entry.</li> </ul>	CON	
	<ul style="list-style-type: none"> <li>The following areas must be demarcated and marked within the construction camp:               <ul style="list-style-type: none"> <li>A waste storage area</li> <li>A materials storage area</li> <li>Areas for fuel and hazardous chemical / flammable goods</li> <li>Stockpile areas</li> <li>Vehicle servicing and wash bay areas (if required)</li> <li>Parking area</li> </ul> </li> </ul>	CON	
Establishing storage areas & Stockpiles	<ul style="list-style-type: none"> <li>A waste storage area must be demarcated, and suitable and sufficient waste bins must be provided within the camps. Storage of waste must be on a hard surface, and undercover. Liquid waste must be situated within a bunded area.               <ul style="list-style-type: none"> <li>Liquid waste and accumulated waste must be removed from the site monthly by a recognised Waste Contractor.</li> </ul> </li> </ul>	CON	
	<ul style="list-style-type: none"> <li>A materials storage area must be identified and designated within the construction camps, which must be located more than 25m from any watercourse. Materials, specifically liquid and potentially environmentally hazardous materials must be stored within a bunded area (110% capacity of the largest container) and on a hard surface. The storage area must be undercover.</li> </ul>	CON	
	<ul style="list-style-type: none"> <li>Areas for fuel and hazardous chemical / flammable goods must be identified and signposted within the construction camps. An inventory of the materials and volumes stored must be maintained and updated once a week. These areas must be located within a bunded, hard-surfaced impermeable area.</li> </ul>	CON	
	<ul style="list-style-type: none"> <li>Bulk fuel storage: No bulk fuel storage to occur on any of the sites.</li> </ul>	CON	



Activity	Mitigation Measure	Responsible Person	Compliant (Yes / No)
	<ul style="list-style-type: none"> <li>• <b>Designated areas for stockpiling of raw materials</b> must be demarcated within the construction camps. No stockpiling is to occur on or near slopes where they could be washed into the surrounding properties or the rivers. All stockpiling areas must be approved by ECO and must be located more than 25m from the edge of any watercourse.</li> </ul>	CON	
	<ul style="list-style-type: none"> <li>• <b>Parking:</b> The contractor must designate parking areas on the sites and ensure that only these parking areas are used.</li> <li>• Vehicles must not park within 25m of any watercourse.</li> </ul>	CON	
	<ul style="list-style-type: none"> <li>• <b>Vehicle servicing and washing:</b> only emergency (breakdown where equipment is no longer mobile) and minor maintenance (e.g. greasing) may be done on the sites.               <ul style="list-style-type: none"> <li>○ A designated area must be set aside for this, which must be hard-surfaced and bunded.</li> <li>○ If emergency repairs are required, this must not be conducted within 15m of any watercourse, riparian zone or wet area.</li> <li>○ Drip trays must be used.</li> <li>○ Any other planned or required maintenance must be done off-site at a suitable location.</li> <li>○ Vehicle washing must also be conducted off-site at a designated vehicle wash bay, the wash bay must be lined with an impermeable material and must drain to a sump to ensure hydrocarbons, and other contaminants are separated before remaining runoff being discharged into the municipal sewer.</li> <li>○ No cement vehicles may be washed on site.</li> </ul> </li> </ul>	CON	
<b>Handling of liquids on site</b>	<ul style="list-style-type: none"> <li>• Decanting of any liquids/chemicals paints etc. must be done within the confines of a drip tray or on a hardened surface within a bunded area.</li> <li>• This must not be carried out within 25m of any watercourse.</li> </ul>	CON	
	<ul style="list-style-type: none"> <li>• Decanting from large containers (e.g. 210L drums) must be done using a hand pump, where possible. If no hand pump is available, liquids must be decanted on a drip tray using a funnel.</li> <li>• This must not be carried out within 25m of any watercourse.</li> </ul>	CON	
	<ul style="list-style-type: none"> <li>• All handling of hazardous materials, including cement, must take place on a hardened surface or within a drip tray or cement mixing tray.</li> <li>• This must not be carried out within 25m of any watercourse.</li> </ul>	CON	
	<ul style="list-style-type: none"> <li>• Decanting of hazardous materials must take place within the site camp above drip trays or containers to prevent the potential spillage into these areas.</li> </ul>	CON	
<b>Inventory and record of substances stored on site</b>	<ul style="list-style-type: none"> <li>• A full inventory of hazardous substances and Material Safety Data Sheet (MSDS) for each substance stored on site must be maintained, and each substance must be stored and managed per the MSDS.</li> </ul>	CON	



Activity	Mitigation Measure	Responsible Person	Compliant (Yes / No)
<b>Storage of hazardous materials</b>	<ul style="list-style-type: none"> <li>Hazardous materials and liquids to be stored in the assigned storage area as per Section 3.0 of this EMPr.</li> </ul>	CON	

## 2.2. Administration & Records

Activity	Mitigation Measure	Responsible Person	Compliant (Yes / No)
<b>Site-Specific EMPr, EA and WUL</b>	<ul style="list-style-type: none"> <li>Keep a hard copy of the Site-Specific EMPr, EA and WUL on-site and ensure that it has been signed and received by the contractor and engineer.</li> </ul>	CON	
	<ul style="list-style-type: none"> <li>All contractors, the engineers and the ECO must have a copy of the EA, WUL and EMPr before coming on to the site.</li> </ul>	ECO/ ENG	
<b>Records</b>	<ul style="list-style-type: none"> <li>An on-site environmental file must be maintained. The following documents must remain on site: <ul style="list-style-type: none"> <li>WUL</li> <li>EA</li> <li>EMPr</li> <li>Audit reports</li> <li>Waste register with safe disposal certificates</li> <li>Proof of toolbox talks.</li> <li>Any other documents requested by the ECO.</li> </ul> </li> </ul>	CON	
<b>Proof of raw material sourcing and resource use</b>	<ul style="list-style-type: none"> <li>Proof of sustainable source of all materials used must be obtained and documented, especially for raw materials i.e. topsoil, sands, natural gravels, crushed stone, clay liners, timber etc. <u>In other words, documented proof that materials have been sustainably sourced must be maintained on-site for review by EDTEA/DWS.</u> <ul style="list-style-type: none"> <li>E.g., sand may only be obtained from approved sand-winning operations, which is licensed by the Department of Mineral Resources (DMR) and have an approved EMPr for operation.</li> <li>Where materials are borrowed (mined), proof must be provided of authorisation to utilise these materials from the landowner/mineral rights owner and the Department of Minerals and Energy.</li> </ul> </li> </ul>	CON/ EO	
<b>Water abstraction for dust suppression</b>	<ul style="list-style-type: none"> <li>Water used on-site must be obtained from a municipal source or from a DWS-approved location.</li> </ul>	CON/ EO	
<b>Proof of training</b>	<ul style="list-style-type: none"> <li>Keep training attendance registers on file at all times.</li> </ul>	EO	

Activity	Mitigation Measure	Responsible Person	Compliant (Yes / No)
<b>Incident records &amp; Photographs</b>	<ul style="list-style-type: none"> <li>Keep records of incidents that have occurred and how they were remediated. It is a good idea to take photographs when incidents occur and then to take follow-up pictures to demonstrate remediation and keep these on record.</li> <li>These records must be kept on-site for review by EDTEA/DWS.</li> </ul>	EO	
<b>Appointment of ECO / EO</b>	<ul style="list-style-type: none"> <li>Appoint an ECO (Environmental Control Officer) before the commencement of construction to monitor the entire construction phase.</li> </ul>	ENG	
	<ul style="list-style-type: none"> <li>Keep proof of appointment and contact details as well as dates of audits.</li> </ul>	APP	
<b>Emergency response plan</b>	<ul style="list-style-type: none"> <li>An emergency response plan must remain on-site.</li> </ul>	ECO	
<b>Audits</b>	<ul style="list-style-type: none"> <li>A record of audits conducted on the site as well as findings must be kept on site.</li> </ul>	CON/ EO	
<b>Permits &amp; Approvals</b>	<ul style="list-style-type: none"> <li>Keep all necessary permits and approvals on file, i.e. construction licences etc.</li> <li>These must be kept on-site for review by EDTEA/DWS.</li> </ul>	CON	
<b>MSDSs</b>	<ul style="list-style-type: none"> <li>Material Safety Data Sheets (MSDSs) are to be kept on-site for all hazardous materials.</li> </ul>	CON	

### 2.3. Training & Awareness

Activity	Mitigation Measure	Responsible Person	Compliant (Yes / No)
<b>Who should be trained &amp; Frequency of training</b>	<ul style="list-style-type: none"> <li>All construction staff must have basic environmental awareness training, which can be conducted at the same time as the required health &amp; safety training.</li> </ul>	EO	
	<ul style="list-style-type: none"> <li>Staff must be trained on their environmental responsibilities before commencing work and refresher sessions can be conducted during toolbox talks on specific areas causing problems.</li> </ul>	EO	
	<ul style="list-style-type: none"> <li>Staff must sign a training register and Records of training must be kept.</li> </ul>	EO	
	<ul style="list-style-type: none"> <li>These records must be maintained on-site for review by EDTEA/DWS.</li> </ul>	EO	
<b>Training Content and staff conduct</b>	<ul style="list-style-type: none"> <li>Training must include               <ol style="list-style-type: none"> <li>The definition of environment (people + air + soil + water +business);</li> <li>Reasons for conserving and protecting the environment;</li> <li>How the following activities can impact the environment: - Not using assigned ablutions, hazardous materials, uncleaned spills, mixing of cement or paint on soil or grass surfaces, waste management, i.e. use of waste receptacles and waste separation for recycling, vehicle washing polluting soil &amp; groundwater; litter;</li> </ol> </li> </ul>	EO	

Activity	Mitigation Measure	Responsible Person	Compliant (Yes / No)
	4. What to do to prevent the above impacting the environment i.e. assign impermeable mixing areas, no vehicle washing on-site, use of waste receptacles and separation of waste to allow for recycling, how to respond in an emergency and deal with a spill; 5. Consideration of neighbours. 6. Do not play music or create any other disturbance to neighbours. 7. Use only the chemical toilets provided. 8. No dumping to occur in sensitive areas on site. 9. Use waste bins provided. 10. Use drip trays provided. 11. Do not build fires for any purpose on the site. 12. Behave in a socially acceptable manner and do not use drugs or alcohol on site. 13. There is to be no hunting of wildlife on the site and no setting of snares or traps. No animals are to be harmed or harassed.		
<b>Neighbours &amp; Working hours</b>	<ul style="list-style-type: none"> <li>Local community members must be notified of the project through community leaders and must be notified of the existence of any hazardous storage areas as well as the type of chemicals being used on site. This can be achieved through the placement of signboards.</li> </ul>	CON	
	<ul style="list-style-type: none"> <li>Limit hours of operation to weekdays 7-5pm and Saturday mornings 7 - 12 pm. Neighbours to be notified before construction on weekends takes place.</li> </ul>	CON	
	<ul style="list-style-type: none"> <li>Advise the adjoining neighbours of the work and hours of work at least one week before commencement. This can also be indicated on the signboards.</li> </ul>	CON	
	<ul style="list-style-type: none"> <li>Neighbours to be advised before periods where work will be done outside normal working hours.</li> </ul>	CON	

#### 2.4. Sensitive Social Areas, Environmental Areas, Vegetation and Vegetation Clearing and Wildlife

Activity	Mitigation Measure	Responsible Person	Compliant (Yes / No)
<b>Topsoil</b>	<ul style="list-style-type: none"> <li>Topsoil removed during the excavations must be kept to one side (stored more than 25m from any watercourse).</li> <li>During excavations the first 300 mm of soil must be stockpiled separate from the soil excavated deeper than 300 mm; and</li> <li>Soil stockpiles must not exceed 2m in height, must be covered, or grassed to prevent erosion caused by exposure to heavy wind or rain.</li> </ul>	CON/ EO	

Activity	Mitigation Measure	Responsible Person	Compliant (Yes / No)
<b>Vegetation clearing and planting</b>	<ul style="list-style-type: none"> <li>Only vegetation within the development footprint may be cleared. Any vegetation clearing must be done under the supervision of the ECO and Engineer.</li> <li>A progressive rehabilitation must be developed and implemented.</li> <li>No non-indigenous garden variety plants must be used.</li> </ul>	CON/ EO	
<b>Alien vegetation control</b>	<ul style="list-style-type: none"> <li>The Alien Management Plan (appended to the EMP) must be implemented.</li> </ul>	CON/ EO	
<b>Cultural and Heritage items</b>	<ul style="list-style-type: none"> <li>The KwaZulu-Natal Amafa and Research Institute must be contacted if any heritage objects are identified during earth-moving activities and all development should cease until further notice.</li> </ul>	CON	
<b>Paleontological Monitoring Programme</b>	<ul style="list-style-type: none"> <li>The Monitoring Programme for Palaeontology must commence once construction activities begin. <ul style="list-style-type: none"> <li>The following procedure is only required if fossils are seen on the surface and when excavations commence.</li> <li>When excavations begin, the rocks must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (wood, plants, insects, bone, coal) must be put aside in a suitably protected place. This way, the project activities will not be interrupted.</li> <li>Photographs of similar fossil plants must be provided to the developer to assist in recognising the fossil plants in the shales and mudstones. This information will be built into the EMP's training and awareness plan and procedures.</li> <li>Photographs of the putative fossils can be sent to the palaeontologist for a preliminary assessment.</li> <li>If there is any possible fossil material found by the developer/environmental officer, then the qualified palaeontologist sub-contracted for this project must visit the site to inspect the selected material and check the dumps where feasible.</li> <li>Fossil plants or vertebrates that are considered to be of good quality or scientific interest by the palaeontologist must be removed, catalogued and housed in a suitable institution where they can be made available for further study. Before the fossils are removed from the site, a SAHRA permit must be obtained. Annual reports must be submitted to SAHRA as required by the relevant permits.</li> <li>If no good fossil material is recovered, then the site inspections by the palaeontologist will not be necessary.</li> <li>If no fossils are found and the excavations have finished, then no further monitoring is required.</li> </ul> </li> </ul>	CON/ EO	

## 2.5. Soil, Stormwater Runoff; Erosion

Activity	Mitigation Measure	Responsible Person	Compliant (Yes / No)
Stormwater system	• Temporary stormwater protection measures must be established before construction activities commence.	CON	
	• No contaminated runoff or greywater is allowed to be discharged from the Site Camps into any watercourse or surrounding environment.	CON	
	• Stormwater must not be allowed to flow into surrounding properties and must enter existing stormwater channels.	CON	
Stormwater Quality	• Only clean stormwater may be diverted to a watercourse, and associated wetlands and then precautions must be in place to prevent erosion of the riverbanks. These precautions can include gabion baskets, berms or diversion ditches, sandbags	CON	
	• Washings from any vessels or any containers must not enter the watercourse. These washings are to be contained and removed as waste.	CON	
Incidents	• The entry of any substance (i.e. any material or substance that is not clean stormwater) into the stormwater or a water body is considered an incident and must be reported to the ECO <b>immediately</b> for the purposes of maintaining the site's incident records.	CON/ EO	
Stormwater flow	• The drainage system must be regularly checked to ensure unobstructed water flow.	CON	
Erosion Control	• Install erosion barriers (gabion baskets, berms or diversion ditches, sandbags) and other sediment control structures (grates or grids, geofabric) before clearing in order to prevent substances from entering exposed drains or channels.	CON	
	• Identify any steeper areas where erosion is more likely to occur. These areas must be protected from erosion. This can be achieved through the planting of vegetation, placement of berms or use of hessian material.	CON/ EO	
	• Regularly check and clean material from behind erosion barriers.	CON/ EO	
	• Sediment/soil must not be permitted to enter the watercourses. The contractor must install erosion barriers (gabion baskets, berms or diversion ditches, sandbags) and other sediment control structures (grates or grids, geofabric).	CON/ EO	

## 2.6. Housekeeping, Waste Storage Handling and Disposal

Activity	Mitigation Measure	Responsible Person	Compliant (Yes / No)
General Waste Storage	• A waste area must be designated and demarcated within the construction camp.	CON	
	• Solid waste must be stored in covered, tip-proof metal drums to be collected and disposed of by a certified waste contractor.	CON	
	• Proof of safe disposal of solid waste must be documented, and these records must be maintained on-site for review by EDTEA/DWS.		
Hazardous waste	• Hazardous materials that require disposal (cement, paints, solvents, old fuel/oil etc.) must be disposed of at a registered hazardous landfill site.	CON	
	• These materials must be removed by a hazardous waste contractor. Proof of disposal must be available to the ECO for scrutiny and kept on record.	CON	
	• Proof of safe disposal of solid waste must be documented, and these records must be maintained on-site for review by EDTEA/DWS.		
Waste from Chemical toilets	• Install chemical toilets and ensure disposal of waste at a licenced disposal facility. Proof of disposal must be kept on-site at all times.	CON	
	• Waste from the toilets must be collected weekly by a registered and reputable company.	CON	
	• Safe disposal certificates for toilet waste must be obtained and kept on-site as assurance that the waste was properly disposed of.	CON	
	• Toilets must not be situated on slopes or within 40m of any watercourse and must be secured to prevent them from tipping over.	CON	
	• Staff must use facilities provided and are not permitted to use any other areas on-site as toilet facilities.	CON	
	• Chemical toilets must be checked daily and cleaned.	CON	
Waste storage and handling	• No waste may be buried or burned on-site or dumped on surrounding properties and farmland. All waste must be disposed of at a licences waste disposal facility. Proof of disposal must be kept on-site at all times.	CON	
	• All skips must be covered to contain odours and prevent waste from blowing around the site.	CON	
	• A register of all waste generated and disposed of must be maintained.	CON/EO	
	• No dumping is permitted. There must be no dumping on site under any circumstances. The contractor is liable to a fine should there be any evidence of illegal dumping.	CON	
	• The ECO to review the damage and advise on rehabilitation measures if required.		
	• Do not place waste containers, skip bins or building materials on steep slopes or within 15m of any watercourse.	CON/EO	

Activity	Mitigation Measure	Responsible Person	Compliant (Yes / No)
Waste separation	<ul style="list-style-type: none"> <li>Waste accumulated on-site must be removed weekly. The waste must be moved to a licenced waste disposal facility.</li> </ul>	CON	
	<ul style="list-style-type: none"> <li>Provide litter bins throughout the site for use by all staff on site.</li> </ul>	CON	
	<ul style="list-style-type: none"> <li><b>Hazardous:</b> Hazardous waste must be stored separately from general waste. <ul style="list-style-type: none"> <li>Hazardous waste must be disposed of at an approved hazardous waste landfill, and safe disposal certificates must be obtained.</li> <li>Hazardous waste includes used oils, lubricants, solvents, solvent-based paints, concrete waste, and cement.</li> </ul> </li> </ul>	CON/EO	
	<ul style="list-style-type: none"> <li><b>Oils</b> must be within a bunded storage area and treated as flammable waste. <ul style="list-style-type: none"> <li>Where possible used oils must be recycled.</li> <li>Safe disposal certificates must be kept on-site demonstrating disposal or recycling of the used oils.</li> <li>Solid paint waste may be disposed of as general waste.</li> </ul> </li> </ul>	CON/EO	
	<ul style="list-style-type: none"> <li><b>Concrete waste:</b> <ul style="list-style-type: none"> <li>Return excess concrete with the delivery truck to the supplier for recycling or proper disposal.</li> <li>Any other excess concrete, i.e. on-site mixed concrete, can be stored in a lined bin for eventual recycling or disposal.</li> </ul> </li> </ul>	CON/EO	

## 2.7. Noise

Activity	Mitigation Measure	Responsible Person	Compliant (Yes / No)
Noise Generation and suppression	<ul style="list-style-type: none"> <li>All construction vehicles must be fitted with standard silencers and be well-maintained.</li> </ul>	CON	
	<ul style="list-style-type: none"> <li>Workers must be trained regarding noise on-site, and construction hours must be kept to working hours (07h00 to 17h00).</li> </ul>	CON	

## 2.8. Dust & Emissions

Activity	Mitigation Measure	Responsible Person	Compliant (Yes / No)
Dust from stockpiles	<ul style="list-style-type: none"> <li>Cover any stockpiled fine material that may release dust with plastic.</li> </ul>	CON	
Dust from surfaces	<ul style="list-style-type: none"> <li>Damp down surfaces and stockpiles as required to reduce windblown dust.</li> </ul>	CON	
	<ul style="list-style-type: none"> <li>A water cart may be used which must remain on designated roadways if required.</li> </ul>	CON	
	<ul style="list-style-type: none"> <li>If dust from the site is likely to create problems for nearby residents, these areas must be shielded with shade cloth.</li> </ul>	CON	

## 2.9. Vehicle Maintenance, Operation, Driving On-Site and Vehicle Washing

Activity	Mitigation Measure	Responsible Person	Compliant (Yes / No)
Access points	<ul style="list-style-type: none"> <li>Haulage roads must be demarcated at the site set-up.</li> </ul>	CON	
	<ul style="list-style-type: none"> <li>Turning areas must be located within the construction footprint and must be designated.</li> </ul>	CON/ EO	
	<ul style="list-style-type: none"> <li>Temporary access roads must not be located within adjoining properties.</li> </ul>	CON/ EO	
	<ul style="list-style-type: none"> <li>No ad hoc haulage roads or turning areas may be created.</li> </ul>	CON/ EO	
	<ul style="list-style-type: none"> <li>Limit vehicle entry point to the designated access point and ensure no other point of entry is used.</li> </ul>	CON/ EO	
	<ul style="list-style-type: none"> <li>All vehicles to remain in the parking area designated within the construction site.</li> </ul>	CON/ EO	
Vehicle Servicing and repairs	<ul style="list-style-type: none"> <li>No major equipment or vehicle servicing to occur on-site, i.e. major disassembly and repair work, clutch replacements and oil or lubricant changes must be carried out at a suitably equipped workshop.</li> </ul>	CON	
	<ul style="list-style-type: none"> <li>Only minor emergency repairs, i.e. those necessary to get the vehicle moving so that it can be taken to a repair facility to be carried out, i.e. stopping of oil leaks, lubricating of hydraulics, changing of buckets/breakers on Excavators and TLBs or changing of tyres. This must be carried out in designated workshop areas within the allowed construction camps. These areas to be hard-surfaced and bunded.</li> </ul>	CON	
	<ul style="list-style-type: none"> <li>Drip trays are to be used by all leaking vehicles and equipment.</li> </ul>	CON/ EO	
	<ul style="list-style-type: none"> <li>All vehicles to be equipped with drip trays.</li> </ul>	CON/ EO	
	<ul style="list-style-type: none"> <li>All small machinery used on site must be situated on a drip tray (i.e. pumps, generators, compressors etc.).</li> </ul>	CON/ EO	



Activity	Mitigation Measure	Responsible Person	Compliant (Yes / No)
	<ul style="list-style-type: none"> <li>All vehicles to be regularly maintained and maintenance records must be made available on request.</li> </ul>	CON/ EO	
	<ul style="list-style-type: none"> <li>No leaking vehicles to be allowed on site.</li> </ul>	CON/ EO	
	<ul style="list-style-type: none"> <li>Any vehicles that are leaking must not be allowed entry to the site.</li> </ul>	CON/ EO	
	<ul style="list-style-type: none"> <li>No vehicles to be washed on-site - cement trucks are not permitted to wash out cement mixers on site.</li> </ul>	CON/ EO	
	<ul style="list-style-type: none"> <li>Only emergency (breakdown where equipment is no longer mobile) and minor maintenance (e.g. greasing) may be done on-site. Any other planned or required maintenance must be done offsite at a suitable location.</li> </ul>	CON	

## 2.10. Incidents, Spills and Emergency Response

Activity	Mitigation Measure	Responsible Person	Compliant (Yes / No)
<b>Spill kits</b>	<ul style="list-style-type: none"> <li>Adequate spill kits and containers for spilt and contaminated material to be on standby on site.</li> </ul>	CON/EO	
	<ul style="list-style-type: none"> <li>Keep marked booms and/or absorbent material on-site to contain spills if they occur.</li> </ul>	CON/ EO	
	<ul style="list-style-type: none"> <li>All staff must be trained on how to react in the case of an emergency.</li> </ul>	CON-SHE	
	<ul style="list-style-type: none"> <li>If a spill occurs, stop the source, contain it, clean up as per MSDSs and notify relevant authorities.</li> </ul>	CON/ EO	
	<ul style="list-style-type: none"> <li>Make staff aware of emergency phone numbers to use in the case of a large spill.</li> </ul>	CON/ EO	
<b>Definition of incidents</b>	<ul style="list-style-type: none"> <li>All incidents are to be recorded.</li> </ul>	CON/ EO	
	<ul style="list-style-type: none"> <li><b>Minor incidents:</b> small spills less than 5 l that do not enter stormwater or the stream/river, minor non-compliance with EMPr that does not cause major environmental impact, i.e. housekeeping issues etc. <ul style="list-style-type: none"> <li><b>Action:</b> Supervisor and staff on-site to record and address and notify ECO. Take photos of the spill. Prevent spill from spreading and contain. Collect spilt material and contaminated soil and place in a sealed container for disposal. ECO to advise on remediation measures and to follow up on actions taken to address the incident.</li> <li><b>Records:</b> On-site incident register.</li> </ul> </li> </ul>	CON/ EO	
	<ul style="list-style-type: none"> <li><b>Major incidents:</b> Large spills or any spills that enter stormwater or the stream/river, fires, explosions. Please see the definition of a reportable incident provided below. <ul style="list-style-type: none"> <li><b>Action:</b> Report immediately to ECO, action to be taken to prevent further damage and</li> </ul> </li> </ul>	CON/ EO	

Activity	Mitigation Measure	Responsible Person	Compliant (Yes / No)
	<p>incident to be reported to authorities. ECO to advise on remediation measures and to follow up on actions taken to address the incident.</p> <ul style="list-style-type: none"> <li>○ <b>Records:</b> On-site incident register and report to authorities.</li> </ul>		

### 2.11. Sewage and Grey Water Management

Activity	Mitigation Measure	Responsible Person	Compliant (Yes / No)
<b>Sewage</b>	<ul style="list-style-type: none"> <li>• Adequate toilet facilities (such as chemical toilets) sufficient in number to cater for the number of staff on-site must be provided. One toilet per 15 staff must be provided.</li> </ul>	CON	
	<ul style="list-style-type: none"> <li>• Waste must be managed as per section 2.6, namely removed by a licensed contractor, and safe disposal certificates retained to prove proper disposal.</li> <li>• Safe disposal certificates must be kept on-site for review by the EDTEA/DWS.</li> </ul>	CON/ EO	
	<ul style="list-style-type: none"> <li>• Greywater must not be permitted to enter the surrounding properties or stormwater.</li> </ul>	CON/ EO	
<b>Greywater/wash water</b>	<ul style="list-style-type: none"> <li>• Vehicles, especially cement trucks, must not be washed on-site these must be washed at a wash bay facility off-site.</li> </ul>	CON/ EO	
	<ul style="list-style-type: none"> <li>• Alternately the wash water can be collected and returned with the supplier's truck for disposal by the supplier.</li> </ul>	CON/ EO	

## SECTION 3: POST-CONSTRUCTION, REHABILITATION AND OPERATION

### 3.1. Post Construction Activities

Activity	Mitigation Measure	Responsible Person	Compliant (Yes / No)
<b>Post Construction Audit</b>	<ul style="list-style-type: none"> <li>Clearance from the ECO must be obtained to ensure the all of the requirements of the EMPr have been complied with.</li> </ul>	ECO	
<b>Stormwater</b>	<ul style="list-style-type: none"> <li>The Contractor must check that the stormwater channels are free from building rubble, spoil materials, and waste materials.</li> </ul>	CON	
	<ul style="list-style-type: none"> <li>Ensure that in the long term; stormwater is protected from ingress by potential pollutants.</li> </ul>	CON	
<b>Waste &amp; Spills</b>	<ul style="list-style-type: none"> <li>All spillages must be cleaned and contaminated soil must be removed and disposed of.</li> </ul>	CON/ EO	
	<ul style="list-style-type: none"> <li>All remaining waste bins and/or skips must be removed and disposed of. Records of disposal must be retained.</li> </ul>	CON/ EO	
	<ul style="list-style-type: none"> <li>All excess concrete must be removed from the site on completion of works and disposed of. Washing of the excess into the ground is not allowed.</li> </ul>	CON/ EO	
	<ul style="list-style-type: none"> <li>All excess aggregate must also be removed.</li> </ul>	CON	
	<ul style="list-style-type: none"> <li>Used oil must have been collected by a registered used oil contractor and documentation to this effect provided.</li> </ul>	CON	
	<ul style="list-style-type: none"> <li>Surfaces are to be checked for waste products from activities such as concreting are cleared in a manner approved by the ECO.</li> </ul>	CON	
	<ul style="list-style-type: none"> <li>No litter must be left on site.</li> </ul>	CON/EO	
<b>Structures, materials and stockpiles</b>	<ul style="list-style-type: none"> <li>Any fences, barriers, or demarcations utilised for the construction phase must be removed and disposed of.</li> </ul>	CON	
	<ul style="list-style-type: none"> <li>All structures and imported materials within the construction camp must be removed.</li> </ul>	CON	
	<ul style="list-style-type: none"> <li>The remaining building materials must be removed from the site.</li> </ul>	CON	
<b>Damage</b>	<ul style="list-style-type: none"> <li>Any damage incurred on the neighbouring homesteads by the contractor must be repaired by the contractor.</li> </ul>	CON	
	<ul style="list-style-type: none"> <li>Any damage to existing infrastructure must be repaired or replaced on completion of the upgrade.</li> </ul>	CON	
<b>Close Out</b>	<ul style="list-style-type: none"> <li>A meeting must be held between Engineer, the ECO, and the contractor to approve all remediation activities and ensure that the site has been restored to a condition, which has been approved by the Engineer.</li> </ul>	ENG	

Activity	Mitigation Measure	Responsible Person	Compliant (Yes / No)
<b>Vegetation</b>	<ul style="list-style-type: none"> <li>All vegetation planting must be completed and any areas that have been disturbed or cleared must have been rehabilitated and revegetated.</li> </ul>	ECO	
	<ul style="list-style-type: none"> <li>Re-vegetation of cleared land must utilise only 100% locally indigenous plant material to ensure no erosion occurs once the site is vacated.</li> </ul>	CON/EO	
	<ul style="list-style-type: none"> <li>Ensure that no sensitive habitats have been damaged during the construction phase.</li> </ul>	ECO	
	<ul style="list-style-type: none"> <li>Where habitats have been damaged, these must be reported to the ECO and procedures for rehabilitation of these habitats must be undertaken.</li> </ul>	CON/EO	
<b>Erosion</b>	<ul style="list-style-type: none"> <li>Any eroded soil on paths/roadways/ other areas must be collected and replaced in the area from which it was eroded. These high-risk erosion areas must be protected from further soil erosion.</li> </ul>	CON/EO	

### 3.2. Rehabilitation

Activity	Mitigation Measure	Responsible Person	Compliant (Yes / No)
<b>Rehabilitation of areas surrounding the site</b>	<ul style="list-style-type: none"> <li>Grass can be reintroduced by Hydroseeding or planting of grass plugs.</li> <li>Cleared areas must not be left exposed for periods longer than two weeks and must be re-vegetated in stages as each section is completed.</li> <li>Where serious habitat damage has taken the damaged must be reported to the ECO. Consultation between the ECO, contractor, and engineer must take place. Whereby the contractor must develop and suitable method statement which must focus on the rehabilitation of the damaged area. This method statement must be approved by both the ECO and engineer. The contractor must then implement this method statement under the supervision of the ECO.</li> </ul>	CON/ EO	
<b>Top Soil</b>	<ul style="list-style-type: none"> <li>Topsoil removed during the excavations must be kept to one side (stored more than 15m from all watercourses) and re-used in the same area that it was excavated from. Much of this topsoil, especially the top 30cm will retain grass and vegetation seeds.</li> <li>This topsoil to be used when re-vegetating and rehabilitating areas cleared for construction/ excavation.</li> </ul>	CON/ EO	
<b>Rehabilitation of eroded areas</b>	<ul style="list-style-type: none"> <li>Any erosion damage caused during construction must be repaired. The affected area must be reshaped, and the soil replaced.</li> </ul>	CON/ EO	

Activity	Mitigation Measure	Responsible Person	Compliant (Yes / No)
	<ul style="list-style-type: none"> <li>The eroded area must be re-vegetated or measures put in place to control further erosion. The contractor must install erosion barriers (gabion baskets, berms or diversion ditches, sandbags) and other sediment control structures (grates or grids, geofabric).</li> </ul>		
<b>Removal of alien invasive plants</b>	<ul style="list-style-type: none"> <li>Alien invasive species must be removed on an on-going basis as per the Alien Plant Plan</li> </ul>	CON/ EO	
<b>Damage to any watercourse</b>	<ul style="list-style-type: none"> <li>Where any watercourse has been damaged, the following measures are to be taken to ensure restoration of the habitat:               <ul style="list-style-type: none"> <li>ECO must assess the damaged area</li> <li>Any construction debris or contaminants within the watercourse must be removed</li> <li>Original soil structure must be restored</li> <li>Any impedance or diversion to water flow must be removed</li> <li>The area must be vegetated with suitable riparian or wetland species</li> </ul> </li> <li>No loose soil or damaged banks can be left behind after construction.</li> </ul>	CON/ EO	

### 3.3. Operation

Activity	Mitigation Measure	Responsible Person	Compliant (Yes / No)
<b>Maintenance of the WWTW</b>	<ul style="list-style-type: none"> <li>The WWTW will require maintenance during operation. This work must be undertaken by appointed staff only. This EMPr must be used to mitigate against any potential risks to the environment. The following mitigation measures must be implemented on-site during all inspections and maintenance work:               <ul style="list-style-type: none"> <li>All maintenance vehicles and machinery must make use of existing access routes;</li> <li>Laydown yards, camps, and storage areas must be more than 25m from any water resource;</li> <li>Work must be restricted to existing cleared property boundary. Clearance of indigenous vegetation is prohibited.</li> <li>All machinery and equipment must be inspected regularly for faults and possible leaks, these must be serviced off-site</li> <li>The contractors used for the maintenance must have spill kits available to ensure that any fuel or oil spills are clean-up and discarded correctly;</li> <li>Uncontrolled access of vehicles through any watercourse must not be permitted;</li> </ul> </li> </ul>	CON/ EO	

Activity	Mitigation Measure	Responsible Person	Compliant (Yes / No)
	<ul style="list-style-type: none"> <li>○ Adequate sanitary facilities and ablutions must be provided for all personnel on-site. Use of these facilities must be enforced;</li> <li>○ All removed soil and material must not be stockpiled more than 15m from any water resource. All stockpiles must be protected from erosion, stored on flat areas where run-off will be minimised, and be surrounded by bunds;</li> <li>○ No dumping of construction material on-site may take place;</li> <li>○ An on-site environmental file must be maintained. The following documents must remain on site:               <ul style="list-style-type: none"> <li>○ WUL</li> <li>○ EA</li> <li>○ EMPr</li> <li>○ Audit reports</li> <li>○ Waste register with safe disposal certificates</li> <li>○ Proof of toolbox talks.</li> <li>○ Any other documents requested by the ECO.</li> </ul> </li> <li>○ The waste hierarchy must be implemented on site, reduce, reuse and recycle. All waste generated on-site during construction must be adequately managed. Separation and recycling of different waste materials should be supported. Safe disposal certificates must be obtained and kept on file for review.</li> <li>○ Toolbox talks must be conducted on a regular basis which must cover environmental topic dealing with but not limited to, waste management, conservation of water, protection of fauna and flora and good housekeeping.</li> <li>○ An ECO (Environmental Control Officer) must be appointed before commencement of construction to monitor the entire construction phase. The ECO must undertake an audit every month during maintenance activities.</li> <li>○ Keep proof of appointment and contact details as well as dates of audits.</li> <li>○ All audit report must be sent to the compliance division of EDTEA/DWS for review.</li> </ul>		
<b>Soil Erosion</b>	<ul style="list-style-type: none"> <li>• The erosion protection features installed on the site must be checked to ensure, they continue to perform their function during the operational phase of the project.</li> </ul>	APP	
<b>Vegetation</b>	<ul style="list-style-type: none"> <li>• Alien vegetation must be monitored and removed on an on-going basis as per the Invasive Alien Plant Programme.</li> <li>• Indigenous vegetation planting must continue on an on-going basis if it is required.</li> </ul>	APP	

## SECTION 4: DEFINITIONS

**Stormwater**

Clean rainwater, must be allowed to enter the stormwater system or natural water bodies without causing erosion. Stormwater must not be contaminated with any other substance including soaps, washings, hazardous materials, soil etc.

**Greywater**

This is wash water that may contain non-hazardous soaps, i.e. bathwater, vehicle wash water etc. This must not be permitted to enter the stormwater system but can be disposed of in the sewage system or as effluent. If no sewage system is available on site, the greywater must be collected and disposed of.

**Sewage**

Human excrement from chemical toilets.

***Raw materials for which source statement must be obtained***

Topsoil, sands, natural gravels, crushed stone, asphalt, clay liners, timber etc. E.G., sand may only be obtained from approved sand winning operations, which is licensed and has an approved EMPr for operation.

**Incidents**

All incidents must be recorded. Minor incidents could include small spills of less than 5l that do not enter a water body or any stormwater drains, as well as housekeeping issues and general small non-compliances with the requirements of the EMPr. Major incidents are those that must be reported to the authorities and include all incidents involving contamination of a water body or stormwater or other reportable incidents as defined below.

**Reportable incident** is defined as 'an unexpected sudden occurrence, including a major emission, fire or explosion leading to serious danger to the public or potentially serious pollution of or detriment to the environment, whether immediate or delayed' NEMA Section 30, 'includes any incident or accident in which a substance (a) pollutes or has the potential to pollute a water resource; or (b) has, or is likely to have, a detrimental effect on a water resource.' NWA Section 20.

## SECTION 5: RECORDS

**Training Register – Record any training that has taken place.**

<b>Training Conducted:</b>
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Training provided by:
-----------------------

[illegible]



[illegible]

[illegible]

## Environmental Emergency Response and Definition of an Incident

<b>Aim of this document</b>	<ul style="list-style-type: none"> <li>To effectively manage the response to emergency incidents and control these incidents should they occur.</li> <li>To ensure that such incidents are recorded and, where possible, all measures are taken to prevent them from re-occurring.</li> <li>To provide a definition for what would be considered a reportable incident in terms of the environmental legislation.</li> </ul> <p>Activities covered in this procedure include:</p> <ul style="list-style-type: none"> <li>Identification and definition of an incident and whether or not it needs to be reported to the authorities.</li> <li>Reporting to the relevant authorities if a reportable incident occurs</li> <li>Procedure to follow in the event of a spill or fire.</li> </ul>
<b>Personnel Duties and Responsibilities</b>	<p>The contractor is responsible for:</p> <ul style="list-style-type: none"> <li>Ensuring all activities are carried out as per this procedure and that the company complies with relevant legislation.</li> <li>Maintaining a register of all incidents as well as ensuring that an incident report is generated for each incident, including details of the incident and how it was closed out.</li> <li>Ensuring that safe disposal certificates are obtained for any waste materials generated as a result of an incident and that this waste is recorded.</li> <li>Providing the necessary spill kit equipment and drums for storage of contaminated soil etc.</li> </ul>
<b>Training Requirements</b>	<ul style="list-style-type: none"> <li>All personnel and workforce to undergo a site safety and environmental induction before starting work on site. All employees to be trained on how to respond to an environmental incident and whom to contact in order to ensure that the incident is addressed and recorded and if necessary reported.</li> </ul>
<b>Definition of a “reportable incident”</b>	<ul style="list-style-type: none"> <li>In terms of the National Environmental Management Act, major incidents must be reported to the authorities. In terms of the National Water Act, any incident involving a substance which has the potential to pollute a water resource must be reported, i.e. any spill of into a watercourse or the stormwater system must be reported. The relevant sections from the legislation are provided below:</li> </ul>
<b>National Environmental Management Act</b>	<p><i>As defined by NEMA, section 30 “Control of emergency incidents”.</i></p> <p><i>(1) In this section—</i></p> <p><i>(a) “incident” means an unexpected sudden occurrence, including a major emission, fire or explosion leading to serious danger to the public or potentially serious pollution of or detriment to the environment, whether immediate or delayed;</i></p> <p><i>(b) “responsible person” includes any person who—</i></p> <p><i>(i) is responsible for the incident;</i></p> <p><i>(ii) owns any hazardous substance involved in the incident; or</i></p> <p><i>(iii) was in control of any hazardous substance involved in the incident at the time of the incident;</i></p> <p><i>(c) “relevant authority” means—</i></p>

	<p>(i) a municipality with jurisdiction over the area in which an incident occurs;</p> <p>(ii) a provincial head of department or any other provincial official designated for that purpose by the MEC in a province in which an incident occurs;</p> <p>(iii) the Director-General;</p> <p>(iv) any other Director-General of a national department.</p>
<b>National Water Act</b>	<p>As defined by the National Water Act section 20 "Control of emergency incidents"</p> <p>(1) In this section "incident" includes any incident or accident in which a substance -</p> <p>(a) pollutes or has the potential to pollute a water resource; or</p> <p>(b) has, or is likely to have, a detrimental effect on a water resource.</p>
<b>Reporting to the authorities</b>	<p>If a reportable incident occurs, the Site Agent / Project Manager and Environmental Control Officer must be notified immediately. No site staff may communicate directly with the authorities.</p> <p>The relevant sections from the legislation are included below:</p> <p>As taken from NEMA, section 30: Control of Emergency Incidents:</p> <p>(3) The responsible person or, where the incident occurred in the course of that person's employment, his or her employer must forthwith after knowledge of the incident, report through the most effective means reasonably available—</p> <p>(a) the nature of the incident;</p> <p>(b) any risks posed by the incident to public health, safety and property;</p> <p>(c) the toxicity of substances or byproducts released by the incident; and</p> <p>(d) any steps that should be taken in order to avoid or minimise the effects of the incident on public health and the environment too—</p> <p>(i) the Director-General;</p> <p>(ii) the South African Police Services and the relevant fire prevention service;</p> <p>(iii) the relevant provincial head of department or municipality; and</p> <p>(iv) all persons whose health may be affected by the incident.</p> <p>(4) The responsible person or, where the incident occurred in the course of that person's employment, his or her employer, must, as soon as reasonably practicable after knowledge of the incident—</p> <p>(a) take all reasonable measures to contain and minimise the effects of the incident, including its effects on the environment and any risks posed by the incident to the health, safety and property of persons;</p> <p>(b) undertake cleanup procedures;</p> <p>(c) remedy the effects of the incident;</p> <p>(d) assess the immediate and long term effects of the incident on the environment and public health.</p> <p>(5) The responsible person or, where the incident occurred in the course of that person's employment, his or her employer, must, within 14 days of the incident, report to the Director-General, provincial head of department and municipality such information as is available to enable an initial evaluation of the incident, including—</p> <p>(a) the nature of the incident;</p> <p>(b) the substances involved and an estimation of the quantity released and their possible acute effect on persons and the environment and data needed to assess these effects;</p> <p>(c) initial measures taken to minimise impacts;</p>

	<p>(d) causes of the incident, whether direct or indirect, including equipment, technology, system, or management failure; and</p> <p>(e) measures taken and to be taken to avoid a recurrence of such incident.</p> <p>(6) A relevant authority may direct the responsible person to undertake specific measures within a specific time to fulfil his or her obligations under subsections (4) and (5): Provided that the relevant authority must, when considering any such measure or time period, have regard to the following:</p> <p>(a) the principles set out in section 2;</p> <p>(b) the severity of any impact on the environment as a result of the incident and the costs of the measures being considered;</p> <p>(c) any measures already taken or proposed by the person on whom measures are to be imposed, if applicable;</p> <p>(d) the desirability of the State fulfilling its role as custodian holding the environment in public trust for the people;</p> <p>(e) any other relevant factors.</p> <p>(7) A verbal directive must be confirmed in writing at the earliest opportunity, which must be within seven days.</p> <p>(8) Should—</p> <p>(a) the responsible person fails to comply, or inadequately comply with a directive under subsection (6);</p> <p>(b) there be uncertainty as to who the responsible person is; or</p> <p>(c) there be an immediate risk of serious danger to the public or potentially serious detriment to the environment, a relevant authority may take the measures it considers necessary to—</p> <p>(i) contain and minimise the effects of the incident;</p> <p>(ii) undertake cleanup procedures; and</p> <p>(iii) remedy the effects of the incident.</p>
<b>National Water Act section 20: Control of emergency incidents</b>	<p>(2) In this section, "responsible person" includes any person who -</p> <p>(a) is responsible for the incident;</p> <p>(b) owns the substance involved in the incident, or</p> <p>(c) was in control of the substance involved in the incident at the time of the incident.</p> <p>(3) The responsible person, any other person involved in the incident or any other person with knowledge of the incident must, as soon as reasonably practicable after obtaining knowledge of the incident, report to -</p> <p>(a) the Department;</p> <p>(b) the South African Police Service or the relevant fire department; or</p> <p>(c) the relevant catchment management agency.</p> <p>(4) A responsible person must -</p> <p>(a) take all reasonable measures to contain and minimise the effects of the incident;</p> <p>(b) undertake to clean-up procedures;</p> <p>(c) remedy the effects of the incident; and</p> <p>(d) take such measures as the catchment management agency may either verbally or in writing direct within the time specified by such institution.</p>
<b>Spill response</b>	
<b>Responsible Person/s</b>	The spill is reported to the site foreman who must notify his superior.

	All employees must be made aware of the procedure in case of a spill.
<b>Procedure</b>	<ol style="list-style-type: none"> <li>1. Identify the nature of the spill, e.g. paint, oil or lubricants</li> <li>2. Locate spill kit</li> <li>3. Contain spill according to the training provided</li> <li>4. Where necessary, contact external spill control contractors</li> <li>5. Ensure spill does not cause any external contamination (such as storm/groundwater or soil)</li> <li>6. Ensure that cleanup measures are taken if any contamination has occurred</li> <li>7. Record in emergency response record the: <ul style="list-style-type: none"> <li>• Nature of incident</li> <li>• Cause of incident</li> <li>• Clean up measures</li> <li>• Mitigation measures are taken</li> </ul> </li> <li>8. Record in non-conformance register</li> <li>9. The ECO and Project Manager will determine if the event qualifies as an incident and take steps to report the incident to the necessary authorities, i.e. EDTEA and DWS.</li> <li>10. The ECO shall review all spill reports</li> </ol>
<b>Fire</b>	
<b>Responsible Person/s</b>	<p>The fire is reported to the site foreman</p> <p>All employees must be made aware of the procedure in case of fire.</p>
<b>Procedure</b>	<ol style="list-style-type: none"> <li>1. Identify the source and nature of fire.</li> <li>2. In case of small fire extinguish with material appropriate to the nature of the fire</li> <li>3. In case of a large fire contact Fire Department</li> <li>4. In the site camp, seal off exposed stormwater drains to ensure firewater does not cause any external contamination. If on-site, take measures to prevent firewater from entering any water body.</li> <li>5. Ensure that clean-up measures are taken if any contamination has occurred</li> <li>6. Record in emergency response record the: <ul style="list-style-type: none"> <li>• Nature of incident</li> <li>• Cause of incident</li> <li>• Clean up measures</li> <li>• Mitigation measures are taken</li> </ul> </li> <li>7. Record in non-compliance register</li> <li>8. The ECO and Project Manager will determine if the event qualifies as an incident and take steps to report to the authorities.</li> <li>9. The EO shall review incident/nonconformance reports</li> <li>10. Adjustments will be made, if necessary, to the operational and emergency procedures and the Environmental Management System to prevent future occurrences</li> </ol>
<b>Explosion</b>	
<b>Responsible Person/S</b>	The explosion is reported to the site foreman who must notify his superior.

	All employees must be made aware of the procedure in case of an explosion.
<b>Procedure</b>	<ol style="list-style-type: none"> <li>1. Identify the source and nature of the explosion.</li> <li>2. In case of small fire as a result of the explosion, extinguish with material appropriate to the nature of the fire</li> <li>3. In case of a large fire as a result of the explosion contact Fire Department</li> <li>4. In the site camp, seal off exposed stormwater drains to ensure firewater does not cause any external contamination. If on-site, take measures to prevent firewater from entering any water body.</li> <li>5. Ensure that clean-up measures are taken if any contamination has occurred</li> <li>6. Record in emergency response record the: <ul style="list-style-type: none"> <li>• Nature of incident</li> <li>• Cause of incident</li> <li>• Clean up measures</li> <li>• Mitigation measures are taken</li> </ul> </li> <li>7. Record in non-compliance register</li> <li>8. The ECO and Project Manager will determine if the event qualifies as an incident and take steps to report the incident to the necessary authorities, i.e. EDTEA and DWS.</li> <li>9. The ECO shall review spill reports</li> </ol>
<b>Resource Requirements</b>	
<b>Materials</b>	<ul style="list-style-type: none"> <li>• Separate drums for contaminated soil.</li> <li>• Spade and clean soil</li> <li>• Fire equipment</li> </ul>


**Alien Management Plan**



 <p><b>edtea</b> Department: Economic Development, Tourism and Environmental Affairs PROVINCE OF KWAZULU-NATAL</p>	<b>ALIEN MANAGEMENT PLAN</b>	Page No.:	1 of 36
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# ALIEN MANAGEMENT PLAN

**October 2024**

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## 1. **PURPOSE**

Invasive alien plant (IAP) species pose the second largest threat to biodiversity after direct habitat destruction. The purpose of this Alien Invasive Plant Management Plan is to provide a framework for the management of alien and invasive plant species on site. The broad aim of the plan include the following:

- Protocols for the removal and control of alien invasive species.
- Guidelines on implementation and post-implementation tasks.

## 2. **SCOPE**

This plan acts as a guideline to be applied on site. The plan is an evolving guideline that needs to be updated or adapted as progress is made in terms of the control of alien invasive species within the project area, and successes and failures of procedures identified.

The objectives of the plan are:

- Actively aid the improvement of indigenous biodiversity within and around the site by removing all invasive alien plant species.
- Improving the ecosystem function of natural landscapes and their associated vegetation.

## 3. **LEGISLATIVE CONTEXT**

### ***Conservation of Agricultural Resources Act (Act No. 43 of 1983)***

In terms of the amendments to the regulations under the Conservation of Agricultural Resources Act (Act No. 43 of 1983) (CARA), all declared alien plant species must be effectively controlled. Landowners are legally responsible for the control of invasive alien plants on their properties. In terms of this Act alien invasive plant species are ascribed to one of the following categories:


- **Category 1:** Prohibited and must be controlled.
- **Category 2** (commercially used plants): May be grown in demarcated areas provided that there is a permit and that steps are taken to prevent their spread.
- **Category 3** (ornamentally used plants): May no longer be planted. Existing plants may be retained as long as all reasonable steps are taken to prevent the spreading thereof, except within the flood line of watercourses and wetlands.

Please see attached Annexure 1, for the list of the Alien Invasive Plants, as identified by CARA.

### ***National Environmental Management: Biodiversity Act, 2004 (Act No.10 of 2004)***

The National Environmental Management: Biodiversity Act (NEMBA) is the most recent legislation pertaining to alien invasive plant species. In August 2014, the list of Alien Invasive Species was published in terms of the National Environmental Management: Biodiversity Act (Act 10 of 2004) (Government Gazette No 78 of 2014). The Alien and Invasive Species Regulations were published in the Government Gazette No. 43726, 18 September 2020. The legislation calls for the removal and/or control of alien invasive plant species (Category 1 species). In addition, unless authorised thereto in terms of the National Water Act, 1998 (Act No. 36 of 1998), no land user shall allow Category 2 plants to occur within 30 meters of the 1:50 year flood line of a river, stream, spring, natural channel in which water flows regularly or intermittently, lake, dam or wetland. Category 3 plants are also prohibited from occurring within proximity to a watercourse. Below is a brief explanation of the three categories in terms of the National Environmental Management: Biodiversity Act (Act 10 of 2004) (NEMBA):

- **Category 1 a:** Invasive species requiring compulsory control. Any specimens of Category 1 a listed species need, by law, to be eradicated from the environment. No permits will be issued.
- **Category 1 b:** Invasive species requiring compulsory control as part of an invasive species control programme. Remove and destroy. These plants are deemed to have such a high invasive potential that infestations can qualify to be placed under a government-sponsored invasive species management programme. No permits will be issued.
- **Category 2:** Invasive species regulated by area. A demarcation permit is required to import, possess, grow, breed, move, sell, buy or accept as a gift any plants listed as Category 2 plants. No permits will be issued for Cat 2 plants to exist in riparian zones.
- **Category 3:** Invasive species regulated by activity. An individual plant permit is required to undertake any of the following restricted activities (import, possess, grow, breed, move, sell, buy or accept as a gift) involving a Category 3 species. No permits will be issued for Cat 3 plants to exist in riparian zones.

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Note that according to the regulations, a person who has under his or her control a category 1b listed invasive species must immediately:

- Notify the competent authority in writing;
- Take steps to manage the listed invasive species in compliance with:
  - Section 75 of the Act;
  - The relevant invasive species management programme developed in terms of regulation 4; and
  - Any directive issued in terms of section 73(3) of the Act.

The following guidelines are a useful starting point for the identification of alien plant species: Bromilow, C. 2010. Problem Plants and Alien Weeds of South Africa. Briza, Pretoria; Henderson, L. 2001. Alien Weeds and Invasive Plants. Agricultural Research Council.

Please note the CARA regulations have been superseded by the NEMBA Regulations which became law on 1 October 2014. However, CARA has not been repealed yet by an updated Act and therefore, both pieces of legislation are in force. Notwithstanding, in the event of conflict between NEMBA and any other national legislation, section 8(1)(a) specifically states that NEMBA prevails where it concerns the management of biodiversity.

Please see attached Annexure 2, for a comprehensive list of the Alien Invasive Plants, as categorised by NEMBA

#### **4. ALIEN PLANT MANAGEMENT PRINCIPLES**

##### **4.1. Prevention and early eradication**


A prevention strategy should be considered and established, including regular surveys and monitoring for invasive alien plants, effective rehabilitation of disturbed areas and prevention of unnecessary disturbance of natural areas.

Monitoring plans must be developed which are designed to identify Invasive Alien Plant Species shortly after they arrive in the affected properties. Keeping up to date on which weeds are an immediate threat to the affected area is important, but efforts should be planned to update this information on a regular basis. When new Invasive Alien Plant Species are recorded on-site, an immediate response of locating the site for future monitoring and either hand-pulling the weeds or an application of a suitable herbicide (where permissible only) should be planned. It is, however, better to monitor regularly and act swiftly than to allow invasive alien plants to become established on site.

Eradication of medium to large invasive alien trees must occur systematically over an extended period - the affected area should be divided into small areas and total eradication should occur within area at a time with an extended period in between to allow for sufficient natural vegetation to resettle. This systematic approach is to ensure that a not-too-large unstable area is left vulnerable at a time as these areas may become prone to erosion. In the case where a plot has a sufficient indigenous plant cover with a low abundance of alien invasive trees, the commencement of the following plot may occur immediately.

##### **4.2. Containment and control**

If any additional alien invasive plants are found to become established on the site or within the affected area, action plans for their control should be developed, depending on the size of the infestations, budgets, manpower considerations and time. Separate plans of control actions should be developed for each location and/or each species. Appropriately registered chemicals and other possible control agents should be considered in the action plans for each site/species. The key is to ensure that no invasions get out of control. Effective containment and control will ensure that the least energy and resources are required to maintain this status over the long-term. This will also be an indicator that natural systems are impacted to the smallest degree possible.

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#### 4.3. General Clearing and Guiding Principles

Alien species control programs are long-term management projects and must include a clearing plan which includes follow up actions for rehabilitation of the cleared area. The lighter infested areas should be cleared first to prevent the build-up of seed banks. All clearing actions should be monitored and documented to keep records of which areas are due for follow-up clearing.

##### **I. Clearing Methods**

Different species require different clearing methods such as manual, chemical or biological methods or a combination of both, fire may also be a form of control. Care should however be taken that the clearing methods used do not encourage further invasion. As such, regardless of the methods used, disturbance to the soil must be kept to a minimum. Clearing of the seasonal and permanent saturated zones should preferably occur in the late winter. Clearing of the seasonal and permanent saturated zones should preferably occur in the late winter.

##### **II. Mechanical control**

This entails damaging or removing the plant by physical action. Different techniques could be used, e.g. uprooting, felling, slashing, mowing, ring barking or bark stripping. This control option is only really feasible in sparse infestations or on a small scale, and for controlling species that do not coppice after cutting. Species that tend to coppice, need to have the cut stumps or coppice growth treated with herbicides following the mechanical treatment. Mechanical control is labour-intensive and therefore expensive and could cause severe soil disturbance and erosion.

##### **III. Chemical Control**

Although it is usually preferable to use manual clearing methods where possible, such methods may create an additional disturbance that stimulates alien plant invasion and may also be ineffective for many woody species which resprout. Where herbicides are to be used, the impact of the operation on the natural environment must be minimised by observing the following:

- Area contamination must be minimised by careful, accurate application with a minimum amount of herbicide to achieve good control.
- All care must be taken to prevent contamination of any water bodies. This includes due care in storage, application, cleaning equipment and disposal of containers, product and spray mixtures.
- Equipment should be washed where there is no danger of contaminating water sources and washings carefully disposed of in a suitable site.
- To avoid damage to indigenous or other desirable vegetation, products should be selected that will have the least effect on non-target vegetation.
- Coarse droplet nozzles must be fitted to avoid drift onto neighbouring vegetation.
- The appropriate health and safety procedures should also be followed regarding the storage, handling and disposal of herbicides.
- The use of chemicals is not recommended for aquatic areas.

For all herbicide applications, the following resources should be followed which are all available from [www.invasives.org.za](http://www.invasives.org.za):

- Working for Water: Species and Herbicide List v14 (2022)  
*Historically referred to as the 'Working for Water' – Species and Herbicide List. This incredibly useful v14 of the list details which herbicides can be used on which invasive species. The List v14 also contains information on label restrictions, herbicide poisoning indicators and hazards.*
- Herbicides for Invasive Alien Plant Control (2022)  
*A detailed table of the various chemical groups, hazard group, hazard criterion and classification for herbicides used in the invasive species sector.*
- DFFE: Environmental Programmes Herbicide Policy (2021)  
*This herbicide policy is the most comprehensive document covering the legal and safe use of herbicides in South Africa.*
- DFFE: Guidelines for PPE Needed per Environmental Programmes Job Category (2020)  
*The excel spreadsheet details all the Personal Protective Equipment (PPE) – including the quantity and per specific criteria – needed by all contractors. These guidelines have become the standard for PPE protocols for the invasive species sector.*

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According to Government Notice No. 13424 dated 26 July 1992, it is an offence to "*acquire, dispose, sell or use an agricultural or stock remedy for a purpose or in a manner other than that specified on the label on a container thereof or on such a container*".

Contractors using herbicides need to have a valid Pest Control Operators License (limited weeds controller) according to the Fertilizer, Farm Feeds, Agricultural Remedies and Stock Remedies Act (Act No. 36 of 1947). This is regulated by the Department of Forestry, Fisheries and the Environment (DFFE).

Chemical treatment of alien invasive species within any **aquatic ecosystem** (including the permanent and seasonal saturated zone) must be avoided as far as possible. Chemical treatment of alien invasive species outside of the aquatic ecosystem should be limited to cut-stump treatment and plugs with great care and management implemented to prevent any potential unnecessary spillage.

#### **IV. Biological control**

Biological weed control consists in the use of natural enemies to reduce the vigour or reproductive potential of an invasive alien plant. Biological control agents include insects, mites, and micro-organisms such as fungi or bacteria. They usually attack specific parts of the plant, either the reproductive organs directly (flower buds, flowers or fruit) or the seeds after they have dropped. The stress caused by the biological control agent may kill a plant outright or it might impact on the plants reproductive capacity. In certain instances, the reproductive capacity is reduced to zero and the population is effectively sterilised. All of these outcomes will help to reduce the spread of the species.

To obtain biocontrol agents, provincial representatives of the Working for Water Programme or the Directorate: Land Use and Soil Management (LUSM), Department of Agriculture, Forestry and Fisheries (DAFF) can be contacted.

##### **I. Fire Control**

Fire can be an excellent tool for reducing the invasive alien plants present in grassland areas, and if the fire is the correct intensity and duration, it can kill certain invasive alien plant species. Other invasive alien plant species will coppice and produce new shoots from ground level, after a fire has passed, these are easier to control with chemical or manual clearing methods. For example, Black Wattle seeds are stimulated to germinate by fire. Once the re-invading seedlings have grown or plants have coppiced and they are at a height of not less than 15 cm, a suitable foliar spray can be used. It is important to note that while fire is a cheap method of control, care must be taken to follow correct precautions and burning procedures.

#### **4.4. General management practices**

The following general management practices should be encouraged or strived for:

- The eradication and management of alien invasive plants should be ongoing.
- Eradication of medium to large invasive alien trees should occur systematically over an extended period - the affected area should be divided into small areas and total eradication should occur within one area at a time with extended period's in-between to allow for sufficient natural vegetation to re-settle. This systematic approach is to ensure that a not too large unstable area is left vulnerable at a time as these areas may become prone to erosion. In the case where a plot with a low abundance of alien invasive trees and a sufficient natural plant covering has been cleared, commencement of the following plot may occur immediately.
- Clearing within the aquatic ecosystem should preferably occur in the late winter.
- Alien vegetation regrowth on areas disturbed by construction activities must be immediately controlled
- Care must be taken to avoid the introduction of alien invasive plant species to the site. Particular attention must be paid to imported material such as building sand and earth-moving equipment. Stockpiles should be checked regularly and any weeds emerging from material stockpiles should be removed.
- Cleared areas that have become invaded by alien species can be sprayed with appropriate herbicides provided that these are such that break down on contact with the soil (except in the aquatic ecosystem). Residual herbicides should not be used.
- The effectiveness of vegetation control varies seasonally and this is also likely to impact alien species. Control early in the wet season will allow species to re-grow and follow-up control is likely to be required.




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It is tempting to leave control until late in the wet season to avoid follow-up control. However, this may allow alien species to set seed before control and hence will not contribute towards reducing alien species abundance. Therefore, vegetation control should be aimed at the middle of the wet season, with a follow-up event towards the end of the wet season. There are no exact dates that can be specified here as each season is unique and management must therefore respond according to the state and progression of the vegetation.

- Alien plant management is an iterative process and it will require repeated control efforts to significantly reduce the abundance of a species. This is often due to the presence of large and persistent seed banks. However, repeated control usually results in a rapid decline once seed banks become depleted.
- Some alien species are best individually pulled by hand. Regular vegetation control to reduce plant biomass within the site and road reserve must be conducted. This should be timed so as to coincide with the critical growth phases of the most important alien species on site. This will significantly reduce the cost of alien plant management as this should contribute towards the control of the dominant alien species and additional targeted control will be required only for a limited number of species.
- No alien species should be cultivated on-site. If vegetation is required for aesthetic purposes, then noninvasive, water-wise locally-occurring species should be used.
- The felled specimens should be removed out of the wetland boundaries as soon as possible (within a week of felling) and care should be taken to prevent any potential for re-seeding.
- During operation, surveys for alien species should be conducted regularly. It is recommended that this be undertaken at least once a year. All alien plants identified should be cleared using appropriate means.

Refer to Table 1 below for a Summary of Invasive Alien Plants expected for the area together with the method of control.

**Table 1: Summary of Invasive Alien Plants expected for the area**

Scientific Name	Growth Form	NEMBA Category	Control
<b><i>Ageratum houstonianum</i> - (Mexican ageratum)</b>			
	Herb	1b	Physical removal ensuring the root system is removed.
<b><i>Albizia lebbek</i> - (Lebbeck tree)</b>			

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Scientific Name	Growth Form	NEMBA Category	Control
	Large tree	1b	Physical removal of seedlings. Large specimens will need to be felled.
<b>Ambrosia artemisiifolia - (Ragweed)</b>			
	Herb	-	Physical removal ensuring that the root system is removed and herbicide treatment.
<b>Arundo donax - (Giant reed)</b>			

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Scientific Name	Growth Form	NEMBA Category	Control
	Megagraminoid	1b	Difficult to control. Plants should be cut down and regrowth sprayed with a herbicide. All slash material must be burnt. Physical removal is only possible by complete removal of the rhizome.
<b><i>Argemone mexicana</i> - (Yellow-flowered Mexican poppy)</b>			
	Herb	1b	Physical removal ensuring the root system is removed.
<b><i>Bidens pilosa</i> - (Black-jack)</b>			



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Scientific Name	Growth Form	NEMBA Category	Control
	Herb	-	Physical removal and post-emergence herbicide.
<b><i>Canna indica</i> - (Indian shot)</b>			
	Herb	1b	Difficult to eradicate with herbicides. Physical removal is required taking care to dig up and destroy the rhizomes.
<b><i>Cardiospermum grandiflorum</i> - (Balloon vine)</b>			

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Scientific Name	Growth Form	NEMBA Category	Control
	Herbaceous climber	1b	The most effective method is to dig up the root and the rest of the plant can be left to die.
<b><i>Centella asiatica</i> - (Pennywort)</b>			
	Herb	-	Physical removal but difficult to control.
<b><i>Chromolaena odorata</i> - (Triffid weed)</b>			

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Scientific Name	Growth Form	NEMBA Category	Control
	Woody shrub	1b	Control is difficult because it is capable of vigorous regrowth from stem coppice, root suckers and seed. Large plants must be cut down and herbicide applied to the stump and regrowth. Small plants can be pulled out by hand.
<b><i>Lantana camara</i></b>			
	Woody shrub	1b	Physical removal of seedlings. Dense bushes can be chopped and sprayed with a herbicide.
<b><i>Litsea glutinosa</i> - (Indian laurel)</b>			



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Scientific Name	Growth Form	NEMBA Category	Control
	Tree	1b	Smaller plants can be pulled out by hand but the long tap root must be removed. Larger specimens must be felled and the stump treated with herbicide.
<b>Melia azedarach - (Syringa)</b>			
	Large tree	1b (3 in urban areas)	Physical removal of seedlings or foliar herbicide application of specimens less than 2.5 m in height. Large specimens must be felled, and stump treated with herbicide.
<b>Passiflora foetida - (Wild water lemon)</b>			

Scientific Name	Growth Form	NEMBA Category	Control
	Herbaceous climber	-	Physical removal and treatment with a systemic herbicide.
<b><i>Parthenium hysterophorus</i> - (Famine Weed)</b>			
	Herb	1b	Systemic herbicides should be used. Area must be re-vegetated with indigenous grasses to impede re-invasion.
<b><i>Datura strumarium</i> - (Downy thorn apple)</b>			

Scientific Name	Growth Form	NEMBA Category	Control
	Herbaceous shrub	1b	Physical removal and post-emergence herbicide.
<b><i>Physalis viscosa</i> - (Wild Gooseberry)</b>			
	Herb	-	Difficult to control. Physical removal ensuring that all parts of the root system are removed. Herbicide treatment is an option in dense growths.
<b><i>Psidium guajava</i> - (Guava)</b>			



Scientific Name	Growth Form	NEMBA Category	Control
	Small tree	3	Difficult to control. Able to withstand many foliar- and soil-applied herbicides. Ring-barking, bark-stripping and felling can encourage root sucker development. A registered herbicide will need to be used in repeated applications.
<b><i>Rubus cuneifolius</i> - (American bramble)</b>			
	Herbaceous shrub	1b	Herbicide treatments are most effective during Autumn. Physical removal of the rhizome is also an option. Follow-up inspections and treatments are essential to ensure complete eradication.
<b><i>Ricinus communis</i> (Caster oil)</b>			

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Scientific Name	Growth Form	NEMBA Category	Control
	Herbaceous shrub	2	Individuals can be uprooted. Herbicides can be used where necessary.
<b><i>Schinus terebinthifolius</i> - (Brazilian pepper tree)</b>			
	Small tree	1b	Large specimens must be cut-down and herbicide applied to the stump. Smaller individuals can be uprooted.
<b><i>Senna septemtrionalis</i> - (Arsenic bush)</b>			



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Scientific Name	Growth Form	NEMBA Category	Control
	Small tree	1b	Physical removal ensuring the root system is removed.
<b><i>Solanum mauritianum</i> - (Bugweed)</b>			
	Small tree	1b	Cutting, stem painting or foliar herbicides. Young plants can be hand pulled. Follow up treatments are essential as seeds are unaffected by herbicide.
<b><i>Tecoma stans</i> - (Yellow bells)</b>			

Scientific Name	Growth Form	NEMBA Category	Control
	Small tree	1b	Once established the species is difficult to control with herbicides. The plant should be removed physically, ensuring all seeds are destroyed. The area should be inspected regularly to manage regrowth.
<b><i>Verbena aristigera</i> - (Tall verbena)</b>			
	Herb	1b	Foliar herbicide treatment.
<b><i>Verbena bonariensis</i> - (Veined verbena)</b>			

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Scientific Name	Growth Form	NEMBA Category	Control
	Herb	1b	Physical removal and herbicide treatment.

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## 5. MONITORING

Monitoring of the area throughout the process is crucial in order to prevent IAPs from growing and spreading out of control, thereby threatening the well-being of indigenous flora and fauna. Table 2 below provides a monitoring framework that should be implemented on-site to control the growth and IAP on site.

**Table 2: Monitoring framework for the control of invasive alien plants**

Metric	Frequency	Method	Response
How effective are the control methods?	4-6 months after every operation	Survey the cleared areas and look for regrowth. Before and after photographs are effective for this. Observe for non-target effects of herbicide application.	If the survey reveals that the control methods are effective, e.g. low levels of re-sprouting, continue following the herbicide mixtures and control methods. If non-target plants are dying off where herbicides were applied, ensure appropriate training for herbicide applicators, demonstrate the off-target effects to herbicide applicators to ensure they are using the correct methods and herbicides. (If the results show that the control methods are not effective, adapt by e.g. cutting lower above ground or changing herbicides or timing of herbicide application.
Do the infestation levels decrease?	Annually	Survey the cleared areas and record species, densities and size. Before and after pictures are very effective.	If the infestation levels are not decreasing, reconsider clearing intervals and look at clearing methods. If infestation levels are decreasing, then continue current control method.
Quantity of herbicides used	During every operation	Keep track of cost and ensure no wastage. Record herbicide usage	Track usage over time, it will reveal a certain trend in quantities for different infestation levels. Less herbicides should be used when the infestation levels are lower. Record herbicide cost.
Does the indigenous vegetation recover in the cleared areas?	Annually	Survey the cleared areas and look out for indigenous species variety and presence. Before and after pictures are effective.	If there is recovery of indigenous vegetation, then continue current control method. If there is no recovery, consider rehabilitation with local indigenous species.
How many jobs were created?	After every operation	Timesheets	Job creation figures are useful when asking for landowner assistance from WFW or to demonstrate contributions to jobs and socio-economic conditions
How many person days (PD) were spent per operations?	After every operation	Timesheets	Keep track of cost and assist with planning and budgeting. Determine cost per person per day (PD)

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**Annexure 1**  
**Listed Invasive Alien Plants (CARA)**

Botanical name	Common Name	Category
<i>Acacia baileyana</i>	Bailey's Wattle	3
<i>Acacia Cyclops</i>	Rooikrans	2
<i>Acacia dealbata</i>	Silver Wattle	Category 1 plant in Western Cape Category 2 plant
<i>Acacia decurrens</i>	Green Wattle	2
<i>Acacia elata</i>	Pepper tree Wattle	3
<i>Acacia implexa</i>	Screw-pod Wattle	1
<i>Acacia longifolia</i>	Long-leaved Wattle	1
<i>Acacia mearnsii</i>	Black Wattle	2
<i>Acacia melanoxylon</i>	Australian Blackwood	2
<i>Acacia paradoxa</i>	Kangaroo Wattle	1
<i>Acacia podalyriifolia</i>	Pearl Acacia	3
<i>Acacia pycnantha</i>	Golden Wattle	1
<i>Acacia saligna</i>	Port Jackson Willow	2
<i>Achyranthes aspera</i>	Burweed	1
<i>Agave sisalana</i>	Sisal Hemp, Sisal	2
<i>Ageratina adenophora</i>	Crofton Weed	1
<i>Ageratina riparia</i>	Mistflower	1
<i>Ageratum conyzoides</i>	Invading Ageratum	1
<i>Ageratum houstonianum</i>	Mexican Ageratum	1
<i>Ailanthus altissima</i>	Tree-of-heaven	3
<i>Albizia lebbbeck</i>	Lebbeck Tree	1
<i>Albizia procera</i>	False Lebbeck	1
<i>Alhagi maurorum</i>	Camel Thorn Bush 1	1
<i>Anredera cordifolia</i>	Madeira Vine, Brida Wreath	1
<i>Araujia sericifera</i>	Moth Catcher	1
<i>Ardisia crenata</i>	Coralberry Tree, Coral Bush	1
<i>Argemone mexicana</i>	Yellow – Flowered Mexican Poppy	1
<i>Argemone ochroleuca</i>	White – Flowered Mexican Poppy	1
<i>Arundo donax</i>	Giant Reed, Spanish Reed	1
<i>Atriplex lindley</i>	Sponge – Fruit Saltbush	3
<i>Atriplex nummularia</i>	Old Man Saltbush	2
<i>Azolla filiculoides</i>	Red Water Fern	1
<i>Bauhinia purpurea</i>	Butterfly Orchid Tree	3
<i>Bauhinia variegata</i>	Orchid Tree	3
<i>Bryophyllum delagoense</i>	Chandelier Plant	1
<i>Caesalpinia decapetala</i>	Mauritius Thorn	1
<i>Campuloclinium macrocephalum</i>	Pom Pom Weed	1
<i>Canna indica</i>	Indian Shot	1
<i>Cardiospermum grandiflorum</i>	Balloon Vine	1
<i>Casuarina cunninghamiana</i>	Beefwood	2
<i>Casuarina equisetifolia</i>	Horsetail Tree	2
<i>Cereus jamacaru</i>	Queen of the Night	1
<i>Cestrum aurantiacum</i>	Yellow or Orange Cestrum	1
<i>Cestrum elegans</i>	Crimson Cestrum	1
<i>Cestrum laevigatum Schtdl</i>	Inkberry	1
<i>Cestrum parqui</i>	Chilean Cestrum	1
<i>Chromolaena odorata</i>	Triffid Weed, Chromolaena	1
<i>Cinnamomum camphora</i>	Camphor Tree	Category 1 plant only in the Northern Province, KwaZulu- Natal & Mpumalanga



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Botanical name	Common Name	Category
<i>Cirsium vulgare</i>	Spear Thistle, Scotch Thistle	1
<i>Convolvulus arvensis</i>	Field Bindweed, Wild Morning Glory	1
<i>Cortaderia jubata</i>	Pampas Grass	1
<i>Cortaderia selloana</i>	Pampas Grass	1
<i>Cotoneaster franchetii</i>	Coloneaster	3
<i>Cotoneaster pannosus</i>	Silver-leaf Cotoneaster	3
<i>Cuscuta campestris</i>	Common Dodder	1
<i>Cuscuta suaveolens</i>	Lucerne Dodder	1
<i>Cytisus monspessulanus</i>	Montpellier Broom	1
<i>Cytisus scoparius</i>	Scotch Broom	1
<i>Datura ferox</i>	Large Thorn Apple	1
<i>Datura innoxia</i>	Downy Thorn Apple	1
<i>Datura stramonium</i>	Common Thorn Apple	1
<i>Dolichandra unguis-cati</i>	Cat's Claw Creeper	1
<i>Echinopsis spachiana</i>	Torch Cactus	1
<i>Echium plantagineum</i>	Patterson's Curse	1
<i>Echium vulgare</i>	Blue Echium	1
<i>Egeria densa</i>	Dense Water Weed	1
<i>Eichhornia crassipes</i>	Water Hyacinth	1
<i>Elodea canadensis</i>	Canadian Water Weed	1
<i>Eriobotrya japonica</i>	Loquat	3
<i>Eucalyptus camaldulensis</i>	Red River Gum	2
<i>Eucalyptus cladocalyx</i>	Sugar Gum	2
<i>Eucalyptus diversicolor</i>	Karri	2
<i>Eucalyptus grandis</i>	Saligna Gum, Rose Gum	2
<i>Eucalyptus lehmannii</i>	Spider Gum	2
<i>Eucalyptus paniculata</i>	Grey Ironbark	2
<i>Eucalyptus sideroxylon</i>	Black Ironbark, Red Ironbark	2
<i>Eugenia uniflora</i>	Pitanga, Surinam Cherry	Category 1 plant in the Northern Province, KwaZulu-Natal and Mpumalanga Category 3 plant in the rest of South Africa
<i>Gleditsia triacanthos</i>	Honey Locust, Sweet Locust	2
<i>Grevillea robusta</i>	Australian Silky Oak	3
<i>Hakea drupacea</i>	Sweet Hakea	1
<i>Hakea gibbosa</i>	Rock Hakea	1
<i>Hakea sericea</i>	Silky Hakea	1
<i>Harrisia martinii</i>	Moon Cactus, Harrisia Cactus	1
<i>Hedychium coccineum</i>	Red Ginger Lily	1
<i>Hedychium coronarium</i>	White Ginger Lily	1
<i>Hedychium flavescens</i>	Yellow Ginger Lily	1
<i>Hedychium gardnerianum</i>	Kahili Ginger Lily	1
<i>Hypericum perforatum</i>	St.Johns' Wort, Tipton Weed	2
<i>Ipomoea alba</i>	Moonflower	Category 1 plant in the Northern Province, KwaZulu-Natal & Mpumalanga Category 3 plant in the rest of South Africa
<i>Ipomoea indica</i>	Morning Glory	Category 1 plant in the Northern Province, KwaZulu-Natal & Mpumalanga Category 3 plant in the rest of South Africa
<i>Ipomoea purpurea</i>	Morning Glory	3
<i>Jacaranda mimosifolia</i>	Jacaranda	3


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Botanical name	Common Name	Category
All seed producing species or seed producing hybrids of <i>Lantana</i> that are non-indigenous to Africa	<i>Lantana/Lantana</i> , Tickberry, Cherry Pie	1
<i>Lepidium</i>	Pepper-cres, Hoary Cardaria, White Top	1
<i>Leptospermum laevigatum</i>	Australian Myrtle	1
<i>Leucaena leucocephala</i>	<i>Leucaena</i>	Category 1 plant in the Western Cape
<i>Ligustrum japonicum</i>	Japanese Wax-leaved Privet	3
<i>Ligustrum lucidum</i>	Chinese Wax-leaved Privet	3
<i>Ligustrum ovalifolium</i>	Californian Privet	3
<i>Ligustrum sinense</i>	Chinese Privet	3
<i>Ligustrum vulgare</i>	Common Privet	3
<i>Lilium formosanum</i>	St Joseph's Lily, Trumpet Lily, Formosa Lily	3
<i>Litsea glutinosa</i>	Indian Laurel	1
<i>Lyrthrum salicaria</i>	Purple Loosestrife	1
<i>Melia azedarach</i>	"Syringa", Persian Lilac	3
<i>Metrosideros excelsa</i>	New Zealand Christmas Tree	3
<i>Mimosa pigra</i>	Giant Sensitive Plant	3
<i>Montanoa hibiscifolia</i>	Tree Daisy	1
<i>Morus alba</i>	White Mulberry, Common Mulberry	3
<i>Myoporum tenuifolium</i>	Manatoka	3
<i>Myriophyllum aquaticum</i>	Parrot's Feather	1
<i>Myriophyllum spicatum</i>	Spiked Water-milfoil	1
<i>Nassella tenuissima</i>	White Tussock	1
<i>Nassella trichotoma</i>	Nassella Tussock	1
<i>Nephrolepis exaltata</i>	Sword Fern	3
<i>Nerium oleander</i>	Oleander	1
<i>Nicotiana glauca</i>	Wild Tobacco	1
<i>Opuntia aurantiaca</i>	Jointed Cactus	1
<i>Opuntia exaltata</i>	Long Spine Cactus	1
<i>Opuntia Mission</i>	Prickly Pear, Sweet Prickly Pear	1
<i>Opuntia humifusa</i>	Large Flowered Prickly Pear, Creeping Prickly Pear	1
<i>Opuntia imbricate</i>	Imbricate Cactus, Imbricate Prickly Pear	1
<i>Opuntia lindheimeri</i>	Small Round-leaved Prickly Pear	1
<i>Opuntia monacantha</i>	Cochineal Prickly Pear, Drooping Prickly Pear	1
<i>Opuntia rosea</i>	Rosea Cactus	1
<i>Opuntia spinulifera</i>	Saucepan Cactus, Large Roundleaved Prickly Pear	1
<i>Opuntia stricta</i>	Pest Pear Of Australia	1
<i>Orobanche minor</i>	Lesser Broomrape, Clover Broomrape	1
<i>Paraserianthes lophantha</i>	Austalian Albizia, Stink Bean	1
<i>Parthenium hysterophorus</i>	Parthenium	1
<i>Passiflora caerulea</i>	Blue Passion Flower	1
<i>Passiflora molissima</i>	Banana Poka, Bandadilla	1
<i>Passiflora suberosa</i>	Devil's Pumpkin, Indigo Berry	1
<i>Passiflora subpeltata</i>	Grandina	1
<i>Pennisetum setaceum</i>	Fountain Grass	1
<i>Pennisetum villosum</i>	Feathertop	1
<i>Pereskia aculeata</i>	Pereskia/Barbados Gooseberry	1
<i>Phytolacca dioica</i>	Belhambra	3
<i>Pinus canariensis</i>	Canary Den	2

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Botanical name	Common Name	Category
<i>Pinus elliotti</i>	Slash Pine	2
<i>Pinus halepensis</i>	Aleppo Pine	2
<i>Pinus patula</i>	Patula Pine	2
<i>Pinus pinaster</i>	Cluster Pine	2
<i>Pinus radiata</i>	Radiata Pine, Monterey Pine	2
<i>Pinus roxburghii</i>	Chir Pine, Longifolia Pine	2
<i>Pinus taeda</i>	Loblolly Pine	2
<i>Pistia stratiotes</i>	Water Lettuce	1
<i>Pittosporum undulatum</i>	Australian Cheesewood, Sweet Pittosporum	1
<i>Plectranthus comosus</i>	Abyssinian' Coleus, Wooly Plectranthus	3
<i>Pontederia cordata</i>	Pickereel Weed	3
<i>Populus alba</i>	White Poplar	2
<i>Populus x canescens</i>	Grey Poplar, Matchwood Poplar	2
<i>Prosopis glandulosa</i>	Honey Mesquite	2
<i>Proposis velutina</i>	Velvet Mesquite	2
<i>Psidium cattleianum</i>	Strawberry Guava	3
<i>Psidium guajava</i>	Guava	2
<i>Psidium guineense</i>	Brazilian Guava	3
<i>Psidium x durbanensis</i>	Durban Guava	1
<i>Pueraria lobata</i>	Kudu Vine	1
<i>Pyranantha angustifolia</i>	Yellow Firethorn	3
<i>Pyranantha crenulata</i>	Himalayan Firethorn	3
<i>Rhus succedanea</i>	Wax Tree	1
<i>Ricinus communis</i>	Castor-oil Plant	2
<i>Rivina humilis</i>	Rivina, Bloodberry	1
<i>Robinia pseudoacacia</i>	Black Locust	2
<i>Rorippa nasturtium – aquaticum</i>	Watercress	2
<i>Rosa rubiginosa</i>	Eglantine, Sweetbriar	1
<i>Rubus cuneifolius</i>	American Bramble	1
<i>Rubus fruticosus</i>	European Blackberry	2
<i>Salix babylonica</i>	Weeping Willow	2
<i>Salix fragilis</i>	Crack Or Brittle Willow	2
<i>Salvinia molesta</i>	Kariba Weed	1
<i>Schinus terebinthifolius</i>	Brazilian Pepper Tree	Category 1 in KwaZulu-Natal Category 3 in the rest of South Africa
<i>Senna bicapsularis</i>	Rambling Cassia	3
<i>Senna didymobotrya</i>	Peanut Butter Cassia	3
<i>Senna pendula</i>		3
<i>Sesbania punicea</i>	Red Sesbania	1
<i>Solanum elaeagnifolium</i>	Silver-leaf Bitter Apple	1
<i>Solanum mauritianum</i>	Bugweed	1
<i>Solanum seaforthianum</i>	Potato Creeper	1
<i>Solanum sisymbriifolium</i>	Wild Tomato, Dense-thorned Bitter Apple	2
<i>Sorghum halepense</i>	Johnson Grass, Aleppo Grass	2
<i>Spartium junceum</i>	Spanish Broom	1
<i>Syzygium cumini</i>	Jambolan	3
<i>Syzygium jambos</i>	Rose Apple	3
<i>Tamarix chinensis</i>	Chinese Tamarisk	Category 1 plant in the Northern, Western and Eastern Cape Category 3 plant in the rest of South Africa



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Botanical name	Common Name	Category
<i>Tamarix ramosissima</i>	<i>Pink Tamarisk</i>	Category 1 plant in the Northern, Western and Eastern Cape Category 3 plant in the rest of South Africa
<i>Tecoma stans</i>	<i>Yellow Bells</i>	1
<i>Thelechitonina trilobata</i>	<i>Singapore Daisy</i>	Category 1 in KwaZulu-Natal Category 3 in the rest of South Africa
<i>Thevetia</i>	<i>Yellow Oleander</i>	1
<i>Tipuana tipu</i>	<i>Tipu Tree</i>	3
<i>Tithonia diversifolia</i>	<i>Mexican Sunflower</i>	1
<i>Tithonia rotundifolia</i>	<i>Red Sunflower</i>	1
<i>Toona ciliata</i>	<i>Toon Tree</i>	3
<i>Triplaris Americana</i>	<i>Indian Almond</i>	1
<i>Ulex europaeus</i>	<i>European Gorse</i>	1
<i>Xanthium spinosum</i>	<i>Spiny Cocklebur</i>	1
<i>Xanthium strumarium</i>	<i>Large Cocklebur</i>	1

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**Annexure 2**  
**Listed Invasive Alien Plants (NEMBA)**

	SPECIES	COMMON NAME	CATEGORY / AREA
1	<i>Acacia adunca</i>	Cascade wattle, Wallangarra wattle	1a
2	<i>Acacia baileyana</i>	Bailey's wattle	3
3	<i>Acacia cyclops</i>	Red eye	1b
4	<i>Acacia dealbata</i>	Silver wattle	2
5	<i>Acacia decurrens</i> and hybrids, varieties and selections	Green wattle	2
6	<i>Acacia elata</i>	Pepper tree wattle	1b
7	<i>Acacia fimbriata</i>	Fringed wattle, Brisbane wattle	1a
8	<i>Acacia implexa</i>	Screw pod wattle	1a
9	<i>Acacia longifolia</i>	Long-leaved wattle	1b
10	<i>Acacia mearnsii</i> and hybrids, varieties and selections	Black wattle	2
11	<i>Acacia melanoxylon</i> and hybrids, varieties and selections	Australian blackwood	2
12	<i>Acacia paradoxa</i>	Kangaroo thorn, Kangaroo wattle	1a
13	<i>Acacia podalyriifolia</i>	Pearl acacia	1b
14	<i>Acacia pycnantha</i>	Golden wattle	1b
15	<i>Acacia saligna</i>	Port Jackson, Port Jackson willow	1b
16	<i>Acacia stricta</i>	Hop wattle	1a
17	<i>Acer buergerianum</i>	Chinese maple	See below
a. 3 in Eastern Cape, KwaZulu-Natal, Limpopo, Mpumalanga, North-West, Northern Cape and Western Cape. b. Not listed in urban areas in the Eastern Cape, KwaZulu-Natal, Limpopo, Mpumalanga, North-West, Northern Cape and Western Cape. c. Not listed elsewhere.			
18	<i>Acer negundo</i>	Ash-leaved maple, Box elder	a. 3 b. Sterile cultivars or hybrids are not listed.
19	<i>Agave americana</i> subsp. <i>americana</i> var. <i>expansa</i>	Spreading century-plant	a. 3 in Western Cape. b. Not listed elsewhere.
20	<i>Agave sisalana</i>	Sisal hemp, Sisal	2
21	<i>Ageratina adenophora</i>	Crofton weed	1b
22	<i>Ageratina riparia</i>	Mistflower	1b
23	<i>Ageratum conyzoides</i>	Invading ageratum	1b
24	<i>Ageratum houstonianum</i>	Mexican ageratum	a. 1b b. Sterile cultivars or hybrids are not listed.
25	<i>Agrimonia procera</i>	Scented agrimony	1b
26	<i>Agrostis castellana</i>	Bent grass	See below
a. 1a Prince Edward Island. b. 1b Marion Island. c. Not listed on mainland or other off-shore islands.			
27	<i>Agrostis gigantea</i>	Black bent grass, Redtop	See below
a. 1a Prince Edward and Marion Islands. b. Not listed on mainland or other off-shore islands.			
28	<i>Agrostis stolonifera</i>	Creeping bent grass	See below
a. 1a Prince Edward Island. b. 1b Marion Island. c. Not listed on mainland or other off-shore islands.			
29	<i>Ailanthus altissima</i>	Tree-of-heaven	1b
30	<i>Albizia lebbek</i>	Lebbeck tree	1b
31	<i>Albizia procera</i>	False lebbeck	1b
32	<i>Alhagi maurorum</i>	Camel thorn bush	1b
33	<i>Alisma plantago-aquatica</i>	Mud plantain, Water alisma	1b
34	<i>Alopecurus geniculatus</i>	Marsh foxtail, Water foxtail	See below
a. 1a Prince Edward and Marion Islands. b. Not listed on mainland or other off-shore islands.			
35	<i>Alpinia zerumbet</i>	Shell ginger, Pink porcelain lily	3
36	<i>Ammophila arenaria</i>	Marram grass	3
37	<i>Anredera cordifolia</i>	Madeira vine, Bridal wreath	1b
38	<i>Antigonon leptopus</i>	Coral creeper	1b
39	<i>Araujia sericifera</i>	Moth catcher	1b

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	SPECIES	COMMON NAME	CATEGORY / AREA
40	<i>Ardisia crenata</i>	Coralberry tree, Coral Bush	1b
41	<i>Ardisia elliptica</i>	Shoebutton ardisia	1b
42	<i>Argemone mexicana</i>	Yellow-flowered Mexican poppy	1b
43	<i>Argemone ochroleuca</i>	White-flowered Mexican poppy	1b
44	<i>Aristolochia elegans</i>	Dutchman's pipe	1b
45	<i>Arundo donax</i>	Giant reed, Spanish reed	1b
46	<i>Atriplex inflata</i>	Sponge-fruit saltbush	1b
47	<i>Atriplex nummularia</i> subsp. <i>nummularia</i>	Old man saltbush	2
48	<i>Austrocylindropuntia cylindrica</i>	Cane cactus	1a
49	<i>Austrocylindropuntia subulata</i>	Long spine cactus	1b
50	<i>Azolla cristata</i>	Tropical red water fern	1b
51	<i>Azolla filiculoides</i>	Azolla, Red water fern	1b
52	<i>Azolla pinnata</i> subsp. <i>asiatica</i>	Mosquito fern	1b
53	<i>Bartlettina sordida</i>	Bartlettina	1b
54	<i>Bauhinia purpurea</i>	Butterfly orchid tree	See below
55	<i>Bauhinia variegata</i>	Orchid tree	See below
1b in Eastern Cape, KwaZulu-Natal, Limpopo and Mpumalanga. 3 in Free State, Gauteng, North-West, Northern Cape and Western Cape.			
56	<i>Berberis thunbergii</i>	Japanese barberry	a. 3 b. Sterile cultivars or hybrids are not listed.
57	<i>Billardiera heterophylla</i>	Bluebell creeper	1a
58	<i>Bryophyllum delagoense</i>	Chandelier plant	1b
59	<i>Bryophyllum pinnatum</i>	Cathedral bells	1b
60	<i>Bryophyllum proliferum</i>	Green mother of millions	1b
61	<i>Buddleja davidii</i>	Chinese sagewood, Summer lilac	a. 3 b. Sterile cultivars or hybrids are not listed.
62	<i>Buddleja madagascariensis</i>	Madagascar sagewood	3
63	<i>Cabomba caroliniana</i>	Cabomba, Carolina fanwort	1a
64	<i>Caesalpinia decapetala</i>	Mauritius thorn	1b
65	<i>Caesalpinia gilliesii</i>	Bird-of-paradise flower	1b
66	<i>Callisia repens</i>	Creeping inch plant	1b
67	<i>Callistemon citrinus</i>	Lemon bottlebrush	3
68	<i>Callistemon rigidus</i>	Stiff-leaved bottlebrush	See below
1b in Eastern Cape and Western Cape. 3 in Free State, Gauteng, KwaZulu-Natal, Limpopo, Mpumalanga, North-West and Northern Cape.			
69	<i>Callistemon viminalis</i>	Weeping bottlebrush	See below
1b in Eastern Cape, KwaZulu-Natal, Limpopo and Mpumalanga. 3 in Free State, Gauteng, North-West, Northern Cape and Western Cape. Sterile cultivars or hybrids are not listed.			
70	<i>Calotropis procera</i>	Calotropis, Giant- milkweed	1b
71	<i>Campuloclinium macrocephalum</i>	Pompom weed	1b
72	<i>Canna indica</i>	Indian shot	a. 1b b. Sterile cultivars or hybrids are not listed.
73	<i>Cardiospermum grandiflorum</i>	Balloon vine	1b
74	<i>Cardiospermum halicacabum</i>	Lesser balloon vine	3
75	<i>Carduus nutans</i>	Nodding thistle	1b
76	<i>Casuarina cunninghamiana</i>	Beefwood	a. 2 b. 1b within 100 metres of riparian areas or untransformed land.
77	<i>Casuarina equisetifolia</i>	Horsetail tree	2
78	<i>Catharanthus roseus</i>	Madagascar periwinkle	a. 1b b. Sterile cultivars or hybrids are not listed.

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	SPECIES	COMMON NAME	CATEGORY / AREA
79	<i>Celtis australis</i>	Nettle tree, European hack- berry	3
80	<i>Celtis occidentalis</i>	Common hackberry	3
81	<i>Centranthus ruber</i>	Red valerian, Devil's beard	a. 1b in Western Cape b. Not listed elsewhere
82	<i>Cerastium fontanum</i>	Common mouse-ear chick- weed	a. 1b Prince Edward and Marion Islands b. Not listed on main- land or other off-shore islands.
83	<i>Cereus hexagonus</i>	Queen of the night	1b
84	<i>Cereus hildmannianus</i>	Queen of the night	1b
85	<i>Cereus jamacaru</i>	Queen of the night	1b
86	<i>Cestrum aurantiacum</i>	Orange cestrum	1b
87	<i>Cestrum elegans</i>	Crimson cestrum	1b
88	<i>Cestrum laevigatum</i>	Inkberry	1b
89	<i>Cestrum parqui</i>	Chilean cestrum	1b
90	<i>Cestrum species not specifically listed</i>	Cestrum species	a. 3 b. Sterile cultivars or hybrids are not listed.
91	<i>Chondrilla juncea</i>	Skeleton weed	1a
92	<i>Chromolaena odorata</i>	Triffid weed, Chromolaena	1b
93	<i>Cinnamomum camphora</i>	Camphor tree	See below
1b in Eastern Cape, KwaZulu-Natal, Limpopo and Mpumalanga. 3 in Western Cape. National Heritage Trees or National Monument Trees in terms of the National Heritage Resources Act, 1999, (Act No. 25 of 1999) in Eastern Cape, KwaZulu-Natal, Limpopo, Mpumalanga and the Western Cape, are not listed. Not listed elsewhere.			
94	<i>Cirsium vulgare</i>	Spear thistle, Scotch thistle	1b
95	<i>Convolvulus arvensis</i>	Field bindweed, Wild morning-glory	1b
96	<i>Coreopsis lanceolata</i>	Tickseed	See below
a. 1a b. Sterile cultivars or hybrids are not listed.			
97	<i>Cortaderia jubata</i>	Pampas grass	1b
98	<i>Cortaderia selloana</i>	Pampas grass	See below
a. 1a b. Sterile cultivars or hybrids are not listed.			
99	<i>Cotoneaster franchetii</i>	Cotoneaster	1b
100	<i>Cotoneaster glaucophyllus</i>	Late cotoneaster	1b
101	<i>Cotoneaster pannosus</i>	Silver leaf cotoneaster	1b
102	<i>Cotoneaster salicifolius</i>	Willow-leaved showberry	1b
103	<i>Cotoneaster simonsii</i>	Himalayan cotoneaster, Simon's cotoneaster	1b
104	<i>Crotalaria agatiflora</i>	Canarybird bush, Bird flower	1b
105	<i>Cryptostegia grandiflora</i>	Rubber vine	1b
106	<i>Cryptostegia madagascariensis</i>	Madagascar rubber vine	1b
107	<i>Cuscuta campestris</i>	Common dodder	1b
108	<i>Cuscuta suaveolens</i>	Lucerne dodder	1b
109	<i>Cylindropuntia fulgida</i> var. <i>fulgida</i>	Chain-fruit cholla (previously known as rosea cactus)	1b
110	<i>Cylindropuntia fulgida</i> var. <i>mamillata</i>	Boxing-glove cactus, Mamillate cactus	1b
111	<i>Cylindropuntia imbricata</i>	Imbricate cactus, Imbricate prickly pear	1b
112	<i>Cylindropuntia leptocaulis</i>	Pencil cactus	1b
113	<i>Cylindropuntia pallida</i>	Pink-flowered sheathed cholla	1a
114	<i>Cylindropuntia spinosior</i>	Cane cholla, Spiny cholla	1a
115	<i>Cytisus scoparius</i>	Scotch broom	1a
116	<i>Datura ferox</i>	Large thorn apple	1b
117	<i>Datura innoxia</i>	Downy thorn apple	1b
118	<i>Datura stramonium</i>	Common thorn apple	1b
119	<i>Diplocyclos palmatus</i>	Lollipop-climber	1a
120	<i>Dolichandra unguis-cati</i>	Cat's claw creeper	1b
121	<i>Duchesnea indica</i>	Wild strawberry	1b

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	SPECIES	COMMON NAME	CATEGORY / AREA
122	<i>Duranta erecta</i>	Forget-me-not-tree, Pigeon berry	See below
3 in Gauteng, Kwazulu-Natal, Limpopo, Mpumalanga and North-West. 2 for breeding in nurseries in Gauteng, Kwazulu-Natal, Limpopo, Mpumalanga and North-West, but may not be transferred within these Provincial boundaries. Not listed elsewhere. Sterile cultivars or hybrids are not listed. "Sheena's Gold" cultivar is not listed.			
123	<i>Echinodorus cordifolius</i>	Creeping burhead	1b
124	<i>Echinodorus tenellus</i>	Amazon sword plant	1b
125	<i>Echinopsis schickendantzii</i>	Torch cactus	1b
126	<i>Echium plantagineum</i>	Patterson's curse	1b
127	<i>Echium vulgare</i>	Blue echium	1b
128	<i>Egeria densa</i>	Dense water weed	1b
129	<i>Eichhornia crassipes</i>	Water hyacinth	1b
130	<i>Elodea canadensis</i>	Canadian water weed	1b
131	<i>Elytrigia repens</i>	Couch grass	a. 1a Prince Edward and Marion Islands. b. Not listed on main- land or other off-shore islands.
132	<i>Equisetum hyemale</i>	Rough horsetail, Common scouring-rush	1a
133	<i>Eriobotrya japonica</i>	Loquat	See below
134	<i>Eucalyptus camaldulensis</i>	River red gum	See below
a. 1 b in Western Cape and Forest biome. b. Not listed in urban areas in Western Cape. c. Not listed elsewhere. d. The fruit of the loquat is not listed if used for human consumption.			
135	<i>Eucalyptus cladocalyx</i>	Sugar gum	See below
136	<i>Eucalyptus conferruminata</i> ( <i>E. lehmannii</i> misapplied in South Africa)	Spider gum	See below
137	<i>Eucalyptus diversicolor</i> and hybrids, varieties and selections	Karri	See below
138	<i>Eucalyptus grandis</i> ( <i>E. saligna</i> in part) and hybrids, varieties and selections	Saligna gum, Rose gum	See below
139	<i>Eucalyptus tereticornis</i> and hybrids, varieties and selections	Forest red gum	See below
a. Category 1b within- (i) riparian areas; (ii) a Protected Area declared in terms of the Protected Areas Act; or, (iii) within a Listed Ecosystem or an ecosystem identified for conservation in terms of a Bioregional Plan or Biodiversity Management Plans published under the Act. b. Not listed within Nama-Karoo, Succulent Karoo and Desert biomes, excluding within any area mentioned in (a) above. c. Category 1b in Fynbos, Grassland, Savanna, Albany Thicket, Forest and Indian Ocean Coastal Belt biomes, but- (i) Category 2 for plantations, woodlots, bee-forage areas, wind-rows and the lining of avenues. (ii) not listed within cultivated land that is at least 50 metres away from untransformed land, but excluding within any area in (a) above. (iii) Not listed within 50 metres of the main house on a farm, but excluding in (a) above. (iv) Not listed in urban areas for trees with a diameter of more than 400 mm at 1000 mm height at the time of publishing of this Notice, but excluding in (a) above.			
140	<i>Eugenia uniflora</i>	Pitanga, Surinam cherry	1b
141	<i>Euphorbia esula</i>	Leafy spurge	1a
142	<i>Euphorbia leucocephala</i>	White poinsettia	1b
143	<i>Fallopia sachalinensis</i>	Giant knotweed	1a
144	<i>Festuca rubra</i>	Creeping red fescue	a. 1a Prince Edward and Marion Islands. b. Not listed on mainland or other off- shore islands.
145	<i>Flaveria bidentis</i>	Smelter's-bush	1b
146	<i>Fraxinus americana</i>	American ash	See below
147	<i>Fraxinus angustifolia</i>	Algerian ash	See below
3 in Eastern Cape, KwaZulu-Natal, Limpopo, Mpumalanga and Western Cape.			

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	SPECIES	COMMON NAME	CATEGORY / AREA
Not listed elsewhere.			
148	<i>Furcraea foetida</i>	Mauritian hemp	1a
149	<i>Genista monspessulana</i>	Montpellier broom	1a
150	<i>Gleditsia triacanthos</i>	Honey locust	a. 1b b. Sterile cultivars or hybrids are not listed.
151	<i>Glyceria maxima</i>	Reed meadow grass, Reed sweet grass	a. 1b in Protected Areas and wetlands. b. Not listed elsewhere.
152	<i>Grevillea banksii</i>	Australian crimson oak, Red flowering silky oak	1b
153	<i>Grevillea robusta</i>	Australian silky oak	3
154	<i>Grevillea rosmarinifolia</i>	Rosemary grevillea	3
155	<i>Hakea drupacea</i>	Sweet hakea	1b
156	<i>Hakea gibbosa</i>	Rock hakea	1b
157	<i>Hakea salicifolia</i>	Willow hakea	a. 1b in Western Cape. b. Not listed elsewhere.
158	<i>Hakea sericea</i>	Silky hakea	1b
159	<i>Harrisia balansae</i>	Strangler prickly apple	1a
160	<i>Harrisia martinii</i>	Moon cactus	1b
161	<i>Harrisia pomanensis</i>	Midnight lady, Devil's rope cactus	1a
162	<i>Harrisia tortuosa</i>	Spiny snake cactus	1b
163	<i>Hedera canariensis</i>	Canary ivy, Madeira ivy, Algerian ivy	See below
164	<i>Hedera helix</i>	English ivy	See below
a. 3 b. Sterile cultivars or hybrids are not listed.			
165	<i>Hedychium coccineum</i>	Red ginger lily	1b
166	<i>Hedychium coronarium</i>	White ginger lily	1b
167	<i>Hedychium flavescens</i>	Yellow ginger lily	1b
168	<i>Hedychium gardnerianum</i>	Kahili ginger lily	1b
168	<i>Homalanthus populifolius</i>	Bleeding-heart tree	1b
170	<i>Houttuynia cordata</i>	Chameleon plant	3
171	<i>Hydrilla verticillata</i>	Hydrilla	1a
172	<i>Hydrocleys nymphoides</i>	Water poppy	1a
173	<i>Hylocereus undatus</i>	Night-blooming cereus, Dragon fruit, Pitahaya	See below
a. 2 b. The fruit of night-blooming cactus is not listed if used for human consumption.			
174	<i>Hypericum androsaemum</i>	Tutsan	1b
175	<i>Hypericum perforatum</i>	St. John's wort, Tipton weed	2
176	<i>Ipomoea alba</i>	Moonflower	1b
177	<i>Ipomoea carnea</i>	Morning-glory bush	1b
178	<i>Ipomoea indica</i>	Morning glory	See below
179	<i>Ipomoea purpurea</i>	Morning glory	See below
a. 3 b. Sterile cultivars or hybrids are not listed.			
180	<i>Iris pseudacorus</i>	Yellow flag	1a
181	<i>Jacaranda mimosifolia</i>	Jacaranda	See below
1b in Gauteng, KwaZulu-Natal, Limpopo, Mpumalanga and North-West. Not listed for urban areas in Gauteng, KwaZulu-Natal, Limpopo, Mpumalanga and North-West. Not listed within 50 metres of the main house on a farm in Gauteng, KwaZulu-Natal, Limpopo, Mpumalanga and North-West, for trees with a diameter of more than 400 mm at 1000 mm height at the time of publishing of this Notice, provided such trees are located outside riparian areas. Not listed elsewhere.			
182	<i>Jatropha curcas</i>	Physic nut	2
183	<i>Jatropha gossypifolia</i>	Cotton-leaf physic nut	1b
184	<i>Juniperus virginiana</i>	Red cedar	a. 3 in Eastern Cape and Free State. b. Not listed elsewhere.
185	<i>Kunzea ericoides</i>	Burgan, White teatree	1a
186	<i>Lantana</i> – all seed- producing species or seed- producing hybrids that are non-	Lantana, Tickberry, Cherry pie	1b



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	SPECIES	COMMON NAME	CATEGORY / AREA
	<i>indigenous to South Africa</i>		
187	<i>Lepidium draba</i>	Hoary cardaria	1b
188	<i>Leptospermum laevigatum</i>	Australian myrtle	1b
189	<i>Leucaena leucocephala</i>	Leucaena	2
190	<i>Ligustrum japonicum</i>	Japanese wax-leaved privet	See below
1b in Eastern Cape, KwaZulu-Natal, Limpopo, Mpumalanga, North-West and Western Cape. 3 in Free State, Gauteng and Northern Cape.			
191	<i>Ligustrum lucidum</i>	Chinese wax-leaved privet	See below
192	<i>Ligustrum ovalifolium</i>	Californian privet	See below
1b in Eastern Cape, KwaZulu-Natal, Limpopo, Mpumalanga, North-West and Western Cape. 3 in Free State, Gauteng and Northern Cape. Sterile cultivars or hybrids are not listed.			
193	<i>Ligustrum sinense</i>	Chinese privet	See below
194	<i>Ligustrum vulgare</i>	Common privet	See below
1b in Eastern Cape, KwaZulu-Natal, Limpopo, Mpumalanga, North-West and Western Cape. 3 in Free State, Gauteng and Northern Cape.			
195	<i>Lilium formosanum</i>	Formosa lily	1b
196	<i>Limonium sinuatum</i>	Statice, Sea lavender	See below
a. 1b in Northern Cape and Western Cape. b. Not listed elsewhere. c. Sterile cultivars or hybrids are not listed.			
197	<i>Linaria dalmatica</i>	Dalmatian toadflax, Broadleaf toadflax	1b
198	<i>Linaria vulgaris</i>	Common toadflax, Butter- and-eggs	1b
199	<i>Litsea glutinosa</i>	Indian laurel	1b
200	<i>Lonicera japonica</i>	Japanese or Hall's honey- suckle	3
201	<i>Ludwigia peruviana</i>	Water-primrose, Peruvian primrosebush	1a
202	<i>Luzula multiflora</i>	Woodrush	See below
a. 1a Prince Edward and Marion Islands. b. Not listed on mainland or other off-shore islands.			
203	<i>Lythrum hyssopifolia</i>	Hyssop loosestrife	1b
204	<i>Lythrum salicaria</i>	Purple loosestrife	1a
205	<i>Malva dendromorpha</i>	Tree mallow	1b
206	<i>Malva verticillata</i>	Mallow	1b
207	<i>Malvastrum coromandelianum</i>	Prickly malvastrum	1b
208	<i>Marsilea mutica</i>	Nardoo, Australian water-clover	1a
209	<i>Melaleuca hypericifolia</i>	Red-flowering tea tree	1a
210	<i>Melaleuca quinquenervia</i>	Bottle brush tree, Broadleaf paperbark tree	See below
a. 1b b. National Heritage Trees or National Monument Trees in terms of the National Heritage Resources Act, 1999, (Act No. 25 of 1999), are not listed.			
211	<i>Melia azedarach</i>	Seringa	a. 1b b. 3 in urban areas.
212	<i>Metrosideros excelsa</i>	New Zealand Christmas tree	See below
a. 1a in the Overstrand District. b. Not listed elsewhere. c. Sterile cultivars or hybrids are not listed.			
213	<i>Mimosa pigra</i>	Giant sensitive plant	1b
214	<i>Mirabilis jalapa</i>	Four-o'clock, Marvel-of -Peru	1b
215	<i>Montanoa hibiscifolia</i>	Tree daisy	1b
216	<i>Morus alba</i>	White mulberry, Common mulberry	See below
a. 3 b. Sterile cultivars or hybrids are not listed. c. The fruit of the white mulberry is not listed if used for human consumption.			
217	<i>Murraya paniculata</i>	Orange Jessamine	See below
1b in KwaZulu-Natal, Limpopo and Mpumalanga. 2 for breeding in nurseries in KwaZulu-Natal, Limpopo and Mpumalanga, but may not be transferred within these Provincial boundaries. Not listed elsewhere. d. Sterile cultivars or hybrids are not listed.			
218	<i>Myoporum insulare</i>	Manatoka, Boobyalla	3
219	<i>Myoporum laetum</i>	New Zealand manatoka	3
220	<i>Myoporum montanum</i>	Manatoka	3

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	SPECIES	COMMON NAME	CATEGORY / AREA
221	<i>Myriophyllum aquaticum</i>	Parrot's feather	1b
222	<i>Myriophyllum spicatum</i>	Spiked water-milfoil	1b
223	<i>Myrtillocactus geometrizans</i>	Bilberry cactus	1a
224	<i>Nassella tenuissima</i>	White tussock	1b
225	<i>Nassella trichotoma</i>	Nassella tussock	1b
226	<i>Nasturtium officinale</i>	Watercress	2
227	<i>Nephrolepis cordifolia</i>	Erect sword fern, Ladder sword fern	See below
1b in Eastern Cape, KwaZulu-Natal, Mpumalanga, Limpopo and Western Cape. 3 in Free State, Gauteng, KwaZulu-Natal, North-West and Northern Cape. Sterile cultivars or hybrids are not listed.			
228	<i>Nephrolepis exaltata</i>	Sword fern, Boston sword fern	See below
1b in Eastern Cape, KwaZulu-Natal, Limpopo, Mpumalanga, North-West and Western Cape. 3 in Free State, Gauteng and Northern Cape, North-West. Sterile cultivars or hybrids are not listed.			
229	<i>Nerium oleander</i>	Oleander	a. 1b b. Sterile cultivars or hybrids are not listed.
230	<i>Nicandra physalodes</i>	Apple-of-Peru	1b
231	<i>Nicotiana glauca</i>	Wild tobacco	1b
232	<i>Nuphar lutea</i>	Yellow water-lily	1a
233	<i>Nymphaea mexicana</i>	Yellow water lilies	1b
234	<i>Nymphoides peltata</i>	Gringed waterlily, Yellow floating-heart	1a
235	<i>Oenothera sinuosa</i>	Wavy-leaf gaura	3
236	<i>Opuntia aurantiaca</i>	Jointed cactus	1b
237	<i>Opuntia elata</i>	Orange tuna	1b
238	<i>Opuntia engelmannii</i>	Small round-leaved prickly pear	1b
239	<i>Opuntia ficus-indica</i>	Mission prickly pear, Sweet prickly pear	See below.
a. 1b b. Spineless cactus pear cultivars and selections are not listed. c. The fruit of the sweet prickly pear is not listed if used for human consumption.			
240	<i>Opuntia humifusa</i>	Large-flowered prickly pear, Creeping prickly pear	1b
241	<i>Opuntia leucotricha</i>	Aaron's-beard prickly-pear	1b
242	<i>Opuntia microdasys</i>	Yellow bunny-ears, Teddy- bear cactus	1b
243	<i>Opuntia monacantha</i> (O. vulgaris misapplied in South Africa)	Cochineal prickly pear, Drooping prickly pear	1b
244	<i>Opuntia pubescens</i>	Velvet bur cactus	1a
245	<i>Opuntia robusta</i>	Blue-leaf cactus	See below
a. 1a b. Spineless cultivars and selections are not listed.			
246	<i>Opuntia salmiana</i>	Bur cactus	1a
247	<i>Opuntia spinulifera</i>	Saucepan cactus, Large round-leaved prickly pear	1b
248	<i>Opuntia stricta</i>	Pest pear of Australia	1b
249	<i>Opuntia tomentosa</i>	Velvet opuntia, Velvet tree-pear	1b
250	<i>Orobancha minor</i>	Lesser broomrape, Clover broomrape	1b
251	<i>Orobancha ramosa</i>	Blue broomrape, Branched broomrape	1b
252	<i>Paraserianthes lophantha</i>	Australian albizia, Stink bean	1b
253	<i>Parkinsonia aculeata</i>	Jerusalem thorn	1b
254	<i>Parthenium hysterophorus</i>	Famine weed	1b
255	<i>Paspalum quadrifarium</i>	Tussock paspalum	1a
256	<i>Passiflora caerulea</i>	Blue passion flower	1b
257	<i>Passiflora edulis</i>	Purple granadilla, Passion fruit	See below
2 in Eastern Cape, Gauteng, KwaZulu-Natal, Mpumalanga, Limpopo and North-West. Not listed in urban areas in Eastern Cape, Gauteng, KwaZulu-Natal, Mpumalanga, Limpopo and North-West. c. Not listed elsewhere. d. The fruit of the purple granadilla is not listed if used for human consumption.			



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	SPECIES	COMMON NAME	CATEGORY / AREA
258	<i>Passiflora tripartita</i> var. <i>mollisima</i>	Banana poka, Bananadilla	1b
259	<i>Passiflora suberosa</i>	Devil's pumpkin, Indigo berry	1b
260	<i>Passiflora subpeltata</i>	Granadina	1b
261	<i>Paulownia tomentosa</i>	Empress tree, Princess tree, Royal Paulownia	1a
262	<i>Peniocereus serpentinus</i>	Serpent cactus, Snake cactus	1b
263	<i>Pennisetum clandestinum</i>	Kikuyu grass	See below
1b in Protected Areas and wetlands in which it does not already occur. Not listed elsewhere.			
264	<i>Pennisetum purpureum</i>	Elephant grass, Napier grass	2
265	<i>Pennisetum setaceum</i>	Fountain grass	See below
a. 1b b. Sterile cultivars or hybrids are not listed.			
266	<i>Pennisetum villosum</i>	Feathertop	1b
267	<i>Pereskia aculeata</i>	Pereskia, Barbados gooseberry	1b
268	<i>Persicaria capitata</i>	Knotweed	1b
269	<i>Phytolacca americana</i>	American pokeweed	1b
270	<i>Phytolacca dioica</i>	Belhambra	3
271	<i>Phytolacca octandra</i>	Forest inkberry	1b
272	<i>Pinus canariensis</i>	Canary pine	3
273	<i>Pinus elliotti</i> and hybrids, varieties and selections	Slash pine	See below
a. 2 for sterile specimens.b. 1b for non-sterile specimens.			
274	<i>Pinus halepensis</i>	Aleppo pine	See below
a. 3 in Eastern Cape, Free State and Western Cape. b. Not listed elsewhere.			
275	<i>Pinus patula</i> and hybrids, varieties and selections	Patula pine	2
276	<i>Pinus pinaster</i> and hybrids, varieties and selections	Cluster pine	See below
a. 2 for plantations and wind-rows.b. 1b elsewhere. c. National Heritage Trees or National Monument Trees in terms of the National Heritage Resources Act, 1999, (Act No. 25 of 1999), are not listed.			
277	<i>Pinus radiata</i> and hybrids, varieties and selections	Radiata pine, Monterey pine	See below
a. 2 for plantations and wind-rows. b. 1b elsewhere. c. National Heritage Trees or National Monument Trees in terms of the National Heritage Resources Act, 1999 (Act No. 25 of 1999), are not listed. d. Specimens with a diameter (calliper width) greater than 400 mm at a height of 1000 mm at the date of publication of this Notice are not listed for urban areas in Cape Town, the Overberg District Council and Winelands District Council, except when in riparian areas where they remain Category 1b.			
278	<i>Pinus roxburghii</i> and hybrids, varieties and selections	Chir pine, Longifolia pine	2
279	<i>Pinus taeda</i> and hybrids, varieties and selections	Loblolly pine	2
280	<i>Pistia stratiotes</i>	Water lettuce	1b
281	<i>Pittosporum crassifolium</i>	Karo, Stiff-leaved cheesewood	3
282	<i>Pittosporum undulatum</i>	Australian cheesewood, Sweet pittosporum	1b
283	<i>Plectranthus barbatus</i> var. <i>grandis</i>	'Abyssinian' coleus, Woolly plectranthus	1b
284	<i>Poa pratensis</i>	Kentucky bluegrass	See below
a. 1a Prince Edward Island. b. 1b Marion Island. c. Not listed on mainland or other off-shore islands.			
285	<i>Polypodium aureum</i>	Rabbits-foot fern	See below
a. 3 in Eastern Cape, KwaZulu-Natal, Limpopo and Mpumalanga. b. Not listed elsewhere.			
286	<i>Pontederia cordata</i>	Pickereel weed	1b
287	<i>Populus alba</i>	White poplar	2
288	<i>Populus x canescens</i>	Grey poplar, Matchwood poplar	2
289	<i>Prosopis glandulosa</i>	Honey mesquite	See below
290	<i>Prosopis velutina</i> and hybrids	Velvet mesquite	See below

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	SPECIES	COMMON NAME	CATEGORY / AREA
a. 1b in Eastern Cape, Free State, North-West and Western Cape. b. 3 in Northern Cape. c. The utilisation of the pods for fodder is not listed in the Northern Cape, Eastern Cape, Free State, North-West and Western Cape. d. Not listed elsewhere.			
291	<i>Prunus serotina</i>	Black cherry	1b
292	<i>Psidium cattleianum</i>	Strawberry guava	1b
293	<i>Psidium guajava</i>	Guava	See below
a. 2 for plantations in Eastern Cape, KwaZulu-Natal, Limpopo, Mpumalanga and North-West. b. 3 elsewhere in Eastern Cape, KwaZulu-Natal, Limpopo, Mpumalanga and North-West. c. The fruit of the guava is not listed if used for human consumption. d. Not listed elsewhere.			
294	<i>Psidium guineense</i>	Brazilian guava	1b
295	<i>Psidium x durbanensis</i>	Durban guava	1b
296	<i>Pueraria montana</i>	Kudzu vine	1a
297	<i>Pyracantha angustifolia</i>	Yellow firethorn	See below
298	<i>Pyracantha coccinea</i>	Red firethorn	See below
299	<i>Pyracantha crenatoserrata</i>	Chinese firethorn, Broad leaf firethorn	See below
300	<i>Pyracantha crenulata</i>	Himalayan firethorn	See below
301	<i>Pyracantha koidzumii</i>	Formosa firethorn	See below
a. 1b b. Sterile cultivars or hybrids are not listed.			
302	<i>Rhus glabra</i>	Scarlet sumach, Vinegar bush	3
303	<i>Ricinus communis</i>	Castor-oil plant	2
304	<i>Rivina humilis</i>	Rivina, Bloodberry	1b
305	<i>Robinia pseudoacacia</i>	Black locust	1b
306	<i>Rosa rubiginosa</i>	Eglantine, Sweetbriar	1b
307	<i>Rubus cuneifolius and hybrid R. x proteus</i>	American bramble	1b
308	<i>Rubus ellipticus</i>	Asian wild raspberry, Yellow Himalayan raspberry	1a
309	<i>Rubus flagellaris</i>	Bramble	1b
310	<i>Rubus fruticosus</i>	European blackberry	See below
a. 2 b. The fruit of the European blackberry is not listed if used for human consumption.			
311	<i>Rubus immixtus</i>	Hogsback raspberry	1b
312	<i>Rubus niveus</i>	Ceylon raspberry, Mysore raspberry	1b
313	<i>Rumex acetosella</i>	Sheep sorrel, Red sorrel	See below
a. 1a Prince Edward and Marion Islands. b. Not listed on mainland or other off-shore islands.			
314	<i>Rumex usambarensis</i>	East African dock	1b
315	<i>Sagina procumbens</i>	Birdeye pearlwort	See below
a. 1a Prince Edward and Marion Islands. b. Not listed on mainland or other off-shore islands.			
316	<i>Sagittaria platyphylla</i>	Delta arrowhead, Slender arrowhead	1a
317	<i>Salsola kali</i>	Tumbleweed	1b
318	<i>Salsola tragus</i>	Russian tumbleweed	1b
319	<i>Salvia tiliifolia</i>	Lindenleaf sage	1b
320	<i>Salvinia minima</i>	Small salvinia	1b
321	<i>Salvinia molesta</i>	Kariba weed, Salvinia	1b
322	<i>Sambucus canadensis</i>	Canadian elder	1b
323	<i>Sambucus nigra</i>	European elder	1b
324	<i>Sasa ramosa</i>	Dwarf yellow-striped bamboo	3
325	<i>Schefflera actinophylla</i>	Australian cabbage tree, Queensland umbrella tree	See below
a. 1b in Eastern Cape, KwaZulu-Natal, Limpopo and Mpumalanga. b. Not listed elsewhere.			
326	<i>Schefflera arboricola</i>	Dwarf umbrella tree	See below
a. 3 in Eastern Cape, KwaZulu-Natal, Limpopo and Mpumalanga. b. Not listed elsewhere.			
327	<i>Schefflera elegantissima</i>	False aralia	See below
a. 3 in Eastern Cape, KwaZulu-Natal, Limpopo and Mpumalanga. b. Not listed elsewhere.			
328	<i>Schinus terebinthifolius</i>	Brazilian pepper tree	See below
1b in Eastern Cape, KwaZulu-Natal, Limpopo and Mpumalanga. 3 in Free State, Gauteng, North-West, Northern Cape and Western Cape.			
329	<i>Senna bicapsularis</i>	Rambling cassia	1b

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	SPECIES	COMMON NAME	CATEGORY / AREA
330	<i>Senna didymobotrya</i>	Peanut butter cassia	See below
1b in Eastern Cape, KwaZulu-Natal, Limpopo, Mpumalanga and Western Cape. Not listed elsewhere.			
331	<i>Senna hirsuta</i>	Hairy senna, Woolly senna	1b
332	<i>Senna occidentalis</i>	Stinking weed, Wild coffee	1b
333	<i>Senna pendula</i>	Climbing cassia, Easter cassia	1b
334	<i>Senna septemtrionalis</i>	Arsenic bush, Smooth senna	1b
335	<i>Sesbania punicea</i>	Red sesbania	1b
336	<i>Solanum betaceum</i>	Tree tomato	See below
3 in Eastern Cape, KwaZulu-Natal, Limpopo and Mpumalanga. The fruit of the tree tomato is not listed if used for human consumption, in the Eastern Cape, KwaZulu-Natal, Limpopo and Mpumalanga. Not listed elsewhere.			
337	<i>Solanum chrysotrichum</i> (S. hispidum misapplied in South Africa)	Giant devil's fig	1b
338	<i>Solanum elaeagnifolium</i>	Silver-leaf bitter apple	1b
339	<i>Solanum mauritianum</i>	Bugweed	1b
340	<i>Solanum pseudocapsicum</i>	Jerusalem cherry	1b
341	<i>Solanum seaforthianum</i>	Potato creeper	1b
342	<i>Solanum sisymbriifolium</i>	Wild tomato, Dense- thorned bitter apple	1b
343	<i>Sorghum halepense</i>	Johnson grass, Aleppo grass	2
344	<i>Spartina alterniflora</i>	Smooth cordgrass, Salt-water cordgrass	1a
345	<i>Spartium junceum</i>	Spanish broom	See below
1b in Eastern Cape and Western Cape. 3 in Free State, Gauteng, KwaZulu-Natal, Limpopo, Mpumalanga, North-West and Northern Cape.			
346	<i>Spathodea campanulata</i>	African flame tree	See below
a. 3 in Eastern Cape, KwaZulu-Natal, Limpopo and Mpumalanga. b. Not listed elsewhere.			
347	<i>Sphagneticola trilobata</i>	Singapore daisy	See below
1b in Eastern Cape, KwaZulu-Natal, Limpopo and Mpumalanga. 3 in Free State, Gauteng, North-West, Northern Cape and Western Cape.			
348	<i>Stachytarpheta cayennensis</i>	Blue snakeweed, Cayenne snakeweed	3
349	<i>Stachytarpheta mutabilis</i>	Pink snakeweed	3
350	<i>Stellaria media</i>	Common chickweed	See below
a. 1a Prince Edward Island. b. 1b Marion Island. c. Not listed on mainland or other off-shore islands.			
351	<i>Syngonium podophyllum</i>	Goose foot, Arrow- head vine	See below
1b in Eastern Cape, KwaZulu-Natal, Limpopo and Mpumalanga. 2 for breeding in nurseries in in Eastern Cape, KwaZulu-Natal, Limpopo and Mpumalanga, but may not be transferred within these Provincial boundaries. c. Not listed elsewhere.			
352	<i>Syzygium cumini</i>	Jambolan	See below
a. 1b b. The fruit of the jambolan is not listed if used for human consumption.			
353	<i>Syzygium jambos</i>	Rose apple	3
354	<i>Tamarix aphylla</i>	Athel tree, Desert tamarisk	1b
355	<i>Tamarix chinensis</i> Not to be confused with indigenous <i>Tamarix usneoides</i>	Chinese tamarisk	1b
356	<i>Tamarix gallica</i> Not to be confused with indigenous <i>Tamarix usneoides</i>	French tamarisk	1b
357	<i>Tamarix ramosissima</i> Not to be confused with indigenous <i>Tamarix usneoides</i>	Pink tamarisk	1b
358	<i>Tecoma stans</i>	Yellow bells	1b
359	<i>Tephrocactus articulatus</i>	Pine cone cactus, Paper- spine cholla	1a
360	<i>Thevetia peruviana</i>	Yellow oleander	1b
361	<i>Tipuana tipu</i>	Tipu tree	3
362	<i>Tithonia diversifolia</i>	Mexican sunflower	1b
363	<i>Tithonia rotundifolia</i>	Red sunflower	1b
364	<i>Toona ciliata</i>	Toon tree	3

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	SPECIES	COMMON NAME	CATEGORY / AREA
365	<i>Toxicodendron succedaneum</i>	Wax tree	1b
366	<i>Tradescantia fluminensis</i>	Wandering Jew	1b
367	<i>Tradescantia zebrina</i>	Wandering Jew	1b
368	<i>Triplaris americana</i>	Ant tree, Triplaris	1a
369	<i>Tropaeolum speciosum</i>	Chilean flame creeper, Flame nasturtium	3
370	<i>Ulex europaeus</i>	European gorse	1a
371	<i>Verbena bonariensis</i>	Wild verbena, Tall verbena, Purple top	1b
372	<i>Verbena brasiliensis</i>	Brazilian verbena	1b
373	<i>Verbena rigida</i>	Veined verbena	1b
374	<i>Vinca major</i>	Greater periwinkle	See below
375	<i>Vinca minor</i>	Lesser periwinkle	See below
a. 1b b. Sterile cultivars or hybrids are not listed.			
376	<i>Vitex trifolia</i>	Indian three-leaf vitex	1b
377	<i>Wigandia urens</i> var. <i>caracasana</i>	Wigandia	3
378	<i>Xanthium spinosum</i>	Spiny cocklebur	1b
379	<i>Xanthium strumarium</i>	Large cocklebur	1b

### **C3.7: CIVIL SPECIFICATIONS**

#### **C3.7.1 STANDARD SPECIFICATIONS**

##### **APPLICABLE STANDARD SPECIFICATIONS**

For the purposes of this contract, the following SANS 1200 Standardized Specifications for civil engineering construction shall apply:

SANS 1200 A	:	General
SANS 1200 C	:	Site clearance
SANS 1200 D	:	Earthworks
SANS 1200 DB	:	Earthworks (pipe trenches)
SANS 1200 DK	:	Gabions and Pitching
SANS 1200 DM	:	Earthworks (roads, subgrade)
SANS 1200 G	:	Concrete (structural)
SANS 1200 GE	:	Precast Concrete (structural)
SANS 1200 H	:	Structural steelwork
SANS 1200 HB	:	Cladding and sheeting
SANS 1200 HC	:	Corrosion Protection of Structural Steelwork
SANS 1200 L	:	Medium-pressure pipelines
SANS 1200 LB	:	Bedding (pipes)
SANS 1200 LC	:	Cable ducts
SANS 1200 LD	:	Sewers
SANS 1200 LE	:	Stormwater Drainage
SANS 1200 LG	:	Pipe Jacking
SANS 1200 M	:	Roads
SANS 1200 ME	:	Subbase
SANS 1200 MF	:	Base
SANS 1200 MH	:	Asphalt Base and Surfacing
SANS 1200 MJ	:	Segmented Paving
SANS 1200 MK	:	Kerbing and channeling
SANS 1200 MM	:	Ancillary Roadwork's

Other applicable Standard Specifications to the project shall apply:

SANS 10108	:	The Classification of Hazardous Locations and the Selection of Apparatus for Use in Such Locations
SANS 10140-3	:	Identification Colour Marking: Contents of Pipelines
SANS 10400	:	Building Regulations

**END OF SECTION**

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**C3.7.2 VARIATIONS AND ADDITIONS TO THE STANDARD SPECIFICATIONS****VARIATIONS AND ADDITIONS TO THE STANDARDIZED SPECIFICATIONS (SANS 1200)**

The following variations and additions to the Specifications will be valid for this contract. The prefix "PSA" indicates an amendment or addition to SANS 1200 A, "PSC" to SANS 1200 C, etc. The numbers following these prefixes are the relevant clause numbers in SANS 1200. The same naming standard applies to payment clauses and items in the Bill of Quantities.

The word "Engineer" is used synonymously with the word "Employer's Agent" throughout the specifications.

The phrase "or equivalent" is used synonymously with the phrase "or similar approved" throughout the specifications.

**PSA            GENERAL (SANS 1200 A)****PSA 1            SCOPE**

*REPLACE THE CONTENTS OF SUBCLAUSE 1.1, INCLUDING THE NOTES, WITH THE FOLLOWING:*

"1.1        This specification covers requirements, principles and responsibilities of a general nature which are generally applicable to civil engineering construction and building works contracts, as well as the requirements for the Contractor's establishment on the Site."

**PSA 2            INTERPRETATIONS****PSA 2.3        DEFINITIONS**

*IN THE OPENING PHRASE, INSERT THE WORDS: 'the definitions given in the Conditions of Contract and' BETWEEN THE WORDS "specification" AND "the following".*

**(a)    General**

*ADD THE FOLLOWING DEFINITIONS:*

"'General Conditions' and 'Conditions of Contract': The General Conditions of Contract specified for use with this Contract, together with the Special Conditions of Contract as applicable.

'Specified': As specified in the Standardised Specifications, the Drawings or the Project Specifications. 'Specifications' shall have the corresponding meaning."

**(b)    Measurement and payment**

*REPLACE THE DEFINITIONS FOR "Fixed charge", "Time-related charge" AND "Value-related charge" WITH THE FOLLOWING :*

"

'Fixed charge': A charge that is not subject to adjustment on account of variations in the value of the Contract Price or the time allowed in the Contract for the completion of the work.

'Time-related charge': A charge, the amount of which varies in accordance with the Time for Completion of the Works, inclusive of special non-working days, adjusted in accordance with the provisions of the Contract.

'Value-related charge: A charge, the amount of which varies pro rata with the final value of the measured work executed and valued in accordance with the provisions of the Contract."

**PSA 2.4        ABBREVIATIONS****(a)    Abbreviations relating to standard documents**

*ADD THE FOLLOWING ABBREVIATION :*

"CKS : SABS Co-ordinating Specification."

The terms "ESCOM", "ESC" and "Electricity Supply Commission" shall mean "Eskom".

The terms "GPO", "P&T" and "Department of Posts and Telecommunications" shall mean "Telkom SA Limited".

The terms "Schedule of Quantities" and "Bill of Quantities" shall be synonymous.

Except for references to the Bureau itself, or to the (official) SABS mark, the term "SABS" shall mean "SANS".

"Number" and "No." shall be interchangeable when relating to the unit of measure of relevant payment clauses.

(b) Other abbreviations

*ADD THE FOLLOWING ABBREVIATIONS :*

"MAMDD: Modified AASHTO maximum dry density.

TMH1: Technical Methods for Highways 1".

### **PSA 3        MATERIALS**

#### **PSA 3.1      QUALITY**

*ADD THE FOLLOWING TO SUBCLAUSE 3.1 :*

"All manufactured materials supplied shall be new materials unless the contrary is specified. All materials specified to be in accordance with SANS Specifications shall bear the SANS mark."

*ADD THE FOLLOWING SUBCLAUSES*

#### **"PSA 3.3      ORDERING OF MATERIALS**

The quantities set out in the Schedule of Quantities have been carefully determined from calculations based on data available at the time of its compilation but are to be considered as approximate quantities only. Before ordering materials of any kind the Contractor shall be solely responsible for determining, from the drawings issued or approved by the Engineer for construction purposes, the actual quantities of materials required for the execution of the Works. No liability or responsibility whatsoever shall be attached to the Employer or the Engineer in respect of materials ordered by the Contractor except when ordered in accordance with the drawings issued or approved by the Engineer for construction purposes."

### **PSA 4        PLANT**

#### **PSA 4.1      SILENCING OF PLANT**

*REPLACE THE CONTENTS OF SUBCLAUSE 4.1 WITH THE FOLLOWING:*

"The Contractor's attention is drawn to the applicable regulations pertaining to noise and hearing conservation, framed under the Occupational Health and Safety Act (Act No. 85 of 1993) as amended.

The Contractor shall at all times and at its own cost, be responsible for implementing all necessary steps to ensure full compliance with such regulations, including but not restricted to the provision and use of suitable and effective silencing devices for pneumatic tools and other Plant which would otherwise cause a noise level in excess of that specified in the said regulations.

Where appropriate, the Contractor shall further, by means of temporary barriers, effectively isolate the source of such noise in order to comply with the said regulations."

#### **PSA 4.2      CONTRACTOR'S OFFICES, STORES AND SERVICES**

*ADD THE FOLLOWING PARAGRAPH BEFORE THE EXISTING FIRST PARAGRAPH IN SUBCLAUSE 4.2 :*



"The Contractor's buildings, sheds and other facilities erected or utilised on the Site for the purposes of the Contract shall be fenced off and shall contain all offices, stores, workshops, testing laboratories, toilet facilities, etc. as may be required by the Contractor. The facilities shall always be kept in a neat and orderly condition. No personnel may reside on the Site. Only night-watchmen may be on the Site after hours.

First aid services required on site shall include, inter alia, a First Aid cabinet fully equipped and maintained with at least the minimum contents as listed in the Annexure (Regulation 3) to the General Safety Regulations of the Occupational Health and Safety Act, 1993 (Act 85 of 1993), to deal with accidents and ailments which are likely to occur during the construction period.

The Contractor shall provide personal safety equipment and facilities as required by Regulation 2 of the General Safety Regulations of the Occupational Health and Safety Act, 1993 (Act 85 of 1993)."

*DELETE "and first-aid services" IN THE SECOND PARAGRAPH OF SUBCLAUSE 4.2 AND ADD THE FOLLOWING :*

"The Contractor shall provide on the Site and in close proximity to the actual locations where the work is being executed, one toilet per 10 workmen, which toilets shall be effectively screened from public view and their use enforced. Such toilets shall be relocated from time to time as the location of the work being executed changes, so as to ensure that easy access to the toilets is maintained. The Contractor shall, where applicable, make all necessary arrangements and pay for the removal of night soil."

*ADD THE FOLLOWING SUBCLAUSE :*

**"PSA 4.3      SITE SECURITY**

The area within the Wastewater Treatment Works security area used by the Contractor for the establishment of his camp site may be subject to a security risk beyond the control of the Municipality's normal protection system. The Contractor must assess the additional risk and make his own provision for additional protection.

No separate payment will be made for these additional security measures and the cost thereof will be deemed to be included in the rates tendered for Items PSA 8.3 and PSA 8.4. Should the Contractor feel that he needs additional insurance to cover these risks, the cost of such insurance will also be deemed to be included in the tendered rates."

**PSA 5      CONSTRUCTION**

**PSA 5.1      SURVEY**

**PSA 5.1.1      Setting Out of the Works**

*ADD THE FOLLOWING TO SUBCLAUSE 5.1.1 :*

"Before commencing any construction, the Contractor shall appoint a suitably qualified surveyor to place survey control points and benchmarks along the Works. The Contractor shall thereafter check the relative positions and levels of all reference pegs, benchmarks and line pegs in relation to the surveyed information indicated on the construction drawings and inform the Engineer of any discrepancy.

The Contractor shall be responsible for the true and proper setting out of the Works and for the correctness of the position, levels, dimensions and alignment of all parts of the Works and for the provisions of all necessary instruments, appliances and labour in connection therewith. The Contractor shall carefully protect and preserve all benchmarks, sight-rails, pegs and other things used in setting out the Works.

The checking of any setting-out or of any line or level by the Engineer shall not relieve the Contractor of his responsibility for the correctness thereof.

If at any time during the progress of the Works, any error shall appear or arise in the position, levels, dimensions or alignment of any part of the Works, the Contractor, on being required to do so by the Engineer, shall at his own expense rectify such error to the satisfaction of the Engineer, but if such error is based on incorrect data supplied in writing by the Engineer or if there is any delay in providing the particulars required, the Contractor shall, in respect of that delay and the cost of such rectification, be entitled to make a claim in accordance with Conditions of Contract."

**PSA 5.1.2      Preservation and Replacement of Survey Beacons and Pegs Subject to the Land Survey Act**

*DELETE THE WORDS "in the vicinity of boundaries" IN THE SECOND SENTENCE OF SUBCLAUSE 5.1.2 AND REPLACE THE WORDS "under the direction of" IN THE SAME SENTENCE WITH "in consultation and liaison with".*

*ADD THE FOLLOWING AFTER THE SECOND SENTENCE OF SUBCLAUSE 5.1.2 :*

"The Contractor and the Engineer shall record on the said list, their concurrence or disagreement (as the case may be) regarding the completeness and accuracy of the details recorded therein."

*REPLACE THE THIRD SENTENCE OF SUBCLAUSE 5.1.2 WITH THE FOLLOWING :*

"At the completion of the Contract, the Contractor shall expose all pegs that were listed at the commencement of the construction as being in order and the Contractor shall arrange with a registered Land Surveyor for the checking of the positions of all such pegs and the replacement of any thereof which the Land Surveyor's check reveals have become disturbed or damaged. The Contractor shall, as a precedent to the issue of the Certificate of Completion, provide to the Engineer, a certificate from the Registered Land Surveyor, certifying that all the pegs listed at the commencement of construction in accordance with the provisions of this clause, have been checked and that those found to have been disturbed, damaged or destroyed have been replaced in their correct positions, all in accordance with the provisions of the said Act.

The costs of all checking, replacement and certification as aforesaid shall be entirely for the Contractor's account; provided always that the Contractor shall not be held liable for the cost of replacement of pegs which :

- (a) cannot reasonably be re-established in their original positions by reason of the finished dimensions of the Permanent Works ; and
- (b) the Contractor can prove beyond reasonable doubt to the satisfaction of the Engineer, were disturbed, damaged or destroyed by others beyond its control."

*ADD THE FOLLOWING SUBCLAUSE:*

**PSA 5.1.3      Drawings and Details**

Tender drawings shall not be used for construction purposes. Construction drawings and additional detailed information will be made available to the Contractor as and when required by him.

The originals of all Drawings and Specifications prepared by or on behalf of the Engineer shall remain in his custody and references herein to delivery to the Contractor of Drawings or specifications shall relate to true copies thereof.

The Contractor shall be entitled to receive free of charge, to the extent provided in the Contract, copies of each such Drawing and specification and to receive, at the cost of reproduction, such additional copies as he shall reasonably require.

One copy of all documents constituting the Contract shall be kept on the Site and be available for perusal by the Engineer or any person authorised by him.

The Contractor shall, in accordance with the Engineer's instructions, maintain a register on the Site of all Drawings and revisions thereof in the chronological order in which they are delivered to him.

### **PSA 5.3      PROTECTION OF STRUCTURES**

*REPLACE* "Machinery and Occupational Safety Act, 1983, (Act No. 6 of 1983)" *WITH* "Occupational Health and Safety Act, 1993 (Act No. 85 of 1993), as amended," *AND INSERT THE FOLLOWING AFTER* "(Act No. 27 of 1956)" : "as amended".

### **PSA 5.4      PROTECTION OF OVERHEAD AND UNDERGROUND SERVICES**

*REPLACE THE HEADING AND THE CONTENTS OF SUBCLAUSE 5.4 WITH THE FOLLOWING :*

#### **"PSA 5.4      LOCATION AND PROTECTION OF EXISTING SERVICES**

##### **PSA 5.4.1      Location of existing services**

Before commencing with any work in an area, the Contractor shall ascertain the presence and actual position of all services that can reasonably be expected by an experienced and competent Contractor to be present on, under, over or within the Site.

Without in any way limiting its liability in terms of the Conditions of Contract in relation to damage to property and interference with services, the Contractor shall, in collaboration with the Engineer, obtain the most up-to-date plans as are available, showing the positions of services existing in the area where it intends to work. Neither the Employer nor the Engineer offer any warranty as to the accuracy or completeness of such plans and because services can often not be reliably located from plans, the Contractor shall ascertain the actual location of services depicted on such plans by means of careful inspection of Site and the provision and utilisation of suitable detecting and testing equipment.

Thereafter, the Contractor shall, by the use of appropriate methodologies carefully expose the services at such positions as are agreed to by the Engineer, for the purposes of verifying the exact location and position of the services. Where the exposure of existing services involves excavation to expose underground services, the further requirements of Subclauses 4.4 and 5.1.2.2 of SANS 1200D (as amended) shall apply.

The aforesaid procedure shall also be followed in respect of services not shown on the plans but which may reasonably be anticipated by an experienced Contractor to be present or potentially present on the site.

All services, the positions of which have been determined as aforesaid at the critical points, shall henceforth be designated as 'Known Services' and their positions shall be indicated by the Contractor on a separate set of Drawings, a copy of which shall be furnished to the Engineer without delay.

As soon as any service which has not been identified and located as described above is encountered on, under, over or within the Site, it shall henceforth be deemed to be a Known Service and the aforesaid provisions pertaining to locating, verifying and recording its position on the balance of the Site shall apply. The Contractor shall notify the Engineer immediately any such service is encountered or discovered on the Site.

Whilst it is in possession of the Site, the Contractor shall be liable for all loss of or damage as may occur to :

- (a) Known Services, anywhere along the entire lengths of their routes, as may reasonably be deduced from the actual locations at which their positions were verified as aforesaid, due cognisance being taken of such deviations in line and level which may reasonably be anticipated ; and
- (b) any other services which ought reasonably to have been a Known Service in accordance with the provisions of this clause ;

as well as for consequential damage, whether caused directly by the Contractor's operations or by the lack of proper protection;

Provided always that the Contractor will not be held liable in respect of damages occurring to services not being Known Services.

No separate payment will be made to the Contractor in respect of its costs of providing, holding available on the Site and utilising the said detecting and testing equipment, nor for any costs incurred in preparing and submitting to the Engineer, the Drawings as aforesaid and these costs shall be deemed included in the Contractor's other tendered rates and prices included in the Contract.

Payment to the Contractor's in respect of exposing services at the positions agreed by the Engineer and as described above will be made under the payment items (if any) as may be provided therefor in the respective sections of the Specifications pertaining to the type of work involved.

#### **PSA 5.4.2      Protection during construction**

The Contractor shall take all reasonable precautions and arrange its operations in such a manner as to prevent damage occurring to all Known Services during the period which the Contractor has occupation and/or possession of the Site.

Services left exposed shall be suitably protected from damage and in such a manner as will eliminate any danger arising therefrom for the public and/or workmen, all in accordance with the requirements of the prevailing legislation and related regulations.

#### **PSA 5.4.3      Alterations and repairs to existing services**

Unless the contrary is clearly specified in the Contract or ordered by the Engineer, the Contractor shall not carry out alterations to existing services. When any such alterations become necessary, the Contractor shall promptly inform the Engineer, who will either make arrangements for such work to be executed by the owner of the service or instruct the Contractor to make such arrangements himself.

Should damage occur to any existing services, the Contractor shall immediately inform the Engineer, or when this is not possible, the relevant authority, and obtain instructions as to who should carry out repairs. In urgent cases the Contractor shall take appropriate steps to minimise damage to and interruption of the service. No repairs of telecommunication cables or electric power lines and cables shall be attempted by the Contractor.

The Employer will accept no liability for damages due to a delay in having alterations or repairs effected by the respective service owners. The Contractor shall provide all reasonable opportunity, access and assistance to persons carrying out alterations or repairs of existing services."

#### **PSA 5.5      DEALING WITH WATER ON WORKS**

*ADD TO THE END OF THIS SUBCLAUSE THE FOLLOWING:*

“The Contractor shall ensure that the water level outside all water retaining structures is at all times kept below the lowest top of concrete floor level (or a specified level stated on the Drawing) of the particular structure until the structure is filled with water to prevent structural damage or floating.”

**PSA 5.7****SAFETY**

*REPLACE THE CONTENTS OF SUBCLAUSE 5.7 WITH THE FOLLOWING:*

“Pursuant to the provisions of the Conditions of Contract, and without in any way limiting the Contractor’s obligations thereunder, the Contractor shall at its own expense (except only where specific provision (if any) is made in the Contract for the reimbursement to the Contractor in respect of particular items) :

- (a) Provide to its Employees on the Site of the Works, all safety materials, clothing and equipment necessary to ensure full compliance with the provisions of the Occupational Health and Safety Act (Act No 85 of 1993) as amended (hereinafter referred to as the Act) at all times, and shall institute appropriate and effective measures to ensure the proper usage of such safety materials, clothing and equipment at all times ; and
- (b) Provide, install and maintain on all barricades, safety signage and other measures to ensure the safety of workmen and all persons in, on and around the Site, as well as the general public; and
- (c) Implement on the Site of the Works, such procedures and systems and keep all records as may be required to ensure compliance with the requirements of the Act at all times; and
- (d) Implement all necessary measures as to ensure compliance of the Act by all subcontractors engaged by the Contractor and their employees engaged on the Works; and
- (e) Comply fully with all other requirements pertaining to safety as may be specified in the Contract.

The Employer and the Engineer shall be entitled, although not obliged, to make such inspections on the Site, as they shall deem appropriate, for the purpose of verifying the Contractor’s compliance with the requirements of the Act. For this purpose, the Contractor shall grant full access to the Site of all parts of the Site and shall co-operate fully in such inspections and shall make available for inspection, all such documents and records as the Employer’s and/or Engineer’s representative may reasonably require.

Where any such investigations reveal, or where it comes to the Engineer’s attention that the Contractor is in any way in breach of the requirements of the Act or is failing to comply with the provisions of this clause, the Engineer shall, in accordance with the provisions of Clause 6.8 of the Conditions of Contract, be entitled to suspend progress on the Works or any part thereof until such time as the Contractor has demonstrated to the satisfaction of the Engineer, that such breach has been rectified.

The Contractor shall have no grounds for a claim against the Employer for extension of time and/or additional costs if the progress on the Works or any part thereof is suspended by the Engineer in terms of this clause and the Contractor shall remain fully liable in respect of the payment of penalties for late completion in accordance with the provisions of Clause 5.13.1 of the Conditions of Contract should the Contractor fail to complete the Works on or before the specified Due Date for Completion in consequence of the suspension.

Persistent and repeated breach by the Contractor of the requirements of the Act and/or this clause shall constitute grounds for the Engineer to act in terms of Clause 9.2 of the Conditions of Contract and for the Employer to cancel the Contract in accordance with the further provisions of the said Clause 9.2.”

---

*ADD THE FOLLOWING SUBCLAUSES:*

**"PSA 5.9      SITE MEETINGS**

The Contractor or its authorised agent will be required to attend regular site meetings, which shall normally be held once a month on dates and at times determined by the Engineer, but in any case, whenever reasonably required by the Engineer. Unless otherwise indicated in the Contract or instructed by the Engineer, such meetings shall be held at the Contractor's offices on the Site. At such monthly meetings, matters such as general progress on the Works, quality of work, problems, claims, payments, and safety etc., shall be discussed, but not matters concerning the day-to-day running of the Contract.

**PSA 5.10      MARKING AND AS-BUILT SURVEY OF ALL CONSTRUCTED STRUCTURES**

The Contractor shall supply the Engineer with as-built survey data for the entire Works (including invert and cover levels, coordinates of manholes, etc.). The Completion Certificate will not be issued until the as-built survey information had been approved by the Engineer.

The Contractor shall fix a brass benchmark (BM) accurately in the concrete cover slab of each manhole, using an approved epoxy adhesive to fix the bolt securely in place.

**PSA 5.11      REMOVAL OF SITE ESTABLISHMENT**

On completion of the Works the Contractor shall scarify all disturbed areas where offices, stores, workshops, etc., were located and all temporary roads and tracks, and he shall place a 100 mm thick layer of approved topsoil over all such areas. These areas shall then be seeded with rye grass or other approved seed, watered and fertilized in an approved manner and in such quantity as to promote rapid growth."

**PSA 6      TOLERANCES**

**PSA 6.2      DEGREES OF ACCURACY**

*ADD THE FOLLOWING TO SUBCLAUSE 6.2 :*

"Degree of Accuracy 1 shall be applicable to the following parts of the Works unless stated to the contrary elsewhere; weirs, flanges at civil/mechanical interfaces."

*ADD THE FOLLOWING SUBCLAUSE:*

**"PSA 6.4      USE OF TOLERANCES**

No guarantee is given that the full specified tolerances will be available independently of each other, and the Contractor is cautioned that the liberal or full use of any one or more of the tolerances may deprive him of the full or any use of tolerances relating to other aspects of the work.

Except where the contrary is specified, or when clearly not applicable, all quantities for measurement and payment shall be determined from the 'authorised' dimensions. These are specified dimensions or those shown on the Drawings or, if changed, as finally prescribed by the Engineer, without any allowance for the specified tolerances. Except if otherwise specified all measurements for determining quantities for payment will be based on the 'authorised' dimensions.

If the work is constructed in accordance with the 'authorised' dimensions plus or minus the tolerances allowed, the calculation of quantities will be based on the 'authorised' dimensions, regardless of the actual dimensions to which the work has been constructed.

When the work is not constructed in accordance with the 'authorised' dimensions plus or minus the tolerances allowed, the Engineer may nevertheless, at his sole discretion, accept the work



for payment. In such cases no payment shall be made for quantities of work or material in excess of those calculated from the 'authorised' dimensions, and where the actual dimensions are less than the 'authorised' dimensions minus the tolerance allowed, quantities for payment shall be calculated based on the actual dimensions as constructed."

**PSA 7            TESTING**

**PSA 7.1        PRINCIPLES**

**PSA 7.1.2      Standard of Finished Work Not to Specification**

*INSERT THE WORDS "or checks by an approved laboratory ..." AFTER THE WORDS "Where the Engineer's checks ..." IN THE FIRST LINE OF SUBCLAUSE 7.1.2.*

**PSA 7.2        APPROVED LABORATORIES**

*REPLACE THE CONTENTS OF SUBCLAUSE 7.2 WITH THE FOLLOWING :*

"Unless otherwise specified in the relevant specification or elsewhere in the Project Specification, the following shall be deemed to be approved laboratories in which design work, or testing required in terms of a specification for the purposes of acceptance by the Engineer of the quality of materials used and/or workmanship achieved, may be carried out :

- (a) any testing laboratory certified by the South African National Accreditation Systems (SANAS) in respect of the nature and type of testing to be undertaken for the purposes of the Contract ;
- (b) any testing laboratory owned, managed or operated by the Employer or the Engineer ;
- (c) any testing laboratory established and operated on the Site by or on behalf of the Employer or the Engineer.

**PSA 8            MEASUREMENT AND PAYMENT**

**PSA 8.1        MEASUREMENT**

**PSA 8.1.1      Method of Measurement, All Sections of the Schedule**

*DELETE THE WORDS "and South West Africa".*

**PSA 8.1.2      Preliminary and General Item or Section**

**PSA 8.1.2.1    Contents**

*REPLACE THE LAST SENTENCE OF SUBCLAUSE 8.1.2.1(b) WITH THE FOLLOWING :*

"Separate items will be scheduled to cover the Fixed, Value-related and Time-related components of the Contractor's Preliminary and General costs." *AND REPLACE THE WORDS "substantial completion" IN SUBCLAUSE 8.1.2.1(c) WITH "Certificate of Completion".*

**PSA 8.1.2.2    Tendered sums**

*REPLACE THE CONTENTS OF SUBCLAUSE 8.1.2.2 WITH THE FOLLOWING :*

"Except only where specific provision is made in the Specifications and/or the Schedule of Quantities for separate compensation for any of these items, the Contractor's tendered sums under items PSA 8.3 and PSA 8.4 shall collectively cover all charges for :

- risks, costs and obligations in terms of the Conditions of Contract and of this standardised specification ;

- head-office and site overheads and supervision ;
- profit and financing costs ;
- expenses of a general nature not specifically related to any item or items of the permanent or temporary work ;
- providing such facilities on Site as may be required by the Contractor for the proper performance of the Contract and for its personnel, including, but without limitation, providing offices, storage facilities, workshops, ablutions, for providing services such as water, electricity, sewage and rubbish disposal, for access roads and all other facilities required, as well as for the maintenance and removal on completion of the Works of these facilities and for the cleaning-up of the site of the Contractor's establishment and reinstatement to not less than its original condition ;
- providing the Facilities for the Engineer and his staff (Site Offices, Carports, Site Meeting Venue, Contract Nameboards, Survey Equipment and assistants, Telephone and Computer Facilities etc. as applicable) as per the Projection Specifications in Section C3.4.2, and their removal from the Site on completion of the Contract ;

## **PSA 8.2      PAYMENT**

### **PSA 8.2.1      Fixed-Charge and Value-Related Items**

*REPLACE THE CONTENTS OF SUBCLAUSE 8.2.1 WITH THE FOLLOWING :*

#### **"PSA 8.2.1.1      Fixed Charge Items**

Payment of fixed charges in respect of item PSA 8.3.1 will be made as follows :

- (a) EIGHTY PERCENT (80%) of the sum tendered will be paid when the facilities have been provided and approved ; and
- (b) The remaining TWENTY PERCENT (20%) will be paid when the Works have been completed, the facilities have been removed and the site of the Contractor's establishment has been cleared and cleaned to the satisfaction of the Engineer.

No adjustment will be made to the sum tendered in respect of item 8.3.1 should the value of the Works finally executed or the Time for Completion vary in any way from that specified in the Tender.

#### **PSA 8.2.1.2      Value Related Items**

Payment for the sum tendered under item PSA 8.3.2 will be made in three separate instalments as follows:

- (a) The first instalment, which is 40% of the sum, will be paid when the Contractor has fulfilled all its obligations to date under this Specification, the General Conditions of Contract and the Special Conditions of Contract, and when the value of work certified for payment, excluding materials on Site and payments for preliminary and general items, is equal to not less than 5% of the total value of the work listed in the Schedule of Quantities.
- (b) The second instalment, which is 40% of the sum, will be made when the amount certified for payment, including retention monies but excluding this second instalment, exceeds 50% of the Contract Sum.
- (c) The final payment, which is 20% of the sum, will be made when the Works have been certified as completed and the Contractor has fulfilled all its obligations to date under this Specification, the General Conditions of Contract and the Special Conditions of Contract.

Should the value of the measured work finally completed be more or less than the Contract Sum, the sum tendered under item PSA 8.3.2 will be adjusted up or down in



accordance with the provisions of Clause 6.8 of the Conditions of Contract, and this adjustment will be applied to the third instalment."

**PSA 8.2.2      Time-related Items**

*REPLACE THE CONTENTS OF SUBCLAUSE 8.2.2 WITH THE FOLLOWING :*

"Subject to the provisions of Subclauses 8.2.3 and 8.2.4, payment under item PSA 8.4.1 (time-related item) will be made monthly in equal amounts, calculated by equally dividing the sum tendered for the item by the tendered contract period in months and will be inclusive of special non-working days.

Provided always that the total of the monthly amounts so paid for the item is not out of proportion with the value of the progress of the Works as a whole."

**PSA 8.3      SCHEDULED FIXED-CHARGE AND VALUE-RELATED ITEMS**

*REPLACE THE HEADING AND CONTENTS OF SUBCLAUSE 8.3.1 WITH THE FOLLOWING :*

**"PSA 8.3.1      Fixed Preliminary and General Charges ..... Unit : Sum**

The sums tendered shall include full compensation for all fixed charge preliminary and general charges as described in Subclause PSA 8.1.2.2. Payment will be made as described in Subclause PSA 8.2.1.1.

*REPLACE THE HEADING AND CONTENTS OF SUBCLAUSE 8.3.2 WITH THE FOLLOWING :*

**"PSA 8.3.2      Value-related Preliminary and General Charges .....Unit : Sum**

The sums tendered shall include full compensation for all value-related preliminary and general charges as described in Subclause PSA 8.1.2.2. Payment will be made as described in Subclause PSA 8.2.1.2."

*ADD THE FOLLOWING SUBCLAUSE:*

**"PSA 8.3.5      Locate, record, protect and reinstate pegs ..... Unit : Sum**

This item must cover all costs incurred to locate, record and protect pegs during the duration of the contract and reinstate all disturbed pegs on completion of the contract in the manner as prescribed by the Land Survey Act."

**PSA 8.4      SCHEDULED TIME-RELATED ITEMS**

*REPLACE THE CONTENTS OF SUBCLAUSE 8.4 WITH THE FOLLOWING :*

**"PSA 8.4.1      Time-related preliminary and general charges ..... Unit : Sum**

The sum tendered shall include full compensation for all time-related preliminary and general charges as described in Subclause PSA 8.1.2.2. Payment will be made as described in Subclause PSA 8.2.2."

**PSA 8.5      SUMS STATED PROVISIONALLY BY THE ENGINEER**

*REPLACE THE CONTENTS OF SUBCLAUSE 8.5 WITH THE FOLLOWING :*

**"PSA 8.5.1      Works Executed by the Contractor**

The Contractor will be reimbursed in substitution of the Provisional Sums (if any) allowed in the Schedule of Quantities for work to be executed by the Contractor, in the amounts determined in accordance with the provisions of Clause 6.6 of the Conditions of Contract.

**PSA 8.5.2      Works Executed by Nominated Subcontractors**

- (a)    Work to be executed by a Nominated Subcontractor ..... Unit : Prov Sum
- (b)    Overheads, charges and profit on item (a) above ..... Unit : % or Sum

Sub-items (a) and (b) will be provided in the Schedule of Quantities for each different Nominated Subcontract included in the Contract.

The Contractor shall be reimbursed under sub-item (a), in substitution of the respective Provisional Sums (if any) allowed in the Schedule of Quantities, the amounts actually paid or payable by the Contractor to the respective Nominated Subcontractors, in accordance with the provisions of Clause 6.6 of the Conditions of Contract.

The Contractor shall be paid under sub-item (b), either :

- 1) where the unit of measurement for sub-item (b) was specified as being a percentage, the respective percentage, as stated by the Contractor in its Tender, of the amount certified by the Engineer for payment under the related sub-item (a), all in accordance with the provisions of Clause 6.6 of the Conditions of Contract ,

**OR**

- 2) where the unit of measurement for sub-item (b) was specified as being a Lump Sum, an amount which is in the same proportion to the amount certified for payment under sub-item (a) and the tendered Lump Sum is to the amount of the Provisional Sum stated under sub-item (a) ; provided always that where the Contractor has failed for any reason, to insert a percentage or Sum (as applicable) for sub-item (b) in its tender, or where no provision was made in the Tender Documents for Tenderers to make any such entry, the Contractor will, in accordance with the provisions of Clause 6.6, be paid an amount equal to SEVEN AND ONE HALF PERCENT (7½%) of the amount actually certified by the Engineer for payment under sub-item (a).

The percentage or sum (as applicable) paid under sub-item (b) as aforesaid, shall be deemed to include for full and final compensation to the Contractor for all costs as may be incurred and all charges and profits associated with the engagement, supervision, administration and management of the Nominated Subcontractor and in fulfilling its obligations under the contract as the principal Contractor."

**PSA 8.6      PRIME COST ITEMS**

*REPLACE THE HEADING AND CONTENTS OF SUBCLAUSE 8.6 WITH THE FOLLOWING :*

**"PSA 8.6      PRIME COST SUMS**

- (a)    Description of Item to which Prime Cost Sum Applies ..... Unit : PC Sum
- (b)    Charge Required by Contractor on Sub-item (a) above ..... Unit : %

Sub-items (a) and (b) will be provided in the Schedule of Quantities for each different item to which a Prime Cost Sum applies.

The Contractor shall be reimbursed under sub-item(s) (a) in substitution of the respective Prime Cost Sums included in the Contract, the actual price(s) paid or payable by him in respect of the goods, materials or services supplied, but excluding any charges for the Contractor's labour, profit, carriage, establishment or other charges related to such goods, services or materials.

The Contractor shall be paid under sub-item (b), the respective percentage, as stated by the Contractor in its Tender, of the amount certified by the Engineer for payment under the related sub-item (a). The percentages tendered by the Contractor for each respective sub-item (b) included in the Schedule of Quantities shall be deemed to in full and final compensation to the Contractor in respect of any charge by the Contractor for labour, carriage profit, establishment and for any other charges related to the goods, services or materials supplied under the related sub-item (a).

If the Contractor shall have omitted within its Tender to insert a tendered percentage under sub-item (b), or tendered a zero percentage, the Contractor's tendered rate for sub-item (b) shall be deemed to be zero and the Contractor shall not be entitled to any payment under sub-item (b)."

**PSA 8.7      DAYWORK**

*INSERT THE FOLLOWING SENTENCE AT THE END OF SUBCLAUSE 8.7:*

"Measurement and payment shall be in accordance with the provisions of Subclause 6.5.4 of the Conditions of Contract."

**PSA 8.8      TEMPORARY WORKS**

*REPLACE ITEM 8.8.1 WITH THE FOLLOWING:*

**"PSA 8.8.1      Dealing with access**

The Contractor will be held to have satisfied himself with regard to the accessibility of the site and the standard of access available via the existing main roads, minor roads and tracks. The tendered sums shall include the cost of the upgrading or constructing where necessary, and maintenance of existing access, including new access roads as required by the Contractor.

The cost of maintenance, watering of roads and access tracks to minimise dust, and temporary repair of all existing access roads, new access roads required by the Contractor and tracks shall be included in the sum. The tendered sum shall cover the cost of all maintenance required to the standard specified throughout the construction period and the reinstatement/scarifying of the roads."

**PSA 8.8.2      Dealing with Traffic .....Unit : Sum**

*ADD THE FOLLOWING TO SUBCLAUSE 8.8.2:*

"This amount shall cover all costs in respect of the provision, erection, moving, re-erection and maintenance of all barriers, road signs, lights and flagmen necessary for the protection of the works, for the construction, gravelling and maintenance of detours and entrance roads affected by the work, as well as the breaking up and removal thereof at the contract completion, and for compliance with all necessary traffic rules and regulations, liaising with the road authorities, and all other costs necessary in respect of accommodation of traffic."

*REPLACE THE HEADING AND CONTENTS OF SUBCLAUSE 8.8.4 WITH THE FOLLOWING:*

**"PSA 8.8.4      Location and protection of existing services**

Where particular items are provided in other sections of the schedule the costs of detection, exposure, protection and alterations shall be covered by such particular items. Where no such particular items are provided and where there is reason to expect the presence of such a service or services, the following items will apply:

**PSA 8.8.4.1      Provision of detecting devices for:**

(a) Water and sewer pipes .....Unit : Sum

- (b) Electrical and other cables ..... Unit: Sum
- (c) Other ..... Unit : Sum

The tendered sums shall cover the cost of providing and operating suitable equipment for as long as is necessary in order to locate all existing services likely to be affected by the construction activities. Alternatively, an approved specialist firm may be employed to carry out the work.

**PSA 8.8.4.2 Hand excavation necessary for locating and exposing existing services in all materials:**

- (a) In roadways ..... Unit : m<sup>3</sup>
- (b) In all other areas ..... Unit : m<sup>3</sup>

The rates shall cover the cost of excavating by means of hand tools within authorised dimensions, for all precautionary measures necessary to protect the services from damage during excavation and backfilling and for subsequent backfilling and compacting. Compaction of material in all areas except in roadways shall be to 93% of modified AASHTO density.

The rate for hand excavation in roadways shall also include compensation for compacting excavated or selected backfill material to 100% of modified AASHTO density. Reinstating layerworks and surfacing shall be measured and paid for under SANS 1200 DB.

The tendered rates shall also include for keeping excavations safe, for dealing with surface and subsurface water and for removal of surplus excavated material from the site."

*ADD THE FOLLOWING SUBCLAUSES:*

**"PSA 8.8.7 Dealing with water**

- (a) Dealing with subsurface water ..... Unit : Sum
- (b) Dealing with surface water ..... Unit : Sum

The sum shall cover the cost for the provision, operation, maintaining and removal of all plant and materials required to deal with any water anywhere on the Site as required in terms of Subclause 5.1.3 and 5.1.7 of SANS 1200 D and Subclause 5.1.2 of SANS 1200 DB. No additional payment will be made for "Special water hazards".

The sum shall cover the cost of providing the necessary plant or materials, or both, fully erected and operative on the Site, the cost of operating and maintaining pumps, well points, sheeting, close timbering, and other equipment, as applicable, for 24 hours a day, 7 days a week, throughout the period during which the facilities are required, and the cost of removing such goods and restoring the Site to its original condition on completion of that part of the project for which the temporary works were erected.

Payments will be made, in equal monthly amounts over the contract period.

**PSA 8.8.8 DEALING WITH EXISTING SERVICES**

The following works that are executed by the Contractor on the instruction of the Engineer:

- i) All additional work to locate and expose the existing service if the existing service is situated further than 2,0 m from the position indicated, (i.e., excluding the initial work within 2,0 m from the indicated position).
- ii) Work that is carried out by the Contractor with regard to existing services that are not indicated on the drawings and for which the Employer will carry the cost according to Subclause PSA 5.4, with the exception of activities for which provision is made in PSA 8.7.

Other than payment of the cost of alterations to overhead services and for dealing with and protecting poles affected by the excavations, dealing with and working below overhead wires will not be measured separately for payment as the costs thereof will be held to be covered by the other scheduled items.

**PSA 8.9      INSURANCE TO BE EFFECTED BY THE CONTRACTOR.....Unit : Sum**

The tendered sum shall include full compensation for all costs incurred to effect and maintain the insurance required in terms of the Contract.

75% of the tendered sum will be paid in the Certificate following the submission of proof that all the required insurance has been affected, and 25% will be paid in the Certificate of Completion of the Works.

The cost of extended cover required due to late completion shall be borne by the Contractor, but not the cost of extended cover in respect of extension of time granted in accordance with Clause 5.12 of the Conditions of Contract.

**PSA 8.10      ACCOMMODATING OTHER CONTRACTORS .....Unit : Sum**

The amount tendered shall cover the cost of accommodating civil, electrical and mechanical contractors on the Site of the Works. Payment will be made in equal monthly amounts over the Contract period.

**PSA 8.11      ADHERING TO THE ENVIRONMENTAL MANAGEMENT PLAN ..... Unit : Sum**

The amount tendered for this item shall allow for full compensation for all costs, of whatever nature, for adhering to the Environmental Management Plan, as set out in Particular Specification PSEM of this document. Payment will be made in equal monthly amounts over the contract period.

**PSA 8.12      COMPLYING WITH THE HEALTH AND SAFETY REQUIREMENTS ..... Unit : Sum**

The sum tendered shall allow full compensation for all costs, of whatever nature, for complying with the Occupational Health and Safety Act 1993, Construction Regulations 2014, the Occupational Health and Safety Specification as set out in Particular Specification PHS of this document, the provision of the Health and Safety Plan and the maintenance of the Health and Safety file. Payment will be made in equal monthly amounts over the contract period.

**PSA 8.13      ACCOMMODATION OF EXISTING FLOWS AND LIVE INTERCONNECTIONS FOR TEMPORARY OR PERMANENT CONNECTIONS OR CONSTRUCTION OF NEW STRUCTURES**

(a) (Description                      of                      tie-in/connections/temporary                      structures                      stated)  
.....Unit : m<sup>3</sup> or Sum

The tendered sums shall include full compensation for any inconvenience suffered for normal and exceptional risks, for all material required for the connections, for unforeseen eventualities and for maintaining the accommodated flow as long as necessary and shall include for the design and construction of all necessary temporary measures such as additional clearing, grubbing, earthworks, culverts, structures, pipework, pumping, cleaning up and any other associated work that may be required. Where a temporary structure for the accommodation of an existing flow has been designed by the Engineer and is to be constructed by the Contractor, payment for such structure shall be made under the applicable sub-items in this payment item.

Unless specifically scheduled, timing and co-ordination for the installation and connection of new pipelines into new or existing structures shall be deemed to be included in the tendered rates as this will be carried out concurrently with the isolation/decommissioning of the structures for other purposes such as structural work. The Contractor should therefore carefully determine the full extent of each scheduled item according to the various drawings, specifications and procedures

as the descriptions in the Schedule of Quantities are abbreviated and no later claims will be entertained in this regard.

The Civil Contractor will, for the purpose of this Contract, also be responsible for the accommodation of flow during the installation of mechanical equipment.

**PSA 8.14      FENCING OF CONTRACTOR'S SITE**

The fencing of the Contractor's site will be held to have been covered by the tendered rates for the establishment and removal of site facilities.

**PSA 8.15      FREEHAUL AND OVERHAUL**

Except as scheduled for the disposal of surplus/unsuitable excavation material (see PSDB5.6 and PSDB8.3.3.4), all haulage will be considered to be free haul and the cost thereof will be deemed to be covered by the rates for the provision or disposal of the applicable material and, notwithstanding any clauses in any Standardized Specification or Standard Specification Section dealing with the definition, measurement and/or payment for transport, free haul and/or overhaul, no other measurement nor payment for overhaul will be made.

Excess material from trench excavations for large diameter pipes is expected and will have to be spoiled by the Contractor as part of free haul.

**PSA 8.16      MISCELLANEOUS ITEMS**

An item which, in payment clause column of the schedule of quantities, refers to this clause (PSA 8.16) will be measured in the unit scheduled. The sum or rate of such item shall cover the cost of all materials; labour and plant required to excavations and complete the work as specified, described in the schedule of quantities or shown on the drawing(s).

**PSA 8.17      EMPLOY A COMMUNITY LIASON OFFICER ..... Unit : Sum**

The tendered amount shall allow full compensation for all costs, of whatever nature, for complying with the Specification as set out in Clause 12 (Contract Data). The costs shall include monthly rate for the CLO which shall be deemed inclusive of all costs (i.e. management, overheads and profit). Payment will be made monthly for the duration of the required CLO services.

**PSC SITE CLEARANCE (SANS 1200 C)****PSC 3 MATERIALS****PSC 3.1 DISPOSAL OF MATERIAL**

*DELETE THE CONTENTS OF THIS SUBCLAUSE AND SUBSTITUTE THE FOLLOWING:*

"Material, that is not re-usable, obtained from clearing and grubbing and from the demolition of structures shall be disposed of at areas off site identified by the Contractor and approved by the Engineer.

Fencing wire shall be neatly wound into rolls or coils and all such wire, together with all re-usable material from structures, etc., shall be stacked at designated points.

The Contractor shall obtain his own dumping sites for the disposal of material and all transport costs shall be included in the rates tendered for site clearance."

**PSC 5 CONSTRUCTION****PSC 5.1 AREAS TO BE CLEARED AND GRUBBED**

*ADD THE FOLLOWING TO THE END OF THIS SUBCLAUSE:*

"Notwithstanding the above, the Engineer may, where particular areas are scarcely vegetated, order that the clearing and grubbing operation be totally or partially omitted, in which case no payment will be made under this section.

Unless otherwise ordered by the Engineer, pipeline routes shall be cleared to a distance of 3,5 m on both sides of the pipeline centre line. Route pegs or markers shall not be destroyed or damaged during clearing operations.

The following applies to other clearing widths:

- a) The width to be cleared for roads shall not exceed 0,5 m beyond the road footprint, including the toe of fill and top of cut.
- b) The area to be cleared for the Works and stock pile areas shall not exceed the specified dimensions by a margin of 0,5 m measured from the perimeter.

Payment will then only be made for excavation included under the relevant earthworks section.

Clearing and grubbing shall be done in accordance with the Environmental Management Programme (EMPr)."

**PSC 5.2 CUTTING OF TREES****PSC 5.2.3 Preservation of trees****PSC 5.2.3.2 Individual trees**

*REPLACE THE LAST SENTENCE OF SUBCLAUSE 5.2.3.2 WITH THE FOLLOWING:*

"An amount stated in the Environmental Management Programme will be deducted from moneys due to the Contractor as a penalty for every tree that is damaged or removed unnecessarily."

**PSC 5.5 RECLEARING OF VEGETATION**

*ADD THE FOLLOWING TO SUBCLAUSE 5.5:*



"When areas have to be re-cleared on the written instructions of the Engineer, such re-clearing shall be carried out at the Contractor's own cost and the Contractor is therefore advised not to clear the areas at such an early stage that re-clearing may become necessary.

Clearing of vegetation shall be done in accordance with the Environmental Management Programme (EMPr)."

## **PSC5.6      CONSERVATION OF TOPSOIL**

*ADD THE FOLLOWING TO SUBCLAUSE 5.6:*

"Topsoil up to a depth of 150 mm, if available or where directed by Engineer on site, shall be removed from the above specified cleared areas and stockpiled on approved sites for later reuse.

Until required for spreading, the stockpiles of topsoil material shall be stabilized by watering or other approved means.

Conservation of Topsoil shall be done in accordance with the Environmental Management Programme (EMPr)."

## **PSC 8      MEASUREMENT AND PAYMENT**

### **PSC 8.1      BASIC PRINCIPLES**

*ADD THE FOLLOWING TO SUBCLAUSE 8.1:*

"The Contractor shall survey the site after completion of Site Clearance and agree with the Engineer the levels to be used for earthworks quantity calculations."

### **PSC 8.2      SCHEDULED ITEMS**

#### **PSC 8.2.1      Clear and grub**

*REPLACE THE FIRST LINE OF SUBCLAUSE 8.2.1 WITH THE FOLLOWING:*

"The area designated by the Engineer to be cleared and grubbed will be measured in square metre to the nearest square metre or, "

#### **PSC 8.2.2      Remove, grub and relocate on site large trees and tree stumps of girth**

*REPLACE THE FOURTH LINE OF SUBCLAUSE 8.2.2 WITH THE FOLLOWING:*

"The rate shall cover the cost of clearing (relocating if required by Engineer) and grubbing trees and stumps of all sizes, cutting branches, "

#### **PSC 8.2.5      Take down and dispose of existing fences**

*REPLACE SUBCLAUSE 8.2.5 WITH THE FOLLOWING:*

"The rate shall cover the cost of taking down the fence and posts, including supplying clean backfill material (sand) and compacting in layers not exceeding 150mm thick to 95% MOD AASHTO. Any spoil material is to be loaded and disposed of at an approved dump site."

(a) Steel fence (wire or steel palisade) relocation/installation on site as instructed by the engineer ..... Unit : m

(b) Steel fence (wire or steel palisade) store on site as instructed by the engineer ..... Unit : m



(c) Concrete fence..... Unit : m

**PSC 8.2.7**     **Dismantle, remove and reinstate pipelines, electricity transmission lines, cables, etc. ..**  
Unit : m

*REPLACE THE CONTENTS OF SUBCLAUSE 8.2.7 WITH THE FOLLOWING:*

"The tendered rates shall include full compensation for the detection, disconnection, removal, stockpiling, safeguarding, reinstatement and reconnection of services, including all necessary excavation, bedding, concrete bases and backfilling. In the event of the contractor damaging any of the services he will replace it at his own cost."

**PSC 8.2.8**     **Demolish and remove structures/buildings and dismantle and remove steelwork .....**  
Unit : m<sup>3</sup>/No/Sum

*REPLACE THE SECOND PARAGRAPH OF SUBCLAUSE 8.2.8 WITH THE FOLLOWING:*

"The rate shall cover the cost of excavating around the structure, demolishing the structure, disposal of excavated material and rubble, and backfilling of the hole with clean sand in layers of 300 mm including compaction to 100% of MOD AASHTO. The building rubble with then be cleaned of any steel, tiles, glass, asbestos or any other hazardous material. The building rubble clear of any steel, tiles, glass, asbestos or any other hazardous material will be disposed (including transport) of at a disposal site provided by the Contractor off site. Any steel, tiles and glass will be disposed of at a suitable disposal site selected by the Contractor and subject to approval of the Engineer. The careful removal of all mechanical and electrical equipment and stored on site at a suitable area selected by the Engineer shall be included within this rate. The disposal of asbestos or any other hazardous material will be in accordance with clause PSC 8.2.8 (a) below. Different structures will be listed separately in the Schedule of Quantities."

*ADD THE FOLLOWING TO SUBCLAUSE 8.2.8*

**PSC 8.2.8 (a)**     **Extra over item PSC 8.2.8 for removing hazardous materials off-site**

The rate shall cover all costs involved in removing, transporting and disposal charges of any material deemed hazardous by the Engineer to an approved hazardous landfill site in accordance with the Health and Safety specifications.

The unit rate of measurement shall be per square meter .....Unit : m<sup>2</sup>

**PSC 8.2.10**     **Remove topsoil, maintain and stockpile/spoil for depths .....** Unit : m<sup>3</sup>

*ADD THE FOLLOWING TO SUBCLAUSE 8.2.10 :*

"The rate tendered for topsoil shall also cover the cost of stabilizing and protecting the stockpiles of topsoil or spoil at the designated spoil site(s) until required for use elsewhere."

*ADD THE FOLLOWING NEW SUBCLAUSES:*

**"PSC 8.2.11**     **Remove and dispose of kerbing .....** Unit : m

The rate shall cover the cost of the removal and disposal of existing kerbs to a spoil site furnished on site, at the disused biological reactor, including all necessary excavation and backfill compacted to 100% modified AASHTO density.

**PSC 8.2.12**     **Remove and reinstate existing:**

(a)     Kerbs ..... Unit : m

The tendered rates shall include full compensation for the careful removal of kerbs, the temporary stockpiling thereof and the reinstatement once the work has been completed, including all necessary excavation, backfilling and concrete bedding and backing with 15 MPa concrete. In the event of the contractor damaging any of the kerbs, he will replace it at his own cost.

(b) Edging ..... Unit : m

The tendered rates shall include full compensation for the careful removal of edging, the temporary stockpiling thereof and the reinstatement once the work has been completed, including all necessary excavation, backfilling and concrete bedding and backing with 15 MPa concrete.

(c) Road layers ..... Unit : m<sup>2</sup>

The tendered rate shall include full compensation for removing the existing road layers and constructing new layers once the work has been completed. The new layers shall consist of 40 mm continuously Graded Asphalt (Medium Grade) compacted to 93% of Rice Density, on 150 mm G2 basecourse material compacted to 102% MOD AASHTO density, on 150 mm G5 subbase material compacted to 95% MOD AASHTO density on 500 mm sand compacted to 100% of MOD AASHTO.

**PSC 8.2.13     Demolish and remove existing concrete up to 250mm thick..... Unit : m<sup>2</sup>**

The unit of measurement shall be the square metre of concrete excavated from the existing pavement and spoiled as instructed by the engineer.

The tendered rates shall include full compensation for breaking-up the concrete pavement, loading, transporting material regardless of transportation distance, off-loading and disposing material on site, at the disused biological reactor, and for furnishing all the necessary labour, plant and other incidentals. There will be distinguished between plain and reinforced concrete. The saw-cutting will be compensated for under item PSC 8.2.14).

**PSC 8.2.14     Saw cutting of existing concrete up to 250mm thick..... Unit : m**

The unit of measurement shall be the metre of cut as instructed by the engineer.

The tendered rates shall include full compensation for all labour, constructional plant and material required, for sawing or cutting costs, and for all incidentals of cutting or sawing in accordance with the instructions of the engineer.

**PSC 8.2.15     Saw cutting of existing asphalt..... Unit : m**

The unit of measurement shall be the metre of cut as instructed by the engineer.

The tendered rates shall include full compensation for all labour, constructional plant and material required, for sawing or cutting costs, and for all incidentals of cutting or sawing in accordance with the instructions of the engineer."

**PSC 8.2.16     Remove and dispose of asphalt surfacing ..... Unit : m<sup>2</sup>**

The rate tendered shall cover the provision of all labour and equipment necessary to remove and dispose of asphalt surfacing, regardless of volume (saw-cutting will be compensated for under item PSC 8.2.15).

**PSC 8.2.17     Take down and re-erect existing fences ..... Unit : m**

The rate shall cover the cost of taking down the fences, coiling wire, sorting, stacking and guarding all material, the cost of loading, transporting and off-loading such material, the cost

of re-erecting the fence in its original position using the dismantled material and the cost of temporary bracing the sections of fence not taken down.

The rate shall also cover the cost of using new tying wire but not the cost of any other new material that may have to be used on the written instructions of the engineer, as such new material will be paid for under Particular Specification : FENCING.

**PSC 8.2.18      Final finishing and cleaning up of site.....Unit: Sum**

The tendered sum shall include full compensation for the clearing, disposal of material, finishing, tidying and all other work required to finish and clean up the Site of the works and affected areas by removing excess earth, stones, boulders, debris and other waste material, by clearing stormwater inlets and outlets and pipe barrels, by clearing the surfacing of all dirt, mud and foreign material, and by neatly finishing off all junctions, intersections and kerbing.

All material resulting from the finishing operations shall be disposed of to a spoil site furnished by the Contractor.

The tendered rate shall make provision for the reinstatement of existing driveways to their original condition where these have been affected by the works, as these items will not be measured and paid for separately.

**PSD            EARTHWORKS (SANS 1200 D)****PSD 2            INTERPRETATIONS****PSD 2.1          SUPPORTING SPECIFICATIONS**

*REPLACE THE CONTENTS OF SUBCLAUSE 2.1.2 WITH THE FOLLOWING :*

"Any of the other SANS 1200 Specifications may form part of the Contract Documents."

**PSD 2.3          DEFINITIONS**

*REPLACE THE WORD AND THE DEFINITION FOR "Borrow" WITH THE FOLLOWING :*

**"Borrow material** : Material, other than material obtained from excavations required for the Works, obtained from sources such as borrow pits or the authorised widening of excavations. 'Borrow' shall have a corresponding meaning."

*REPLACE THE DEFINITION FOR "Specified density" WITH THE FOLLOWING:*

**"Specified density** : The specified dry density expressed as a percentage of modified AASHTO dry density."

*REPLACE THE DEFINITION FOR "Stockpile" WITH THE FOLLOWING:*

**"Stockpile** (verb) : The process of selecting and, when necessary, loading, transporting and off-loading material in a designated area for later use for a specific purpose."

*ADD THE FOLLOWING DEFINITIONS :*

**"Commercial Source** : A source of material provided by the Contractor, not the Employer, and including any borrow pit, provided by the Contractor.

**Fill** : An embankment or terrace constructed of material obtained from excavations or borrow pits. In roads it includes the earthworks up to the underside of the selected subgrade level.

**Fill** (material) : Material used for the construction of an embankment or terrace.

**Roadbed** : The natural in situ material on which the fill, or in the absence of fill, the pavement layers, are constructed."

**PSD 3            MATERIALS****PSD 3.1          CLASSIFICATION FOR EXCAVATION PURPOSES****PSD 3.1.1        Method of Classifying**

*ADD THE FOLLOWING TO SUBCLAUSE 3.1.1:*

"The classification of material other than 'soft excavation' shall be agreed upon before excavation may commence. The Contractor shall immediately inform the Engineer if and when the nature of the material being excavated changes to such an extent that a new classification is warranted for further excavation. Failure on the part of the Contractor to advise the Engineer in good time shall entitle the Engineer to reclassify, at his discretion, such excavated material."

**PSD 3.1.2        Classes of Excavation**

*REPLACE THE FIRST SENTENCE WITH THE FOLLOWING:*

"Notwithstanding the provisions of SANS Subclause 3.1.2, the materials excavated, other than hard rock, will not be classified for the purposes of measurement and payment. The unit rate for excavation shall cover the cost of excavation in all materials with the only extra-over item payable being that for excavation in hard rock. Boulders will be classified as hard rock."

**PSD 3.2      CLASSIFICATION FOR PLACING PURPOSES**

**PSD 3.2.3      Material Suitable for Backfill or Fill against Structures**

*REPLACE THE CONTENTS OF SUBCLAUSE 3.2.2 WITH THE FOLLOWING :*

"Material used for backfill behind structures shall generally be the material excavated, subject to the following conditions:

- (a) The material shall not contain an excessive number of stones retained on a 50mm sieve.
- (b) The material shall not contain large clay lumps that do not break up under the action of the compaction equipment.
- (c) The liquid limit of the material shall not exceed 40, neither shall the PI exceed 18.
- (d) The minimum modified AASHTO density shall be 93%."

**PSD 3.3      SELECTION**

**PSD 3.3.1      General**

*REPLACE THE SECOND PARAGRAPH OF SUBCLAUSE 3.3.1 WITH THE FOLLOWING :*

"The Contractor shall deal selectively with materials from all excavations to ensure that no acceptable backfill or bedding material is contaminated by material unfit for use. No additional payment shall be made in this regard and all costs related to the above selection process shall be included in the applicable payment items. Should useful material be contaminated to such an extent that it is regarded as unfit for use the Contractor shall at his own cost dispose of this material and replace it with material of an equivalent standard to the acceptable in situ material."

**PSD 3.3.2      Backfilling and embankments**

*ADD TO THE END OF THIS SUBCLAUSE THE FOLLOWING:*

With reference to the last line of this subclause the material to be used for backfilling shall be either 15MPa/19 concrete or material complying with 3.2.2 compacted in 150mm layers to 90% of modified AASHTO maximum density, as ordered on site.

*ADD THE FOLLOWING NEW SUBCLAUSE:*

**"PSD 3.3.3      Selection in Borrow Pits and Excavations**

Approval of a borrow area for a certain purpose does not necessarily mean that all the material in that area is suitable for the specified purpose. What it does mean is that the borrow area contains some suitable material. The onus shall rest on the Contractor to ensure that only material that is indeed suitable is removed and used for the specified purpose.

When the Contractor has to select excavated material for a specific purpose, the above provisions relating to borrow areas shall apply *mutatis mutandis* to excavations.

The Contractor shall not waste or contaminate material that has been selected for a specific purpose."

**PSD 4      PLANT**

**PSD 4.4      DETECTORS**

*REPLACE THE CONTENTS OF SUBCLAUSE 4.4 WITH THE FOLLOWING:*

"The Contractor shall, for the purposes of detecting and locating underground services in accordance with the provisions of Subclause 5.4 of SANS 1200 A and Subclause 5.1.2 of SANS 1200 D, at its own cost, provide and use detecting equipment which is suitable for the detection of underground cables and pipes."

*ADD THE FOLLOWING NEW SUBCLAUSE:***"PSD 4.5            RESTRICTION ON USE OF PLANT**

Where the Contractor finds it impractical to use mechanical plant for excavation or to complete portions of the work due to restrictions caused by difficult access or the presence of existing structures, pipelines or services shown on tender drawings, the Contractor will be deemed to have satisfied himself as to the alternative requirements when entering rates against the appropriate items in the Schedule of Quantities as no claim for extra payment based on the inability to use plant in such circumstances will be considered."

**PSD 5            CONSTRUCTION****PSD 5.1        PRECAUTIONS****PSD 5.1.1      Safety****PSD 5.1.1.1    Barricading and Lighting**

*REPLACE* "Machinery and Occupational Safety Act, 1983 (Act 6 of 1983)" *WITH THE FOLLOWING:*

"Occupational Health and Safety Act, 1993 (Act 85 of 1993) and Construction Regulations 2014".

**PSD 5.1.1.2    Safeguarding of Excavations**

*REPLACE* "Machinery and Occupational Safety Act" *WITH THE FOLLOWING:*

"Occupational Health and Safety Act, 1993 (Act 85 of 1993) and Construction Regulations 2014".

*ADD THE FOLLOWING TO PARAGRAPH (b)(1) :*

"Payment for supporting the sides of excavations and trenches shall be deemed to be included in the rates tendered for excavations. No separate payment will be made in this regard and it will be the Contractor's responsibility to ensure the safety and stability of all excavations. Where trenches have to be widened to accommodate manholes, junction boxes, etc., the cost of supporting the vertical sides of such additional excavations will be deemed to be included in the rates tendered for excavation."

*ADD THE FOLLOWING TO PARAGRAPH (b)(2) :*

"The slope of the sides of an excavation or trench may never be steeper than 60° to the horizontal and all costs incurred to slope the sides of an excavation or trench will, irrespective of the angle of the slope, be deemed to be included in the rates quoted for excavation."

**PSD 5.1.1.3    Explosives**

*REPLACE THE CONTENTS OF SUBCLAUSE 5.1.1.3 THE FOLLOWING :*

"The use of explosives is prohibited on this project."

**PSD 5.1.2      Existing Services****PSD 5.1.2.2    Detection, Location and Exposure**

*REPLACE THE CONTENTS OF SUBCLAUSE 5.1.2.2 WITH THE FOLLOWING :*

"The exposure by the Contractor of underground services, as required in terms of Subclause 5.4 of SANS 1200 A (as amended) shall be carried out by careful hand excavation at such positions and to such dimensions as are agreed to by the Engineer. Unless otherwise instructed or agreed by the Engineer, no service shall be left exposed after its exact position has been determined and all excavations carried out for the purposes of exposing underground services shall be promptly backfilled and compacted to the following densities :

- (a) In roadways : 95% Mod AASHTO density ; and
- (b) In all other areas : 93% Mod AASHTO density.

Where hand excavations to expose underground services have to be carried out in roadways, the Contractor shall reinstate the road layerworks in accordance with the provisions of Subclause 5.9 of SANS 1200DB.

Payment in respect of the exposing of the services by means of hand excavation as described above, will be made in accordance with Subclause PSD 8.3.8.1.

Payment in respect of the reinstatement of layerworks in road ways will be made in accordance with Subclause 8.3.6.1 of SANS 1200DB (as amended).

**PSD 5.1.2.3 Protection of cables**

*REPLACE THE HEADING AND CONTENTS OF SUBCLAUSE 5.1.2.3 WITH THE FOLLOWING :*

**"PSD 5.1.2.3 Protection during Construction**

Further to the requirements of Subclause 5.4.2 of SANS 1200A (as amended), major excavating equipment and other Plant shall not be operated dangerously close to Known Services. Where necessary, excavation in close proximity to Known Services shall be carefully carried out with suitable hand tools, excluding picks wherever their use could damage the services. No additional payment will apply to such more difficult work.

Should any service not being a Known Service be discovered or encountered during the course of the Contract, the Contractor shall, in addition to complying with the requirements of Subclause 5.4.2 of SANS 1200A (as amended), immediately notify the Engineer thereof and implement such measures as will prevent damage of such service or, if it was damaged in the course of discovery, will prevent and minimise the occurrence of any further damage occurring."

**PSD 5.1.2.4 Negligence**

*DELETE THE CONTENTS WITHIN THIS SUBCLAUSE AND REPLACE WITH THE FOLLOWING:*

"The Contractor shall not repair any service damaged due to his negligence. Where the damage is the result of the Contractor's negligence, he shall bear all costs of the repairs undertaken by the owner, as well as the costs of associated damages."

**PSD 5.1.3 Stormwater and groundwater**

*ADD TO THE END OF THIS SUBCLAUSE THE FOLLOWING:*

"The Contractor shall, where applicable and at the earliest practicable opportunity, install the permanent drainage specified or shown on the Drawings and shall also provide the temporary drainage required to protect the works."

**PSD 5.1.4 Nuisance**



**PSD 5.1.4.3      Excavated material not to endanger or interfere**

*DELETE THE LAST SENTENCE AND SUBSTITUTE WITH THE FOLLOWING:*

"All material that is unsuitable or not required for backfilling shall be disposed of at the approved disposal sites. No additional payment will be made for these activities."

**PSD 5.1.6      Road Traffic Control**

*DELETE THE SECOND SENTENCE OF SUBCLAUSE 5.1.6 AND REPLACE WITH THE FOLLOWING:*

"The provisions of PSA 5.10 shall apply as applicable. Where the work affects the operation or safety of public road traffic, vehicular and/or pedestrians in addition, to complying with the requirements of 5.1.1.1, the Contractor shall provide, erect and maintain traffic signs, personnel and equipment that conform to the requirements, layout and guidelines of the "South African Road Traffic Signs Manual", as well as the Site Manual entitled "Safety at Roadworks in Urban Areas" as published by the Department of Transport, in number and in layout, as shown in these manuals.

Where necessary and as shown in these manuals, warning lights, an adequate number of flagmen and appropriate barricades, clearly visible to oncoming traffic at all times of the day and night shall be provided. If steel drums are used for this purpose, they shall be ballasted with soil, sand or stones and the outside shall be whitewashed and provided with retro-reflective material (in the case of tape, of minimum width 10mm), red on the left-hand side facing oncoming traffic and white on the right-hand side

The drums shall be maintained in a clean and effective condition and no stones shall be placed on them.

No direct payment will be made for the cost of providing and complying to the aforementioned. Payment will be deemed to be covered by the rates and sums tendered and paid for the various items of work included under the Contract."

*ADD THE FOLLOWING NEW SUBCLAUSE:*

**"PSD 5.1.7      Dewatering around buoyant structures**

The Contractor's responsibility in terms of Subclause 5.5 of SABS 1200 A and 5.1.3. of SABS 1200 D, as relevant (relating to water on site), will be held to accommodate for floatation / buoyancy design of the structures where the details associated with floatation design are shown on the Drawings. The contractor shall allow for maintaining (through pumping if necessary) the groundwater levels around the structure below the lowest top of concrete floor level (or a specified level stated on the Drawing) while the structure is being emptied and as long as it remains empty during construction. During construction, the underdrainage system should be maintained and fully operational at all times to facilitate pumping and monitoring. Failure to ensure the above may result in the buoyancy / floating and catastrophic failure of the structure."

**PSD 5.2      METHODS AND PROCEDURES****PSD 5.2.1      Site Preparation****PSD 5.2.1.2      Conservation of Topsoil**

*DELETE THE CONTENTS WITHIN THIS SUBCLAUSE AND REPLACE WITH THE FOLLOWING:*

"When so scheduled and when there is suitable topsoil within the limits of the area to be cleared, the Contractor shall remove, and conserve topsoil in accordance with the



Environmental Management Programme (EMPr). The Contractor will not be required to remove topsoil from any area in which the average depth of soil is less than 150 mm."

## **PSD 5.2.2      Excavation**

### **PSD 5.2.2.1      Excavation for general earthworks and for structures**

*ADD THE FOLLOWING TO PARAGRAPH (b) :*

"When the nature of the material precludes the above procedure, additional excavations shall be carried out to provide working space for the erection of formwork. The tendered rate for item 8.3.5 will be deemed to include the cost of a working width of 600mm, but the Contractor may excavate a greater working width at no additional cost to the Employer."

*REPLACE THE CONTENTS OF PARAGRAPH (d) WITH THE FOLLOWING :*

"The Contractor shall excavate the foundation to a depth of approximately 300mm above the founding level, and the remaining depth shall only be excavated at most 48 hours prior to casting the blinding (or no-fines) concrete layer. In addition, the Contractor shall arrange for the inspection by the Engineer or his Representative of all surfaces 48 hours before casting concrete."

*REPLACE THE FIRST SENTENCE OF PARAGRAPH (e) WITH THE FOLLOWING :*

"Where excavations have been carried below the authorised levels, the Contractor shall backfill such excavations to the correct level with approved sand fill from commercial sources compacted to 100% of modified AASHTO density or approved gravel compacted to 90% of modified AASHTO density or to the density of the surrounding material, whichever is the higher density. The cost of the remedial measures shall be for the Contractor's account.

Where excavations for structures have been carried out in hard material, the Engineer may direct that over-excavation be backfilled with weak concrete if there is a danger of settlement or differential settlement of the foundations.

Where backfilling is required below structures, either due to over-excavation or where ordered by the Engineer, such backfill shall be mass concrete of Grade 15 MPa/19 mm or no-fines concrete, as directed by the Engineer. Backfilling with 5% cement stabilized sand (typically equates to 75kg cement per m<sup>3</sup> of backfill) compacted to 100% MOD AASHTO in 150mm layers may be appropriate for use under certain structures, if approved by the Engineer or where indicated on the drawings. The cement stabilized sand to be thoroughly mixed in the presence of the Engineer. The cost of backfilling due to over-excavation shall be for the Contractor's account.

Where the sides of excavations against which concrete is to be cast have been over-excavated or have collapsed partially, the Contractor shall retrim the excavations if necessary and, unless other remedial measures are agreed to by the Engineer, shall cast the concrete, including the additional concrete that may be required as a result of the over-excavation or partial collapse. The cost of the additional concrete or remedial measures shall be for the Contractor's account."

### **PSD 5.2.2.3      Disposal**

*REPLACE THE SECOND SENTENCE OF SUBCLAUSE 5.2.2.3 WITH THE FOLLOWING :*

"The Contractor shall, provide all necessary spoil sites for the spoiling of all surplus and unsuitable materials and shall make the necessary arrangements with the owner of the site where the material is disposed of, and pay all charges and levies as may be applicable for the use of such spoil sites. Every spoil site provided by the Contractor shall be approved by the local authority in whose area it is located, and the spoiling shall comply with the applicable statutory and municipal regulations as well as the requirements of the owner of the spoil site. Payment to the Contractor in respect of locating and making arrangements for suitable spoil sites and

spoiling material at such sites will be made in accordance with the provisions of Subclause PSD 8.3.15.”

*ADD THE FOLLOWING NEW SUBCLAUSE :*

**"PSD 5.2.2.4 Selection and Stockpiling**

Approval or designation of the material in a particular borrow pit or excavation for a particular purpose does not imply that all the material in the borrow pit or excavation is suitable for the particular purpose for which the said approval or designation relates, nor that all material in the borrow pit or source should be used for the particular purpose. The Contractor shall select suitable material from that borrow pit or source, discard unsuitable material and reserve material for other purposes as necessary.

The Contractor shall organise and carry out its operations in such a manner as will prevent the contamination of suitable embankment and backfill material with unsuitable materials. Any excavated material which becomes, in the Engineer's opinion, unsuitable for use in embankments or backfill as a result of contamination, shall be disposed of in a manner acceptable to the Engineer and shall be replaced by the Contractor with materials acceptable to the Engineer, all at the Contractor's cost. Stockpiling of material shall be done in accordance with the Environmental Management Programme (EMPr).

When required, or when ordered by the Engineer, material shall be stockpiled for later use. The additional costs of stockpiling material shall be paid to the Contractor in accordance with the provisions of Subclause PSD 8.3.14.”

**PSD 5.2.2.5 Recording of original ground profiles**

The Contractor shall inform the Engineer, in writing, at least 14 days before commencing any work which will result in a change in the topography of the site, whether such work be for the permanent works or for temporary works which the Contractor intends to execute for his own convenience. Thereupon, before commencing the work, the Contractor shall undertake and be assisted by the Engineer in taking cross-sections of the original ground profiles at structures and a centreline survey of the pipeline or another approved method to determine the ground profiles of the entire area to be worked. In addition, all rock and/or foundation levels shall be recorded as the work proceeds.

The information so obtained shall be permanently recorded on a drawing or drawings which shall each be signed by both the Contractor and the Engineer. The Contractor shall then provide the Engineer with a reproducible copy of each drawing to serve as a permanent record both for the purpose of redesign, of pipeline vertical alignment, determining the quantities of excavation and earthworks carried out in the construction of the permanent works and the extent to which temporary works shall be removed or temporary excavations shall be refilled upon completion of the Works.”

**PSD 5.2.3 Placing and Compaction**

**PSD 5.2.3.1 Embankments**

*OMIT "98% in the case of non-cohesive soil" AND SUBSTITUTE "100% in the case of non-cohesive soil".*

*REPLACE THE FIRST SENTENCE OF THE SIXTH PARAGRAPH WITH THE FOLLOWING:*

“Each layer shall be compacted at OMC to a density as specified and in the case of cohesive soil and 100% of modified AASHTO maximum density in the case of non-cohesive soil.”

*REPLACE THE SECOND SENTENCE OF THE SIXTH PARAGRAPH WITH THE FOLLOWING:*

"The material of each area of fill shall, unless otherwise approved, be deposited in layers of thickness, before compaction, not exceeding 150 mm. The material shall be spread to form a layer that is approximately uniform thickness and graded over the whole area of the fill site."

*REPLACE THE SEVENTH PARAGRAPH WITH THE FOLLOWING:*

"Should the material be too wet, owing to rain or any other cause, it shall be harrowed and allowed to dry out to the correct moisture content before compaction is undertaken."

*REPLACE THE LAST PARAGRAPH WITH THE FOLLOWING:*

"The contractor shall ensure that stormwater will at all times be discharged uniformly over the full fill area or through specially prepared and protected drainage ditches to prevent scouring of the slopes."

#### **PSD 5.2.3.2 Backfilling of trenches and backfilling against structures**

*AFTER THE SECOND LAST PARAGRAPH ADD THE FOLLOWING:*

"Each layer shall be compacted at OMC to a density of at least 93% MAMDD in the case of cohesive soils or 100% in the case of non-cohesive soils. Should the material be too wet, owing to rain or any other cause, it shall be harrowed and allowed to dry out to the correct moisture content before compaction is undertaken."

The contractor shall ensure that stormwater will at all times be discharged uniformly over the full fill area or through specially prepared and protected drainage ditches to prevent scouring of the slopes."

*ADD THE FOLLOWING NEW SUBCLAUSE IN SUBCLAUSE 5.2.3 :*

#### **"PSD 5.2.3.3 Fill under floors or foundations**

If required by the Engineer the in-situ material below all structures shall be excavated to a depth specified by the Engineer below the footings/slabs, to spoil and replaced with imported material from commercial sources as instructed by the Engineer.

Where cement-stabilised fill is specified for filling under floor slabs, the soilcrete shall comply with the requirements of subclause PSDB 3.5(d) of section 1200 DB as amended and shall be placed as specified in the subclause.

Where soilcrete is specified for filling under floor slabs, the soilcrete shall comply with the requirements of subclause PSDB 3.5(d) of section 1200 DB as amended and shall be placed as specified in the subclause."

#### **PSD 5.2.4 Finishing**

##### **PSD 5.2.4.2 Topsoiling**

*ADD THE FOLLOWING TO SUBCLAUSE 5.2.4.2 :*

"Topsoil shall be placed as directed in Subclause 5.2.4.2 on the faces of cut slopes and embankments and other flatter areas, as shown on the drawings or ordered by the Engineer, to a nominal thickness of 150mm after light compaction."

Topsoiling shall be done in accordance with the Environmental Management Programme (EMPr).

##### **PSD 5.2.4.3 Grass or other vegetation**

*ADD THE FOLLOWING TO SUBCLAUSE 5.2.4.3 :*

"Hydroseeding

The following materials shall be used in hydroseeding:

(a) Fertilizer

The type of fertiliser to be used shall be 2:3:2 (22 + 2N) and superphosphate.

(b) Grass seed

The following seed mixture at an application rate of not less than 45 kg of seed mixture per hectare, shall be used:

10 kg	Cynodon dactylon
10 kg	Festuca rubra
6 kg	Lolium multiflorum
6 kg	Agrostis tenius
3 kg	Trifolium subterranean
4 kg	Dactylis glomerata
6 kg	Serredella
<b>45 kg</b>	<b>per hectare</b>

Cellulose pulp shall be added to the hydroseeding mix at a rate of 25 kg of pulp per kilolitre of water used, except where otherwise instructed in respect of flat slopes.

Hydroseeding shall be carried out with an approved hydroseeding machine at a rate of application of not less than 45 kg of seed mixture per hectare, unless otherwise specified in the project specifications.

If the Contract starting time and program is such that the work cannot be executed within the Contract period, then the work shall be executed during the 12-month maintenance period.

Straw Stabilization

One bale of hay per 20 m<sup>2</sup> shall be rotovated or harrowed into the sand. Harrowing or rotovating shall be done across the direction of the prevailing winds."

Grass Sods

Grass sods shall be 100% Cynodon dactylon. It shall be vigorous, well rooted, healthy turf, free from disease, insect pests, weeds, other grasses, stones, and other harmful matter.

## (a) Cutting, lifting, and handling of grass sods

- (1) Prior to cutting and lifting, the sod shall be inspected and approved in its original location by the Engineer or the Landscape Architect. Under no circumstances shall any sodding work be done unless weather and soil conditions are suitable, as determined by the Engineer or the Landscape Architect.
- (2) Sods shall be cut by an approved mechanical sod cutter and cut to a thickness of not more than 40 mm nor less than 25 mm. Sod pieces shall be cut to 0,5 m<sup>2</sup> in area. The width shall be 300 mm or 450 mm.
- (3) Sod shall be rolled or folded prior to lifting. Handling of sods shall be done in such a manner that will prevent tearing, breaking, drying or any other damage. All damaged pieces of sod shall be rejected by the Engineer or the Landscape Architect.
- (4) Sods shall be installed in place on the Site not more than 48 after cutting.

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(b) Sodding procedures

- (1) Rolling: Rolling shall be done in 2 (two) directions perpendicular to each other. The roller shall be a hand roller weighing not more than 90 kg or less than 70 kg. Roll in such a manner so as to eliminate the necessity of walking on the finished grade.
- (2) After rolling, check finished grading for depressions, lumps, or any other irregularities. Repair and re-roll all areas as directed by the Engineer or the Landscape Architect.
- (3) Moisten soil surface immediately before sod laying, as directed by the Engineer or the Landscape Architect. Use a fine spray that will not cause a disturbance of the finished surface.
- (4) Lay sod parallel to the direction of the slope and in a manner that will permit joints to alternate.
- (5) Fit sod pieces together tightly so that no joint is visible and tamp sod firmly and evenly by hand. Peg sod where slope is greater than 1:3.
- (6) During sod laying operation, protect all sods as it is laid and finished, from depressions, lumps or any other irregularities in the finished surface.
- (7) After sodding is complete and has been approved, roll in the same manner as described above and to the satisfaction of the Engineer or the Landscape Architect.
- (8) Water all sodded areas immediately after final rolling with a fine spray to a depth of 100 mm.

(c) Scope of maintenance work

- (1) Maintenance on the grassing shall begin when the planting commences and shall continue until Final Acceptance (three months after issue of Take-Over Certificate).
- (2) Maintenance shall consist of mowing, watering, weeding, fertilising, disease and insect pest control, aerating, replacement of unacceptable material, topdressing, and any other procedure consistent with good horticultural practice.
- (3) Maintenance personnel shall visit the Site on a minimum weekly basis during the three month maintenance period. A proposed maintenance schedule shall be submitted by the Contractor to the Landscape Architect for approval. Prior to any maintenance work commencing, all defects that may become apparent during this period shall be thoroughly investigated and rectified by the Contractor to the Engineer or the Landscape Architect's satisfaction.
- (4) The Contractor shall be responsible for the use of all materials, labour and equipment, and any injury to plant material caused by such material, labour and equipment, shall be corrected and repaired by the Contractor at no additional expense to the Client.

(d) Establishment and maintenance of the grass

- (1) All planted or sodded areas shall be adequately watered at frequent and regular intervals in order to ensure proper growth until the area has established an acceptable cover and, thereafter, until the beginning of the Maintenance Period. The amount and frequency of watering shall be subject to the Engineer or the Landscape Architect's approval.
- (2) The Contractor shall mow the grass on all areas that have been grassed to maintain an average height of 30 mm or when instructed by the Landscape Architect, until

the end of the Maintenance Period. All grass cuttings shall be collected and disposed of if so directed by the Engineer or the Landscape Architect. Weeds shall be controlled by means of pulling, cutting, or any other approved means.

- (3) The Contractor shall top dress areas planted with sods once during the Maintenance Period with approved topsoil mix and fertilizer appropriate to negate any deficiency, according to the growth and colour of the grass.
- (4) Any bare patches where the plant material has not taken, or where it has been damaged, shall be recultivated, planted, or sodded at the Contractor's own expense.
- (5) All plant areas shall have acceptable cover as defined below at the end of the Maintenance Period.
- (6) An acceptable vegetation cover shall mean that no less than 75% of the area planted shall be covered and that there shall be no bare patches of more than 500 mm in maximum dimension.
- (7) The Maintenance Period on the grassing shall last three (3) months.

#### Weeding

Keep all planting areas free from weeds and undesirable grasses, by a method and materials approved by the Engineer or the Landscape Architect.

#### Topdressing

All lawn areas shall be top dressed as necessary, to remove any minor depressions and visible joints in the grass sods. Topdressing shall be as previously specified.

#### Vegetation for constructed wetlands

Vegetation to be planted in constructed wetlands shall include the following species:

- (a) *Phragmites australis* (50% by number)
- (b) *Typha latifolia* (50% by number).

The final stem density of all plants shall be no less than 15 shoots / m<sup>2</sup>.

Plant rhizomes shall be brought to site and transplanted into the wetland substrate layer. Planted rhizomes shall be watered daily when there is no flow through the wetland."

### **PSD 5.2.5 Transport for Earthworks**

*REPLACE THE CONTENTS OF SUBCLAUSE 5.2.5 WITH THE FOLLOWING :*

"The transport of all excavated materials as well as material imported from commercial sources or borrow pits selected by the Contractor, irrespective of the distance and source, shall be deemed to be free haul, the cost of which is included in the Contractor's tendered rates and prices for the excavation of the materials. No separate compensation shall apply for the transportation of excavated materials."

### **PSD 6 TOLERANCES**

#### **PSD 6.1 POSITION, DIMENSIONS, LEVELS, ETC.**

*ADD THE FOLLOWING AT THE END OF THE FIRST PARAGRAPH:*

"The tolerances applicable to excavations for structural foundations (degree of accuracy I), as specified in Sub-clause 6.1(a) shall apply, provided no ponding areas or adverse grades result."

**PSD 7            TESTING**

**PSD 7.2        TAKING AND TESTING OF SAMPLES**

*REPLACE THE CONTENTS OF THIS SUB-CLAUSE WITH THE FOLLOWING :*

"The Contractor shall arrange with the approved independent laboratory engaged by the Contractor in terms of C3.4.2.4 in Part C3: Scope of Works, to carry out sufficient tests on a regular basis as agreed between it and the Engineer to determine whether the degree of compaction, and, where applicable, the quality of materials used, comply with the Specifications and shall submit the results of these tests to the Engineer in a form approved by him. The compaction requirements shall be deemed complied with when the dry-density tests on any lot show values equal to or above the specified density and when no single value is more than five percentage points below the specified value."

Testing by the Engineer will not relieve the Contractor of his obligations to provide materials and workmanship in accordance with the specifications."

**PSD 8            MEASUREMENT AND PAYMENT**

**PSD 8.1        BASIC PRINCIPLES**

*REPLACE THE FIRST SENTENCE OF SUBCLAUSE 8.1.1 WITH THE FOLLOWING:*

"The basic principles of measurement and payment for all earthworks are that the rates tendered for excavation shall cover the cost of excavating at the Site and the re-use of the excavated material in backfilling, forming embankments, terraces, etc, or (where ordered) the replacement of excavated material with material from commercial sources for backfilling, and the cost of disposal of any surplus and unsuitable excavated material within the free haul distance."

**PSD 8.3        SCHEDULED ITEMS**

**PSD 8.3.1      Site Preparation**

**PSD 8.3.1.1    Clear and strip site**

*REPLACE THE CONTENTS WITHIN SUBCLAUSES 8.3.1.1 WITH THE FOLLOWING :*

"Where Site preparation such as clearing, grubbing, the removal of large trees or the removal and stockpiling of topsoil is required, the provisions and scheduled items of SANS 1200 C shall apply."

**PSD 8.3.1.2    Remove topsoil to nominal depth 150mm (or stated depth), stockpile and maintain**

In Subclause 8.3.1.2 change the unit to "m<sup>3</sup>".

*AT THE END OF THE FIRST SENTENCE IN SUBCLAUSE 8.3.1.2 ADD THE FOLLOWING:*

"including maintaining and vegetating the stockpiles."

*ADD THE FOLLOWING NEW SUBCLAUSE:*

**"PSD 8.3.1.3    Remove and spoil sludge from existing waste pond(s) :**

- (a) Sludge pumped to adjacent waste pond, head of works or sludge treatment facilities as directed by the Engineer ..... Unit : m<sup>3</sup>



- (b) Excavate, load, transport and spoil at landfill site ..... Unit : m<sup>3</sup>

The rate must include all labour, plant and material to remove the sludge from the existing waste pond in order to construct the wall and concrete lining for the new emergency pond as shown on the drawings. Sludge that can be pumped to the adjacent waste pond and sludge that must be removed by means of excavation will be distinguished between and priced separately.”

### **PSD 8.3.2 Bulk Excavation**

*REPLACE THE CONTENTS OF SUBCLAUSE 8.3.2 WITH THE FOLLOWING :*

#### **“PSD 8.3.2.1 Excavate in all materials and use for berm, channels, swales, embankment or backfill as ordered, from:**

- (a) Necessary excavations ..... Unit : m<sup>3</sup>

The unit of measurement shall be the cubic metre measured in place in accordance with Subclause 8.2 of SANS 1200D.

Separate items will be scheduled for embankments and backfills for different parts of the Works.

The tendered rates shall cover the cost of complying with all the precautions required in terms of Subclause 5.1 of SANS 1200D (as amended), in addition to the cost of excavating in all materials, basic selection, stockpiling loading, transporting within the applicable free haul distance, off-loading, spreading or backfilling, watering, compacting, final grading, complying with the requirements of for tolerances, providing for testing, finishing and tidying, all in accordance with the specifications.

In addition to the foregoing, the tendered rate for sub-item (b) shall, further include for the costs of royalties (if applicable).

All excavations on the site between existing structures shall be deemed to be bulk excavation. No additional costs for restricted excavation will be payable.

#### **PSD 8.3.2.2 Excavate in all materials and dispose ..... Unit : m<sup>3</sup>**

The unit of measurement shall be the cubic metre of material excavated, measured in place in accordance with Subclause 8.2 of SANS 1200D.

Separate items may be scheduled for excavations for different parts of the Works.

The tendered rates shall cover the cost of complying with all the precautions required in terms of Subclause 5.1 of SANS 1200D (as amended), in addition to the cost of excavation, basic selection, stockpiling, loading, transporting within the applicable free haul distance, off-loading at the spoil site, maintaining and finishing the spoil site, all in accordance with the specifications.

All excavations on the site between existing structures shall be deemed to be bulk excavation. No additional costs for restricted excavation will be payable.

#### **PSD 8.3.2.3 Excavate in all materials and dispose of, and backfill with material from commercial sources (clean sand unless otherwise indicated)..... Unit: m<sup>3</sup>**

The unit of measurement shall be the cubic metre of material excavated on Site which is replaced with material from commercial sources, measured in place in accordance with 8.2. Separate items will be scheduled for different parts of the works and for importation from different sources.

The tendered rates shall cover the cost of complying with all the precautions required in terms of 5.1 in addition to the cost of excavating in all materials and disposing of these materials, the cost of complying with the requirements of 5.2.2.3, basic selecting, loading, transporting, off-



loading at the spoil site, maintaining and finishing the spoil site and for all other incidental costs to excavate and dispose of the material, all in accordance with the specifications.

The tendered rate shall also include for the costs of finding a commercial source of suitable material, for making arrangements with the owner of the source, for procuring the material, selection, for the payment of all requisite royalties, charges or damages, for transporting the material to the site regardless of the distance involved, for spreading or backfilling, watering, compacting, complying with the requirements for tolerances, providing for testing, finishing and tidying, all in accordance with the specifications. No payment will be made for the removal of overburden or stockpiling at the commercial source."

**PSD 8.3.2.4 Extra-over Items PSD 8.3.2.1 (a), PSD 8.3.2.2 and PSD 8.3.2.3 for :**

(1) Hard rock excavation ..... Unit : m<sup>3</sup>

The rate shall cover the additional cost of the operations enumerated in Subclauses 8.3.2.1 and 8.3.2.2 above for any portion of the excavation that is classified as hard rock (see Drawing D-1 and D-2). "

**PSD 8.3.3 Restricted Excavation**

*REPLACE THE SUB-HEADING OF 8.3.3(a) WITH :*

"(a) Excavate in all materials and use for backfill or embankment or dispose as ordered by the Engineer ..... Unit : m<sup>3</sup>"

*REPLACE THE WORDS "in 1 m increments" AT THE END OF THE FIRST SENTENCE OF SUB-ITEM (a) WITH THE FOLLOWING:*

"in the increments indicated in the Schedule of Quantities".

*REPLACE "in 5.2.2.1 – 5.2.2.3 (inclusive)" AT THE END OF SUBCLAUSE (a) WITH THE FOLLOWING:*

"in Subclauses 5.2.2.1 to 5.2.2.4 as amended (inclusive)".

IN SUBCLAUSE (b), replace both "1) intermediate excavation" and the corresponding unit of measure with "1) Not applicable (VOID)". No extra-over payment will be made for excavation in material classified in terms of 3.1.2 as intermediate excavation.

OMIT "intermediate," FROM THE SECOND LAST LINE OF SUBCLAUSE 8.3.3(b).

*ADD, AFTER SUB-ITEM (a) :*

"It is the express intention of the Engineer to loosen the problematic distinction between Bulk Excavation and Restricted Excavation and call for all the excavation of the individual structures solely as Restricted Excavation."

*ADD THE FOLLOWING NEW SUB-ITEMS AFTER 8.3.3 (b):*

"(c) Hand excavation and backfill by hand where ordered by the Engineer ..... Unit : m<sup>3</sup>"

This item shall apply to hand excavation ordered by the Engineer or when the Engineer considers that, owing to circumstances, excavation by mechanical excavators is not practicable. It shall not apply to hand excavation for trimming or finishing an excavation made by mechanical means.

The tendered rate shall include full compensation for the additional cost of excavating by means of hand tools."

(d) Soilcrete backfill where directed by the Engineer.....Unit: m<sup>3</sup>

The unit of measurement shall be the cubic metre of soilcrete placed on the Engineers instructions in accordance with Sub-clause 3.5(d), measured in place according to the authorised dimensions.

(e) Backfill stabilised with 5% cement where directed by the Engineer.....Unit: m<sup>3</sup>

The unit of measurement shall be the cubic metre of backfill material stabilized, measured in place according to the authorised dimensions after compaction, which was stabilized as shown on the drawings or on the Engineer's instructions. The tendered rate shall include full compensation for any work additional to that priced for in 8.3.2 and 8.3.3 (as applicable) to stabilize the backfill material with 5% cement and compacting the stabilised material to the required modified AASHTO density (100% unless otherwise stated).

(f) Excavate for restricted foundations, footings and pipe trenches in all materials and dispose of, and backfill with material from commercial sources (clean sand unless otherwise indicated).....Unit: m<sup>3</sup>

The unit of measurement shall be the cubic metre of material excavated on Site, which is replaced with material from commercial sources, measured in place in accordance with 8.2. Separate items will be scheduled for separate structures, for importation from different sources and, in the case of pipe trenches, to different depths in the increments indicated in the Schedule of Quantities.

All restricted excavations will be measured by volume. The volume of short pipe trenches will be computed from the minimum base width of the trench (see SANS 1200 DB). The rate shall cover the cost of complying with all the precautions required in terms of 5.1 in addition to the cost of excavating in all materials and disposing of these materials, for basic selecting, loading, transporting, off-loading at the spoil site, maintaining, and finishing the spoil site and for all other incidental costs to excavate and dispose of the material, all in accordance with the specifications.

The tendered rate shall also include for the costs of finding a commercial source of suitable material, for making arrangements with the owner of the source, for procuring the material, selection, for the payment of all requisite royalties, charges or damages, for transporting the material to the site regardless of the distance involved, for spreading or backfilling, watering, compacting, complying with the requirements for tolerances, providing for testing, finishing and tidying, and as more fully specified in Subclauses 5.2.2.1 to 5.2.2.4 (inclusive) and 5.2.3. No payment will be made for the removal of overburden or stockpiling at the commercial source.

(g) Excavate for Sewer Conservancy Tanks in all materials and use for backfill or berm or dispose as ordered.....Unit: m<sup>3</sup>

The provisions of subclause 8.3.3 of SANS 1200 D 8.3.3(a) and PSD 8.3.3 (d) shall as applicable apply.

The rate shall further cover the cost of preparing the bottom of the excavations as specified in PSLD 5.1.1, as well as for selective stockpiling of excavated material (refer SANS 1200LD 8.3.3(i)).

(h) Excavate unsuitable material from bottom of conservancy tank excavations and replace with selected material complying with SANS 1200D 3.2.4

- (i) Using material from sewer conservancy tank excavations.....Unit: m<sup>3</sup>
- (ii) Using Material from other excavations on site.....Unit: m<sup>3</sup>
- (iii) Using Material from commercial sources.....Unit: m<sup>3</sup>

(i) Backfill Sewer Conservancy Tank using selected material complying with SANS 1200D 3.2.4

- (1) Material from other excavations on site.....Unit: m<sup>3</sup>  
 (2) Material from commercial sources.....Unit: m<sup>3</sup>

The quantity measured for payment shall be the volume of the tank excavations calculated from the nett outline of a tank plus 300mm side allowance along its entire perimeter and depth of excavation, less the total outside volume of the tank itself.

The rate tendered shall cover the cost of acquiring the material, loading, haulage (in the case of (ii) above irrespective of distance), offloading, placing, watering and compacting the backfill, as well as for additional material required due to any over excavation. (Backfill of a tank using selected material generated by its excavation shall be deemed to be covered by SANS 1200D 8.3.3(c)).”

**PSD 8.3.4 Importing of materials**

*REPLACE THE HEADING OF 8.3.4(a) WITH THE FOLLOWING HEADING, WITHOUT CHANGING THE UNIT OF MEASURE:*

“Importation of additional material from commercial sources or from borrow pits and use for fill”

*REPLACE THE CONTENT OF 8.3.4(a) WITH THE FOLLOWING:*

“Importation of material used for fill will only be the measure of imported material which does not replace excavated material and thus cannot be measured under 8.3.2.3 or 8.3.3(d). Imported material which replaces disposed of excavated material will not be paid for separately under this Subclause but shall be included for in the rates provided under 8.3.2.3 and 8.3.2.4.

The unit of measurement shall be the cubic metre of material imported, measured in place once compacted in accordance with 8.2. Separate items will be scheduled for different parts of the Works and for importation from different sources.

The tendered rate for importation of material for fill as described in this Subclause shall cover the cost of complying with any relevant precautions of 5.1 in addition to the cost of finding a commercial source of suitable material, for making arrangements with the owner of the source, for procuring the material, selection, for the payment of all requisite royalties, charges or damages, for transporting the material to the site regardless of the distance involved, for spreading or filling, watering, compacting, complying with the requirements for tolerances, providing for testing, finishing and tidying, all in accordance with the specifications. No payment will be made for the removal of overburden or stockpiling at the commercial source.”

**PSD 8.3.5 Extra Excavation in All Materials to Provide Working Space around Structure**

*ADD THE FOLLOWING TO THE END OF THE LAST PAYMENT PARAGRAPH:*

“The cost of a working width of 600mm as specified in item 5.2.1.2 (Subclause 5.2.2.1) will be deemed to be included in the tendered rate for this item.”

**PSD 8.3.6 Overhaul**

*DELETE SUBCLAUSE 8.3.6.*

The transport of all materials, irrespective of the distance and source, shall be deemed to be free-haul as defined in 5.2.5.

**PSD 8.3.8 Existing services**

**PSD 8.3.8.1 Location**

*REPLACE THE HEADING AND CONTENTS OF SUBCLAUSE 8.3.8.1 WITH THE FOLLOWING :*

**PSD 8.3.8.1 Hand Excavation for Locating and Exposing Existing Services :**

- (a) In roadways ..... Unit : m<sup>3</sup>
- (b) In all other areas ..... Unit : m<sup>3</sup>

The unit of measurement shall be the cubic metre of material excavated, measured in place according to the authorised or actual dimensions of the excavation, whichever is the lesser.

The tendered rates shall cover the cost of excavating in all materials by means of hand tools within authorised dimensions and at locations approved by the Engineer in accordance with the requirements of Subclause PSA 5.4.1, for all precautionary measures necessary to protect the services from damage during excavation and backfilling, and for subsequent backfilling and compacting. Compaction of material in all areas except in roadways shall be to 90% of the modified AASHTO density.

The tendered rate for hand excavation in roadways shall include compensation for compacting excavated or selected backfill material to 93% of modified AASHTO density. Reinstating layerworks and surfacing shall be measured and paid for in terms of SANS 1200DB.

The tendered rates shall also include for keeping excavations safe, for dealing with surface and subsurface water, for removing surplus excavated material from the Site, for transporting all material within the free-haul distance, and for supplying adequate supervision during both excavation and backfilling operations. Overhaul, if applicable, will be measured and paid for in terms of SANS 1200DB."

**PSD 8.3.10 Topsoiling**

*CHANGE THE UNIT TO "m<sup>3</sup>" AND REPLACE THE CONTENTS OF SUBCLAUSE 8.3.10 WITH THE FOLLOWING:*

"The unit of measurement shall be the cubic metre and the quantity shall be calculated from the authorised dimensions.

The tendered rate shall include full compensation for loading of the topsoil from stockpiles, transporting it for the free-haul distance, and off-loading, spreading, shaping and lightly compacting the topsoil in accordance with the requirements of PSD 5.2.4.2."

**PSD 8.3.11 Grassing or other Vegetation Cover**

*REPLACE THE CONTENTS OF SUBCLAUSE 8.3.11 WITH THE FOLLOWING:*

**PSD 8.3.11.1 Planting of grass cuttings** ..... Unit : m<sup>2</sup>

The tendered rate shall include full compensation for supplying, planting and maintenance in accordance with the requirements of PSD 5.2.4.3.

**PSD 8.3.11.2 Planting of grass sods** ..... Unit : m<sup>2</sup>

The tendered rate shall include full compensation for supplying, planting and maintenance in accordance with the requirements of PSD 5.2.4.3.

**PSD 8.3.11.3 Hydroseeding** ..... Unit : m<sup>2</sup>

The tendered rate shall include full compensation of the seed mixture, for furnishing cellulose pulp and mixing it with seed and water and applying the mixture, watering, weeding, re-

hydroseeding bare patches, and for any other work except mowing, which may be necessary for establishing an acceptable cover and maintaining the grass for a period of three months after an acceptable cover has been established.

**PSD 8.3.11.4 Straw Stabilization ..... Unit : m<sup>2</sup>**

The tendered rate shall include all costs to supply, spread and rotovate or harrow the straw 100 mm deep into the sand in accordance with the requirements of PSD 5.2.4.3."

**PSD 8.3.12 Road Traffic Signs and Markings**

*REPLACE THE FIRST WORD (viz. "Separate") OF THE FIRST SENTENCE OF SUBCLAUSE 5.3.12 WITH THE FOLLOWING :*

"Where the Engineer requires the provision of road traffic signs and/or road markings and/or any other measures additional to those to be provided by the Contractor in accordance Subclause 5.1.6, separate".

*ADD THE FOLLOWING SUBCLAUSES :*

**PSD 8.3.14 Extra over item PSD 8.3.2.1(a) for temporary Stockpiling ..... Unit : m<sup>3</sup>**

The unit of measurement shall be the cubic metre of material from necessary excavations, temporarily stockpiled by the Contractor on the instructions of the Engineer, before being used in embankments or backfill. Measurements shall be taken in place in compacted embankment or backfill as the case may be. The tendered rate shall include for the costs, additional to those provided for in PSD 8.3.2.1(a) and PSD 8.3.3(a) for clearing of the proposed stockpile area, off-loading, forming and maintaining the stockpile for as long as is required, including dust control, reloading and transporting within the applicable free haul distance from the stockpile.

Care is to be taken to avoid clearing of vegetation in areas beyond the limits indicated on the drawings. Areas contaminated or occupied by stockpiles of natural or treated materials are to be reinstated. The Contractor is required to produce environmental method statements that outline the approach to minimise the impact of his work activities on the environment as well as measures to reinstate the area after construction to a condition at least equivalent to its state before construction. Method statements shall be submitted to the Engineer for approval prior to any commencement.

Payments to the Contractor under this item will only be made in respect of that material stockpiled on the instructions of the Engineer (which instruction shall state specifically that payments for such stockpiling will be paid for under this item) and no payments will be made to the Contractor under this item in respect of materials stockpiled by the Contractor on his own volition, nor for materials necessarily stockpiled by the Contractor in consequence of the sequence of operations adopted by it in the course of executing the Works, whether such stockpiling was avoidable or otherwise.

**PSD 8.3.15 Extra over items PSD 8.3.2.2 and PSD 8.3.3(a) for disposing of spoil material on a site provided by the Contractor ..... Unit : m<sup>3</sup>**

The unit of measurement shall be the cubic metre measured in accordance with Subclause 8.2 of SANS 1200D, of surplus and/or unsuitable material disposed of, on the instruction of the Engineer, at a spoil site or spoil sites provided by the Contractor.

The tendered rate shall include full compensation for the additional cost of providing a spoil site or other means of disposing of surplus spoil material, for transporting the material regardless of the distance involved, for acceptance charges for such material and for all other incidental costs to dispose of the spoil material.

**PSD 8.3.16 Importing of Materials for Fill Under Floors and Foundations**

Separate items will be scheduled for each different class and type of fill material. The tendered rate shall cover the cost for importing from commercial sources, transporting, placing and compacting material.

- (a) Clean Sand compacted to 100% Modified AASHTO (unless otherwise stated) in 150 mm thick layers (unless otherwise stated) ..... Unit : m<sup>3</sup>
- (b) G5 compacted to 97% Modified AASHTO (unless otherwise stated) in 150 mm thick layers (unless otherwise stated) ..... Unit : m<sup>3</sup>
- (c) G6 compacted to 95% Modified AASHTO (unless otherwise stated) in 150 mm thick layers (unless otherwise stated) ..... Unit : m<sup>3</sup>
- (d) G7 compacted to 95% Modified AASHTO (unless otherwise stated) in 150 mm thick layers (unless otherwise stated) ..... Unit : m<sup>3</sup>
- (e) Clay material from commercial sources or borrow pits (Classified in Particular Specification PDP 03, Section 3.2) ..... Unit : m<sup>3</sup>
- (f) Backfill (class of material stated) stabilised with 5% cement where directed by the Engineer ..... Unit : m<sup>3</sup>

The unit of measurement shall be the cubic metre of backfill material, measured in place after compaction according to the authorised dimensions, which was stabilised on the Engineer's instructions in accordance with Subclause PSDB 3.5(c).

The tendered rate shall include full compensation for supplying the cement and for selecting, mixing, backfilling and compacting the stabilised material to 90% of modified AASHTO density.

- (g) Soilcrete backfill (class of material stated) where directed by the Engineer ..... Unit : m<sup>3</sup>

The unit of measurement shall be the cubic metre of soilcrete placed on the Engineer's instructions in accordance with Subclause PSDB 3.5(d), measured in place according to the authorised dimensions.

The tendered rate shall include full compensation for supplying the cement and for selecting, mixing and placing the soilcrete as well as for the cost of shuttering if required. The rate will make full provision placing, vibrating and compacting as applicable.

- (h) G7 quality material compacted to 95% (100% for sand) Modified AASHTO (unless otherwise stated) in 150 mm thick layers (unless otherwise stated) ..... Unit : m<sup>3</sup>
- (i) G9 quality material compacted to 95% (100% for sand) Modified AASHTO (unless otherwise stated) in 150 mm thick layers (unless otherwise stated) ..... Unit : m<sup>3</sup>
- (j) G5 compacted to 95% Modified AASHTO (unless otherwise stated) in 150 mm thick layers (unless otherwise stated) ..... Unit : m<sup>3</sup>
- (k) 300mm compacted pioneer layer consisting of 100mm to 200mm boulders (unless otherwise stated) ..... Unit : m<sup>3</sup>

#### **PSD 8.3.17 Excavate and disposal of unsuitable material**

Excavate and dispose of unsuitable material from sides or bottom of open drains outside road reserves, channel cross drains and road side channels, where ordered and replace with:

- (a) Selected material complying with subclause 3.2.2 of SABS 1200 ME compacted to 90% of modified AASHTO maximum density ..... Unit: m<sup>3</sup>

The rate shall also include full compensation for taking of dynamic core penetration (DCP) tests as ordered by the Engineer prior to the commencement of the compaction operation, which results shall be used by the Engineer to determine the depth of the in-situ layer to be compacted."



**PSDB EARTHWORKS (PIPE TRENCHES) (SANS 1200 DB)****PSDB 3 MATERIALS****PSDB 3.5 BACKFILL MATERIALS**

*ADD THE FOLLOWING TO SUBCLAUSE 3.5 :*

"(c) Cement-stabilised backfilling

Backfilling shall, where directed by the Engineer, be stabilised with 5% cement. The aggregate shall consist of approved soil or gravel containing stones not bigger than 38 mm and with a plasticity index not exceeding 10.

The soil or gravel shall be mixed with 5% cement and shall be compacted in layers of 100 mm thick to 90% of modified AASHTO density.

(d) Soilcrete backfilling

The aggregate for soilcrete shall be mixed with 5% cement and shall consist of approved soil or gravel containing stones not bigger than 38 mm and with a plasticity index not exceeding 10.

The soil or gravel shall be mixed in a concrete mixer with the cement and enough water to acquire a consistency that allows the mixture to be placed with vibrators to fill all voids between the pipe and the sides of the trench. Shuttering shall be used where necessary."

**PSDB 3.7 SELECTION**

*REPLACE THE WORDS "if he so wishes" IN THE FIRST LINE OF THE SECOND PARAGRAPH WITH THE WORDS "at his own cost".*

**PSDB 5 CONSTRUCTION****PSDB 5.1 PRECAUTIONS**

*ADD THE FOLLOWING NEW ITEM TO SUBCLAUSE 5.1.2 :*

**PSDB 5.1.2.4 Groundwater**

The provisions of PSDB 5.1.2.4 shall apply to all trenches and structures excavations. Sections of the works will be laid below the water table and ground water will be encountered during excavation. The Contractor shall dewater the excavations to such an extent as to draw the water table down to at least 100 mm below the top of the crushed stone layer, or bottom of the blinding layer, and keep it there until the backfill is complete."

**PSDB 5.1.3 Accommodation of Traffic and Access to Properties**

*REPLACE THE SEMI-COLON AND THE WORD "and" AT THE END OF SUBCLAUSE 5.1.3(a) WITH A FULL STOP AND SUBCLAUSE 5.1.3(b) WITH THE FOLLOWING :*

- "(b) Where necessary to achieve compliance by the Contractor with his obligations in terms of C3.1.5 and C3.4.2.4(e) in Part C3: Scope of Works to provide and maintain pedestrian and vehicular access to properties affected by the Works, the Contractor shall construct and maintain to the satisfaction of the Engineer, such temporary access roads around, and/or steel or timber bridges over excavations in roads, pavements, entrances or accesses to properties.

Temporary pedestrian access bridges shall be at least 1,2 m wide and temporary access bridges for vehicles shall be at least 3,6 m wide. All temporary access bridges shall be fitted with handrails as well as protective mesh fencing on both sides.



On completion of the work, the Contractor shall dismantle and remove all such temporary constructions and reinstate these areas to their former condition.

Except only where the Engineer has included in the Schedule of Quantities, particular payment items specifically therefor, the Contractor will not be paid directly for the construction and maintenance of temporary access roads and/or the provision and maintenance of bridges as aforementioned, and the costs thereof shall be deemed included in the Contractor's tendered rates for excavation."

*ADD THE FOLLOWING SUBCLAUSE :*

**PSDB 5.1.5     Removal of Existing Pipelines**

Where existing pipes have to be removed, they shall be carefully opened up by machine excavation to 300mm above the pipes after which the whole pipe shall be fully exposed by means of hand excavation. The excavation width shall comply with Subclause PSDB 8.2.3.

The pipes shall be removed from the trench in a manner approved by the Engineer, and brought to the surface for inspection by the Engineer.

Pipes that are declared suitable for re-use and pipes declared unfit for re-use shall be dealt with in accordance with the respective manner described in the specifications, or on the drawings or the Engineer's instructions, as relevant."

**PSDB 5.2     MINIMUM BASE WIDTHS**

REPLACE PARAGRAPH (a) WITH THE FOLLOWING :

(a) "Where two pipes are placed in the same trench, they shall be 300mm apart and the specified side allowance shall still be applicable."

ADD THE FOLLOWING AFTER PARAGRAPH (b) :

"The above is not applicable to trenches for subsurface drains. Trenches for subsurface drains shall be excavated to the dimensions and gradients shown on the drawings or directed by the Engineer. The specified width of trenches and the width of the excavation measured for payment shall not be less than 0,5m, but the Contractor may reduce the actual width with the Engineer's permission."

**PSDB 5.4     EXCAVATION**

*ADD THE FOLLOWING TO SUBCLAUSE 5.4:*

"Except where otherwise specified, trenches shall be of such a depth that the minimum cover over the pipes shall be 800mm except at road-crossings where the minimum cover shall be 1 000mm."

All excavated material shall be kept within the working width and designated sites as indicated on the drawings and shall be so deposited as not to interfere with or endanger the Works (for example, by causing the sides of the excavation to collapse), other property, or traffic.

The toe of the stockpile shall be trimmed well back from the edge of the trench so as to leave a minimum 1,0 m clearance between the edge of the stockpile and the edge of the trench. The Contractor shall keep this strip clear of excavated material at all times and take all necessary steps to prevent mixing with material set aside for backfill.

The Engineer may, in terms of Subclauses 5.6.3 and 5.6.4, order the Contractor to remove any material which he considers liable to endanger or interfere with the Works, private property, traffic, or pedestrians, and to place such material at some other approved position. If the necessity for such removal is, in the opinion of the Engineer, a result of some default on

the part of the Contractor, the cost thereof shall be borne by the Contractor, otherwise the cost will be borne by the Employer at a sum pre-agreed with the Engineer or measured as Dayworks, whichever is the more appropriate in the opinion of the Engineer.

The construction of the Works shall be restricted to the "working widths" indicated on the drawings. The working width inside or near wetland buffer zones shall not exceed 25 m. The Contractor requires written permission from the Engineer should he wish to work outside the specified "working widths".

**PSDB 5.6      BACKFILL**

**PSDB 5.6.3      Disposal of Soft Excavation Material**

*REPLACE THE WORDS "unless otherwise required in the project specification." AT THE END OF SUBCLAUSE 5.6.3 WITH : "or to spoil in accordance with the requirements of Subclause PSD 5.2.2.3, as instructed by the Engineer."*

*ADD THE FOLLOWING TO SUBCLAUSE 5.6.3:*

"Except where in the opinion of the Engineer the excavated material is unsuitable for disposal in one or the other of the following methods, surplus material may be spread evenly over the area cleared and grubbed provided it does not raise the original ground level, or it may be disposed of in a dumping area approved by the Engineer within a free haul distance of 5,0 km from the point of excavation. Excess material from trench excavations for large diameter pipelines must be spoiled in accordance with the aforementioned.

Should an approved disposal site not be available within the specified 5,0 km free haul distance, the surplus/unsuitable material shall be disposed of at a municipal dump site or similar approved. Material disposed of in approved disposal areas shall be spread in such a manner that it will not cause water to dam up, and shall be levelled, trimmed and lightly compacted to neat lines and levels."

*ADD THE FOLLOWING SUBCLAUSE :*

**PSDB 5.6.9      Backfilling around structures**

Backfilling around a structure shall not be commenced before it has been approved by the Engineer.

Granular material shall be used as backfill material around structures as shown on the drawings and shall be placed in layers not exceeding 150mm compacted thickness, each layer being thoroughly compacted to 100% of modified AASHTO density as instructed by the Engineer before the succeeding layer is placed. Unsuitable or surplus excavated material shall be spoiled off Site."

**PSDB 5.7      COMPACTION**

**PSDB 5.7.1      Areas not Subject to Traffic Loads**

*ADD THE FOLLOWING SENTENCE TO SUBCLAUSE 5.7.1:*

"All non-cohesive material shall be compacted to 100% MOD AASHTO density."

**PSDB 5.7.2      Areas Subject to Traffic Loads:**

*DELETE "98%" AND SUBSTITUTE "100%".*

*ADD THE FOLLOWING TO SUBCLAUSE 5.7.2 :*

"All pipe trenches that fall within the road reserves shall be regarded as areas subject to traffic loads."

*ADD THE FOLLOWING SUBCLAUSES :***PSDB 5.11      REMOVAL OF EXISTING PIPES**

- PSDB 5.11.1** Where shown on the drawings or where so instructed by the Engineer, the Contractor shall excavate, expose and remove from the ground, existing water pipelines.
- PSDB 5.11.2** If so instructed by the Engineer, the Contractor shall, before commencing with the excavation of the pipeline, expose the pipeline to be removed by means of careful hand excavation at positions agreed with the Engineer, in accordance with the requirements of C3.4.5 of Part C3: Scope of Works. Measurement and payment for locating the exact positions of the pipelines where required by the Engineer, shall be made in accordance with and under Item PSD 8.3.8.1.
- PSDB 5.11.3** Thereafter, the existing pipelines to be removed shall be carefully opened up by machine excavation to a depth of not more than 300 mm above the pipes after which the whole pipeline shall be fully exposed by means of careful hand excavation. The excavation width shall comply with Subclause 5.2.
- PSDB 5.11.4** The pipes and all specials encountered (e.g. bends, valves, valve box covers and the like) shall be removed from the trench in a manner as to avoid causing damage and as approved by the Engineer, cleaned sufficiently as to allow inspection of the pipes and specials by the Engineer and stacked in such a manner as will facilitate the inspection of each pipe and special by the Engineer.
- PSDB 5.11.5** Pipes and specials that are declared by the Engineer as suitable for re-use shall be transported to the Employer's store yard located on Site where they shall off-loaded and neatly stacked to the satisfaction of the Engineer. The Contractor shall be responsible for obtaining a written receipt of all pipes so delivered to the Employer's store yard.
- PSDB 5.11.6** Pipes and specials which are declared by the Engineer as unsuitable for re-use shall be transported to a spoil site and covered with spoil material to a depth of not less than 300 mm.
- PSDB 5.11.7** After removal of the pipelines, the trenches shall be backfilled using the excavated material and compacted to 90% Mod AASHTO density. The provisions of Subclauses 5.6. and 5.7 shall apply."

**PSDB 8      MEASUREMENT AND PAYMENT****PSDB 8.1      BASIC PRINCIPLES****PSDB 8.1.2** *ADD THE FOLLOWING TO SUBCLAUSE 8.1.2 :*

"In the road prism the ground surface from which depth will be measured will always (irrespective of operation sequenced) be the road bed level at centre-line."

**PSDB 8.2      COMPUTATION OF QUANTITIES****PSDB 8.2.3** *REPLACE THE CONTENTS OF SUBCLAUSE 8.2.3 WITH THE FOLLOWING:*

"Wherever volumetric measurement is required, the volume will be computed according to the depths indicated on the drawings, or to the bottom of the specified bedding cradle, whichever is the greater, and the width determined from the applicable side allowance set out below (see drawing DB-4) plus the nominal width of the pipe. Side allowance shall be measured from the outside of the pipe. No allowance shall be made for the extra thickness of the collars or couplings.

All Pipes Excluding Ducts

<u>Nominal Diameter, mm</u>		<u>Side clearance on each side, mm</u>
<u>From</u>	<u>To</u>	
0	125	200
125	700	300
700	1000	400
1000	2000	500
2000	-	600

The side allowance for ducts shall be 150 mm and there shall be 300 mm between a Telkom duct and any other duct/service placed in the same trench.

Where two or more pipes/ducts are to be placed in one trench, the specified base width shall be calculated as follows:

The trench width for the deeper service shall be calculated according to above specifications. The effective trench width for the shallower service shall then be the difference between its specified base width and the overlap with the trench width of the deeper service.

The trench width for subsurface drains shall be as shown on the drawings.

Hand excavation will be measured by volume in accordance with Subclause 8.2.3. An extra-over payment will be made for hand excavation in those areas where, in the opinion of the Engineer, it is impossible to operate a back-acting excavator of bucket capacity 0,3 m<sup>3</sup> to do the excavation due to very steep slopes (in excess of 1:3), or the lack of unobstructed space, provided that prior approval has been obtained for such payment. The tendered rate shall cover all additional costs of excavation by hand in such areas. Hand excavation for the location of or in the vicinity of existing services will not be measured under this item."

### **PSDB 8.3      SCHEDULED ITEMS**

#### **PSDB 8.3.2      Excavation :**

- (a)    Excavate in all materials, for trenches, backfill, compact and dispose of surplus material

*REPLACE "of 1,0 m" IN THE FIRST SENTENCE OF SUBCLAUSE 8.3.2(a) WITH : "as specified in the Schedule of Quantities".*

- (b)    Extra over item (a) above for:

*DELETE LIST ITEMS (1) AND (2) AND REPLACE WITH THE FOLLOWING:*

- (1)    Hard material ..... Unit : m<sup>3</sup>

*ADD THE FOLLOWING AT THE END OF SUBCLAUSE 8.3.2(b) :*

"No payments will be made under sub-items (1) and (2) in respect of any materials measured and paid for under sub-item 3 below."

*AND ADD THE FOLLOWING TO SUBCLAUSE 8.3.2(b) :*

- "(3)    Hand excavation and backfill where ordered by the Engineer in :

- (a)    Soft and intermediate material ..... Unit : m<sup>3</sup>  
 (b)    Hard material ..... Unit : m<sup>3</sup>

The unit of measurement shall be the cubic metre of material, measured in place according to the authorised dimensions, which was excavated by hand on the specific prior written instructions of the Engineer; provided always that the Engineer's said instruction shall have

stated that measurement and payment for such hand excavation will be in accordance with this item.

The tendered rate shall include full compensation for the additional cost, effort and time resulting from excavating in the respective materials using hand methods only.

The Engineer shall not be obliged to authorise payment under this item in respect of any hand excavation carried out (whether ordered in writing or otherwise), which hand excavation was in any case necessary to achieve compliance by the Contractor of his obligations under the Contract to:

- (i) utilise construction appropriate to the nature of the specific parts of the Works and/or
- (ii) protect existing structures and/or services; and/or
- (iii) comply with all prevailing legislation and regulations.

(4) Backfill stabilised with 5% cement where directed by the Engineer ..... Unit : m<sup>3</sup>

The unit of measurement shall be the cubic metre of backfill material, measured in place after compaction according to the authorised dimensions, which was stabilised on the Engineer's instructions in accordance with Subclause PSDB 3.5(c).

The tendered rate shall include full compensation for supplying the cement and for selecting, mixing, backfilling and compacting the stabilised material to 90% of modified AASHTO density.

(5) Soilcrete backfill where directed by the Engineer ..... Unit : m<sup>3</sup>

The unit of measurement shall be the cubic metre of soilcrete placed on the Engineer's instructions in accordance with Subclause PSDB 3.5(d), measured in place according to the authorised dimensions.

The tendered rate shall include full compensation for supplying the cement and for selecting, mixing and placing the soilcrete as well as for the cost of shuttering if required.

6) Hand backfilling machine excavated trenches where ordered..... Unit: m<sup>3</sup>  
The rate tendered shall cover the additional cost, extra over that provided for under 8.3.2.1 (a) to, except for compaction which shall be carried out by machine, hand backfill machine excavated trenches where ordered by the Engineer.

The volume shall be computed from the dimensions specified, shown on the Drawings or ordered by the Engineer.

7) Selective stockpiling of topsoil where ordered..... Unit: m<sup>3</sup>  
The rate tendered shall cover the additional cost, extra over that provided for under 8.3.2.1 (a), to selectively stockpile topsoil where ordered by the Engineer, including of off-loading, forming and maintaining the stockpile for as long as is required, reloading and transporting within the applicable free haul distance from the stockpile.

The volume shall be computed from the dimensions ordered by the Engineer.

8) Disposing of spoil material on a site provided by the Contractor..... Unit: m<sup>3</sup>  
The unit of measurement shall be the cubic metre of backfill material, measured in place after compaction according to the authorised dimensions, which was stabilised on the Employer Agent instructions in accordance with Subclause SABS 1200DB 3.5(c).

The tendered rate shall include full compensation for supplying the cement and for selecting, mixing, backfilling and compacting the stabilised material to 90% of modified AASHTO density.

(9) Mass concrete Class 15 Mpa/20 mm in encasing around pipes under structures where directed by the Engineer..... Unit : m<sup>3</sup>

The unit will be the cubic metre as measured in Item 8.3.2 for the applicable material.

The rate will make full provision for the excavation, backfilling, vibrating and compacting as applicable.

The tendered rates shall include full compensation for supplying the cement and for selecting, mixing and placing the soilcrete or mass concrete, as well as for the cost of shuttering if required.

(10) Excavation in marshy areas irrespective of depth ..... Unit : m<sup>3</sup>

The unit will be the cubic metre as measured in Item 8.3.2 for the applicable material.

The rate will make full provision for the excavation, backfilling, vibrating and compacting as applicable.

The tendered rate shall include full compensation for all additional costs as a result of excavating in marshy areas, for pumping and draining if required and for vibrating and compacting to the specified density.

(11) Backfill with clean sand compacted to 100% modified AASHTO density ..... Unit : m<sup>3</sup>

The unit will be the cubic metre as measured in Item 8.3.2 for the applicable material. The rate will make full provision for the excavation, backfilling, vibrating and compacting as applicable.

The tendered rate shall include full compensation for all additional costs as a result of excavating in marshy areas, for pumping and draining if required and for vibrating and compacting to the specified density."

*ADD THE FOLLOWING TO SUBCLAUSE 8.3.2 AFTER ITEM 8.3.2(c) :*

"(d)Excavate in all materials for stormwater inlet and outlet structures and for manholes, catchpits, valve chambers and the like, irrespective of depth and backfill around structures Unit : m<sup>3</sup>

The unit of measurement shall be the cubic metre of material excavated, measured in place according to the authorised dimensions, and excluding the volume of material excavated and paid for under sub-item (a).

The tendered rate shall include for the costs of excavating in all materials, backfilling, compacting, trimming and tidying of the final surface around the structure, disposing of surplus and unsuitable materials within the free haul distance and where applicable, selecting and keeping separate, excavated material suitable for use as backfill.

(e) Excavate open drains in all materials ..... Unit : m<sup>3</sup>

The tendered rates shall include full compensation for excavating in all materials within the dimensions specified or authorised by the Engineer and to the specified lines and profiles, for the disposal of surplus and unsuitable excavated material where applicable, and in the case of item (d), for backfilling with suitable approved material compacted to 90% of modified AASHTO density around the structures.

(f) Extra-over sub-items (d) and (e) for excavating in:

(1) Intermediate material ..... Unit : m<sup>3</sup>

(2) Hard rock material ..... Unit : m<sup>3</sup>

Measurement and payment shall be in accordance with the provisions of 8.3.2(b) of SANS 1200D (as amended)."

### **PSDB 8.3.3      Excavation ancillaries:**

**PSDB 8.3.3.3 Compaction in road reserves**

*REPLACE THE SENTENCE "The volume will be measured as specified in 8.2.2, 8.2.3 and 8.3.3.1" WITH THE FOLLOWING :*

"In the case of gravel roads, determining the volume, the depth will be measured from the underside of the gravel wearing course to the top of the fill blanket, and in the case of bitumen roads, from the underside of the subbase to the top of the fill blanket.

The rest of the trench shall be backfilled as specified in Clauses 5.9.3, 5.9.4 and 5.9.5, as applicable, and payment will be made under item 8.3.6.1."

**PSDB 8.3.3.4 Overhaul**

*REPLACE THE CONTENTS OF SUBCLAUSE 8.3.3.4 WITH THE FOLLOWING :*

"Measurement and payment shall be in accordance with Subclause PSD 5.2.5."

**PSDB 8.3.4 Particular Items****PSDB 8.3.4(a) Shore trench opposite structure or service**

*REPLACE THE HEADING OF SUBCLAUSE 8.3.4(a) WITH THE FOLLOWING:*

**"PSDB 8.3.4(a) Shore trench opposite structure or service or in unsuitable excavated materials on both sides of trench for depths:"**

*ADD THE FOLLOWING TO SUBCLAUSE 8.3.4(a):*

"a) Shoring. Payment for this subclause shall be for shoring of trenches where specified or ordered. Shoring of other excavations shall be dealt with under SANS 1200 D.

The length measured for the payment of trenches will be that of the centre-line of the trench regardless of whether supports are placed on one or on both sides of the trench.

The rate shall cover the cost of supply, placing, maintenance and removal of timbering and other support measures together with any cost that results from the inconvenience of working in the supported excavation, the cost of any risks inherent in the operation and the surrounding geotechnical conditions.

Separate items will be measured for depths of trenches as specified in the Schedule of Quantities. The rate for each stated category shall cover the cost of shoring from ground level up to the full depth of the stated category and on both sides of the trench. Payment for this item will only be made if written instructions were issued by the Engineer.

**PSDB 8.3.5 Existing Services that Intersect or Adjoin a Pipe Trench****PSDB 8.3.5(b) Services that adjoin a trench**

*REPLACE THE LAST PHRASE "measuring for shoring" WITH THE WORDS "protected by shoring". The rate for this item shall cover the cost of any necessary shoring.*

*At the end of the Subclause 8.3.5(b), replace the full stop with a semi colon and add the following:*

- "v) all work involved in locating the service by hand excavation;
- vi) notifying and attending upon the proprietor of the service;
- vii) supporting and protecting the service while the pipeline is installed, inspected, tested and backfilled."

*ADD THE FOLLOWING TO SUBCLAUSE 8.3.5:*



- "(c) This rate shall also cover the additional cost of detection, exposure, hand excavation, protection, alteration and backfill material (the last if outside trench dimensions).  
 (d) An existing service which has been abandoned at the time it is crossed, will not be measured."

### **PSDB 8.3.6 Finishing**

#### **PSDB 8.3.6.1 Reinstate road surfaces complete with all courses**

*ADD THE FOLLOWING:*

"Where the trench crosses asphalt road surfaces, the rate shall include for neatly saw cutting the existing asphalt surfacing and disposal of all spoil material to a designated off site spoil location identified by the contractor."

*ADD THE FOLLOWING SUBCLAUSE:*

#### **"PSDB 8.3.8 Removal of existing pipes:**

- (a) Excavate in all materials to 300mm above the pipelines ..... Unit : m<sup>3</sup>

The unit of measurement shall be the cubic metre of material excavated for the removal of pipelines in accordance with PSDB 5.11, measured in place according to the authorised dimensions. Depth shall be measured from the ground surface on the centreline of the pipeline to 300 mm above the pipe barrel.

The tendered rate shall include for excavating by any method in all materials and placing the excavated material alongside the trench.

- (b) Hand excavation for removal by hand to expose pipes ..... Unit : m<sup>3</sup>

The unit of measurement shall be the linear metre of pipeline finally exposed by hand excavation methods, measured in plan view along the centreline of the pipeline, irrespective of the class of pipe. Separate items will be scheduled for each different diameter of pipe. The pipe volume as well as the volume of all associated structures such as junction boxes, manholes, valve chambers and the like shall be excluded from the volume of excavation measured.

The tendered rates shall be in full and final compensation for excavating by hand methods from a depth of 300 mm above the pipe barrel in accordance with PSDB 5.11.2 to expose the pipe to its bottom, irrespective of the type class of pipe, as well as for excavating by hand around junction boxes, manholes, valve chambers and the like.

- (c) Remove pipes from trench and stack for inspection ..... Unit : m

The unit of measurement shall be the linear metre of each type and diameter of pipe removed from the trench in accordance with Subclause PSDB 5.11, measured in plan view along the centreline of the pipeline, without deduction for specials, junction boxes, manholes, valve chambers and the like as may be encountered. Separate items shall be scheduled for each different class and diameter of pipe.

The tendered rates shall be fully inclusive for uncoupling the individual pipes and specials, all additional excavation as may be necessary to facilitate the insertion of lifting slings or the utilisation of other lifting equipment, the provision and utilisation of all such lifting equipment as may be necessary (e.g. cranes, if required), for lifting the pipes and specials out of the trench, cleaning and stacking them along the side of the trench for inspection, attending during the Engineer's inspection and recording the Engineer's decisions on each pipe/special. The tendered rate shall further include for the demolition and removal from the trench of all associated pipeline structures as may be encountered, such as junction boxes, inlet and outlet structures, valve chambers, anchor blocks and the like, and the loading and removal of the debris to spoil.



## (d) Deliver pipes and specials declared re-usable

## (i) Pipes ..... Unit : m

The unit of measurement shall be the linear metre of pipe declared re-usable by the Engineer and delivered to the address specified in Subclause PSDB 5.11. Separate items will be scheduled for each different type and class of pipe.

The tendered rates shall be fully inclusive for loading the pipes at the side of the trench, transporting to and off-loading at the location specified in Subclause PSDB 5.11, and carefully stacking separately according to the type, class and diameter of the pipes.

## (ii) Specials ..... Unit : No

The unit of measurement shall be the number of specials declared re-usable by the Engineer in accordance with Subclause PSDB 5.11 above, irrespective of the type or diameter of the special, delivered to the address specified in Subclause PSDB 5.11.

The tendered rate shall be fully inclusive for loading the specials at the side of the trench, transporting to and off-loading at the location specified in Subclause PSDB 5.11, and carefully stacking separately according to the type, class and diameter of the specials.

## (e) Dispose of pipes and specials unsuitable for re-use

## (i) Pipes ..... Unit : m

The unit of measurement shall be the linear metre of pipe declared by the Engineer to be unsuitable for re-use and disposed of by the Contractor in accordance with the requirements of Subclause PSDB 5.11.5. Separate items will be scheduled for different types and diameters of pipe.

The tendered rates shall be fully inclusive for loading the pipes at the side of the trench, transporting to and off-loading at the spoil site and dealing with as specified in Subclause PSDB 5.11.5.

## (ii) Specials ..... Unit : No

The unit of measurement shall be the number of specials declared by the Engineer to be unsuitable for re-use and disposed of by the Contractor in accordance with the requirements of PSDB 5.11.5. Separate items will be scheduled for different type of special.

The tendered rate shall include for loading the special at the side of the trench transporting to and off-loading at the spoil site and dealing with as specified in PSDB 5.11.5.

(f) Backfill and compact trench ..... Unit : m<sup>3</sup>

The unit of measurement shall be the cubic metre of compacted fill, measured tight according to the authorised dimensions of the trench.

The tendered rate shall be fully inclusive for placing excavated material in the trench and compacting in accordance with Subclauses 5.6 and 5.7 (as amended)..

(g) Make up deficiency in backfill material ..... Unit : m<sup>3</sup>

The unit of measurement shall be the cubic metre of backfill obtained from sources other than the trench excavated for the purposes of removing the pipeline, in order to make up any deficiencies in backfill material resulting from the volume previously occupied by the pipeline.

Except that the volume shall be determined as the external volume of the pipes removed together with the external volume of all ancillary structures removed along the pipeline, measurement and payment shall be in accordance with 8.3.3.1 of SANS 1200DB."

**PSDK GABIONS AND PITCHING (SANS 1200 DK)****PSDK 1 SCOPE**

*REPLACE THE FIRST PARAGRAPH OF THIS CLAUSE WITH THE FOLLOWING:*

“This specification covers the construction of gabions, stone pitching and rip-rap for the protection of earthworks against erosion. It covers gabion walls and aprons used as retaining walls, channel linings, and the like. It also covers rock rip-rap, used as channel linings, and light to heavy stone pitching, with and without mortar.”

**PSDK 2 DEFINITIONS**

*ADD THE FOLLOWING TO THE END OF THIS SUBCLAUSE:*

**“2.3.10 Rip-rap:** Rock of specified quality and grading placed in layers of specified thickness as erosion protection.”

**PSDK 3 MATERIALS****PSDK 3.1 STONE****PSDK 3.1.1 Stone**

*ADD THE FOLLOWING AFTER THE HEADING OF SUBCLAUSE 3.1.1.1:*

“Stone for gabions must be obtained from commercial sources and be approved by the Employers Agent. Such stone shall be clean and free of foreign matter and, blend in with the environment.”

**PSDK 3.1.2 Gabion Cages**

*ADD THE FOLLOWING TO SUBCLAUSE 3.1.2:*

“Gabion boxes shall comply with the following :

- i. Double twisted hexagonal wire Mesh Type 80 gabions of nominal 80mm mesh, with 2.7mm diameter mesh wire, complete with partitions at 1m centres.
- ii. All wire shall be mild steel to SANS 1580:2010, zinc coated by hot-dip galvanizing to SANS 675:2011 and bonded with heavy duty PVC coating of nominal 0.5mm wall thickness to SANS 1580:2010.

Wire for boxes				
Use	Units	For lacing	For mesh	For selvedge
Galvan + PVC	Ø mm	2,2 / 3,2	2,7 / 3,7	3,4 / 4,4
Wire tolerance *	Ø mm	±0,08	±0,08	±0,1
Quantity of Galfan **	g/m²	230	245	265
Tensile strength ***	N/mm²	350 – 575		
* To SANS 675 / ** To EN 102442-2, Table 2, Class A / *** To SANS 1580 and SANS 675				

Gabion mattresses shall comply with the following :

- iii. Double twisted hexagonal wire Mesh Type 60 gabions of nominal 60mm mesh, with 2.2mm diameter mesh wire, complete with partitions at 1m centres.
- iv. All wire shall be mild steel to SANS 1580:2010, zinc coated by hot-dip galvanizing to SANS 675:2011 and bonded with heavy duty PVC coating of nominal 0.5mm wall thickness to SANS 1580:2010.”

Wire for mattresses				
Use	Units	For lacing	For mesh	For selvedge
Galvan + PVC	Ø mm	2,2 / 3,2	2,2 / 3,2	2,7 / 3,7
Wire tolerance *	Ø mm	±0,08	±0,08	±0,08
Quantity of Galfan **	g/m²	230	230	245
Tensile strength ***	N/mm²	350 – 575		
* To SANS 675 / ** To EN 102442-2, Table 2, Class A / *** To SANS 1580 and SANS 675				

**PSDK 3.1.3    Geotextile**

*REPLACE THE LAST SENTENCE WITH THE FOLLOWING:*

“The make and grade of the geotextile shall, as a minimum, comply with that specified on the drawings and in the Bill of Quantities.”

*ADD THE FOLLOWING TO SUBCLAUSE 3.1.3:*

In addition to the properties as specified in Subclause 3.1.3, the geotextile blanket used beneath the reno mattresses shall have a mass of at least 210 g/m<sup>2</sup> and a minimum strength of 10 kN/m in all directions (“Kaymat U24” or equal, approved), with overlaps of at least 300 mm.

Geotextile fabric to be nonwoven continuous filament, needle punched, polyester geotextile and to comply with the requirements of SANS 10221.

The synthetic-fibre filter fabric is classified according to the mechanical properties thereof, viz its penetration load, puncture resistance and the minimum water percolation rate as measured in the permeability test. Table 3.1 shall be used for determining the grade of a synthetic-fibre filter fabric.

TABLE 3.1  
**GRADE CLASSIFICATIONS OF SYNTHETIC-FIBRE FILTER FABRIC**

PROPERTY	GRADE			TEST METHOD
	1	2	3	
Penetration load (minimum), N	3900	2500	1600	SANS 10221
Puncture resistance (maximum), mm	14	26	32	EN ISO 13433
Water percolation (minimum), l/m <sup>2</sup> /s	70	70	145	SANS 10221

**Notes:** The standard atmosphere for testing and the preconditioning atmosphere for all synthetic-fibre filter fabric tests (SANS tests and other) shall have a relative humidity falling within the range of 10 to 50 per cent and a temperature within the range of 15°C to 50°C.

The resistance of a synthetic-fibre filter fabric to puncture is the average diameter of the hole formed when a 45° cone with a mass of 1 kg is dropped through 500 mm on to the synthetic-

fibre filter fabric fixed in the holding device. The test method and parameters shall be in accordance with EN

SO 13443.

The synthetic-fibre filter fabric shall withstand the level of aggressiveness of the soil and ground water given below without significant loss of its strength and hydraulic properties during its design life of 25 years:

- Soil and ground water with a pH in the range of 4 to 12 (pH to be determined by Method A20, TMH1, 1986); and

Soil (as paste) and ground water containing salts with a conductance of up to 1.0 S/m (conductivity to be determined by Method A21T, TMH1, 1986).

The synthetic-fibre filter fabric shall maintain at least 80% of its original strength after direct exposure to sunlight of 1 500 hours.

The synthetic-fibre filter fabric shall be entirely rot-proof and shall not support the growth of algae.

The synthetic-fibre filter fabric required shall satisfy the criteria for grade 1, 2 or 3 synthetic-fibre filter fabric as listed in the Bill of Quantities or specified on the Drawings.

The Contractor shall, at least 28 days before the installation of the synthetic-fibre filter fabric, submit to the Engineer samples of the synthetic-fibre filter fabric he proposes to use, for review and approval by the Engineer."

*ADD THE FOLLOWING TO NEW SUBCLAUSE:*

**"PSDK 3.1.6 Tensioning frames for gabion baskets**

The Contractor shall supply one set of tensioning frames for gabion baskets."

**PSDK 3.2 PITCHING**

**PSDK 3.2.1 Stone**

*REPLACE THE CONTENTS OF TABLE 2 WITH THE FOLLOWING:*

"TABLE 2 : SIZE AND MASS OF INDIVIDUAL STONES FOR PITCHING			
1	2	3	4
Size/mass of pitching	Thickness of pitching mm, min	Least dimension mm, min	Mass kg, min
Extra heavy	600	300	180
Heavy	400	190	50
Medium	300	150	27
Light	200	110	11

"

*ADD THE FOLLOWING TO NEW SUBCLAUSE:*

**"PSDK 3.3 RIP-RAP**

**PSDK 3.3.1 Stone**

Stone for rip-rap must be obtained from commercial sources and be approved by the Employers Agent. Such stone shall be clean and free of foreign matter and, blend in with the environment. The stone size shall be as shown in the table below:

**STONE SIZES FOR RIP-RAP**

RANGE OF STONE SIZE (IN TERMS OF D <sub>50</sub> STONE SIZE)	FRACTION OF TOTAL WEIGHT SMALLER THAN THE GIVEN SIZE (%)
1.50 - 2.00 D <sub>50</sub>	100
1.30 - 1.80 D <sub>50</sub>	85
1.00 - 1.50 D <sub>50</sub>	60
0.30 - 0.50 D <sub>50</sub>	15

**THE D<sub>50</sub> STONE SIZE FOR RIP-RAP SHALL BE AS SPECIFIED ON THE DRAWINGS.**

### **PSDK 3.3.2 Filter Layers**

Where specified on the Drawings, or ordered by the Employers Agent, filter layers shall be provided between the bottom of the rip-rap layer and the surface that it is intended to protect. The filter material shall be sand, gravel or crushed stone, as appropriate to meet the grading requirements shown on the Drawings, and as approved by the Employers Agent.

## **PSDK 5 CONSTRUCTION**

### **PSDK 5.1 GABION CAGES**

#### **PSDK 5.1.1 Binding and Connecting Wire**

*ADD THE FOLLOWING TO SUBCLAUSE 5.1.1:*

“The standard method of securing the binding wire shall be as follows :

- i. Begin wiring up by securing the binding wire at the top corners of the panels to be joined by looping it through and twisting together.
- ii. Then lace the wire around the selvedge's with single loops and double loops in turn at 100mm intervals.
- iii. Finally, fasten the wire securely at the bottom corner, and poke the loose end inside the case. The cases shall be wired together using the exact method as for assembling single cases as described above.
- iv. Binding wire shall be similar to the box or mattress wire as stated above.”

*ADD THE FOLLOWING NEW SUBCLAUSES:*

#### **“PSDK 5.1.3 Gabion and mattress installation training**

The Contractor shall arrange with a representative from the supplier of the gabions for all workers involved with the installation of gabions and mattress to receive on-site training, which will be provided by the representative from the gabion supplier. Attendance will be compulsory.

#### **PSDK 5.1.4 Construction of trial gabion section**

A 3 m trial length of 1,0 x 1,0 m gabion baskets shall be constructed at the Site to the satisfaction of the Employers Agent and a representative from the supplier.

The approved trial section will be used as the benchmark for future work and photographs of the trial section will be kept on Site, to ensure that the quality of work is comparable with the

benchmark. The Employers Agent reserves the right to reject work that does not meet the benchmark, and such work will be dismantled by the Contractor and re-done."

**PSDK 5.2      GABION WALLS AND APRONS**

**PSDK 5.2.2      Geotextile or Geomembrane**

*ADD THE FOLLOWING TO SUBCLAUSE 5.2.2:*

"Geotextile fabric shall be placed at all interfaces between gabions and the ground."

*ADD THE FOLLOWING TO NEW SUBCLAUSE:*

**PSDK 5.2.8      General**

In addition to the above, gabion mattresses and boxes shall be installed strictly in accordance with the approved manufacturer's installation guidelines and the Contractor shall ensure that sufficient pliers, nippers, Spenax tools as well as closing tools are available for use by his labour force.

**PSDK 5.3      PITCHING**

**PSDK 5.3.1      General**

*ADD THE FOLLOWING TO SUBCLAUSE 5.3.1:*

"Notwithstanding the provisions of this Clause the excavation footing trench shall be backfilled with class 20/19 concrete to the proposed top level of the pitching."

**PSDK 5.3.2      Plain pitching**

*ADD THE FOLLOWING TO THE END OF THE SUBCLAUSE:*

"The exposed stone surfaces shall be cleaned of excess mortar within 1 day of being grouted."

**PSDK 5.3.3      Grouted Pitching**

*ADD THE FOLLOWING TO SUBCLAUSE 5.3.3:*

"The exposed stone surfaces shall be cleaned of excess mortar within 1 day of being grouted."

*REPLACE THE WORDS "(Table 4)" IN THE SECOND LINE OF THE FIRST PARAGRAPH WITH "(Table 2)".*

*ADD THE FOLLOWING TO NEW SUBCLAUSE:*

**"PSDK 5.4      RIP-RAP**

**PSDK 5.4.1      Placing of rip-rap**

Rip-rap shall be placed in layers of the thicknesses specified on the Drawings so as to minimise the spaces between the rocks and to obtain a relatively even surface to the top of the rip-rap layer, with no rock protruding more than 150 mm above the general surface level."

**PSDK 6      TOLERANCES**

*ADD THE FOLLOWING TO CLAUSE 6:*

“Notwithstanding the provisions of this Clause, the materials and the finish of the work applicable to all gabion work shall be to Degree of Accuracy I and the permissible deviations shall be within the limits given for a Degree of Accuracy I.”

**PSDK 7        TESTS**

**PSDK 7.1      Taking and testing of samples**

*DELETE THE CONTENTS OF SUBCLAUSE 7.1 AND REPLACE WITH THE FOLLOWING:*

“The Contractor shall carry out sufficient tests to satisfy himself as to the consistency of the materials used for and placed in gabion cages or used for pitching or rip-rap.

The stone supplied for the contract shall conform to the test procedures and parameters stated under 7.3.

Stone from dolomitic sources shall also satisfy the durability test described in 7.4. The cost of the tests will be deemed to be included in the rates for gabions and mattresses and stone pitching.”

**PSDK 8        MEASUREMENT AND PAYMENT**

**PSDK 8.1      PRINCIPLES**

*DELETE THE CONTENTS OF THIS SUBCLAUSE AND REPLACE WITH THE FOLLOWING:*

**PSDK 8.1.1    Computation of quantities for excavation**

The relevant principles and computation of quantities set out in 8.1 and 8.2 of SANS 1200 DA, shall apply to excavations.

**PSDK 8.1.2    Tensioning frames for gabion baskets**

The cost of providing tensioning frames for installing gabion baskets shall be deemed to be included in the tendered rate for gabions.

**PSDK 8.1.3    Installation training for gabions and mattresses**

The cost of attending the compulsory on-site training session will be deemed to be included in the tendered rates supplying and installing gabions and mattresses.

**PSDK 8.1.4    Construction of trial gabion structure**

The cost of constructing the trial gabion section will be deemed to be included in the tendered rate for supplying and installing gabions.”

**PSDK 8.2      SCHEDULED ITEMS**

*REPLACE THE HEADING AND CONTENTS OF CLAUSE 8.2.1 WITH THE FOLLOWING:*

**PSDK 8.2.1    Surface preparation for bedding of gabions..... Unit m<sup>2</sup>**

The rate tendered shall cover the cost of all labour, plant and equipment required to effect minor shaping as well as compact any loose material to leave a firm surface, ready for bedding the gabion cages, mattresses, and pitching.”

**PSDK 8.2.5    Pitching..... Unit : m<sup>3</sup>**

The rates tendered shall cover the cost of excavating footing trenches over the lengths, widths and depths ordered as if in soft material, trimming trenches, compacting inverts, class 20/19



concrete backfill, as well as the cost of loading, transporting within a free haul distance of 0,5km and disposal of excavation material as directed.

The volume will be computed from the dimensions ordered. No payment will be made for over-excavation or resultant additional concrete backfill."

*ADD THE FOLLOWING NEW SUBCLAUSES:*

**PSDK 8.2.8    Rip-rap..... Unit : m<sup>3</sup>**

The rate for rip-rap shall cover the cost of supplying and placing the rip-rap in a uniform layer of specified thickness to the satisfaction of the Employers Agent.

**PSDK 8.2.9    Geotextile beneath rip-rap..... Unit m<sup>2</sup>**

The area measured will be the area of the rip-rap layers ordered or shown on the Drawings to be underlain by geotextile. The rate shall cover the cost of supplying geotextile of the specified grade, cutting, waste, placing, joining, overlapping, and fastening the geotextile in position.

**PSDK 8.2.10    Sand layer on top of geotextile..... Unit m<sup>2</sup>**

The area measured will be the area of the geotextile covered by the sand layer as ordered or shown on the Drawings.

**PSDK 8.2.11    Filter layers beneath rip-rap..... Unit m<sup>2</sup>**

The area measured will be the area of each filter layer of specified grading and thickness ordered, or shown on the Drawings, to be placed beneath the rip-rap layer.

**"PSDK 8.2.12    Cutting and adjusting mattress to fit around stormwater pipe ..... Unit : No**

The rate shall cover the cost of cutting the cages, adjusting the wires and securing all around the stormwater pipe.

**PSDK 8.2.13    Excavation and concrete backfill of footing trenches for pitching ..... Unit : m<sup>3</sup>**

The rates tendered shall cover the cost of excavating footing trenches over the lengths, widths and depths ordered as if in soft material, trimming trenches, compacting inverts, class 20/20 concrete backfill, as well as the cost of loading, transporting within a free haul distance of 0,5km and disposal of excavation material as directed.

The volume will be computed from the dimensions ordered. No payment will be made for over-excavation or resultant additional concrete backfill."

**PSDM EARTHWORKS (ROADS, SUBGRADE) (SANS 1200 DM)****PSDM 2 INTERPRETATIONS****PSDM 2.3 DEFINITIONS AND ABBREVIATIONS**

"Notwithstanding the definition of roadbed given under Clause 2.2 of SANS 1200 M, all in-situ surfaces requiring compaction as indicated on the drawings, shall be classified as roadbed."

**PSDM 3 MATERIALS****PSDM 3.2 CLASSIFICATION FOR PLACING PURPOSES****PSDM 3.2.2 Fill**

"Notwithstanding the requirements of this Clause, material from commercial sources or borrow pits located by the Contractor, to be used in the fill, shall comply with the requirements of Clause 3.2.3 and PSDM 3.2.3."

**PSDM 3.2.3 Selected Layer**

*REPLACE THE CONTENTS OF SUBCLAUSE 3.2.3 WITH THE FOLLOWING:*

"The following requirements shall apply in respect of the selected layer:

(a) Maximum particle size: 60% of compacted layer thickness

(b) Unstabilised selected layer

(i) Upper selected layer:

Minimum CBR at 93% of modified AASHTO density : 15

Maximum PI : 12 (The Employer's Agent has the right to alter this requirement to 3 x the grading modulus + 10)

NOTE: These requirements for the upper selected layer also apply where only one unstabilised selected layer is specified.

(ii) Lower selected layer:

Minimum CBR at 90% of modified AASHTO density : 7

Maximum PI : 12

(c) For stabilised selected layer

Minimum grading modulus of natural material : 0,75

UCS of stabilised material 300 kPa - 500 kPa at 93% of modified AASHTO density

Maximum PI for stabilised material : 10"

**PSDM 3.3 SELECTION**

"Notwithstanding the provisions of this Clause, the Contractor shall note that the excavation from the cutting shall be utilized for the construction of the lower layers of fills.

**PSDM 5 CONSTRUCTION****PSDM 5.2 METHODS AND PROCEDURES**

**PSDM 5.2.2.2 Dimensions of Cuts**

*DELETE "suitable material .....7" IN THE FIFTH LINE AND REPLACE WITH THE FOLLOWING:*

*"material complying with 3.2.3 and PSDM 3.2.3."*

*ADD AFTER "drawings" IN THE SECOND LINE OF THIS SUBCLAUSE:*

*"which shall include for road side channels, cross drains and sidewalks within the road reserve".*

**PSDM 5.2.2.3 Use of Material**

*ADD AFTER "borrow pits" IN THE SECOND LINE OF SUBCLAUSE (d) THE FOLLOWING:*

*"or commercial sources."*

*ADD THE FOLLOWING AFTER SUBCLAUSE (d):*

*"(e) Commercial sources*

*The provisions of subclause PSD 5.2.2.5 of SANS 1200 D as amended shall apply."*

**PSDM 5.2.2.5 Disposal of surplus or unsuitable Material**

*ADD AFTER "directed" IN THE SECOND LINE OF THIS CLAUSE THE FOLLOWING:*

*"(refer PSD 5.2.2.3)".*

**PSDM 5.2.2.6 Catchwater mounds and mitre banks and channels**

*ADD THE FOLLOWING TO THE END OF THIS SUBCLAUSE:*

*"Catchwater mounds and mitre banks shall be compacted to a minimum density of 90% of modified AASHTO density."*

**PSDM 5.2.3 Treatment of the Road-Bed****PSDM 5.2.3.2 Removal of unsuitable ground**

*REPLACE THE SECOND SENTENCE OF SUBCLAUSE 5.2.3.2(a) WITH THE FOLLOWING:*

*"The excavated spaces shall then be backfilled with approved imported material compacted to the required density."*

*ADD THE FOLLOWING SENTENCE TO SUBCLAUSE 5.2.3.2(b):*

*"Unsuitable excavated material will be paid for as cut to spoil."*

**PSDM 5.2.3.3 Treatment of road-bed**

*ADD THE FOLLOWING TO SUBCLAUSE 5.2.3.3:*

*"(a) Preparation and compaction of Road-bed*

*"The depth of compaction shall be 150mm."*

*"(c) Three-pass roller compaction*

Any portion of the roadbed that is shown on the drawings or is specified or is directed by the Employer's Agent to be given three-pass roller compaction because of its inadequate natural density, shall be prepared by shaping where necessary and compacting with a roller, complying with the requirements specified below.

Compaction shall comprise three complete coverages by the wheels of the specified roller over every portion of the area that is being compacted. While it is not the intention that the Contractor should apply water to the roadbed for this type of compaction, and while no rigid moisture control will be exercised during compaction, the Contractor shall nevertheless satisfy the Employer's Agent that everything is being done to take full advantage of favourable soil moisture conditions during the rainy season, and that such compaction is as far as possible carried out when the roadbed is neither excessively dry nor excessively wet.

The Employer's Agent has the authority to decide when conditions are favourable for compaction and where such compaction is to be carried out at any particular time and he has the right to instruct the Contractor to water the roadbed at the Contractor's expense when, in the opinion of the Employer's Agent, the Contractor failed, neglected or refused to comply with these requirements.

The rollers to be used for roller-pass compaction shall conform to the following requirements:

Grid roller : The grid roller shall have a mass of not less than 13,5 t when ballasted, shall be loaded to this mass if required, and shall be moved at a speed of not less than 12 km/h.

Vibratory roller : The vibratory roller shall be capable of exerting a combined static and dynamic force of not less than 120 kN/m width for every metre of loose-layer thickness at an operating frequency not exceeding 25 Hz and shall move at a speed not exceeding 4 km/h."

#### **PSDM 5.2.4 Fill**

##### **PSDM 5.2.4.3 Finishing**

*ADD THE FOLLOWING BELOW THE HEADING OF THIS SUBCLAUSE:*

"Notwithstanding the provisions of this Clause the requirements of PSDM 5.2.9 shall as applicable apply to the finishing off of verges."

*REPLACE THE SECOND SENTENCE OF SUBCLAUSE 5.2.4.3 (e) TOPSOILING WITH THE FOLLOWING:*

"The thickness of the topsoil shall be as directed by the Employers Agent."

#### **PSDM 5.2.5 Selected Layer**

*REPLACE THE CONTENTS OF SUBCLAUSE 5.2.5 WITH THE FOLLOWING:*

"Except with regard to density, the requirements of Subclause 5.2.4 shall apply. The degree of compaction shall be:

Upper Selected*	:	95% of modified AASHTO density
Lower selected*	:	93% of modified AASHTO density."

#### **PSDM 5.2.6 Gravel Surfacing**

*REPLACE THE THIRD SENTENCE OF SUBCLAUSE 5.2.6 WITH THE FOLLOWING:*

"The relevant requirements in Subclause 5.2.4.2 shall apply, except that the material shall be compacted to 93% of modified AASHTO density."

---

**PSDM 5.2.8    Transport****PSDM 5.2.8.1    Free haul**

*REPLACE THE CONTENT OF SUBCLAUSE 5.2.8.1 WITH THE FOLLOWING:*

"All transport within the site boundaries will be regarded as free haul."

**PSDM 5.2.8.2    Overhaul**

*REPLACE THE CONTENTS OF SUBCLAUSE 5.2.8.2 WITH THE FOLLOWING:*

"No overhaul within the site boundaries will be paid. All transport costs for spoiling or importation of material will be deemed to be included in the relevant rates."

*ADD THE FOLLOWING NEW SUBCLAUSES:*

**PSDM 5.2.9    Trimming and grading of verges**

During the initial earthworks the verge width shall be cut or filled to approximately the final level and shall be kept trimmed and tidy during construction of the works. After completion of the road layers, including the premix surface, and after construction of the necessary kerbs, including the satisfactory backfilling behind the kerb, the verge shall be finished off to the lines and levels shown on the drawings or as specified.

The verge material shall consist of that material which would normally be occurring at that position or depth when in cut and shall not be contaminated by foreign materials such as bricks, basecourse material, horticulturally inferior materials from trench excavation, etc. Verges in fill conditions are to consist of the material as specified for the fills and similarly not be contaminated with foreign materials.

Over those sections of verge where grass is to be planted in which case the Contractor shall load, transport and spread as ordered by the Employer's Agent. In the case of topsoil provided and imported by the Contractor the quality of the topsoil shall be approved of by the Employer's Agent beforehand.

The Contractor shall be responsible for taking the necessary precautions and measures to control the dust nuisance which may arise due to his operations on the verge, whether from the natural ground surface or topsoil layer, until the verge is accepted by the Employer's Agent.

**PSDM 5.2.10    Dimension and level control and process control**

The Contractor shall submit to the Employer's Agent records of dimension and level control and/or process control prior to requesting the Employer's Agent to carry out any routine tests and/or inspections.

**PSDM 5.2.11    Requesting of tests**

Tests and Inspections of the works will only be carried out by the Employer's Agent once the appropriate test/inspection request forms have been fully completed. Test/inspection request forms can be obtained from the Employer's Agent."

**PSDM 6        TOLERANCES****PSDM 6.2       DIMENSIONS, LEVELS, ETC.****PSDM 6.2.2    Cut**

ADD THE FOLLOWING TO SUBCLAUSE 6.2.2:

"(d) Final level of all cuttings +0 mm to -50 mm."

ADD THE FOLLOWING NEW SUBCLAUSE:

**PSDM 6.5 DIMENSIONS AND LEVEL CONTROL**

The requirements of PSM 6.4 shall apply.

**PSDM 7 TESTING**

**PSDM 7.3 ROUTINE INSPECTION AND TESTING**

REPLACE TABLE 2 AND THE CONTENTS OF SUBCLAUSE 7.3.2 WITH THE FOLLOWING:

**"PSDM 7.3.2** The dry density requirements for a particular lot of selected layer or wearing course shall be deemed to be satisfied if the average density and the results of individual tests meet the requirements specified in Table 2 below. Refer to SANS 1200 DM, subclause 7.2 for the requirements for fill.

TABLE 2 - DENSITIES				
1	2	3	4	5
Layer	Specified density (% of modified AASHTO density)	Number of tests per lot	Average density %	Minimum density for any single test, %
Upper selected	95	3 and 4 5 6	95.1 95.4 95.6	91.4 91.2 91.0
Lower selected layer and gravel wearing course	93	3 and 4 5 6	93.1 93.4 93.6	89.4 89.2 89.0

"

ADD THE FOLLOWING NEW SUBCLAUSE:

**PSDM 7.4 INSPECTION AND TESTING BY EMPLOYER'S AGENT**

"The requirements of PSM 7.3 shall apply."

**PSDM 8 MEASUREMENT AND PAYMENT**

**PSDM 8.1 BASIC PRINCIPLES**

ADD THE FOLLOWING:

"The requirements of PSM 8.2 shall apply. The Contractor shall further make provision in the various rates for the construction of the roadbed, fill and selected layer for the cost of his own process control testing and the cost of complying with PSDM 6.5 and PSDM 7.4."

**PSDM 8.2 COMPUTATION OF QUANTITIES**

REPLACE SUBCLAUSES 8.2.1 TO 8.2.3 (INCLUSIVE) WITH THE FOLLOWING:

**"PSDM 8.2.1** The provisions of Subclause 8.2.1 of SANS 1200 D shall apply.

**PSDM 8.2.2** The provisions of Subclause 8.2.2 of SANS 1200 D shall apply.

**PSDM 8.2.3** The provisions of Subclause 8.2.2 of SANS 1200 D shall apply."

**PSDM 8.2.5** **Verifying Quantities**

*REPLACE THE FIRST SENTENCE OF SUBCLAUSE 8.2.5 WITH THE FOLLOWING :*

"Before any earthworks are commenced but after completion of any site preparation, the Employer's Agent will, upon a written request from the Contractor, provide cross-sections for the purpose of measurement of earthworks quantities."

**PSDM 8.3** **SCHEDULED ITEMS**

**PSDM 8.3.3** **Treatment of roadbed**

(a) Roadbed preparation and compaction of material to

*ADD THE FOLLOWING TO SUBCLAUSE 8.3.3(a) :*

"The unit of measurement shall be the cubic metre of material recompacted as specified and the volume shall be determined from levelled cross-sections on which are superimposed the levels to which the roadbed is to be constructed. When material is imported to make up the required volume, such material will be paid for as cut or borrow to fill as relevant."

*ADD THE FOLLOWING SUBCLAUSE :*

"(c) Three-pass roller compaction:

- |      |                        |                       |
|------|------------------------|-----------------------|
| (i)  | Grid roller .....      | Unit : m <sup>2</sup> |
| (ii) | Vibratory roller ..... | Unit : m <sup>2</sup> |

The units of measurement shall be the square metre of roadbed compacted as specified in Subclause PSDM 5.2.3.3(c) for the areas designated by the Employer's Agent.

The tendered rates shall include full compensation for shaping the areas, providing the rollers and for compacting the roadbed by means of three roller passes over the entire area."

**PSDM 8.3.4** **Cut to fill, borrow to fill**

*REPLACE THE LAST SENTENCE OF SUBCLAUSE 8.3.4 WITH THE FOLLOWING:*

"(a) Cut to fill compacted to 93% of modified AASHTO maximum density..... Unit : m<sup>3</sup>

The rate tendered shall cover the cost of excavating from the site as if in soft material, transporting, preparing, processing, shaping (including forming road side channels and channel cross drains), watering, mixing, compacting to percentage of modified AASHTO maximum density specified, trimming, and testing the fill.

(b) Borrow to fill from commercial or off site sources located by the Contractor compacted to 93% of modified AASHTO maximum density..... Unit : m<sup>3</sup>

The rate tendered shall cover the cost of acquiring the material from commercial or off site sources located by the Contractor, any excavation and selection required, loading, transporting to the point of use irrespective of distance, temporary stockpiling if necessary,

REPLACE THE HEADING AND THE CONTENTS OF SUBCLAUSE 8.3.5 WITH THE FOLLOWING:

i. 93% of modified AASHTO maximum density ..... Unit : m<sup>3</sup>

ii. 95% of modified AASHTO maximum density ..... Unit : m<sup>3</sup>

iii. 93% of modified AASHTO maximum density ..... Unit : m<sup>3</sup>

iv. 95% of modified AASHTO maximum density ..... Unit : m<sup>3</sup>

Note : No additional payment will be made for difficult work or hand operations in confined areas.”

*"items 8.3.4, 8.3.5 and 8.3.16".*



**PSDM 8.3.7 Cut to spoil or stockpile from**

*REPLACE THE HEADING AND THE CONTENTS OF THE SUBCLAUSE WITH THE FOLLOWING:*

**“PSDM 8.3.7 Cut to spoil from**

Replace “a) Soft excavation” with the following:

“a) Soft and intermediate excavation”.

*Replace both “b) Intermediate excavation” and the corresponding unit of measure with “b) Not applicable (VOID)”.*

*Add the following:*

Separate items will be scheduled for cut to spoil and cut to stockpile. The rate tendered shall further cover the cost of complying with the requirements of Clause 5.2.3.2 irrespective of the depth or extent of the material ordered to be removed, or whether the order to remove unsuitable material is given after the completion of any initial cut operation, with the exception of unsuitable material ordered to be removed from the completed cut surface of channel cross drains and road side channels which will be measured for payment under PSD 8.3.16.

The tendered rate shall further, in the case of cut to spoil, include full compensation for transporting the material regardless of the distance involved and for all other incidental cost to dispose of the spoil material at a spoil site or spoil sites provided by the Contractor. (Refer also 5.2.2.3, 5.2.5 and 8.3.12).”

**PSDM 8.3.9 Overbreak of excavation in:**

*Replace both “a) Intermediate excavation” and the corresponding unit of measure with “a) Not applicable (VOID)”. No extra-over payment will be made for overbreak of excavation in intermediate excavation.*

**PSDM 8.3.11 Extra-over Items 8.3.2, 8.3.4 or 8.3.5 for temporary stockpiling of material**

*REPLACE THE HEADING AND THE CONTENTS OF SUBCLAUSE 8.3.11 WITH THE FOLLOWING:*

**"PSDM 8.3.11 Extra-over item PSDM 8.3.7 for temporary stockpiling of material**

The unit of measurement shall be the cubic metre and the quantity will be calculated from the authorised dimensions of the compacted layer.

The tendered rates shall include full compensation for excavating the material as if in soft material for loading, transporting for the free-haul distance, for off-loading, spreading, watering, mixing, breaking down and compacting the layer."

**PSDM 8.3.12 Overhaul**

*REPLACE THE CONTENTS OF SUBCLAUSE 8.3.12 WITH THE FOLLOWING:*

“Delete this item as no overhaul will be paid on material for the purposes of this contract and all the costs for transporting material shall be included in the applicable tendered rates and amounts.”

**PSDM 8.3.13 Surface Finishes**

*REPLACE THE CONTENTS OF SUBCLAUSE 8.3.13 WITH THE FOLLOWING:*

## (a) Topsoiling

- (i) Topsoiling (from stockpile)..... Unit: m<sup>2</sup>
- (ii) Topsoiling (from commercial sources)..... Unit: m<sup>2</sup>

The rate shall cover the costs of excavating from stockpiles formed in terms of 5.2.1 and hauling and spreading in terms of Subclauses 5.2.4.2 of SABS 1200 D of Subclause 5.2.5.2 of SABS 1200 DA, as applicable, or for procuring the commercial source material, delivery to site as well as spreading and light compaction as necessary.

## (b) Grassing or other vegetation cover:

- (c) "(i) Planting of grass sods..... Unit: m<sup>2</sup>
- (d) (ii) Hydroseeding..... Unit: m<sup>2</sup>
- (e) (iii) Trim, shape and roll verge..... Unit: m<sup>2</sup>

The tendered rate shall be irrespective of the number of applications required to obtain the required spread rate.

The tendered rate shall cover the costs of preparing the area for grassing or vegetation cover as specified, procuring all materials, equipment and labour, placing the product as specified by the suppliers specifications, including a 6 month maintenance period which includes watering weekly and ensuring a final cover rate of 90% of the total area vegetated.

Measurement for trim, shape and roll verge shall be the surface area of the verge prepared in accordance with the requirements of 5.2.9. The rate tendered shall cover the cost of all things necessary to finish off the verge as specified, including the incorporation of material to make up for material lost due to weather or other reasons. (Cut and fill to bring verge to level payment under 8.3.4)."

**PSDM 8.3.14 Borrow pits:**

*REPLACE THE CONTENTS OF SUBCLAUSE 8.3.14 WITH THE FOLLOWING:*

- "(a) Opening up and closing down of borrow pit .....Unit : Sum
- (b) Dealing with overburden ..... Unit : m<sup>3</sup>

The provisions of Subclauses 8.3.4(b) and 8.3.4(c) of SANS 1200 D shall apply respectively to items (a) and (b) above."

**PSDM 8.3.16 Gravel surface layer**

*REPLACE THE CONTENTS OF SUBCLAUSE 8.3.16 WITH THE FOLLOWING:*

"The unit of measurement shall be the cubic metre of gravel surface layer and the quantity will be determined from the authorised dimensions of the compacted layer.

The tendered rate shall include full compensation for excavating the material as if in soft material, for loading and transporting the material for the free-haul distance, for off-loading, spreading, breaking down, watering, mixing and compacting the material."

*ADD THE FOLLOWING SUBCLAUSES:*

**"PSDM 8.3.17 Extra over item PSDM 8.3.5 for obtaining material from commercial sources .... Unit : m<sup>3</sup>**

The tendered rate shall include full compensation for the additional cost of finding a suitable source of material, for procuring the material and paying all royalties or other charges to the

owner of the source, for transporting the material to the point of use regardless of the distance hauled and for excavating in, hard or boulder material as required.

Items PSDM 8.3.6, PSDM 8.3.12 and PSDM 8.3.14 do not apply to material obtained from commercial sources.

**PSDM 8.3.18 Final finishing and cleaning up of the Site of the Works..... Unit : Sum**

The tendered sum shall include full compensation for the clearing, disposal of material, finishing, tidying and all other work required to finish and clean up the Site of the Works and affected areas by removing excess earth, stones, boulders, debris and other waste material, by clearing stormwater inlets and outlets and pipe barrels, by clearing the surfacing of all dirt, mud and foreign material, and by neatly finishing off all junctions, intersections and kerbing.

All material resulting from the finishing operations shall be disposed of to a spoil site furnished by the Contractor. The tendered rate shall make provision for the reinstatement of existing driveways to their original condition where these have been affected by the Works, as these items will not be measured and paid for separately.

**PSDM 8.3.19 Existing Services**

Location: Where particular items are provided in other sections of the schedule (e.g. crossing services in pipe trenches), the costs of detection, exposure, protection and alterations shall be covered by such particular items. Where no such particular items are provided and where there is reason to expect the presence of services, the following items will apply:

- (a) Supply of specialist equipment for detection ..... Unit : Sum
- (b) Excavate by hand in soft material to expose service ..... Unit : m<sup>3</sup>

The rates above shall cover the cost of delays and disruption of the progress of the work caused by the search for the particular service, in addition to the cost of searching for it, liaising with the local authority, excavating by hand of all material and backfilling holes that will not fall in the prism of road excavation.

**PSDM 8.3.20 Temporary protection of Services ..... Unit : m,No**

The rate for each service shall cover the cost of location etc. as specified in PSDM 5.1.3.2 liaison with the relevant local authority, delays and disruptions of the progress of the work due to the existence of the service and dealing with the service during the construction period to maintain an uninterrupted continuation of the specified service. The rate shall also cover the total cost of all repairs required should any of the services be damaged.

**PSDM 8.3.21 Tie in with existing road edge ..... Unit : m**

The tendered rate shall include full compensation for removal and disposal of existing concrete backing, protecting the existing paving when excavating the road box adjacent to it and benching the new layerworks to the existing in 150 mm steps for each layer.

**PSDM 8.3.22 Raising or lowering of existing structures ..... Unit : No**

The rate shall cover the cost of locating the manholes/chambers, the necessary excavation to do the works, removing the cover and frame and the cover slab, providing materials, labour and plant for raising the

manhole/chamber to the designated new level, provision of new materials in the event of any damage, setting and grouting the cover and frame to the correct level, and backfilling around the manhole to specifications."

**PSDM 8.3.23 Extra over item PSDM 8.3.5 for benching into existing layerworks ..... Unit : m**

The unit of measurement shall be the cubic metre, measured in accordance with Subclause 8.2, of surplus and/or unsuitable material disposed of, on the instruction of the Employer's Agent, at a spoil site or spoil sites provided by the Contractor.

The tendered rate shall include full compensation for the additional cost of providing a spoil site or other means of disposing of surplus spoil material, for transporting the material regardless of the distance involved, for acceptance charges for such material and for all other incidental costs to dispose of the spoil material.”

**PSG CONCRETE (STRUCTURAL) (SANS 1200 G)****PSG 2 INTERPRETATIONS****PSG 2.3 DEFINITIONS****a) General**

*ADD THE FOLLOWING:*

“Construction joint.

A joint required on account of constraints or convenience in the method of construction and that is not a movement, contraction or expansion joint.

Unforeseen joint.

A joint formed during concreting when plant failure, inclement weather, or some unforeseen event has enforced a halt in the placing of concrete and has thus created a situation in which a construction joint has to be made in a location that was neither designated nor approved before the commencement of concreting.

Extender:

Material which, when placed with Portland Cement, has a cementing property and is used as a portion of the cement in a concrete mix for economic reasons or for the chemical or physical properties (or both) that it gives to the concrete mix.

Cementitious binder (also referred to as binder):

Common cement that complies with the requirements of SANS 50197-1, and blends of certain types of common cement and cement extenders that comply with the requirements of SANS 55167-1&2, SANS 50450-1&2, SANS 53263-1&2 as and where applicable.

Water/binder ratio:

Ratio (by mass) of the water to the cementitious binder in a concrete mix.

Immediate protection of concrete:

The prevention of moisture loss from the concrete from the time of compaction until full wet-curing is possible.

Scabbling:

Removing all laitance and exposing the aggregate over 100% of the area using mechanized plant such as scabblers, abrasive blasters or other approved method.

Scabble:

Scabble shall be synonymous with scabbling.”

**PSG 2.4 EXPLANATION OF TERMS****PSG 2.4.2 Strength Concrete**

*ADD THE FOLLOWING:*

“Grade 35 MPa/19 mm means strength concrete Grade 35 MPa with 19 mm stone.”

**PSG 2.4.3 Joints**

*REPLACE WITH THE FOLLOWING:*

"The location of joints is controlled by design requirements and construction limitations. "Designated joints" will only be those joints whose locations are shown on the drawings. The terms "constructional joints", "movement joints", "contraction joints" and "expansion joints" are used to identify various types of designated joints. All other joints required by the Contractor,

including unforeseen joints as defined in 2.3(a) and those resulting from construction constraints, whether approved by the Engineer or not, will not be considered as designated joints (i.e. they will be considered as "non-designated" joints). All non-designated joints (except for unforeseen joints) need to be approved by the Engineer, in writing, before commencing with construction thereof."

**PSG 3            MATERIALS**

**PSG 3.2        CEMENT**

**PSG 3.2.2      Alternative types of cement**

*REPLACE THE CONTENTS OF THIS SUBCLAUSE WITH THE FOLLOWING:*

"Only CEM I 52.5 or CEM I 42.5 (Portland Cements), CEM II A 52.5 or CEM II A 42.5 in accordance with SANS 50197-1 may be used. Further blending with a suitable extender shall be as per PSG 5.5.1.7 and PSG 5.5.11.

If the Contractor wishes to use any other type/blend of cement, he shall obtain the Engineer's prior written approval. The tendered rates, however, shall be based on the use of the above mentioned cements/blends only.

The test results conducted to evaluate the conformity of cement in terms of SANS 50197-1, Clause 9, shall be made available to the Engineer at least 28 days before the materials are used for concrete."

**PSG 3.2.3      Storage of cement**

*ADD THE FOLLOWING:*

"Cementitious binder shall be used in the order in which it is received. Cementitious binder shall not be stored for longer than 8 weeks without the Engineer's permission.

Any cementitious binder that shows signs of hydration, such as the formation of lumps that cannot easily be crumbled to powder between the fingers, may not be used and is to be immediately removed from site."

**PSG 3.3        WATER**

*ADD THE FOLLOWING:*

"Where potable water is not used as mixing water for concrete, the water shall comply with BS EN1008:2002 *Mixing Water for Concrete*.

Final effluent shall not be used for curing concrete."

**PSG 3.4        AGGREGATES**

**PSG 3.4.1      Applicable Specification**

*ADD THE FOLLOWING:*

"The nominal stone size specified in the concrete grade (e.g. 35 MPa/26 mm) shall mean stone conforming to the grading specified in SANS 1083 for the nearest equivalent size, i.e. 26 mm means stone that complies with SANS 1083 for 26.5 mm size.

The fineness modulus of the sand delivered to the mixer shall lie between 1,7 and 2,8 and the standard deviation of fineness moduli of samples of sand that is delivered to the mixer during one shift shall be not more than 0,10."

**PSG 3.4.3      Storage of aggregates**

*ADD THE FOLLOWING:*

"When aggregates of different chloride content are stored on the Site, their use in the various classes of concrete shall be strictly controlled."

*ADD THE FOLLOWING SUBCLAUSES:***"PSG 3.4.4     Types of coarse aggregates for watertight concrete**

In the Kwazulu-Natal, coarse aggregates for watertight concrete shall be granites from a commercial source with a known low reactivity potential when reacting with free alkali in the cementitious binder.

**PSG 3.4.5     Fine aggregates for watertight concrete**

Reference is made to "Fulton's Concrete Technology, Chapter 3, Aggregates for concrete".

Sands used for watertight concrete shall be well-graded, with wide variety of well-distributed particle sizes, to help in reducing water-demand for the mix while maintaining workability. The shape of the sand particles shall be as close to spherical as possible to aid in lubrication and ensure that inter-particle friction is reduced. For recommended grading of sands, refer to table 3.4 in Fulton's Ninth Edition Chapter 3.

The Contractor shall provide the Engineer with relevant results for the sand to be used in the concrete mix, such as grading curves and certificate stating the clay content.

"All costs of the analyses/testing described above shall be deemed to be included in the cost of the rates for concrete."

**PSG 3.5     ADMIXTURES****PSG 3.5.2     Air-Entraining Agents***REPLACE WITH THE FOLLOWING:*

"No air-entraining agents will be permitted."

**PSG 3.6     REINFORCEMENT***ADD THE FOLLOWING:*

"All reinforcing steel shall have a certified post-consumer recycled content greater than 90% by mass."

*ADD THE FOLLOWING NEW SUBCLAUSES:***"PSG 3.9     WATERSTOPS**

Waterstops shall be of approved manufacture and of the pattern and the material widths scheduled on the drawings. They shall conform to Specifications CKS 388 or 389, for natural rubber or PVC respectively.

All intersections between waterstops shall be prepared by mitring and welding/vulcanising intersection pieces in the factory in accordance with the manufacturer's instructions and to approval of the Engineer. Only straight lengths of waterstop may be field welded, using appropriate jigs and tools.

Where required, waterstops shall have eyelets so that they may be tied securely to the adjacent reinforcement. "Rearguard"-type waterstops shall have flanges or cleats that grip effectively.

Where the Contractor proposes alternative products/brands, the widths, profiles, flanges and cleats shall be similar to the specified products and are subject to the approval of the Engineer.

Floor placed waterstops shall always be welded continuous to vertical wall waterstops at points of intersections.

### PSG 3.10 ALKALI-AGGREGATE REACTION

Reference is made to "Fulton's Concrete Technology, Chapter 10, Alkali-silica reaction."

Coarse aggregates for watertight concrete in the Western Cape shall be granites as per PSG 3.4.4. The following shall apply in other regions as well as to strength concrete with other coarse aggregates.

In accordance with this reference, the Contractor shall provide the Engineer with the following (with the concrete mix design submission):

- Type of coarse aggregate
- Source of coarse aggregate
- Recent SANS 6245:2006 test results (accelerated mortar prism method) for the coarse aggregate
- Certificates from cement (and extender) supplier stating the certified active alkali content(s)
- Total active alkali content of the various mix designs, adhering to the maximum values stated below (including calculations)

Result of SANS 6245 Coarse aggregate test (@12 days)	Description	Limit on total active alkali content of mix (kg/m <sup>3</sup> )
Linear Expansion < 0.10%	Aggregate innocuous	N/A
0.10% < Linear Expansion < 0.20%	Slowly reactive/ inconclusive	2.8
Linear expansion > 0.20%	Deleteriously reactive, rapidly expansive	2.1

Over and above the table above, aggregates from the Witwatersrand Supergroup shall have a limit of 2.0kg/m<sup>3</sup> active alkalis in the mix design.

The Engineer may instruct a petrographic analysis of the coarse aggregate for new/unknown coarse aggregates in addition to the tests above.

All costs of the testing described above shall be deemed included in the cost of the rates for concrete.

Note: The equivalent sodium oxide content is measured as Na<sub>2</sub>O + 0.658K<sub>2</sub>O. For cement it is expressed as a percentage by mass, for concrete it is expressed in kg/m<sup>3</sup>.

### PSG 3.11 JOINT FILLERS

Fillers for movement joints shall be closed cell expanded cross-linked polyethylene with properties equivalent to products manufactured by Sondor for this purpose. The filler shall have the following minimum densities:

- a) Water retaining / water excluding structures: 110kg/m<sup>3</sup>
- b) All other applications: 35kg/m<sup>3</sup>

All fillers shall be pre-cut to suit the application with a tear out strip for forming the specified recess for the bond breaker and sealant.

### PSG 4 PLANT



**PSG 4.3      MIXING PLANT****PSG 4.3.1      General requirements for mixing plant**

*ADD THE FOLLOWING SUBCLAUSE:*

"Standby mixers of adequate capacity and with an independent power unit shall be maintained on the site for immediate use in the event of breakdown of the regular mixers or failure of the power supply.

In addition, the Contractor shall have the following minimum plant available and in sound working order:

- (a) Two concrete mixers (for circular walls, each mixer shall be of sufficient capacity to complete a section of the wall between horizontal construction joints within 4 hours and without interruption).
- (b) Two weigh-batchers to supply the mixers.
- (c) Four concrete vibrators, at least one of which shall be powered by an internal combustion engine.
- (d) One air compressor.
- (e) Suitable and adequate Plant to transport and raise concrete and other material and equipment from ground level to the top of the structure at all stages of construction.
- (f) Elevated storage tanks of adequate capacity to ensure that sufficient water will be available before commencement of every major concrete-placing operation.

If the Plant used for placing concrete for the structure is electrically or mechanically powered, the Contractor shall also provide some other approved, non-electrically-powered standby means for placing concrete at an adequate rate in the event of a power or mechanical failure of the main Plant.

When the Contractor elects to place a crane inside the walls of the structure during the construction period, he shall communicate with the Engineer in good time to ensure that the design and layout of the panels that form the roof slab and floor allow for such positioning of the crane. When sections of the roof and floor have to be redesigned to accommodate the crane, the redesign cost shall be borne by the Contractor."

**PSG 4.5      FORMWORK****PSG 4.5.1      Design**

*ADD THE FOLLOWING:*

"In accordance with the Construction Regulations under Section 43 of the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993), the Contractor shall appoint a competent person to design, inspect and approve the erected temporary works on site, inclusive of formwork and scaffolding. Written approval (signed-off) of the design, inspections and erection of the temporary works by competent person shall be submitted to the Engineer for recordkeeping purposes throughout the various stages."

**PSG 4.5.2      Finish**

*ADD THE FOLLOWING:*

"All exposed concrete edges and external angles in concrete work shall have 20mm x 20mm chamfers unless otherwise specified or ordered, with the following exceptions:

- a) edges to which bolt-on frames for grid flooring are to be fixed,
- b) the sides of staircase risers,
- c) and staircase treads

Edges to which bolt-on frames for grid flooring are to be fixed shall be finished neatly and uniformly with a rubbing stone to remove protrusions and slightly round the edge.

The sides of staircase risers (vertical edges) shall be edged with an 8mm round fillet (forming this round edge by neatly applying a silicone bead inside the shutters prior to casting is acceptable).

Staircase treads will, unless otherwise specified, be topped with a 25mm granolithic screed. The screed shall receive an 8mm round edge."

### **PSG 4.5.3      Ties**

*ADD THE FOLLOWING:*

"No plugs, bolts, ties or clamps of any description used to hold the formwork will be allowed to project into or through the concrete unless expressly approved by the Engineer.

Only approved tie-rods consisting of solid rods (that remain embedded in the concrete) and with removable ends shall be used to hold the formwork of the walls. The removable tie-rod ends shall facilitate removal without damage to the concrete, and no permanently embedded parts of such tie-rods shall have less than 50 mm of cover to the finished concrete surface.

The cavities left in the concrete when the tie-rod end cones are removed shall be soundly caulked with a cement mortar to which an approved shrinkage-reducing agent has been added, and shall be neatly finished to a smooth surface uniform with that of the surrounding concrete.

The cost of supplying special tie-rods as well as the filling of cavities left by the tie-rod cones shall be included in the rates tendered for formwork under the appropriate pay items.

Under no circumstances shall formwork be secured to reinforcing bars."

*ADD THE FOLLOWING NEW SUBCLAUSE:*

### **"PSG 4.6      WATER BATH**

A temperature-controlled water-bath with a capacity to cure two hundred cubes shall be provided and maintained on site. The water-bath shall be located under cover."

## **PSG 5      CONSTRUCTION**

### **PSG 5.1      REINFORCEMENT**

#### **PSG 5.1.2      Fixing**

*ADD THE FOLLOWING:*

"Welding of reinforcing steel will not be permitted.

The Contractor shall make provision for the Engineer to inspect reinforcing once it has been fixed in place, with cover blocks secured and construction joints prepared, and before the concreting commences. Formwork that prevents arm-length access to any reinforcing or construction joints for checking shall not be erected until the Engineer is satisfied that preparations at that stage meet specification.

Should the reinforcement of a pre-stressed reservoir wall be supported by the joint filler, the filler shall be covered with a hard surface on the side to be concreted. The hard surface shall be sufficiently resilient to ensure that the joint and surfaces will be without defects. The cast-concrete shall however be in direct contact with the elastomeric bearing surfaces.

Where reinforcing clashes with tensioning cables/ducts, the reinforcing shall be re-arranged to accommodate the cables/ducts as instructed by the Engineer."

### **PSG 5.1.3      Cover**

*In Subclause 5.1.3(a) amend the words "or stirrup" to read: ", secondary reinforcement, tie, stirrup, tying-wire knots or wire ends".*

**ADD THE FOLLOWING:**

Tying wire may not encroach on the specified minimum cover by more than a single strand thickness.

The distance between pipes in the concrete and the reinforcing steel shall nowhere be less than

- (a) 40 mm or
  - (b) 5 mm plus the maximum size of the coarse aggregate, whichever is the largest, or
  - (c) the cover specified on the Drawings.
- Whichever is the largest.

The Contractor shall make provision for the Engineer to inspect cover once all formwork has been erected and secured, joints prepared and items that are to be cast in are fixed in place. Where poor lighting between formwork prevents the Engineer from adequately completing the inspection, the Contractor shall make available, for the Engineer's use, a portable light (flashlight) of sufficient brightness to complete the inspection."

## **PSG 5.2      FORMWORK**

### **PSG 5.2.1      Classification of finishes**

*Replace the phrase "are classified as follows and will be so scheduled:" at the end of the first paragraph with the following:*

"are classified below unless otherwise classified on the drawings, and will be so scheduled. Except where otherwise specified, formwork for formed concrete surfaces against which backfill will be placed shall be rough and formwork for all other formed surfaces shall be smooth."

*In Subclause 5.2.1(b) amend the words "to Degree of Accuracy II as defined in terms of Clause 6" to read: "to the Degree of Accuracy specified in 6.2".*

- (c) Special

**ADD THE FOLLOWING:**

"This finish is obtained by first giving the surface a smooth finish with the joints between formwork panels forming an approved regular pattern suitable for the appearance of the structure. All projections shall then be removed, irregularities repaired, and the surface rubbed or otherwise treated until it is smooth with an even texture, appearance and colour.

If the finish of exposed surfaces does not comply with the requirements for uniformity of the texture and appearance, the Contractor shall, when instructed to do so by the Engineer, rub down the exposed surfaces of the entire structure or any part thereof as specified below, entirely at his own cost. All repairs must be completed before the rubbing commences.

The surface shall be saturated with water for at least one hour. The initial rubbing of the face shall be carried out with a medium coarse carborundum stone together with a small amount of mortar of the same cement/sand ratio as the concrete being repaired. Rubbing shall continue until all form marks, projections and irregularities have been removed and a uniform surface has been obtained. The paste produced by the rubbing shall be kept in place. The final rubbing shall be carried out with a fine carborundum stone and water. This rubbing shall continue until the entire surface has a smooth, even texture and is

uniform in colour. The surface shall subsequently be washed with a brush to remove surplus paste and powder."

**PSG 5.2.2**      **Preparation for formwork**

*ADD THE FOLLOWING:*

"Construction joints shall be approved by the Engineer."

**PSG 5.2.5**      **Removal of formwork**

*REPLACE TABLE 2 WITH THE FOLLOWING TABLE:*

1	2	3	4	5	6	7	8	9	10
Formwork to Structural Member	Strength Class of Cement								
	CEM-1			CEM-II-A (or blend of CEM-I with less than 20% FA/GGCS /GGBS)			CEM-II-B, CEM-III (or blend of CEM-I and more than 20% FA/GGCS /GGBS)		
	Minimum time (24 hour periods) before removal of formwork								
	Weather								
	Hot or Normal	Cool	Cold	Hot or Normal	Cool	Cold	Hot or Normal	Cool	Cold
Beam sides, walls and unloaded columns	1	1.25	1.5	1.5	2	3	3	4	5
Slabs with props left underneath	2	3	4	4	5.5	7	6	8	10
Beam soffits with props left underneath and ribs with a ribbed floor construction	3	4	5	5	7	10	10	13.5	17
Slab props including cantilevers	5	7	9	10	13.5	17	10	13.5	17
Beam props including cantilevers	7	9.5	12	14	17.5	21	14	17.5	21

*ADD THE FOLLOWING TO THE END OF SUBCLAUSE 5.2.5.3:*

"This shall include evidence that curing and protection as per 5.5.8 is strictly adhered to."

*ADD THE FOLLOWING TO THE END OF SUBCLAUSE 5.2.5:*

**"PSG 5.2.5.6**      The Contractor shall make provision for the continued support of beams and slabs while the formwork is being removed and/or for back propping of beams and slabs.

**PSG 5.2.5.7**      Where walls/beams have top slabs attached, the contractor shall keep the wall/beam propped until such a time as the top slab has attained its design strength. Back-propping of such structures shall be discussed and agreed with the Engineer at the time of programme approval."

**PSG 5.2.5.8**      Any deviation from the table above or the agreed upon programme for back-propping, shall not be permitted without the Engineer's acceptance in writing."

**PSG 5.3**      **HOLES, CHASES AND FIXING BLOCKS**

*ADD THE FOLLOWING:*

"Cover blocks shall be made of mortar to achieve a strength class (and equivalent durability) of the concrete of the element they are placed in. They shall be placed at a spacing so as to avoid crushing from any applied construction and self-weight loads.

The holes or cavities left by ferrule heads in the concrete of water-retaining structures shall be filled with an approved non-shrink grout applied strictly in accordance with the manufacturer's specifications.

Plastic cover blocks will not be permitted in water-retaining and water-excluding structures."

#### **PSG 5.4      PIPES AND CONDUITS**

*ADD THE FOLLOWING:*

"All pipes passing through concrete elements (floors, walls, slabs, etc.) shall be cast into the concrete element simultaneously with the casting of the element. Openings for pipes shall only be left in concrete elements when so directed by the Engineer or when shown on the drawings. Pipes shall be installed in such openings according to the details shown on the drawings."

#### **PSG 5.5      CONCRETE**

##### **PSG 5.5.1      Quality**

##### **PSG 5.5.1.2      Consistency**

*REPLACE THE CONTENTS OF THIS CLAUSE AND TABLE 3 WITH THE FOLLOWING:*

"The slump, measured in accordance with SANS 5862-1, shall be within the limits given in the following table for both conventionally placed and pumped concrete:

Design Slump (mm), as per approved mix design	Tolerance (mm)
Slump $\leq$ 50	-10 to +15
50 < Slump < 75	-10 to +25
75 $\leq$ Slump $\leq$ 120	$\pm$ 25

Design slump > 120mm will be reviewed and approved/rejected at the discretion of the Engineer. Concrete with slumps measured on site higher than 145mm will not be accepted for conventional and pumped concrete mixes (unless pre-approved by the Engineer).

For self-compacting concrete, acceptance based on slump will be at the discretion of the Engineer but based on recommendations by the mix design suppliers.

##### **PSG 5.5.1.4      Chloride Content**

*ADD THE FOLLOWING:*

"With reference to Table 4, efflorescence will not be acceptable on any exposed concrete surface."

##### **PSG 5.5.1.5      Durability**

*DELETE TABLE 5.*

*REPLACE THE CONTENTS OF THIS CLAUSE AND TABLE 3 WITH THE FOLLOWING:*

"The exposure conditions for the watertight concrete and strength concrete are classified as **"severe"**.

The maximum allowable water: binder ratio for watertight concrete shall be **0.50**.

The maximum water: binder ratio for strength concrete shall be **0.53**."

##### **PSG 5.5.1.7      Strength concrete**

*ADD THE FOLLOWING:*

"With the exception of mixes weaker than 15 MPa, all concrete for the Works shall be considered to be strength concrete. Watertight concrete shall also comply with requirements as stated in 5.5.11.

The concrete mixes shall be designed by an approved laboratory.

a) Design of concrete mixes

The proportions of the various sizes of aggregate, cement and water shall be such as to produce a dense concrete of adequate workability for the particular circumstances under which the concrete will be transported, placed and compacted. Approved plasticizing additives may be used to ensure adequate workability in preference to varying the proportions of water and cementitious binder.

All exposed concrete shall be of the same colour. No change in materials or processes shall be made without the Contractor first satisfying the Engineer that no change in colour will result.

Where extenders are proposed by the Contractor for building surface beds and trafficable slabs, a maximum of 15% cement replacement with a suitable extender will be allowed.

b) Trial Mixes

The Contractor shall for each class of concrete required for the works, have trial mixes designed within the limits specified herein for 28 day and 7 day strengths and he shall have cubes made and tested by an approved laboratory at his own expense. The test results of cubes made from trial mixes shall be used to determine the proportions for the "Designed Mixes" to be used in the Works.

Details of the mixes as designed shall in all cases be submitted to the Engineer for approval, 30 days before concreting is carried out and no concrete shall be placed in structures before such approval in writing has been obtained. The proportions of cement, aggregates and water for each mix as approved shall not be changed except with approval of the Engineer.

The Engineer must receive for any particular concrete mix:

- Proportions of each design tested
- Strength of each cube tested
- Density of each cube tested
- The Contractor's nomination of the design he proposes."

**PSG 5.5.3     Mixing****PSG 5.5.3.2     Ready-mixed concrete***ADD THE FOLLOWING:*

"If the Contractor elects to use ready-mixed concrete in the Works he shall provide a qualified technical assistant who shall check the quality of materials used, the accuracy and effectiveness of the water gauges and all relevant parts of the batching and mixing equipment, the moisture content of the aggregates, the quantities batched, the time of departure of each batch and all other matters which may affect the quality of timely arrival of the concrete.

The technical assistant shall commence work at the batching plant sufficiently in advance of the batching of the first mix to carry out all the required checks and shall remain at the plant throughout the period in which concrete for the Works is being batched.

The technical assistant shall maintain a continuous record of all the tests and checks carried out by him. The record shall be available for the Engineer's inspection at all times and a copy of the record for each day shall be given to the Engineer the following morning."

**PSG 5.5.5      Placing****PSG 5.5.5.5      *REPLACE CONTENTS OF THIS SUBCLAUSE WITH THE FOLLOWING:***

“Concrete shall not be allowed to fall freely through a height of more than 3m unless otherwise approved by the Engineer. In this case, approval shall be subject to the Contractor submitting a detailed method statement to the Engineer. All costs included for casting to heights of more than 3m shall be deemed to be included in the tendered rates for concrete of the specific structure/wall element.”

***ADD THE FOLLOWING:***

- “PSG 5.5.5.10** Concreting of circular walls (without vertical joints) between horizontal construction joints shall be carried out in both directions from a point on the wall in order to close the gap with fresh concrete.
- PSG 5.5.5.11** Pumping of concrete shall not be permitted unless approved by the Engineer. For such approval, the Engineer will require 12-day accelerated shrinkage tests of the concrete to meet the criteria in PSG 5.5.11. The rates for concrete will be deemed to include such testing costs.
- PSG 5.5.5.12** Should excessive cracking of pumped-concrete occur, the Engineer may instruct the Contractor to revert to conventionally placed concrete. All costs associated with changes in mix design, site placing equipment, and any remedial repairs to concrete will be at the Contractor's expense.
- PSG 5.5.5.13** Structural concrete shall not be cast directly against the side of any excavation without the use of formwork unless prior approval has been obtained in writing from the Engineer.
- PSG 5.5.5.14** Concrete used in pipe trenches for encasement may be cast directly against the side of the excavation. Concrete for thrust/anchor blocks shall be cast directly against the side of the excavation.
- PSG 5.5.5.15** Blinding layers shall be cast on the same day that earthworks excavation (Restricted as per Subclause 8.3.3 of SANS 1200D and Extra excavation as per Subclause 8.3.5 of SANS1200D) have been completed.”

**PSG 5.5.7      Construction joints*****ADD THE FOLLOWING:***

“The position and pattern of all joints (designated or non-designated) shall be subject to the Engineer's approval.

The construction joints in water-retaining and water-excluding structures (designated or non-designated) shall be made strictly in accordance with the details shown on the drawings. Where alternative joint details are proposed by the Contractor, these are subject to the Engineer's approval.

For construction joints at kickers, all additional costs for concrete, formwork preparation, etc. will be deemed to be included in the rates tendered for concrete in walls and formwork. Kickers shall be cast monolithically with the floor/slab concrete and the Contractor shall ensure that kickers are thoroughly compacted, immediately protected, and cured using suitable techniques, as specified.

Walls shall be cast in lifts of a height that permits each lift to be poured without interruption in one continuous operation during normal working hours.

It is the Contractor's responsibility to ensure that construction joints for water-retaining and water-excluding structures are watertight. The Contractor's proposed method for ensuring the watertightness of such joints shall be submitted to the Engineer for his approval.



The joints between screeds and concrete floors shall be regarded as construction joints and the surface of the floor shall be prepared as described for construction joints."

*IN SUBCLAUSE 5.5.7.3 (b), REPLACE THE WORDS "sand-blasted or chipped with a light hammer" WITH THE WORD "scabbled".*

**PSG 5.5.8      Curing and protection**

*ADD THE FOLLOWING:*

"Curing shall be conducted for a minimum of 7 days. The method of curing shall be approved by the Engineer for the various elements.

Concrete will not be paid for unless properly cured and proof of curing is continuously visible on Site. The cost of immediate protection and curing shall be deemed to be included in the rates for concrete.

The Contractor is to pay special attention to both the immediate protection and long-term curing of the concrete for the various elements. Where deemed necessary by the Engineer, the Contractor shall submit a Method Statement for approval outlining in detail the various measures that the Contractor will undertake to ensure effective immediate protection and long-term curing of the concrete.

Curing compounds will not be accepted as a stand-alone system for the immediate protection of concrete. Only resin-based curing compounds complying with ASTM C309 Type 1 or 2 Class B will be accepted where approved by the Engineer.

Where accepted, the curing compound shall be applied immediately as formwork is progressively stripped or, in the case of unformed surfaces, after a minimum of 48 hours of immediate protection. It shall preferably be applied by spraying and the rate of application shall be strictly in accordance with the manufacturer's recommendations. A method of monitoring the area to which curing compound has been applied and the application rate shall be as approved by the Engineer and rigidly applied by the Contractor.

Surfaces of joint rebates, where elastomeric sealant is to be applied, shall be protected from contamination by curing compound by the use of masking tape."

**PSG 5.5.9      Adverse weather conditions**

*ADD THE FOLLOWING TO SUBCLAUSE 5.5.9.2:*

"If concrete is to be cast during times of high ambient temperature or hot drying winds, the Contractor shall be responsible for taking the necessary steps to keep the placement temperature as low as possible. Such steps include the spraying of the coarse aggregate with water, the painting of silos with reflecting aluminium paint, the insulation of tanks and pipelines, and the protection of concrete ingredients against the direct rays of the sun. The area of the pour shall be shaded before and during concreting and the concrete shall be shaded from the time of mixing until eight hours after placing.

Windbreaks shall be erected if necessary."

**PSG 5.5.10      Concrete surfaces**

*ADD THE FOLLOWING:*

"Under no circumstances shall cement mortar be added while floating concrete."

*ADD THE FOLLOWING SUBCLAUSE:*



**"PSG 5.5.10.4** Where the surfaces of the concrete are to be additionally hardened or protected the positions of such surfaces and the method to be used will be shown on the drawings and will be scheduled. Materials or products with a ferrous content will not be allowed."

**PSG 5.5.11** **Watertight concrete**

*ADD THE FOLLOWING:*

"The mix designs for watertight concrete must be aimed at ensuring concrete durability and must therefore be guided by the need to:

- Minimise the permeability of the concrete; and
- Maximise the chemical resistance of the concrete to aggressive agents in the environment.
- Reduce the heat of hydration and thermal gradient of thick sections (greater than 400mm thick) at early-age.

The following parameters shall be adhered to:

Parameter	Limit
Maximum shrinkage strain (based on 12-day accelerated shrinkage test performed according to SANS 6085 specifications):	350 $\mu\text{m/m}$
Maximum water: binder ratio:	See PSG 5.5.1.5
Minimum cementitious binder content:	300kg/m <sup>3</sup>
Maximum cementitious binder content:	360kg/m <sup>3</sup>
Maximum water content	180kg/m <sup>3</sup>
Maximum alkali content:	See PSG 3.10
Maximum thermal coefficient of expansion for concrete:	10x10 <sup>-6</sup> /°C
Minimum coarse aggregate fraction (as a percentage of total (coarse + fine) aggregates).	0.55
Type of extender required:	Ground Granulated Blast Furnace Slag (GGBS) OR Fly Ash (FA)
Minimum and maximum range of extender replacement (as a percentage of total binder content)	40% - 50% (GGBS) 20% - 30% (FA)

Nominal coarse aggregates size for watertight concrete shall be either 19mm or 26mm and shall be specified on drawings or in the Bill of Quantities. The Engineer may request evidence (shrinkage testing, test panels, historic use of the specific concrete mix, etc.) indicating that the reduced aggregate size will not result in excessive shrinkage of the concrete.

Where extenders are used/specified, Table 2 (as amended) shall apply, and the immediate protection during casting and the curing of concrete should be given special attention by the Contractor. Where extenders specified may not be locally available, the Contractor should take into account all the costs required to import and batch the specified extender in the rates for concrete (Item PSG 8.4.3).

The following structures shall be considered water retaining/water-excluding and shall be constructed using watertight concrete:

- Inlet works
- Settled Effluent Sump
- Second Class Water reservoir
- Collection/ancillary chambers
- Any other structure or element(s) of a structure retaining water.
- Any other structure or element(s) of a structure excluding water (including ground water with level assumed to be at top of final ground level)."

**PSG 5.5.13     Grouting**

*ADD THE FOLLOWING:*

“Unless otherwise approved by the Engineer, proprietary grouting materials shall be obtained ready-mixed in sealed pockets as supplied by the manufacturers.”

**PSG 5.5.14     Defects**

*ADD THE FOLLOWING AT THE END OF SUBCLAUSE 5.5.14.1:*

“All defects shall be repaired as soon as possible after the formwork has been removed and the Engineer has inspected the concrete. A statement of the method to be used for each repair shall be submitted to the Engineer for his approval before any work is carried out. Such methods should deal separately with methods for the various depths of defects as follows:

- a) Repair of shallow surface irregularities (e.g. blowholes or minor grout loss)
- b) Repair of 5mm to 50mm deep irregularities with polymer modified repair mortars
- c) Repair of deeper defects by means of formed micro-concretes

Each method should deal in detail with surface preparation, dealing with minimum product application depths (sawcutting and roughening of saw-cut edges etc.), the use of bonding agents and/or other proprietary product where specified by the applicator, product window periods and curing of the repair products.

The Engineer may prohibit the further placing of concrete in the particular area concerned until he is satisfied that the repair has been satisfactorily executed.”

*ADD THE FOLLOWING NEW SUBCLAUSES:*

**"PSG 5.5.16     Creating box-outs for and casting in of items**

- a) Where an item (i.e. pipe, special, etc.) is to be cast/grouted into a concrete member/element at a later stage (such as for items supplied by others), the Contractor shall provide a box out hole in the concrete element. When constructing such holes, the reinforcement bars shall not be cut but shall run through the hole/opening.

Once the concrete element has been cast and the box out hole made, all formwork and boxing remaining in the holes shall be removed. Any alterations required to the position and shape

of the holes shall then be made. This shall be followed by preparing the surface as specified in 5.5.7.3(c), including thoroughly scabbling the sides of the holes to obtain a satisfactory surface to which the new concrete/grout will bind to.

- b) When the item is ready to be cast in, the reinforcement shall then be cut (with the approval of the Engineer) and/or bent out to suit the item being cast in. Cutting of reinforcing shall be kept to an absolute minimum. After positioning of the item, the remaining reinforcement shall be bent back in position (i.e. after flanges or similar protruding components have been passed through the reinforcing). Cover of concrete over reinforcing as detailed in 5.1.3 shall be adhered to, including cover between reinforcing and the item installed (unless otherwise directed or approved by the Engineer).
- c) The surface of the existing concrete shall be kept continuously wet for 24 hours before a layer of mortar slurry and the new concrete/grout are placed. Right before casting, all standing water shall be removed and the surface shall be covered with a layer of mortar slurry (or other approved method), as thick as practical, made of the same mix as the concrete in which the items are to be cast. Under no circumstances shall the
- d) mortar slurry be allowed to dry out prior to casting.

If watertightness is a requirement where the item is cast into the concrete element, the Contractor shall ensure watertightness by using an approved method (unless one is

already specified by the Engineer) such as tape wrapping the pipes or applying an approved swellable waterbar and profile around the pipe prior to casting in. The cost of such waterproofing method will be deemed to be included in the rates tendered for items PSG 8.7 and PSG 8.13, as applicable.

Formwork shall be constructed and the item secured in position to prevent movement from the required position during casting. The Engineer shall be called on to inspect the work for compliance at agreed milestones and, at minimum, while there is still sufficient access to inspect the work before the final formwork is positioned and casting commences.

The concrete/grout shall be mixed and placed as dry as possible to obtain a dense, watertight concrete. The concrete/grout shall be carefully worked around item, including the puddle flange (if any) and the pipe barrel or body of the special (as applicable), and shall be vibrated in layers so as to prevent the already-placed concrete from falling away from the item's (pipe/special etc.) surface. The whole shall, when set, form a dense, homogeneous, and waterproof mass.

#### **PSG 5.5.17      No-Fines Concrete**

A nominal aggregate size of 19mm shall be used in the manufacture of "no-fines" concrete. Each size of aggregate shall be a single size aggregate graded in accordance with SANS 1083.

The concrete shall be mixed in the following proportions:

Cement	: 50 kg
Aggregate	: 0.30m <sup>3</sup>
Water	: 20 Litres

Cement shall be measured by mass or in full pockets of 50 kg each and aggregate shall be measured by volume in approved measuring boxes or barrows. The aggregate shall be moist or wetted before the cement is added. Where drum mixers are used, about 20% of the water shall be poured into the drum before the aggregate and cement are loaded. The mixing time in the drum shall be about 45 to 50 seconds.

The quantity of water added shall be just sufficient to form a smooth grout which will adhere to and completely coat each and every particle of aggregate, and which is just wet enough to ensure that, at points of contact of the aggregate, the grout will run together to form a small fillet to bond the aggregate together. The mix shall contain no more than 20 litres of water for every 50 kg of cement. Mixing shall be done in an approved batch-type mechanical mixer, but small quantities may be hand-mixed.

No-fines concrete shall be placed in accordance with the procedure approved by the Engineer. It shall be placed in its final position on an approved geotextile bidim, within 15 minutes of having been mixed. The concrete shall be worked sufficiently to ensure that it will completely fill the space to be concreted and that adjacent aggregate particles are in contact with one another. Excessive tamping or ramming shall be avoided and under no circumstances shall the concrete be vibrated.

All no-fines concrete shall be protected from the elements and loss of moisture. Protection against loss of moisture shall be accomplished by one or more of the following methods:

- Retaining formwork in place
- Covering exposed surfaces with sacking or other approved material kept continuously wet.
- Covering exposed surfaces with plastic sheeting.

Between 24h and 48h after the no-fines layer has been laid, it shall be covered with a 1:4 cement: sand mortar skim layer 20mm thick. The mix shall be comparatively dry to ensure that it does not penetrate and clog the cavities in the no-fines concrete. The surface shall be steel-floated to form a plane surface.

The mortar skim shall be cured in the same manner as concrete for a period of not less than 2 days.

No wheel loads will be permitted on the no-fines layer unless previously approved by the Engineer.

**PSG 5.5.18     Precast paving slabs**

The paving slabs shall comply with the requirements of SANS 541, shall be as scheduled and with patterned surface, or equivalent. Samples of the types which the Contractor proposes to use shall be submitted for approval prior to construction.

The area to be paved shall be compacted to 98% of MAMDD (Mod AASHTO maximum dry density), trimmed and then treated with an approved weedkiller, with care being taken to avoid contaminating surrounding areas. The paving slabs shall be laid on a sand bed approximately 25 mm thick, which shall be graded to the required levels and slopes as approved by the Engineer.

The joints between the slabs shall be 2 mm to 6 mm wide and shall be grouted with cement mortar. Gaps in the pattern of slabs shall be filled with Grade 15 MPa/20 mm concrete and given a wood floated finish.

**PSG 5.5.19     Grouting in of equipment**

- a) The Contractor shall form pockets to the details shown on the drawings to accommodate holding down bolts for equipment provided by the Contractor or by the Mechanical and Electrical Contractor. The holding down bolts will be provided and positioned by the Mechanical and Electrical Contractor for his equipment.
- b) After casting of the concrete all shuttering shall be removed and the inside of the bolt holes and the surface on which any machine base is to be placed shall be cleaned and scabbled to remove all defective concrete, laitance, dirt, oil, grease and loose material.
- c) Upon completion of the positioning and alignment of equipment (the Mechanical and Electrical Contractor will position his own equipment), and when instructed by the Engineer, the Contractor shall in collaboration with the Mechanical and Electrical Contractor, grout up pockets and baseplates by filling pockets and voids under the baseplates with an approved non-shrink grout.

**PSG 5.5.20     Backfilling of excess excavations**

Wherever the Contractor has over-excavated below the specified founding levels, such over-excavation shall be backfilled to bring the founding surface to the correct level by placing and compacting no-fines concrete or mass concrete of Grade 15 MPa/19 mm, as directed by the Engineer.

Backfilling with 5% cement stabilized sand compacted to 100% MAMDD (MOD AASHTO maximum dry density) in 150mm layers may be appropriate for use under certain structures, if approved by the Engineer. The cement stabilized sand to be thoroughly mixed in the presence of the Engineer.

**PSG 5.5.21     Applied loads**

No loads (e.g. crushed-stone or any other covering) shall be placed on the roof of the structure before the concrete has attained its design strength, unless approved supports are provided.

**PSG 5.5.22     Soilcrete**

Soilcrete shall consist of an approved soil or gravel mixed with 5 % by mass of Portland Cement and only sufficient water to give it a consistency that will permit the soilcrete to be placed, using vibrators. The material used for soilcrete shall be sandy granular material of the following specifications:

Minimum Grading Modulus:     1.2

Maximum Plasticity Index: 10%  
Maximum particle size: 38mm

Detrimental percentages of silt and clay shall be avoided

The soilcrete shall be mixed on site using suitable concrete mixers and the water and cement contents shall be carefully controlled. It shall be placed and thoroughly compacted by means of concrete vibrators so that all voids are filled.

#### **PSG 5.5.23 Holding-down bolts**

Where holding down bolts (HD bolts) are to be cast into concrete or grouted into pockets and where they are not specified and measured with the items they are fastening, these bolts shall be Class 8.8 and shall be manufactured from stainless steel Grade 316L (unless otherwise specified), shall be fitted with insulating washers and shall have a nickel-based anti-seize compound applied along the full length of fastener threads before the nut is applied.

#### **PSG 5.5.24 Sterilisation of water retaining structures**

Unless otherwise specified, before a water-retaining structure is sterilized, the structure shall have been tested for watertightness as set out in **7.2.5**, and the pipelines serving the structure shall have been sterilized. The inside of the structure shall then be thoroughly cleaned out and washed down with clean water. Thereafter the roof soffit, beams, columns and walls shall be thoroughly sprayed down, using pressurised equipment, and the floors shall be scrubbed with a calcium hypochlorite solution of concentration 0,15 g/L, as specified in Subclause 5.10 of SANS 1200 L.

On completion of the sterilization, the sterilizing solution shall be run to waste before the water-retaining structure is filled.

Should additional work be required inside the structure after a watertightness test has been completed, the structure shall be re-sterilized at the Contractor's expense.

#### **PSG 5.5.25 Granolithic screeds**

Where the type of screed required is not stated, the screed shall comply with this granolithic screed specification unless it is applied to a roof top, in which case it shall comply with the roof screed specification in Specification PD.

##### **PSG 5.5.25.1 Mix design**

Only CEM I 52.5 or CEM I 42.5 (Portland cements), CEM II A 52.5 or CEM II A 42.5 in accordance with SANS 50197-1 may be used. Where extenders are proposed by the Contractor, a maximum of 15% fly ash, or 30% GGBS/GGCS will be allowed.

The maximum allowable water: binder ratio for granolithic screed shall be 0.50 and the minimum 28-day cube strength shall be 35MPa.

The coarse aggregate shall consist of granite or other approved aggregate. For screeds with a nominal thickness of up to 40mm, the coarse aggregate shall pass through a 10mm sieve but be retained on a 5mm sieve. For screeds with average thickness greater than 40mm, the nominal size of the coarse aggregate should be increased to one-quarter the thickness of the topping, subject to a maximum of 19mm.

The mix design must be submitted to the Engineer for approval.

##### **PSG 5.5.25.2 Preparation of base concrete**

Before placing any granolithic screeds, the base concrete (substrate) shall be scabbled to remove all laitance and expose the aggregate over 100% of the area to be screeded using mechanized plant such as scabblers or abrasive blasters. After scabbling, the surface shall be

thoroughly cleaned from dust and debris by scrubbing and/or high pressure wash, followed by soaking the surface with water for at least 24 hours. The Engineer shall be called to inspect all prepared surfaces prior to placing the screed

### **PSG 5.5.25.3 Placing**

Remove all surface water and apply a 1:1 cement/clean sand grout with just enough water to provide the consistency of a slurry. The grout is to be vigorously brushed into the scabbled surface with brooms (which have bristles long and flexible enough to reach down into all the irregularities of the concrete surface).

On completion of brushing the grout into the scabbled surface, the surplus grout must be brushed off to leave only a thin grout coating (without pools of grout in depressions) and the screed must be placed while this grout coating is still visibly wet. Under no circumstances should the grout be allowed to dry out before placing the screed as this will cause debonding. This will typically require grouting over small areas at a time, just ahead of laying the screed.

Where a screed to fall is required but no fall (i.e. 1:100) is given for the area, the screed shall be laid to fall (slope) as indicated below.

- Where the screed only falls in one direction, the fall shall be 1:100.
- Where the screed consists of multiple sections sloping in various directions, the section(s) with the most gradual slope shall have a fall of 1:100. All other sections shall have slopes steeper than 1:100 to fall in the direction shown and tie into adjacent sections.

Where a screed is required and a fall is given for the area comprising of multiple sections sloping in various directions, the fall given shall be the minimum fall (fall for the most gradually sloped section) and some sections will require steeper falls to tie into adjacent sections.

Granolithic screeds applied to stairs shall be 25mm thick and level, unless otherwise indicated. The thickness of all other granolithic screeds shall be 30mm at the thinnest point (unless otherwise indicated).

The granolithic screed must be laid and compacted in one layer and care must be taken to obtain maximum compaction. All laitance on the surface of the fresh screed must be struck off prior to mechanical trowelling. Over-trowelling, causing an excessive cement-water paste to come to the surface, must be strictly avoided. Under no circumstances should cement or a dry cement-sand mixture be sprinkled directly onto the surface of a finish in order to absorb bleed water or laitance. Surface water should not be trowelled back into the finish and, similarly, water should not be applied between trowelling operations, since this may cause surface weakness.

The granolithic screed shall have exposed corners and edges rounded ( $r=8$  mm) and shall be finished with a steel trowel to Degree of Accuracy I, or in the case of receiving a surface finish application, in strict accordance with the manufacturer's specification and approved by the Engineer. Where granolithic screeds are applied to stairs, a portion of each tread shall be reeded (finished with a non-slip pattern) to the satisfaction of the Engineer.

### **SG 5.5.25.4 Curing**

Granolithic screeds shall be protected from damage and cured in accordance with the requirements of PSG 5.5.8.

### **PSG 5.5.25.5 Joints**

The granolithic screed shall be divided into panels with joints that align/coincide with joints in the base concrete (including joints at columns, walls, etc.). Additional joints are to be made in the screed if, when matching the base concrete joints, the screed panel size will exceed  $9\text{m}^2$ . These additional joints shall be made such that joints are no more than 3m apart, equally spaced and the length: width ratio of the panels adheres to a 1.5:1 limit. The Contractor shall have his proposed additional joint locations approved by the Engineer prior to commencing with the screeding work.



Unless detailed otherwise, screed joints that align with the base concrete joints shall be full-depth and of the same width as those in the base concrete. Joints that do not align with the base concrete joint

shall be formed by cutting grooves 3mm wide by 25mm deep into the screed within 8 hours of placing the screed and sealed as specified on the drawings.

All joints shall be straight, neat and of workmanlike appearance. All joints shall be sealed as shown on the drawings.

When placing granolithic screed against an adjacent band of granolithic screed, the edge of the latter shall be prepared by wire brushing and brushing with grout. Under no circumstances shall the brushed grout be allowed to dry out prior to placing screed.

#### **PSG 5.5.25.6 General**

Screeds found to be delaminating shall not be accepted.

The interface between the screed and substrate, if visible (i.e. sides of walkways or stairs that have received a screed and do not abut the structure), shall be finished flush and made neat either by rubbing down or by another suitable method approved by the Engineer. Fairing coats are not acceptable.

#### **PSG 5.5.26 Concrete protection and proprietary floor finishes**

Concrete protection and proprietary floor finishing products shall be applied where specified on the drawings or in the Bill of Quantities. The Contractor shall ensure that the substrate and preparation thereof meet the requirements of the product being applied (if applicable), and the Engineer shall be called to inspect all prepared substrates prior to applying/installing the finish. A trial panel (including skirting if applicable) shall be prepared in advance by the Contractor for the Engineer's approval

All installations of proprietary products shall be carried out by supplier-approved applicators and in strict accordance with the manufacturer's specifications. The finish (including joints) shall be level, plum, uniform, straight and of a neat and workmanlike appearance. The supplier's technical representative shall carry out regular inspections to ensure that their specifications are adhered to during installation. Any thicknesses specified shall be the dry film thickness. Although some of the more common finishes are specified below, other finishes may be specified elsewhere.

Where aluminium straight edge trim (flooring trim) is specified as a stop end for the finish, the underside of the trim shall be lightly sanded, and the entire underside adhered securely to the substrate with Sikadur-30 (or equivalent approved) epoxy paste prior to applying the finishing products. The finishing products shall be applied over the appropriate section of the aluminium trim and worked into holes in that section provided for the product to bond to. The exposed edges of the aluminium trim shall

be masked and protected during construction and shall have a clean and 'new' appearance once construction is complete. Any visible gaps between the aluminium trim and the substrate to which it is affixed due to undulations in the substrate shall be filled with Sikafloor-161 (or equivalent approved epoxy primer and mortar) and neatly finished.

##### **a) Epoxy Finish**

Unless otherwise indicated, epoxy finishes for an area are to be applied after completing the Works in that area.

Epoxy finishes shall be completed in strict accordance with the manufacturer's method statements and product data sheet instructions. Although Sika products are used as basis products below, equivalent alternatives may be approved by the Engineer. A 10-year guarantee shall be given, in writing, on epoxy finishes.

Prior to applying finishes, edges and trim shall be masked off for neatness and areas adjacent to where the coatings are to be applied shall be protected from coating splatter, tearing, etc. (areas defaced by coatings are not acceptable and will be remedied at the Contractor's cost).

Concrete expansion joints are to be extended through the epoxy finish and sealed with Sikaflex Pro-3 or equivalent approved. If day joints are required and unavoidable, the Contractor shall have his proposed joint locations approved by the Engineer prior to commencing with work.

Unless otherwise indicated, where epoxy finishes abut other elements, where they cross over elements/interfaces and where there is a change from one finish to another, these interfaces shall be neatly finished off and fully sealed by applying a bead of Sikaflex Pro-3 at the interface (except for where cove skirting is used). For example, this would include applying a bead in corners where walls/plinths/columns meet the floor, where the finish abuts a support or other equipment, etc.

**Type 1: Epoxy-cement seal finish:**

The epoxy-cement seal finish shall consist of a 2mm thick layer of Sikagard 720 EpoCem. Where a thicker layer is specified, each coat will not exceed 2mm thickness.

**Type 2: Epoxy chemical resistant finish:**

The epoxy chemical resistant finish shall consist of 2x brushed coats of Sikafloor 161 or a 2mm thick layer of Sikagard 720 Epocem (as a primer / temporary moisture barrier), and at least 2x coats of Sikagard-63N (min. 0.25mm thick).

**Type 3: Epoxy finish:**

The epoxy finish shall consist of 2x brushed coats of Sikafloor-161 (for priming and to provide a levelled surface), followed by a 3mm thick (min.) Sikafloor-263 SL ZA wearing course (combined with Sikafloor Quartsand SS2). The finished colour shall be RAL 7038 unless otherwise indicated. All edges of the floor finish that do not terminate up against an element (i.e. do not terminate up against a wall, column, plinth, etc.) shall be edged with a 3mm aluminium straight edge trim (Kirk ASE030 or equivalent approved), installed in accordance with the specification provided at the start of this Subclause.

**Type 4: Epoxy broadcast finish:**

The epoxy floor broadcast finish shall be at minimum 4mm thick and shall consist of 1-2 brushed coats of Sikafloor-161 (for priming and to provide a levelled surface), followed by a Sikafloor-263 SL ZA base coat (combined with Sikafloor Quartsand SS2), followed by a broadcast layer of 0.4-0.7mm quartz sand and finished with a Sikafloor-264 ZA seal coat. The finished colour shall be RAL 7038 unless otherwise indicated. All edges of the finish that do not terminate up against an element (i.e. do not terminate up against a wall, column, plinth, etc.) shall be edged with a 3mm aluminium straight edge trim (Kirk ASE030 or equivalent), installed in accordance with the specification provided at the start of this Subclause.

**Type 5: Epoxy cove skirting:**

The epoxy cove skirting shall have a 25mm radius cove and be 100mm high. The top edge shall be neatly finished with a 6mm aluminium straight edge trim (Kirk ASE060 or equivalent approved) as a stop end.

The skirting shall be formed with Sikafloor-161 mortar bulked up with clean sand and overcoated with Sikafloor-263 SL ZA or Sikafloor-264 ZA (as applicable to match the adjacent finish type and colour). The interface between the floor and the cove skirting shall be seamless.

The thickness of the completed cove skirting shall be 7mm at the top edge and at least 4mm at the bottom edge, and the bottom of the skirting shall tie in level with the finished floor (they shall meet without a step). This will require the concrete substrate near the bottom edge of the cove to be cut back slightly (no more than 5mm) before constructing the cove.



Any gaps between the substrate and aluminium trim due to the substrate not having a flat surface shall be filled with an approved mortar and finished to match the finish of the wall (not to be finished to appear similar to the aluminium trim).

**Type 6: Epoxy seal coat finish:**

The epoxy seal coat finish shall consist of 1x brushed coat of Sikafloor Garage (as a primer) and at least 2x seal coats of Sikafloor Garage. The finished colour shall be RAL 7035 unless otherwise indicated. Sikafloor-161 or equivalent repair mortar and primer shall be used to repair any minor damages to the substrate prior to applying the seal coat finish.

**Type 7: Epoxy roller coat finish:**

The epoxy roller coat finish shall consist of 1x brushed coat of Sikafloor Garage (as a primer) and at least 2x seal coats of Sikafloor-264 ZA. The finished colour shall be RAL 7038 unless otherwise indicated. For coating vertical surfaces, Sika Extender T shall be added to the seal coats.

**Type 8: Epoxy non-slip roller coat finish:**

The epoxy non-slip roller coat finish shall consist of 1x brushed coat of Sikafloor Garage (as a primer) and 1x coat of Sikafloor-264 ZA with Sika Extender T and 0.1-0.5mm quartz sand. The finished colour shall be RAL 7038 unless otherwise indicated.

**b) Polyurethane Finish**

Unless otherwise indicated, polyurethane finishes for an area are to be applied after completing the Civil Works but before commencing with M&E Works for that area.

Polyurethane finishes shall be completed in accordance with the manufacturer's method statements and product data sheet instructions. The polyurethane finish shall also include retaining/anchor groove openings (along joints, around openings and around the perimeter of all application areas to prevent curling or lifting of the products), and free edge grooves (for terminating the products so as to maintain the minimum product thickness as the product cannot be feathered at the edges).

Although Sika products are used as basis products below, equivalent alternatives may be approved. The finished colour shall be RAL 7037 unless otherwise indicated.

Prior to applying finishes, edges shall be masked off for neatness and areas adjacent to where the coatings are to be applied shall be protected from coating splatter, tearing, etc. (areas defaced by coatings are not acceptable and will be remedied at the Contractor's cost).

Concrete expansion joints are to be extended through the polyurethane finish. Joints shall be sealed with Sikaflex Pro-3. Additional joints through the polyurethane finish shall be incorporated when necessary to ensure that any area of polyurethane finish enclosed by expansion joints does not exceed 16m<sup>2</sup>. The Contractor shall have the locations of these additional joints approved by the Engineer prior to commencing with work.

Unless otherwise indicated, where polyurethane finishes abut other elements, where they cross over elements/interfaces and where there is a change from one finish to another, these interfaces shall be neatly finished off and fully sealed by applying a bead of Sikaflex Pro-3 at the interface (except for where cove skirting is used). For example, this would include applying a bead in corners where walls/plinths/columns meet the floor, where the finish abuts a support or other equipment, etc.

A 10-year guarantee shall be given, in writing, on polyurethane finishes.

**Type 1: Polyurethane cement textured finish:**

The polyurethane cement textured finish shall consist of a 6mm thick (min.) layer of Sikafloor-20 PurCem. All edges of the finish that do not terminate up against an element (i.e. do not terminate up against a wall, column, plinth, etc.) shall be edged with a 6mm aluminium straight edge trim (Kirk ASE060 or equivalent approved), installed in accordance with the specification provided at the start of this Subclause.

**Type 2: Polyurethane cement smooth finish:**

The polyurethane cement smooth finish shall consist of 1.5mm (min.) scratch coat of Sikafloor-21 PurCem followed by a 4.5mm thick (min.) layer of Sikafloor-21 PurCem. All edges of the finish that do not terminate up against an element (i.e. do not terminate up against a wall, column, plinth, etc.) shall be edged with a 6mm aluminium straight edge trim (Kirk ASE060 or equivalent approved), installed in accordance with the specification provided at the start of this Subclause.

**Type 3: Polyurethane cement cove skirting:**

The polyurethane cement cove skirting shall have a 25mm radius cover and be 100mm high with the top edge finished neatly at a right angle. The skirting shall be formed with Sikafloor-29 PurCem detailing mortar overcoated with 2 layers of Sikafloor-31 PurCem. The thickness of the completed cove skirting at the top and bottom edge shall match the thickness of the abutting floor finish, with the cove being thicker. The bottom of the finished cove shall tie in level with the finished floor (they shall meet without a step). Unless otherwise indicated, the interface between the top edge of the skirting and the substrate shall be neatly finished and fully sealed by applying a bead of Sikaflex Pro-3.

**c) Quartz-encapsulated Resin Finish**

Unless otherwise indicated, quartz-encapsulated resin finishes for an area are to be applied after completing the Works in that area. The finished colour shall be light grey unless otherwise indicated.

Quartz-encapsulated resin finishes shall be completed in strict accordance with the manufacturer's method statements and product data sheet instructions. Although Flowcrete and Sika products are used as basis products below, equivalent alternatives may be approved by the Engineer. A 10-year guarantee shall be given, in writing, on quartz-encapsulated resin finishes.

Prior to applying finishes, edges and trim shall be masked off for neatness and areas adjacent to where the coatings are to be applied shall be protected from coating splatter, tearing, etc. (areas defaced by coatings are not acceptable and will be remedied at the Contractor's cost).

Concrete expansion joints are to be extended through the resin finish and sealed with Sikaflex Pro-3. If day joints are required and unavoidable, the Contractor shall have his proposed joint locations approved by the Engineer prior to commencing with work.

Unless otherwise indicated, where quartz-encapsulated resin finishes abut other elements, where they cross over elements/interfaces and where there is a change from one finish to another, these interfaces shall be neatly finished off and fully sealed by applying a bead of Sikaflex Pro-3 at the interface (except for where cove skirting is used). For example, this would include applying a bead in corners where walls/plinths/columns meet the floor, where the finish abuts a support or other equipment, etc.

**Type 1: Quartz-encapsulated resin finish:**

The quartz-encapsulated resin finish shall be a 4mm thick Flowcrete Peran STB system with a power floated finish, and shall consist of various layers specified by the manufacturer including Flowprime, Scatter 3, Peran STB Slurry, STB Coloured Quartz, Peran STB Sealcoat and UV resistant Super Satin Sealer.

All edges of the finish that do not terminate up against an element (i.e. do not terminate up against a wall, column, plinth, etc.) shall be edged with a 3mm aluminium straight edge trim (Kirk ASE030 or equivalent approved), installed in accordance with the specification provided at the start of this Subclause.

#### **Type 2: Quartz encapsulated cove skirting:**

The quartz-encapsulated resin cove skirting shall be Flowcrete Peran STB cove skirting to match the adjacent flooring system. The interface between the floor and cove shall be seamless.

The skirting shall have a 25mm radius cove and be 100mm high. The top edge shall be neatly finished with a 6mm aluminium straight edge trim (Kirk ASE060 or equivalent approved) as a stop end.

The skirting shall comprise of Flowtex F1 Coving resin (natural) as a primer, followed by forming the cove with Flowtex F1 coving resin mixed with STB Coloured Quartz. The coving shall then be completed with topcoats and seal coats as recommended by the floor finish manufacturer such that the skirting matches the adjacent Flowcrete Peran STB system floor.

The thickness of the completed cove skirting shall be 7mm at the top edge and 4mm at the bottom edge, and the bottom of the skirting shall tie in level with the finished floor (they shall meet without a step). If required by the manufacturer, the concrete substrate near the bottom edge of the cove shall be cut back slightly (no more than 5mm) before constructing the cove to ensure the minimum required thickness is maintained.

Any gaps between the substrate and aluminium trim due to the substrate not having a flat surface shall be filled with an approved mortar and finished to match the finish of the wall (not to be finished to appear similar to the aluminium trim).

#### **d) HDPE anchor-knob sheeting**

A protective lining to soffit and walls shall be manufactured from 3mm thick HDPE with anchor knobs which will be cast into concrete. The HDPE anchor-knob sheeting shall be fit-for-purpose with a proven history in the environment into which it is to be placed. The lining shall be sealed or fusion welded to be watertight at all joints in strict accordance with the manufacturer's specifications. A trial panel shall be prepared by the Contractor for the Engineer's approval.

#### **e) Calcium Aluminate Cement Lining**

A Calcium Aluminate Cement lining is to be applied to the concrete surface post-cast (or to existing concrete), in strict accordance with the manufacturer's specifications. A trial panel shall be prepared by the Contractor for the Engineer's approval.

#### **f) Microbial Protective Admixture**

The concrete mix shall be designed with the inclusion of a microbial protective admixture (Penetron BIOMIC, Xypex Bio-San C500 or equivalent approved) to provide protection against biogenic acid attack and subsequent concrete spalling and rebar corrosion in highly corrosive environments. Quantity of admixture to be batched in the concrete mix will be as per manufacturer's recommendations and the costs of the admixture shall be deemed to be included in the cost of the rates for concrete.

### **PSG 5.5.27 Construction of weir crests**

Weir crests shall be constructed to the tolerances provided in 6.2.1 and finished surfaces shall have a smooth finish. Rounded/chamfered/flat weir crests shall be constructed monolithically with the final wall cast (i.e. from the below designated joint level, or approved non-designated joint level, up to top of concrete weir level). The Contractor shall, prior to casting, provide a method statement for construction of each weir type for approval by the Engineer. Creating

the weir profile with a cement mortar (or any other proprietary product) will not be accepted, nor will delamination of the concrete surface be accepted.

**PSG 5.5.28      Temperature measurement and monitoring of concrete**

The temperature of thick concrete sections (where indicated on the drawings and/or in the bill of quantities) shall be monitored for 14 days after it has been cast:

This shall be achieved by installing thermocouples and storing the data on a data logger. Each of the panels/elements shall have one set of thermocouples. One set will consist of 5 thermocouples installed at various heights/levels (as instructed by the Engineer) within the concrete section. The thermocouples shall be wired to a central weatherproof terminal box provided by the contractor, and each set shall also include a wire for measuring ambient temperature. The terminal box shall be a lockable, polycarbonate, pole mounted, weatherproof box of at least 300x400x200mm and shall be placed in an easily accessible position well above the water table. One 230V switched socket outlet shall be allowed for inside the weather box.

The contractor will undertake the monitoring of the thermocouples and will record and report readings to the Engineer on a daily basis. If an acceptable temperature gradient in the concrete has been observed before the end of the 14 day period, the Engineer may instruct the contractor to stop monitoring."

**PSG 6              TOLERANCES**

**PSG 6.2           PERMISSIBLE DEVIATIONS**

**PSG 6.2.1        General**

*REPLACE THE LAST SENTENCE OF SUBCLAUSE 6.2.1 WITH THE FOLLOWING:*

"If no degree of accuracy is specified, the following shall apply:

Degree of Accuracy I shall apply to the following structures/components of the Works, as well as further accuracy requirement where so stated:

- a) Top of weirs, including all weir crest surfaces.
- b) All precast units
- c) Reinforced concrete dome roofs on reservoir structures (as well as further accuracy requirement as stated on drawings)

Degree of Accuracy II shall apply to all other structures/components of the Works, unless specified otherwise on the drawings.

Every specified permissible deviation is binding in itself. The cumulative effect of permissible deviations will not be considered. The maximum permissible vertical deviation is subject to the other permissible deviations."

**PSG 6.2.3        Specified PDs**

*ADD THE FOLLOWING:*

*REPLACE SUBCLAUSE 6.2.3(a)(3) WITH THE FOLLOWING:*

"Cover to reinforcement (see (e) below) .....

Permissible deviation		
Degree of accuracy		
III	II	I
mm	mm	mm
-0+10	-0+10	-0+10

"

REPLACE SUBCLAUSE 6.2.3(d)(5) WITH THE FOLLOWING:

"Verticality, per metre of height .....  
subject to a maximum of ....."

Permissible deviation		
Degree of accuracy		
III	II	I
mm	mm	mm
5 50	3 30	2 10

"

ADD THE FOLLOWING SUBCLAUSE:

**“PSG 6.2.4      Special tolerances for settling tank walls**

The top of circular concrete ring-walls that are to support rotating mechanical platforms shall have a vertical tolerance of +/- 2mm from the specified level.

In addition, the level variance shall not exceed 3mm over any 1m length.

The setting out of such circular walls (in plan) and the verticality of the walls shall be to Degree of Accuracy I (noting PSG 6.2.3(d)(5)).”

**PSG 7      TESTS**

**PSG 7.1      FACILITIES AND FREQUENCY OF SAMPLING**

**PSG 7.1.1      Facilities**

ADD THE FOLLOWING:

"The Contractor shall provide sufficient storage capacity on site for the concrete cubes and shall arrange to have them tested by an approved laboratory.

Site sampling methods and storage shall be in accordance with SANS5861-3:2006.

The cost of all testing, including the cost of sampling, storage and transport of samples shall be included in the rates tendered for concrete work."

**PSG 7.1.2      Frequency of Sampling**

ADD THE FOLLOWING:

"One sample shall consist of three concrete test cubes.

For each sample taken the position in the structure shall be recorded where the batch represented by that sample is placed."

**PSG 7.2      TESTING***ADD THE FOLLOWING NEW SUBCLAUSES***“PSG 7.2.5      Watertightness test****PSG 7.2.5.1      General**

The Works will not be certified Practically Complete until the structures and concrete roofs have been proved by testing to be watertight to the satisfaction of the Engineer. If required by the Engineer, the structure shall be retested during and before the expiry of the Defects Liability Period.

**PSG 7.2.5.2      Water-retaining structures**

Watertightness testing shall be undertaken on all water retaining structures, with each component tested independently of adjacent components. i.e. if two water-retaining components share a wall then they shall not be tested at the same time. If any existing structures are being retained and refurbished for use as part of the upgrade, then these structures shall be tested prior to any modifications to the structure and again after construction has been completed.

Any openings in the structure, including those allowed for equipment to be provided at a later stage by the Mechanical and Electrical Contractor, shall be fitted with temporary watertight closures. The closures shall be fabricated from steel plate of thickness determined by the Contractor, but with a minimum of 5 mm. The closures shall be provided with suitable seals and shall be held in place by props or anchor bolts.

Water for testing shall be provided by the Contractor and he shall be responsible for providing all necessary equipment that may be required for filling the structures. Potable water shall be used for testing of some of the water retaining structures, and tendered rates are to include the supply and use of potable water. To reduce the demand of potable water supply required for water tightness testing, the structures to be tested with potable water will need to be tested in series. The structures listed below shall be tested with potable water:

- Second Class Water Reservoir

For the balance of the structures to be water tightness tested the water for testing may be obtained from the treated effluent stream of the existing treatment system on site, the contractor shall be responsible for providing all necessary equipment that may be required for filling the structures. Treated effluent may only be used provided that the water is withdrawn after the point of final disinfection and provided the draw-off rate does not exceed that given below. The structures listed below shall be tested with treated effluent.

- Inlet works
- Settled Effluent Sump
- Flow splitter/diversion/mixing structures
- Collection/ancillary chambers

Should earth-backfilling of the structure be required, watertightness testing shall be conducted prior to backfilling to facilitate the detection of leaks, unless otherwise approved by the Engineer.

The structures shall be tested as follows:

The structure shall be filled with water at a uniform rate not exceeding 2,0 m in 24 hours until the top water level/full supply level has been reached. The top water level is stated on the drawings and if unclear, should be provided by Engineer. Structures should not be allowed to overtop/overflow. The water level will then be carefully noted and recorded by the Engineer in relation to a fixed bench-mark, and shall be maintained by the addition of further water for a stabilizing period to permit complete absorption of water by the concrete.

The stabilizing period should be 21 days. After the stabilizing period, the level of the liquid surface shall be recorded at 24 hour intervals for a test period of 7 days. During this 7-day test period the total permissible drop in level, after allowing for evaporation, shall not exceed 1/500<sup>th</sup> of the average water depth of the full structure, or 10 mm, whichever is less.

The evaporation shall be measured by the mean drop in level caused by the evaporation of the water in three flat containers floating in the water being recorded.

In the event of appreciable leakage or dampness being evident at any stage of the filling or testing or in the event of the Engineer considering the final degree of watertightness to be unsatisfactory, the Contractor when ordered by the Engineer shall discontinue such filling or testing and shall, at his own expense, take approved steps immediately to rectify the leakage, until a satisfactory test is obtained, which shall prove to the Engineer that a sufficient degree of watertightness has been obtained. T

e costs of retesting the structure for watertightness shall be borne by the Contractor. The time required for testing and all remedial work shall be part of the Contract time.

The Contractor shall empty the structure once the structure has passed the watertightness test, unless otherwise instructed by the Engineer. On successful completion of the watertightness test, the Contractor shall remove the temporary watertight closures, along with any anchor bolts, and shall grout the holes allowed for the anchor bolts with a non-shrink grout approved by the Engineer.

The costs of emptying a water-retaining structure which cannot be drained shall be borne by the Contractor. The water shall be discharged in a manner approved by the Engineer and shall be such that the employer can utilize the water if he so desires. The water shall not be used as a medium for additives to effect remedial work or to stop leaks.

#### **PSG 7.2.5.3     Concrete roofs of structures and of water-retaining structures**

All concrete roofs (whether receiving a waterproof finish or constructed from watertight concrete) shall be watertightness tested. Testing shall be done after applying the waterproof finish (if applicable) by ponding the roof with at least 25mm of water for 24 hours. For domed or sloped slabs where ponding is not practical, each section of the roof shall be continuously hosed or irrigated using a sprinkler system whereby every part of the rooftop remains drenched for 24 hours. The slab or roof will be considered satisfactory if no leaks or damp patches are visible from the underside during or following the tests. For water-retaining structures, concrete roofs shall be tested for watertightness before the structure is filled for watertightness testing.

#### **PSG 7.2.6     Grouting tests**

The Contractor shall, where so ordered, carry out a site test for each grouting procedure and each grouting gang to be used. The tests shall be carried out on a dummy bedplate similar in configuration to that which is to be grouted, but not exceeding 1 m<sup>2</sup> in area unless otherwise ordered. When the dummy bedplate is dismantled, the underside shall show a minimum grout contact area of 80% with reasonably even distribution of the grout over the surface grouted except that, in the case of expanding grout, the minimum grout contact area shall be 95%. The test shall show evidence of good workmanship and materials and the results shall be to the satisfaction of the Engineer.

The Contractor shall, when so ordered, make standard test cubes from various grout mixtures and also subject them to compression tests to determine whether the specified strength has been achieved. Test procedures shall comply with the relevant requirements of Subclause 7.2.1 to 7.2.3."

#### **PSG 7.3     ACCEPTANCE CRITERIA FOR STRENGTH CONCRETE**

*ADD THE FOLLOWING:*



"Test results obtained from the supplier of ready-mixed concrete will not be accepted for evaluation in terms of Subclause 7.3, but samples for testing shall be taken of such concrete at the point of placing."

**PSG 8                    MEASUREMENT AND PAYMENT**

**PSG 8.1                MEASUREMENT AND RATES**

**PSG 8.1.1            Formwork**

*DELETE "and of fillets or splays over 20 mm x 20 mm" FROM THE FIRST LINE OF SUBCLAUSE 8.1.1.2.*

*ADD THE FOLLOWING TO SUBCLAUSE 8.1.1.2:*

"Splays, chamfers and fillets up to and including 40 mm x 40 mm will not be measured separately and will be deemed to be included in the formwork costs."

*ADD THE FOLLOWING TO THE END OF SUBCLAUSE 8.1.1.3:*

"

- f) For back shuttering or formwork to top of revealed sloping or conical surfaces which will only be measured to surfaces of 35° and up to 85°."

*ADD THE FOLLOWING TO THE END OF SUBCLAUSE 8.1.1:*

**"PSG 8.1.1.7** "For construction joints at kickers (in accordance with PSG 5.5.7), all additional costs for formwork to edges up to 300 mm high (vertical kickers) will be deemed to be included in the rates tendered for vertical formwork to sides of walls and will not be measured separately in narrow widths.

**PSG 8.1.1.8** No formwork will be measured to edges of blinding layers and no-fines concrete under structures and the cost thereof, (if needed), will be deemed to be included in the rates tendered for concrete in blinding layers and no-fines concrete as applicable.

**PSG 8.1.1.9** Formwork to horizontal surfaces in enclosed structures/chambers such as valve chambers, manholes or sumps shall either be removed through the manhole cover opening or the Contractor may use permanent formwork at his own cost as no claims in this regard will be considered.

**PSG 8.1.1.10** Larger splays, chamfers or fillets over 40mm will be measured by length in accordance with 8.2."

**PSG 8.1.2            Reinforcement**

*REPLACE THE CONTENTS OF THIS SUBCLAUSE WITH THE FOLLOWING:*

"The unit of measurement for steel bars shall be the ton of reinforcement in place, in accordance with the drawings or as authorised by the Engineer.

The unit of measurement for welded steel fabric shall be the kilogram of fabric reinforcement in place, and the quantity, in kilograms, shall be calculated from the net area covered by the mesh, excluding overlaps.

The tendered rate shall include full compensation for the supply, delivery, cutting, bending, welding, placing and fixing of the steel reinforcement, including all tying wire, stools, supports and waste."

**PSG 8.1.3            Concrete**

*DELETE ", or the plan size of the excavation where additional excavation is provided to facilitate erection of forms" FROM THE SECOND LINE OF SUBCLAUSE 8.1.3.1(c).*



ADD THE WORDS “(including requirements for trial mixes)” AFTER THE WORDS “design of the mix” in line 1 of Subclause 8.1.3.3.a).

DELETE THE WORDS “(made with ordinary Portland cement unless otherwise scheduled)” IN LINE 2 OF SUBCLAUSE 8.1.3.3.a).

ADD THE WORDS “, non-designated joints” AFTER THE WORDS “stop-ends” IN LINE 3 OF SUBCLAUSE 8.1.3.3.a).

REPLACE THE WORDS “and curing” WITH “curing and immediate protection of concrete,” IN LINE 4 OF SUBCLAUSE 8.1.3.3.a).

ADD THE FOLLOWING TO THE END OF SUBCLAUSE 8.1.3.3:

“e) The rates for concrete shall also cover other concrete-related requirements specified but which are not scheduled separately.”

#### **PSG 8.2.6      Box Out Holes/Form Voids**

ADD THE FOLLOWING LIST ITEMS TO 8.2.6

“(e) Larger, circular, of diameter over 0.7m up to and including 1.5m .....Unit : No.  
Depths as in (a) above.

(f) Larger, other than circular, of area over 0.5m<sup>2</sup> up to and including 1.5 m<sup>2</sup> .....Unit : No.  
Depths as in (a) above.

(g) Larger, other than circular, of area over 1.5m<sup>2</sup> up to and including 2.5 m<sup>2</sup> .....Unit : No.  
Depths as in (a) above.

Etc. for additional size categories as stated in the Bill of Quantities.”

#### **PSG 8.3      SCHEDULED REINFORCEMENT ITEMS**

##### **PSG 8.3.2      High-Tensile Welded Mesh**

REPLACE “Unit : m<sup>2</sup>” with “Unit : kg”.

#### **PSG 8.4      SCHEDULED CONCRETE ITEMS**

##### **PSG 8.4.3      Strength concrete:**

REPLACE WITH THE FOLLOWING:

“The grade and positions or elements in the Works will be stated. The type of cement and blended extender (if applicable) shall be as specified herein, or on drawings or Bill of Quantities.

“In the case of structural floor screeds, the unit of measurement shall be the square metre and the average thickness and proportions will be stated.”

##### **PSG 8.4.4      Unformed surface finishes:**

REPLACE “Unit: m<sup>2</sup>” with “Unit: m or m<sup>2</sup>”

#### **PSG 8.5      JOINTS**

ADD THE FOLLOWING:

Only designated joints as shown on the drawings will be measured for payment according to the length of each type of joint installed and constructed (see 2.4.3). The rate shall cover the

cost of all materials, labour and plant required to construct each type of joint scheduled, complete as specified on the drawings (including waterbars, sealants, dowels etc.) and shall further include the cost of all shuttering, preparation of concrete (as specified in 5.5.7) etc.

Non-designated joints (2.4.3) shall not be paid for separately and shall be assumed to be included in the various rates for concrete, reinforcing and formwork (this includes preparation of concrete to form non-designated construction joints)."

**PSG 8.7****GROUTING**

*REPLACE THE LAST SENTENCE OF SUBCLAUSE 8.7 WITH THE FOLLOWING:*

"The rate shall further include all formwork necessary to complete the work."

*ADD THE FOLLOWING TO SUBCLAUSE 8.7 (a):*

"Grouting in of equipment (such as base plates for machines) provided by the Contractor or by the Mechanical and Electrical Contractor will be measured by the volume of grout used.

The rate shall cover the cost of meeting the requirements of 5.5.19, and the supply and floating in of grout under the plates to ensure solid and complete filling of the gap."

*REPLACE SUBCLAUSE 8.7(b) AND ITS HEADING WITH THE FOLLOWING:*

"b) HD bolts

Unit: No.

Separate items will be scheduled for different diameters, lengths, and types. The quantity measured will be the number of bolts grouted in. No deduction will be made for bolts and packers protruding into the grout space."

*ADD THE FOLLOWING TO THE END OF THE SUBCLAUSE 8.7:*

"c) Grouting around pipes etc:

Unit: m<sup>3</sup>

If so scheduled, grouting around pipes and other mechanical equipment in boxouts or voids in concrete members will be measured by the volume of grout necessary to fill the voids and pockets between the outside surface of the pipe or mechanical equipment and the surface of the concrete wall/slab. The rate shall cover the cost of meeting the requirements of 5.5.16(c) and shall include all formwork necessary to complete the work. Grouting shall be watertight."

*REPLACE SUBCLAUSE 8.8 AND ITS HEADING WITH THE FOLLOWING:*

**"PSG 8.8****HD BOLTS AND MISCELLANEOUS METAL WORK:**

*REPLACE SUBCLAUSE 8.8 AND IT'S HEADING WITH THE FOLLOWING:*

"8.8 HD bolts (cast in and/or supply)  
or No.

Unit: t

- a) Supply and casting in of HD bolts. The rate shall cover the cost of supplying, delivering and casting into concrete HD bolts as specified, and all cleaning, preparation, and finishing. The rate shall also cover the cost of meeting the requirements of 5.5.23, and all items and operations necessary to ensure that the bolts are effectively and rigidly held in position during casting, complete with sleeved pockets, all as detailed on the drawings.
- b) Casting in of HD bolts. The rate shall cover the cost of taking delivery of HD bolts supplied by others, casting into concrete as specified, and all cleaning, preparation, and finishing. The rate shall also cover the cost of meeting the requirements of 5.5.23, and all items and operations necessary to ensure that the bolts are effectively and rigidly held in position during casting, complete with sleeved pockets, all as detailed on the drawings.

HD bolts that are already included in other rates (such as SANS 1200 H Subclause 8.3.1), will not also be measured here.”

*ADD THE FOLLOWING NEW SUBCLAUSES:*

**PSG 8.9      IMPERVIOUS DPC MEMBRANE UNDER CONCRETE SLABS:      Unit : m<sup>2</sup>**

The impervious DPC membrane under concrete slabs (375 micron unless specified otherwise on the drawings or in the Bill of Quantities) consisting of DPC/DPM/PVC sheets as indicated on the drawings will be measured by the surface area covered (laps and wastage are not measured). The rate shall cover the cost of the supply, laying, jointing of sheets as recommended by the supplier and final trimming of outer edges.

**PSG 8.10      NO-FINES CONCRETE:      Unit : m<sup>2</sup>**

No-fines concrete will be measured by area (unit of measurement shall be square meter) to the thickness as shown on the drawings or as scheduled. The provisions of subclause 8.1.3 of SANS 1200 G shall apply *mutatis mutandis* and the rate shall include for the geotextile bidim, steel-floated 20mm mortar skim.

**PSG 8.11      SPECIALIST CRYSTALLIZING ADDITIVES TO CONCRETE:      Unit : m<sup>3</sup>**

The unit of measurement shall be the cubic metre (extra-over) of concrete for the addition of a concrete crystallising waterproofing additive (Xypex C500NF, Penetron Admix or equivalent approved) to exact manufacturer's specifications.

**PSG 8.12      GRANOLITHIC SCREEDING      Unit : m<sup>2</sup>**

Granolithic screeding will be measured as the square metre of screeds constructed (in plan view) to the average thickness as specified. The unit rate shall cover the cost of all materials, labour and equipment for the supply and application of the specified material, complete as specified in 5.5.25. Where a screed to fall is specified, the average thickness shall be stated. Repairs to unsatisfactory work will not be paid for. The rate shall also include the required float finish.

**PSG 8.13      CASTING ITEMS IN CONCRETE**

Casting items in concrete members (where so scheduled separately) will be measured by number for each type or range of items. The rate shall cover all costs related to fixing in position, formwork and casting in the item, including meeting the requirements of 5.5.16(b), 5.5.16(c) and 5.4. Where not scheduled separately, the rate for the applicable item shall include casting the item in concrete.

If the Contractor chooses (subject to the Engineer's approval) to box out a hole and cast the item in subsequently, instead of casting the item into the concrete member simultaneously to casting of the concrete member, this rate shall also cover these activities and the requirements of 5.5.16(a).

**PSG 8.14      CREATING BOXOUTS IN CONCRETE FOR OTHERS TO CAST ITEMS IN**

Box-outs created in accordance with 5.5.16(a) for items to be cast in concrete by others will be measured by number separately for each type of item or range of items.

The rate shall cover the cost of creating the box-out, maintaining continuous reinforcing, removing all formwork and boxing remaining in the holes, and thoroughly scabbling the sides of the holes so as to obtain a satisfactory bond surface for the new concrete, as described in 5.5.16(a). As this rate already includes for creating box-outs, no additional payment will be made under 8.2.6.

<b>PSG 8.15</b>	<b><u>PRECAST PAVING SLABS</u></b>	Unit : m <sup>2</sup>
	Precast paving slabs will be measured by the area paved.	
	The rate shall cover the cost of compacting the area, application of weed-killer, supplying, laying and bedding the slabs, grouting the joints and filling any gaps, all as specified.	
<b>PSG 8.16</b>	<b><u>MISCELLANEOUS/MINOR REINFORCED CONCRETE/BRICK STRUCTURES</u></b>	Unit : Sum
	Where minor reinforced concrete and brick structures have been scheduled in the Bill of Quantities, the sum tendered for each item shall cover the cost of all material (including handrailing, banded grating, flooring, ladders where applicable, weir plates and handstops), plant and labour involved in constructing the said item (including 0,12 t of high tensile steel per m <sup>3</sup> of concrete where the amount of reinforcement is not indicated on the drawings) according to the drawings and relevant specifications.	
	Unless otherwise stated in the Bill of Quantities, the sum tendered shall also cover the cost of all excavation and backfilling, and if applicable, watertightness testing.	
<b>PSG 8.17</b>	<b><u>BREAKING INTO AND BUILDING ON TO EXISTING STRUCTURES</u></b>	Unit : Sum
	Where it is necessary for the Contractor to break into and/or build into or onto an existing structure, such an activity shall be measured and paid by the sum.	
	The sums tendered shall cover the cost of dealing with the water (and/or any other contents) in the existing structure (where applicable), breaking away existing concrete, penetration of exposed concrete surfaces, supply and application of a wet to dry epoxy, liaison with the Engineer and the Employer to facilitate the work as specified and all materials or activities not measured elsewhere to complete the construction as specified including joining materials, supply and epoxying in of dowel bars etc.	
	Where it is required to break into existing structures in order to build in new pipes, the rate tendered shall cover the cost of ensuring that a watertight seal is achieved.	
<b>PSG 8.18</b>	<b><u>EMPTYING OF EXISTING STRUCTURES</u></b>	Unit : m <sup>3</sup>
	The unit of measurement shall be the cubic meter of water/sludge/sand/grit removed, as well as any applicable transport and disposal costs. The following broad categories will be specified:	
	(a) Pumping of water/sludge to adjacent or nearby structure/location as instructed as specified.	
	(b) Manual removal of sludge/sand/grit to specified location.	
	For (b) above, "manual" implies removal by hand unless otherwise specified. If the location is specified off-site in the Bill of Quantities or by the Engineer, then the rate supplied by the Contractor will include haulage and any disposal permit costs. Hazardous waste needs to be disposed of appropriately at an appropriate disposal facility.	
<b>PSG 8.19</b>	<b><u>CLEANING OF EXISTING STRUCTURES</u></b>	Unit : m <sup>2</sup>
	The unit of measurement shall be the square meter of surface to be cleaned. The minimum pressure rating of the water-jet (if applicable) will be stated in the Bill of Quantities. The surface must be accepted by the Engineer as cleaned of any dirt, grease, stains and other contaminants to an acceptable standard.	
<b>PSG 8.20</b>	<b><u>DOWELS</u></b>	Unit : No.
	Separate items will be scheduled for each reinforcing diameter.	
	The unit of measurement shall be the number of dowels installed with a suitable epoxy anchor grout designed for reinforcing bars (Fischer FIS EM Injection Mortar, Sika Anchorfix II, Hilti	

HIT RE 500 or approved equivalent) to exact manufacturer's specifications to a minimum embedment depth as indicated below:

Size	Minimum Embedment Depth (mm)
R/Y10	150
R/Y12	150
R/Y16	200
Y20	300
Y25	400

Where dowels are required, the holes are to be drilled with a masonry/percussion drill-bit not capable of cutting through reinforcing.

The tendered rate shall include full compensation for drilling and installation of the dowels and the epoxy anchor-grout. The reinforcing bars shall be measured under PSG 8.1.2.

**PSG 8.21 WATERTIGHTNESS TESTING**

Unit: Sum

Watertightness tests shall be paid by a lump sum separately for each structure. The sum or number shall cover the cost of all water, labour, equipment and materials to carry out the tests, as specified in 7.2.5, including all that is required for the installation of temporary watertight closures and associated props/anchors for openings. It shall also include the rectifying of faults and re-testing to achieve a test result to the satisfaction of the Engineer. No extra payment will be made for re-testing during the Defects Liability Period if leaks in the structure have been observed, thus leading to the Engineer's instruction to undertake the re-testing.

**PSG 8.22 STERILISATION OF WATER-RETAINING STRUCTURES**

Unit: Sum

The tendered sum shall include full compensation for sterilizing the structure as specified.

**PSG 8.23 CONCRETE PROTECTION AND PROPRIETARY FLOOR FINISHES**

Unit : m<sup>2</sup>

The unit of measurement shall be the square metre of finish required, but with skirting measured per meter (see 5.5.26 for finishes). Separate items will be scheduled for each type of finish required. The tendered rates shall include full compensation for all labour, plant, equipment, material, transport, etc., substrate preparation and providing and installing all products necessary to complete the concrete protection/finish, inclusive of trim (e.g. aluminium edging), grooves, joints and sealing of interfaces.

Steel or timber skirting (excluding trim which is included in the rate for the finish) shall be measured and paid for elsewhere (steel skirting under SANS 1200 H and timber skirting under Specification PD).

**PSG 8.24 PREPARATION OF BASE CONCRETE TO RECEIVE BENCHING**

Unit : m<sup>2</sup>

The unit of measurement shall be the square metre of base concrete to be prepared for receiving benching. The rate shall cover chipping/scabbling the base concrete to remove all laitance and expose the aggregate over 100% of the area to be benched using mechanized plant such as scabblers or abrasive blasters. The rate shall further include cleaning the surface from all dust and debris by scrubbing and/or high pressure wash, followed by soaking the surface with water for at least 24 hours.

**PSG 8.25      APPLICATION OF AN EXPANSION/MOVEMENT JOINT BRIDGING FLEXIBLE WATERSTOP      Unit : m**

Joint bridging flexible waterstops specified on the joint detail drawings (for example 'Joint W') are deemed to be included in the rate for joints (see 8.5) and shall not be measured here also.

The unit of measurement shall be the meter running length of proprietary product applied. The tendered rates shall include full compensation for:

Application of a 200mm wide, 2mm thick Sika CombiFlex SG system (or equivalent approved), including all preparation and epoxy adhesive, joints, etc., by a supplier-approved applicator between concrete edges to provide a water-tight seal to the exact manufacturer's specifications.

**PSG 8.26      SWELLABLE WATERSTOP      Unit : m**

Swellable waterstops specified on the joint detail drawings (for example 'Joint V') are deemed to be included in the rate for joints (see PSG 8.5) and shall not be measured here also.

The unit of measurement shall be the meter running length of proprietary product applied. The tendered rate shall include full compensation for:

Application of SikaSwell S-2 sealant + Sikaswell A 2010 profile, or Xypex Kuniseal C-31 DS (or other equivalent approved products) by a supplier-approved applicator, including substrate preparation to provide a water-tight seal to the exact manufacturer's specifications.

**PSG 8.27      SHEAR LOAD CONNECTORS      Unit : as scheduled**

Where shear load connectors have been scheduled in the Bill of Quantities, they will be measured in the unit scheduled.

The sum or rate for such item shall cover the cost of all materials, labour and plant required to execute and complete the work as specified, described in the Bill of Quantities or shown on the drawing(s).

**PSG 8.28      MISCELLANEOUS WORK      Unit : as scheduled**

Separate items will be scheduled for each type of miscellaneous work as described in the Bill of Quantities and shown on the drawings (with drawing number stated). The unit of measurement shall be as scheduled in the Bill of Quantities. The tendered rates shall include full compensation for providing all labour, plant, materials, equipment and transportation etc. required to carry out the work, for all proprietary work, for preparation and construction of the work scheduled in a workmanlike manner and for finishing-off and cleaning up when the work has been completed."

**PSH STRUCTURAL STEELWORK (SANS 1200 H)****PSH 1 SCOPE**

No amendments.

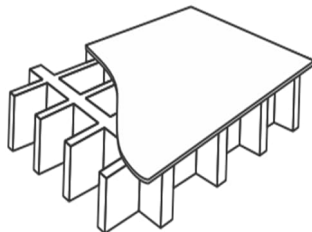
**PSH 2 INTERPRETATIONS****PSH 2.1 DEFINITIONS AND ABBREVIATIONS (SUBCLAUSE 2.3)**

*ADD THE FOLLOWING TO THE END OF THIS SUBCLAUSE:*

“HDG. Hot dip galvanized or hot dip galvanizing (steel), as applicable

SS. Stainless Steel

Covered open grid flooring” and “covered grating” shall be taken to mean open grid flooring with a permanently attached solid top steel cover of the same material and finish as the grid flooring. Figure 2.3a illustrates covered open grid flooring (unbanded).



**Figure 2.3a:** An example of covered open grid flooring (unbanded), cover partially removed for illustration.”

**PSH 3 MATERIALS****PSH 3.1 STRUCTURAL STEEL**

*ADD THE FOLLOWING AFTER THE FIRST SENTENCE OF SUBCLAUSE 3.1.1:*

“Steel shall be Grade S355JR for hot rolled steel sections. All members shall carry the Grade S355JR steel symbol to identify steel grade prior to manufacturing. Mill test certificates to be provided to the Engineer for all structural steel, prior to manufacture.”

**PSH 3.6 BOLTS, NUTS AND WASHERS****PSH 3.6.1 BOLTS AND NUTS (OTHER THAN FRICTION-GRIP)**

*ADD THE FOLLOWING:*

“All bolts, nuts and washers (i.e. fasteners) in the following categories shall be manufactured from Grade 316L stainless steel and shall have a nickel-based anti-seize compound applied along the full length of fastener threads before the nut is applied:

- Those with a diameter of 10mm or less.
- Those of any size used in conjunction with stainless steel items.
- All anchor fasteners of any size in concrete or brickwork, unless otherwise specified.
- All those within water-retaining structures, water-excluding structures or exposed to the rain.

All other bolts, nuts and washers, not listed in the categories above, shall be hot-dip galvanized (HDG) to SANS 121 and coated as per PSHC Subclause 5.12. HDG nuts shall be tapped before galvanizing, taking into consideration the extra clearance necessary to allow for the thickness of galvanizing on the bolts. If, after installation, there is any indication that



galvanising has been stripped from either the nut or the bolt, both nut and bolt shall be removed and replaced. In the case of protective coating being stripped after installation from either the nut or the bolt, refer to item d) in PSHC Subclause 5.12.

All bolts for structural steel shall be Class 8.8 bolts.”

**PSH 4      PLANT**

No amendments.

**PSH 5      CONSTRUCTION**

**PSH 5.1      DRAWINGS AND SHOP DETAILS**

**PSH 5.1.1      DESIGN DRAWINGS**

*ADD THE FOLLOWING:*

“The Contractor shall be solely responsible for the final verification of all steelwork dimensions including confirmation of all relevant dimensions on site) before preparing his shop drawings and manufacturing any steelwork components.”

**PSH 5.1.2      CONTRACTOR PROVIDES SHOP DETAILS**

*ADD THE FOLLOWING:*

“The Contractor shall be responsible for the preparation, in accordance with SANS 10162:2011, of shop drawings and/or details, drawn using Tekla or equivalent software. The drawings (including all applicable .IFC and .TBP files) shall be submitted for approval at least two weeks prior to commencement of fabrication. The Engineer will check the drawings for conformity with design requirements and will return the drawings with additions and corrections, if any, within ten working days of having received them. Detailed checking of shop details for dimensional accuracy and installation fit, will not be done by the Engineer.”

**PSH 5.2      FABRICATION**

**PSH 5.2.1      GENERAL**

*ADD THE FOLLOWING TO THE BEGINNING OF THE SUBCLAUSE:*

“Before commencing with any manufacturing or construction of structural steelwork, the Contractor shall confirm all relevant dimensions on site. Any discrepancies should be brought to the attention of the Engineer immediately.”

*ADD THE FOLLOWING TO THE END OF THE SUBCLAUSE:*

“The main structural members shall be single full length.”

**PSH 5.2.3      CUTTING**

*ADD THE FOLLOWING TO THE END OF THE SUBCLAUSE:*

“The edges of flame-cut plates shall be ground off and smoothed.”

**PSH 5.2.4      HOLES FOR FASTENERS**

*REPLACE THE CONTENTS OF SUBCLAUSE 5.2.4.2 WITH THE FOLLOWING:*

“Holes for fasteners shall be drilled.”

*REPLACE THE CONTENTS OF SUBCLAUSE 5.2.4.5 WITH THE FOLLOWING:*



“Punching of holes shall only be permitted with the written approval of the Engineer.”

*ADD THE FOLLOWING:*

**“PSH 5.2.7     WELDING**

All welders shall be coded welders.

Welding procedures and welder's performance qualifications shall conform to the requirements of AWS D1.1 (and/or SANS 15614-1). These documents/certificates must be submitted in writing to the Engineer and approved prior to the start of welding. Welding certificates are only valid for a period of 12 months. The Contractor shall also submit, for review, an outline of the Quality Control measures that will be enforced by the Contractor to ensure that specified welding procedures are adhered to.

All welds shall be 6 mm or larger continuous fillet welds, unless otherwise specified or agreed by the Engineer.

Welds shall be continuous on all sides of any joint. Welds which are only accessible from one side shall be prepared so that the root run provides an acceptable profile and prevents the formation of crevices. Crevices shall not be accepted.

No staggered or intermittent welding is permitted. Approved splicing of members will be subject to non-destructive testing. In addition, the Engineer may at his discretion identify any welds for non-destructive testing. The cost of testing shall be borne by the Contractor.

No welding on site is permitted unless approved by the Engineer. Any site welder and site welding procedure will have to be re-qualified for site welding.”

**PSH 5.3        ASSEMBLY**

**PSH 5.3.4     WELDING**

*ADD THE FOLLOWING TO THE END OF THE FIRST SENTENCE:*

“The requirements of PSH 5.2.7 shall apply.”

**PSH 5.3.9     PROTECTIVE TREATMENT**

*REPLACE THE CONTENTS OF THIS SUBCLAUSE:*

“Corrosion protection for all structural steelwork shall be done in accordance with SANS 1200 HC and particular specification PSHC.”

**PSH 5.5        ERECTION**

*ADD THE FOLLOWING:*

**“PSH 5.5.6     ANCHOR HOLES**

Drill bits used for creating anchor holes in concrete shall be incapable of cutting through reinforcing steel. The Contractor shall be responsible for accommodating the actual reinforcing positioning and avoiding reinforcing when drilling anchor holes. Any unused or discarded holes shall be cleaned and filled completely with the same chemical product approved for chemically anchoring the fasteners, unless an alternative product is approved. No additional payment shall be made for accommodating the reinforcing, including creating additional holes to achieve the required hole depths, filling unused holes, etc., which shall be included in the tendered price for steel items.

Anchor holes shall be prepared in strict accordance with the relevant chemical mortar/adhesive manufacturer's instructions. This typically includes allowing the substrate to cure beyond 28 days (as applicable), ensuring that the substrate is sound and moisture

content below the maximum allowed, clean, free from contaminants such as dirt, oil, grease, rust, coatings, etc.

After creating and preparing the anchor holes but before anchoring the applicable fasteners, reinforcing or other objects (as applicable), the Contractor shall make provision for the Engineer to inspect the hole depth and preparation. Anchoring shall only take place after receiving the Engineer's approval and after the Contractor's representative overseeing the anchoring has demonstrated to the Engineer that the chemical mortar/adhesive manufacturer's installation method is well understood."

## **PSH 5.6      GROUTING OF SUPPORTS**

*ADD THE FOLLOWING:*

### **"PSH 5.6.5      HOLDING-DOWN BOLTS AND GROUTING SUPPORTS**

The Contractor shall supply detailed layouts of holding-down (HD) bolts, as well as a suitable steel template of each type of HD bolt layout which can be used to accurately position the bolts."

## **PSH 5.7      SUNDRY ITEMS**

### **PSH 5.7.1      HANDRAILS**

*REPLACE THE CONTENTS OF THIS SUBCLAUSE WITH THE FOLLOWING:*

#### "Handrails

5.7.1.1 The terms "handrailing", "handrails" and "guard rails" shall all be synonymous. Handrails shall be of the type and shall be purpose made in the style and shapes given in the project specification and indicated on the drawings. Steel tubing shall comply with SABS 657: Part 1. The Contractor shall ensure, by making in-situ measurements before manufacture is started, that the handrails suit the situation in which they are to be installed. Handrails shall have a vertical height of at least 1 000 mm, measured from the top of the hand rail to the floor or surface. Where handrails terminate up against a wall or other barrier, the gap between the stanchion or closure bend (as applicable) and the barrier shall be less than 100 mm, unless the rails are fixed directly to the barrier (removable handrailing may not be fixed directly to the barrier).

Handrailing shall be supplied by one manufacturer and in one fully integrated style, complete with all the necessary fasteners, connections, corrosion protection, coatings, etc. Handrailing shall, unless otherwise annotated on drawings, be continuous, uninterrupted at changes in direction or angle, i.e. rails shall not terminate and restart at changes in direction or angle but be continuously connected and joined with bends and stanchions formed to suit the changes.

Notwithstanding the above, at the interface between fixed and removable handrailing, rails and kickplates (if applicable) shall be discontinuous, with rails and kickplates ending at stanchions (rather than rails ending with closer bends/returns) and the required c/c spacing for these interfacing stanchions shall be 135mm.

Typically, the handrailing illustrated on drawings for each structure is exclusively for providing a high-level indication of where handrailing is necessary and for annotating (if applicable) the type required. The detailed handrailing requirements to be followed are provided on the general "Handrailing Details" drawing and in these specifications.

5.7.1.2 Unless otherwise indicated on the drawings or in the Bill of Quantities, the complete handrailing system (rails, stanchions, base plates, bends, kickplates, etc.) but

excluding fasteners (which are specified elsewhere) shall be of stainless steel grade 316 material. The completed handrailing shall be of neat and workmanlike appearance, solidly and evenly supported, fastened in place, secure and tight under loading, true to line, level and plumb. Any gaps between stanchion base plates (stanchion feet) and concrete or brick surfaces shall be filled with non-shrink cementitious grout prior to final tightening of nuts. Where stanchion base plates are to be attached directly to metallic surfaces, Denso Tape (or equivalent approved) shall be fitted under the stanchion feet to prevent direct contact.

Unless otherwise indicated stanchions shall be top mounted (base mounted) to suit the arrangement requirements and shall be of welded construction. Stanchions which are hollow shall be self-draining. When anchoring top mounted or removable stanchions to brickwork or concrete, they shall be installed with their centre line 140 mm from the edge of a concrete slab or wall (unless otherwise indicated) and centred atop upstand beams. No stanchion shall be mounted with its centre closer than 300mm to a concrete or brickwork joint.

All handrailing joints, excluding kickplate joints which shall be bolted, shall be fully welded and smoothly finished without shoulders. Handrailing shall be free from sharp corners, edges and projections which may injure persons or damage clothing. Edges shall be rounded to a radius of at least 2 mm.

- 5.7.1.3 Handrail stanchion spheres shall be preformed with orientation to suit the situation in and the angle at which they will be installed. Incorrectly orientated stanchion spheres will not be accepted. Stanchions shall be spaced at no greater than 1 200 mm centres for horizontal handrails and 1 000 mm centres for sloping handrails, unless otherwise indicated on the drawings or approved by the Engineer. Stanchions for a particular run shall be evenly spaced after first positioning those required at end and corners.

Railings shall be ended off with positively fixed closure bends/returns or by fixing directly to a wall or other barrier if appropriate and approved by the Engineer. At corners, short radius bends with stanchions on both ends shall be employed or, alternatively, stanchions specifically manufactured for such a position shall be employed.

- 5.7.1.4 At certain positions where it shall be necessary to have infrequent access to parts of the works which shall normally be equipped with handrails, the Engineer may instruct that handrails over these short sections be omitted in favour of guard chains. A guard chain shall consist of a 6 mm diameter stainless steel grade 304 chain secured across stanchions with an M8 hook bolt on one end and an M8 eye bolt on the other. The bolts shall be fastened tightly to the stanchions and it shall only be possible to unhook the chain at one end. If alternative hook designs are approved by the Engineer, these hooks shall not be damaged nor undergo noticeable deflection when a point load of 1 500 Newtons is applied in a horizontal or downward direction to the secured guard chain.

- 5.7.1.5 Where kickplates are required, these shall be of the same material and receive the same coatings as the handrails (unless otherwise indicated) and provided along the full length of the handrailing system. Kickplates shall be at least 150 mm high unless otherwise indicated and fastened securely to the guard rails with M12 U-bolt fasteners. The top corners of kickplates shall be rounded to  $r=16\text{mm}$ .

For horizontal top mounted and removable handrailing, the kickplate shall be installed on the outside face of the handrailing (face furthest from the walkway centre). For horizontal side mounted handrailing, the kickplate shall be installed on the inside face of the handrailing.

At corners, kickplates shall be bent to suit the angle of the corner. Where kickplates meet, they shall overlap by 100 mm, separated by a 150 x 100 x 1.5 mm stiff solid neoprene (or equivalent) rubber strip and fastened together with 2 x M12 fasteners. These fasteners shall be orientated such that the bolt head ends of the fasteners point towards the centre of the walkway and ends with exposed threads point away from the walkway centre.

5.7.1.6 Should HDG handrailing be specified, the galvanizing shall be done in accordance with SANS 121 and SANS 10064, and all fabrication, sizing, modifying, drilling, cutting, welding and machining shall be carried out prior to HDG. Items modified after HDG shall be returned to the galvaniser for stripping of the zinc coating and re-galvanising. Other corrosion protection systems or coatings specified shall comply with the general corrosion protection specification provided with the contract document.

5.7.1.7 All fasteners associated with handrailing shall be of stainless steel grade 316. Fastener threads shall project (once tightened) above the nut by at least 1 but no more than 4 threads and the exposed fastener ends shall be free of sharp edges. The diameter of anchor fasteners shall not be less than M16 and other fasteners not less than M12 unless otherwise indicated. Washers shall be provided under the bolt head (as applicable) and nut.

Anchor fasteners for anchoring handrailing to concrete or brickwork shall be chemically anchored to the substrate with anchor depth of 140 mm using Sika Anchorfix-2+ or Hilti HIT-RE 500 (or equivalent approved). Anchor fasteners shall be delivered to Site in the correct lengths and already deburred, pickled and passivated, and no cutting of these fasteners will be permitted on Site. Holes shall be drilled to correct depths and cleaned in accordance with the anchor adhesive manufacturer's instructions. The Contractor shall have all holes inspected by the Engineer after completing preparations but before installing the adhesive and fasteners.

5.7.1.8 Unless otherwise indicated on the drawings or in the Bill of Quantities, handrailing for public spaces shall also comply with the requirements above with the exception of those indicated in 5.7.1.3, 5.7.1.4 and 5.7.1.5. In addition, handrailing for public spaces shall comply with the requirements of SANS 10104 and no opening in handrailing installed in public places shall allow the passage of a ball of 100 mm diameter.

## **PSH 5.7.2 LADDERS**

*REPLACE THE CONTENTS OF THIS SUBCLAUSE WITH THE FOLLOWING:*

### "Ladders:

5.7.2.1 Ladders shall be manufactured in accordance with the details and general arrangements shown on the drawings. Before commencing with any manufacturing or construction, the Contractor shall confirm and accommodate the actual dimensions and details measured on Site which may differ from those provided on drawings. Unless otherwise indicated, ladders and related ancillaries (threshold plates, grab bars, etc.) but excluding fasteners, shall be of stainless steel grade 316 material. Fasteners shall be of stainless steel grade 316 regardless of the ladder material specified.

5.7.2.2 All members shall be of solid structural sections (e.g. flat bar). Hollow sections are not acceptable for any part of the ladder.

All rungs in a flight shall be uniformly spaced at 250 mm centres (unless otherwise indicated) after positioning the rung nearest the upper platform (or threshold

platform, as applicable) in the position shown on the drawings. A minimum clear space of 230 mm shall be provided behind the rungs, unless otherwise indicated on the drawings.

Anchoring supports (mounting brackets) shall be uniformly spaced at a distance not exceeding 2m. When mounted to concrete or brickwork, the gap between anchoring supports and the substrate to which they affix shall be no greater than 15 mm, and any gaps between them shall be filled with flowable non-shrink cementitious grout after the supports have been secured in place prior to final tightening of the nuts. Where ladders are mounted to steel surfaces, no gap shall be left between the surface and the anchoring support, and Denso Tape or approved equivalent shall be fitted under the anchoring support feet to completely seal the crevices between the two metallic surfaces.

Where the strings (also referred to as stringers) extend above an upper landing, they shall complement any handrailing at this level. Ladder-to-handrailing connections shall be bolted.

Generally, and unless otherwise indicated on drawings or in the BOQ, ladders of height greater than 5 m and up to 10 m shall be provided with cages. No part of the cage shall be more than 700 mm away from the plane of the rungs.

- 5.7.2.3 All joints shall be fully welded (leaving no crevices) and smoothly finished without shoulders. Ladders shall be free from sharp corners, edges and projections which may injure persons or damage clothing. Edges shall be rounded to a radius of at least 2 mm. Sharp edges, pits, inclusions, weld spatter, undercuts, indentations and other surface defects are not acceptable. Stainless steel ladders shall be pickled and passivated prior to installation.

If HDG ladders are specified, they shall be hot-dip galvanised after all fabrication has been completed. The unit shall be blasted and re-galvanised if it is welded, drilled or ground after galvanizing or if the zinc layer is damaged.

- 5.7.2.4 If a ladder as a single unit is excessively long, for ease of handling and transporting, the ladder may (at the discretion of the engineer) be divided into practical portable lengths and reassembled on Site. Should the ladder be divided, jointing fishplates will be required (500 x 65 x 10 for the stringer joints and 500 x 45 x 8 for caging joint) and shall be located on the outside of the ladder user area with 6 No M12 countersunk bolts on the inside of the same area (3 No equally spaced on both sides of the joint). Any costs for dividing the ladder shall not be paid for separately, but shall be taken to be included in the rate tendered for the ladder.

- 5.7.2.5 The Contractor shall make arrangements for the Engineer to inspect the fabricated ladders for compliance prior to installation. Only ladders that comply shall be installed.

- 5.7.2.6 Ladders shall be supplied complete with all the necessary fasteners, etc. for fixing. All fasteners associated with ladders shall be of stainless steel grade 316. Fastener threads shall project (once tightened) above the nut by at least 1 but no more than 4 thread and the exposed fastener end shall be free of sharp edges. Unless otherwise indicated, the diameter of anchor fasteners shall not be less than M16 and other fasteners not less than M12. Washers shall be provided under bolt heads (as applicable) and nuts.

Unless otherwise indicated, fasteners for anchoring the ladder and ancillaries to concrete or brickwork shall be chemically anchored to the substrate with an anchor depth of 140 mm using Sika Anchorfix-2+ or Hilti HIT-RE 500 (or equivalent approved). Anchor fasteners shall be delivered to Site in the correct lengths and

already deburred, pickled and passivated (as no cutting of these fasteners will be permitted on site). Holes shall be drilled to correct depths and cleaned in accordance with the anchor adhesive manufacturer's instructions. The Contractor shall have all holes inspected by the Engineer after completing preparations but before installing the adhesive and fasteners.

### **PSH 5.7.3 OPEN GRID FLOORS**

*REPLACE THE CONTENTS OF THIS SUBCLAUSE WITH THE FOLLOWING:*

"Steel open grid floors:

5.7.3.1 The term "grating" shall be synonymous with "grid flooring". Open grid flooring panels (whether or not they are covered with a vastrap or equivalent plate) shall be manufactured by an approved firm specializing in such work. Before commencing with any manufacturing or construction, the Contractor shall confirm and accommodate the actual dimensions and details measured on Site which may differ from those provided on drawings.

5.7.3.2 The grid flooring depth as well as the thickness and pitch (spacing) of both bearer bars and transverse bars shall be as specified on the drawing. Unless otherwise indicated, bearer bars shall run parallel to shorter span (bearer bars to run between closest supports).

Grid flooring shall be manufactured with transverse bars permanently locked to bearer bars (i.e. compressive pressure locked or welded or both, unless otherwise indicated). Grid flooring panels shall be banded around all edges, including edges of cut-outs and removable or hinged access covers. These bands shall be of equal height and thickness to the bearer bars and shall be fully welded to the flooring panel (leaving no crevices at joints).

5.7.3.3 The panels shall be supplied prefabricated with cut-outs given on the details and those necessary to accommodate the Contractor's equipment. Cut-outs made to accommodate equipment shall be neat and as small as practical and gaps between equipment and grid flooring shall not exceeding 100mm in extreme cases. Panels/off-cuts may not be welded together to create larger panels.

Unless otherwise specified, cutting of grating with top covers shall be done at angles and curves to suit the equipment. For grating without top covers, cutting shall generally be done parallel or perpendicular to bearer bars (as applicable), except for cut-outs made to accommodate circular objects or pipes larger than DN 300 where the cut-out shall instead be circular to prevent excessive gaps between the object and sides of the cut-out. Unless authorized to do so, the Contractor shall not cut or weld grid floor panels on Site.

5.7.3.4 The gap between the edge of grid flooring and the support frame or abutting structure (as applicable) shall be at least 2 mm and no greater than 10 mm on each side (or no greater than 20mm on one side when the panel is shifted up against the support frame/abutting structure on the opposite side). No gaps shall be left between adjacent panels.

Grid flooring shall be mounted firm and level (unless the surrounding floor has a fall, in which case the grating shall match this fall) orientated uniformly and shall be of neat and workmanlike appearance, solidly and evenly supported, true to line, level, plumb and in proper working order. Adjacent floor panels shall have vertical edge alignment of within 3 mm of each other. A least four fixing clip sets of the appropriate types (depending on the location being secured) shall be used to secure each panel to the supports and adjacent panels. No perceptible movement or rocking will be



acceptable. Fixing clip sets shall be stainless steel grade 316 with M8 or larger fasteners, of standard types (i.e. M-Type, F-Type, G-Type, etc.) and approved by the grid flooring manufacturer.

Individual panel lengths (measured parallel to the bearer bars) shall be no greater than 2.4m. Unless otherwise approved, individual panels which are not supported along their entire perimeter shall be no less than 1m wide at the narrowest section (where the width is measured at right angles to the bearer bars), except for the final panel in a series of panels where a smaller width may be needed to close the remaining opening. Where narrower widths are specified or approved, each unsupported panel edge shall be fixed with clip sets to the adjacent flooring panel at 350mm centre or with a minimum of 2 clip sets, whichever is greater (these over and above the four fixing clip sets aforementioned).

- 5.7.3.5 Where vastrap plate flooring covers are required, they shall cover the entire top of the grid flooring panel (with the edges of the vastrap plate flush with the edges of the flooring panel) and shall be welded to the panel with 20 to 30mm welds at 300mm centres. Stainless steel grade 316 countersunk bolts shall be used with clip sets to secure flooring panels which are covered with vastrap plates to supports and to each other. Suitably positioned countersunk bolt holes shall be made in the vastrap plates prior to them being HDG (if HDG is applicable). The countersunk bolts shall not protrude above the vastrap plate beyond the height of the tread pattern.

- 5.7.3.6 The angle supports (also referred to as frames) indicated on drawings (including added flat bars where required) are to be installed continuously along the full perimeters of openings which are to be covered with flooring panels. Notwithstanding the above, where the support frame crosses a concrete or brickwork joint, the joint is to be extended through the angle frame.

Where two different angle support types (flooring details) are specified for supporting one area of flooring, the cast-in angle support type shall be used wherever possible, with the bolt-on angle support type only used where the cast-in angle support cannot be used.

Where a structural member is to pass through a flooring panel, adequately sized bolt-on angle supports shall be installed around and fastened to the circumference of the structural member to support the flooring panel, unless otherwise directed by the Engineer. All angle supports will not be paid for separately but shall be included in the rate tendered for the relevant flooring panels.

ted by the Engineer. All angle supports will not be paid for separately but shall be included in the rate tendered for the relevant flooring panels.

- 5.7.3.7 Additional support systems which exclude angle supports and top hat sections (thus I-beams and channels, etc. are additional supports) may be specified on drawings. Each support type, complete with end plates, flat bars, fasteners, etc. will be scheduled and paid for separately under 8.3.1. The grid flooring shall be fabricated to suit the additional supports.

Unless otherwise indicated, additional supports that cross from one side of an opening to the opposite side (i.e. a straight support beam) shall be orientated such that each runs parallel to the shorter span (i.e. for a channel, they shall run between the nearest channel walls).

Where a cut-out in the flooring larger than 480mm in width or diameter (irrespective of whether the cut-out bridges more than one panel) is necessary to accommodate an object(s) passing through the flooring (which objects are not designed to structurally support the flooring, i.e. pipes and equipment), these additional supports shall first be placed as close as practical on either side of the object. The remaining



supports shall be evenly spaced with appropriate centres that fall within the spacing range indicated on the drawings (or at specific centres if so specified).

Notwithstanding the above, the additional supports shall be suitably positioned to prevent more than 50% of the bearer bars of a single panel being cut in the event of multiple cut-outs being required in the same panel. Where this is unavoidable, suitable alternative support designs shall be submitted by the Contractor to the Engineer for approval.

The gap between additional support ends and the substrates to which they affix shall be no greater than 10mm, and this gap shall be neatly filled with flowable non-shrink cementitious grout after the supports have been secured in place and prior to final tightening of nuts. Additional supports shall not be mounted over or with the centreline within 200mm of a concrete or brickwork joint.

- 5.7.3.8 The Contractor shall submit for approval all relevant details for additional cut-outs and supports to flooring which are not specified but are required by him to accommodate his equipment. These flooring modifications and supports shall ensure that, while under design load conditions, the deflection of any bearer bars does not exceed 1/200th of the clear span, or 10 mm, whichever is the lesser. Any approved modifications shall be done prior to HDG. Cut-outs and supports required by the Contractor will not be measured or paid for separately but shall be included in the rate tendered for the relevant flooring panels.
- 5.7.3.9 Unless otherwise indicated, all joints to be fully welded with no crevices. All steel items, excluding fasteners, handles, hinges and clip sets, shall be HDG unless otherwise indicated. HDG shall be done in accordance with SANS 121 and SANS 10064. All fabrication, sizing, modifying, drilling, cutting, welding and machining shall be carried out prior to HDG. Items modified after HDG shall be returned to the galvaniser for stripping of the zinc coating and re-galvanising.
- 5.7.3.10 All fasteners shall be of stainless steel grade 316, unless otherwise specified. Fasteners shall be delivered to Site in the correct lengths and already deburred, pickled and passivated (as no cutting of these fasteners will be permitted on Site). Anchor fasteners shall be chemically anchored into concrete or brickwork using Sika Anchorfix-2+ or Hilti HIT-RE 500 (or equivalent approved). The anchor holes required shall be drilled to correct depths and cleaned in accordance with the anchor adhesive manufacturer's instructions. The Contractor shall have all holes inspected by the Engineer after completing preparations but before installing the adhesive or fastener. SS316 washers shall be provided under both bolt head (where applicable) and nut. Unless otherwise approved, fastener threads shall project no less than 1 thread and no more than 8 threads from the head of the nuts when fixed.

**PSH 6      TOLERANCES**

No amendments.

**PSH 7      TESTING**

**PSH 7.1      TEST CERTIFICATES**

*ADD THE FOLLOWING:*

"Test certificates pertaining to steel used for the various members shall be supplied by the Contractor to the Engineer when requested."

*ADD THE FOLLOWING:*

**“PSH 7.4      WELDING TESTING**

All non-destructive testing procedures, techniques and acceptance criteria shall be in accordance with AWS D1.1 (and/or SANS 15614-1) and certificates of all testing shall be submitted to the Engineer. Personnel performing non-destructive testing (other than visual) shall be qualified in accordance with the stipulations of the code. All non-destructive examinations shall be carried out in accordance with written procedures approved by the Engineer .

Full penetration butt welds are to be radio graphically tested in accordance with AWS D1.1 (and/or SANS 15614-1). A minimum of 50% of full penetration welds shall be tested. If more than 5% of the examined welds show unsatisfactory results, then additional examinations covering all welds shall be performed. Fillet welds will be inspected and tested to AWS D1.1 (and/or SANS 15614-1) at the discretion of the Engineer. Ultrasonic and radiographic examinations shall not be made within the period of 24 hours after completion of welding.

All costs (time, travelling, testing etc.) incurred by non-destructive examinations (whether due to non-conformance of specifications, any latent defects in material and welding, or as requested by the Engineer) shall be borne by the Contractor.

**PSH 7.5      TESTING OF CHEMICALLY ANCHORED FASTENERS**

The Engineer may require that the Contractor perform pull-out tests on a select number (as determined by the Engineer) of chemically anchored fasteners to confirm that the fasteners meet the chemical mortar/adhesive manufacturer's characteristic loads. The Engineer shall identify the fasteners to be tested and the Contractor shall provide all equipment required and conduct the tests in the presence of the Engineer. The pull direction shall not be more than 5° off the axis of the bolt.

The pull-out test equipment will typically include an eye-nut for connecting to the anchored fastener, a pulling device (mechanical or hydraulic), a calibrated crane scale and a temporary support structure.”

**PSH 8      MEASUREMENT AND PAYMENT****PSH 8.1      BASIC PRINCIPLES**

*ADD THE FOLLOWING TO THE END OF THIS SUBCLAUSE:*

“8.1.3 The tendered price for steel items includes for the production of shop drawings/details, all procurement costs, supply, fabrication, corrosion protection and finishes as specified, inspections as per Subclause 7.2 of SANS 1200 HC, transportation and erection, welding, all plant, labour, materials, fasteners (including holding-down bolts), etc. necessary for proper completion of structural steelwork, including casting in holding-down bolts (if applicable), fixing it to the concrete or brickwork, etc. as shown on drawings or as specified. These listed items will not be measured separately.”

**PSH 8.3      SCHEDULED ITEMS**

*DELETE SUBCLAUSES 8.3.1, 8.3.2, 8.3.3, 8.3.4, 8.3.5, 8.3.6 AND 8.3.13 AND SUBSTITUTE WITH THE FOLLOWING:*

“8.3.1 Structural steel .....Unit: t or No

The rate shall include for the production of shop drawings/details, all procurement costs, supply, fabrication, corrosion protection and finishes as specified, inspections as per Subclause 7.2 of SANS 1200 HC, testing (unless scheduled separately), transportation and erection, welding, all plant, labour, materials, fasteners (including holding-down bolts), etc. necessary for proper completion of structural steelwork, including casting in holding-down

bolts (if applicable), fixing it to the concrete or brickwork, etc. as shown on drawings or as specified.  
The supply and fixing of roof sheeting, cladding and rainwater goods shall be scheduled separately.”

**PSH 8.3.7      HANDRAILS**

*REPLACE THE CONTENTS OF THIS SUBCLAUSE WITH THE FOLLOWING:*

“Handrail assembly complete (drawing number stated/details given):

- a) Horizontal top mounted.....Unit: m
- b) Horizontal side mounted flush .....Unit: m
- c) Horizontal side mounted offset .....Unit: m
- d) Horizontal removable .....Unit: m
- e) Sloping top mounted .....Unit: m
- f) Sloping angle mounted .....Unit: m
- g) Sloping side mounted flush.....Unit: m
- h) Step ladders top mounted.....Unit: m
- i) Step ladders side mounted flush .....Unit: m
- j) Bends .....Unit: No.
- k) End closures .....Unit: No.
- l) Sleeves for removable stanchions .....Unit: No.
- m) Kickplates.....Unit: m
- n) Handrailing for public places.....Unit: Sum or m
- o) Guard chains.....Unit: No

The per-meter rates (a) through (i), shall be per meter of handrailing assembly complete. The per-number rates (j) through (l) shall be extra over to the relevant per meter rate (a) through (i). The rate for bends shall be 1 No. per change in handrailing direction/angle (i.e. a bend in the handrailing shall typically incorporate a bend in both the hand rail and a knee rail, which shall together be measured as 1 bend). The per-meter rate for kickplates shall be per meter of kickplate assembly complete. The rate for handrailing in public places shall be for the complete assembly as indicated, or per meter of the type indicated. The per-number rate for guard chains shall be the number of each guard chain assembly complete, separated for different guard chain details and for each width (or range of widths) between substrates (stanchions/walls/stringers, as applicable) to which the guard chain eye and hook bolts will be affixed.

The tendered rates shall include for the production of shop drawings/details (where required), all procurement costs, supply, fabrication, corrosion protection (such as galvanizing and painting) as specified, inspections as per Subclause 7.2 of SANS 1200 HC, testing (unless scheduled separately), transportation and erection, all plant, labour and materials (including fasteners) necessary for proper completion of the handrails, kickplates, guard rails, etc., including grouting in/fixing to concrete, brickwork, steel substrates, etc. as shown on drawings and as specified.”

**PSH 8.3.8      LADDERS, COMPLETE AND INSTALLED**

*IN THE HEADING, REPLACE THE WORD “LENGTH” WITH THE WORD “HEIGHT”*

*REPLACE THE CONTENTS OF THIS SUBCLAUSE WITH THE FOLLOWING:*

“Separate items will be scheduled for ladders of different types and heights (or height ranges). The height shall be measured as the vertical distance between the two levels which the ladder provides access between (i.e. the distance between the upper and lower levels connected by the ladder).

The rate for ladders shall include for the production of shop drawings/details, all procurement costs, supply, fabrication, corrosion protection (such as galvanizing and painting) as specified, inspections as per Subclause 7.2 of SANS 1200 HC, testing (unless scheduled separately), transportation and erection, all plant, labour and materials (including fasteners) necessary for proper completion of the ladders, including fixing it to the concrete, brickwork, etc. as shown on drawings or as specified.

The rate shall also include for all ladder ancillaries shown on the ladder drawings such as threshold plates, grab bars, etc.”

### **PSH 8.3.9 FLOORING, COMPLETE AND INSTALLED WITH FRAMES**

*REPLACE THE CONTENTS OF THIS SUBCLAUSE WITH THE FOLLOWING:*

“The rate shall cover the cost of supplying the specified or scheduled type of flooring complete with angle supports/frames (including added flat bars where required) and top hat sections as indicated on the drawings and the cost of all fixings, installing, fixing, grouting/casting in, etc. The rate shall further include for the production of shop drawings/details (where required), all procurement costs, fabrication, cutting, welding, banding, cut-outs, corrosion protection (including galvanizing, painting, etc.) as specified, inspections as per Subclause 7.2 of SANS 1200 HC, testing (unless scheduled separately), transportation and erection, all plant, labour and materials (including fasteners, clips, etc.) necessary for proper completion of the flooring and support frames.

Any additional supports and cut-outs not specified but which are required by the Contractor to accommodate his equipment layout shall not be paid for separately, but shall be included for in the above rate for flooring.

Additional support systems specified (i.e. specified I-beams and channel sections) will be scheduled and paid for separately under 8.3.1, which rate shall also include for the required end connections, flat bars, fasteners, etc. Additional support systems exclude angle support/frames, etc. which are already included for under the rate for flooring.”

*ADD THE FOLLOWING:*

### **“PSH 8.3.14 MISCELLANEOUS STEEL ITEMS**

a) Items measured by area:

Description of or drawings reference to item .....Unit: square metre (m<sup>2</sup>)

b) Items measured by length:

Description of or drawings reference to item .....Unit: metre (m)

c) Items measured by number:

Description of or drawings reference to item .....Unit: No

d) Items measured by mass:

Description of or drawings reference to item .....Unit: kg or ton

The unit of measurement shall be the square metre, linear meter, number or mass as applicable to each item. The tendered rates shall include full compensation for all labour, materials, fasteners (including holding-down bolts), plant, equipment, transport, etc, manufacturing or providing and installing each item complete as scheduled and shown on the

Drawings, and shall include all corrosion protection, finishes and inspections as per Subclause 7.2 of SANS 1200 HC, testing (unless scheduled separately), where applicable.”

**PSHB CLADDING AND SHEETING (SANS 1200 HB)****PSHB 3 MATERIALS****PSHB 3.1 THICKNESS OF SHEETING****a) General***REPLACE*

"The thickness of the sheeting" *with* "Unless specified elsewhere in Clause 3 or specified on the Drawings or in the Bill of Quantities, the thickness of the sheeting".

**PSHB 3.2 STEEL SHEETING****PSHB 3.2.1 Galvanized Steel Sheeting***REPLACE*

"Galvanizing shall comply with" *with* "galvanizing shall, unless otherwise specified, comply with".

**PSHB 3.2.2 Pre-painted Galvanized Steel Sheeting***REPLACE*

"Galvanizing shall comply with" *with* "galvanizing shall, unless otherwise specified, comply with".

*ADD THE FOLLOWING SUBCLAUSES:***"PSHB 3.2.4 Proprietary Steel Sheeting**

Proprietary steel roof sheeting and cladding specified on the drawings or in the Bill of Quantities shall be provided with a certificate verifying material compliance and be clearly marked on the reverse side at one-meter intervals indicating thickness, material quality, coating thickness and paint system. The proprietary roof sheeting and cladding provided shall have a successful record (of 5 years minimum) of use in similar applications locally. In addition, the proprietary roof sheeting and cladding shall comply with the following requirements:

**0.54mm Safintra SAFLOK 410 Bluescope Clean COLORBOND ULTRA AZ200 (or equivalent):**

0.54mm Safintra SAFLOK 410 Bluescope Clean COLORBOND ULTRA AZ200 (or equivalent): 0.54mm thick Safintra SAFLOK concealed fix, standing seem, Aluminium-Zinc coated (AZ200) Grade G550 steel roofing (minimum yield strength 550 MPa), with Bluescope Clean COLORBOND ULTRA proprietary system both sides and including touching-up cut and slit edges ("Ultimate Grey" colour if no colour is specified on the drawings). Sheeting profile to have an effective cover width of 410mm and rib height of 41mm and roll-formed to full required lengths (continuous lengths without lap). The SAFLOK interlocking clipping system shall be fixed to purlins (through over-purlin insulation if applicable) with Safintra approved fasteners (class 4) and all clips to be 2k polyurethane coated. The complete roofing system (all strictly in accordance with manufacturer's specifications) shall be provided with a minimum 10-year guarantee and shall be inspected and approved in writing by the supplier after installation."

**PSHB 3.3 ALUMINIUM SHEETING***ADD THE FOLLOWING SUBCLAUSES:*

**“PSHB 3.3.3    Proprietary Aluminium Sheeting**

Proprietary aluminium roof sheeting and cladding specified on the drawings or in the Bill of Quantities shall be provided with a certificate verifying material compliance and be clearly marked on the reverse side at one-meter intervals indicating thickness, material quality, coating thickness and paint system. The proprietary roof sheeting and cladding provided shall have a successful record (of 5 years minimum) of use in similar applications locally. In addition, the proprietary roof sheeting and cladding shall comply with the following requirements:

**a)    0.8mm Aluminium Safintra SAFLOK 410 Color-Tech PVDF (or equivalent):**

0.80mm thick Safintra SAFLOK 410 Aluminium (Alloy 3004) interlocking concealed fix roofing, pre-painted both sides with Color-Tech PVDF (colour as stated in bill of quantities or on drawings), with an effective cover width of 410mm and rib height of 41mm, roll-formed to full required lengths (continuous lengths without lap), complete with 2k Polyurethane coated SAFLOK 410 aluminium clips fixed to purlins (through over-purlin insulation if applicable) with Safintra approved stainless steel 316 wafer head fasteners, all strictly in accordance with manufacturer's specifications. The complete roofing system shall be provided with a 10-year guarantee, and shall be inspected and approved in writing by the supplier after installation.”

**PSHB 3.4        FC SHEETING**

*ADD THE FOLLOWING SUBCLAUSES:*

**“PSHB 3.4.3    Proprietary Fibre Cement Sheeting****a)    6mm Fibre-cement Nutec BigSix (or equivalent):**

6mm (nominal thickness) fibre-cement Nutec BigSix roofing profile, with an effective cover width of 875mm and corrugation height of 57mm. All bolts, clips and fasteners shall be stainless steel grade 316 (including stainless steel J-bolts where required for fixing to steel purlins) and fixing/installation shall be strictly in accordance with manufacturer's specifications. A non-porous insulator shall be provided between stainless steel fasteners and steel support structure. Unless otherwise specified on the drawings, purlins (steel supports) will be spaced at 1.2m max. The complete roofing system shall be inspected and approved in writing by the supplier after installation.”

**PSHB 3.7        FASTENERS****PSHB 3.7.1      General**

*ADD THE FOLLOWING TO THE END OF THIS SUBCLAUSE:*

“Fasteners for cladding, sheeting, ridge capping, flashings, etc. shall be in strict accordance with the manufacturer's specifications, taking into account high wind loads and severe corrosion conditions with proximity to the sea. Where the cladding, sheeting, ridge capping, flashings, etc. are stainless steel, fibre cement or aluminium, the fasteners shall be stainless steel grade 316 and otherwise in strict accordance with the manufacturer's specifications.”

**PSHB 3.8        RAINWATER GOODS**

*ADD THE FOLLOWING:*

“Unless otherwise indicated on Drawings or Bill of Quantities, rainwater goods shall be manufactured from aluminium and finished in a colour to match the cladding and roof sheeting.”

*ADD THE FOLLOWING SUBCLAUSES:*



**“PSHB 3.11     FLASHINGS AND RIDGE CAPPING**

Flashings and ridge capping shall be manufactured from the same material and have the same corrosion protection and finish as the roof sheeting and cladding, and the thickness shall, unless otherwise specified on the Drawings or in the Bill of Quantities, be at least the thickness of the roof sheeting and cladding.”

**PSHB 5         CONSTRUCTION****PSHB 5.1       RESPONSIBILITY****PSHB 5.1.4     Installation Details**

*REPLACE THE FIRST SENTENCE OF THIS SUBCLAUSE WITH THE FOLLOWING:*

“The Contractor shall be solely responsible for ensuring that materials and installation of cladding, sheeting, ridge capping, flashings, etc. comply with the manufacturer's specifications, the project specifications, **Engineer's** drawings of the general arrangement and details and, subject to **Engineer's** approval, the Contractor's additional detail drawings.”

**PSHB 5.5       INSTALLATION OF SHEETING**

*ADD THE FOLLOWING TO THE END OF THIS SUBCLAUSE:*

“Fitting and fixing shall be according to the manufacturer's specifications for the wind conditions on site.”

**PSHB 5.6       FLASHINGS**

*ADD THE FOLLOWING TO THE END OF THIS SUBCLAUSE:*

“Fitting and fixing shall be according to the manufacturer's specifications for the wind conditions on site.”

**PSHB 5.7       PROTRUSIONS THROUGH SHEETED SURFACES**

*ADD THE FOLLOWING TO THE END OF THIS SUBCLAUSE:*

“Fitting and fixing shall be according to the manufacturer's specifications for the wind conditions on site.”

*ADD THE FOLLOWING SUBCLAUSES:*

**“PSHB 5.8       DETAIL DRAWINGS**

The Contractor shall be responsible for preparing drawings of all sheeting/flashings/insulation details required (including details of the fasteners which he proposes to use). The drawings shall be submitted for approval at least two weeks prior to commencement of fabrication.

The **Engineer** shall require seven working days for the approval of the detail drawings submitted by the Contractor. No sheeting work shall be permitted to commence until such time as the detail drawings have been approved.”

**PSHB 6         TOLERANCES****PSHB 6.2       INSTALLATION****PSHB 6.2.2     Sheeting and Cladding**

*ADD THE FOLLOWING:*

“The maximum deviation from the theoretical position of sheeting/flashing lines shall be  $\pm 5$  mm.

The maximum deviation from the straightness of sheeting/flashing lines or abrupt change in same shall be 3 mm. the deviation shall be measured as the maximum deviation of the surface from any straight line of length 3 mm joining two points on the surface, determined by means of a straight edge, the ends of which are supported on identical blocks of suitable thickness placed over each of the points.”

**PSHB 8      MEASUREMENT AND PAYMENT**

**PSHB 8.2      SCHEDULED ITEMS**

**PSHB 8.2.2      Supply and Install Cladding and Sheeting**

*ADD THE FOLLOWING:*

“The rate tendered shall also cover the cost of corrosion protection and/or coloured finish (i.e., painting) as specified, required clips, insulating tape and washers (if applicable), and all plant, labour and material necessary for proper completion of the work, as well as the provision of detailed drawings required in terms of 5.8.”

**PSHB 8.2.3      Supply and Install Ancillaries**

*ADD THE FOLLOWING:*

“The rate tendered shall also cover the cost of corrosion protection and/or coloured finish (i.e., painting) as specified, required clips, insulating tape and washers (if applicable), and all plant, labour and material necessary for proper completion of the work, as well as the provision of detailed drawings required in terms of 5.8.”

**PSHB 8.2.4      Painting**

*DELETE THIS SUBCLAUSE.*

Painting and corrosion protection of cladding, sheeting and ancillaries is already included for under their respective rates.

*ADD THE FOLLOWING SUBCLAUSES:*

**“PSHB 8.2.6      Supply and Install Insulation**

The unit of measurement shall be the square meter of area covered by the insulation (or insulation system) installed, with no deduction being made for protrusions or areas covered by overlaps.

The rate tendered shall cover the cost of the supply, delivery, installation and fixing of insulation as well as all the plant, labour, and material necessary for proper completion of the work, including all straining wires and/or other supports.”

**PSHC CORROSION PROTECTION OF STRUCTURAL STEELWORK (SANS 1200 HC)****PSHC 2 INTERPRETATIONS****PSHC 2.3 DEFINITIONS AND ABBREVIATIONS**

*ADD THE FOLLOWING TO THE END OF THIS SUBCLAUSE:*

“Or hot dip galvanized (as applicable)”

**PSHC 3 MATERIALS**

*ADD THE FOLLOWING SUBCLAUSES:*

**“PSHC 3.4 STAINLESS STEEL**

All stainless steel shall be pickled and passivated after manufacture and all heat tint, weld splatter and impurities introduced by grinding, cutting etc. are to be removed. Passivation shall be in an approximate 15 percent solution by mass of nitric acid, at 60 degrees Celsius, for 20 to 30 minutes. Before passivation, the equipment shall be thoroughly cleaned, and all traces of oil and other contaminants removed. The equipment shall be washed thoroughly after passivation.

Only descaled steel shall be used.

**PSHC 3.5 INSULATION**

Where different metals are fastened together, such as mild steel and stainless steel, a non-porous insulator shall be inserted in the joint to prevent direct contact of the metals.

**PSHC 3.6 PROCUREMENT OF PAINT**

The Contractor shall provide the Engineer with details of the paints he intends on using, including the manufacturer's data sheets for each product and shall only proceed with the purchase of the paints upon receipt of written approval from the Engineer.

All materials in a paint system shall be purchased from one supplier. The Contractor shall provide the paint supplier with a copy of the relevant sections of the Specification. The Contractor shall obtain a certificate from the paint supplier certifying that the materials to be supplied comply with the relevant Specification and are suitable for the intended purpose.

No variation in brand or material from those quoted in the tender documents and/or as approved by the Engineer shall be permitted without the approval of the Engineer in writing.

Any conflict between the manufacturer's data sheet and the Specification shall be referred to the Engineer for adjudication.”

**PSHC 5 CONSTRUCTION****PSHC 5.7 COATING SYSTEM**

*REPLACE THE CONTENTS OF THIS SUBCLAUSE WITH THE FOLLOWING:*

“The coating system shall be as indicated in the following table:

Location	Structural/mild steel elements	Coating system
Isipingo WWTW:	All structural steelwork on the plant.	Duplex coating system, as per Subclause 5.12
Isipingo WWTW:	Handrails, ladders, open grid flooring	as per SANS 1200H Subclause 5.7

**PSHC 5.8      APPLICATION OF PAINT COATINGS**

*ADD THE FOLLOWING AT THE END OF THIS SUBCLAUSE:*

“All paintwork shall be executed by tradesmen skilled in this class of work, and in strict accordance with the manufacturer’s recommendations as approved.

All surfaces which cannot be painted after erection shall be painted as specified herein before erection.”

**PSHC 5.9      APPLICATION OF METAL COATINGS**

*ADD THE FOLLOWING AT THE END OF THIS SUBCLAUSE:*

“Hot-dip galvanized material which is to remain unpainted shall be passivated as specified in SANS 121. Items to be painted after hot-dip galvanizing shall be air dried and not passivated.”

**PSHC 5.10      REPAIR OF DAMAGED COATINGS**

*ADD THE FOLLOWING AT THE END OF THIS SUBCLAUSE:*

“Unless otherwise approved by the Engineer, items modified after HDG shall be returned to the galvaniser for stripping of the zinc coating and re-galvanising.”

*ADD THE FOLLOWING SUBCLAUSES:*

**“PSHC 5.11      SURFACE PREPARATION****PSHC 5.11.1      General**

All items to be corrosion protected shall be tested and inspected for compliance with the applicable Specifications before any cleaning of the surface is commenced.

All surfaces to be corrosion protected shall be degreased prior to any other method of surface preparation.

The area affected by weld heating shall be polished by means of plastic abrading pads until free of discolorations, and subsequently thoroughly degreased using a water rinseable detergent and allowed to dry.

**PSHC 5.12      DUPLEX COATING SYSTEM**

A duplex system of coating shall consist of firstly hot dip galvanizing the steel, followed by an organic coating.

Fabrication of items to receive a duplex system shall be in accordance with SANS 14713. HDG shall be done in accordance with SANS 121 and coatings shall be to the thicknesses detailed in the Standard.

After HDG, the items shall be air dried and not passivated as these items are to be painted.

Preparation and application of organic coatings on HDG shall be done in accordance with the Hot Dip Galvanizers Association of Southern Africa’s Code of Practice for Surface Preparation and Application of Organic Coatings.

The duplex system shall comply with the following:

- a) Hot dip galvanized, as specified above, without passivation of the zinc coating.
- b) Application of one coat of an epoxy primer (two part; for hot-dip galvanized surfaces) with a dry film thickness (DFT) of 75 µm.
- c) Polyurethane enamel topcoat (two part) with a DFT of 50 µm; done at the factory after suitable repair to the primer.
- d) Touch up repairs on site after erection.

Refer to 5.8 for application of paint coatings.”

**PSHC 6        TOLERANCES**

**PSHC 6.5      DRY FILM THICKNESS**

*DELETE THE FIRST TWO SENTENCES OF THIS SUBCLAUSE.*

*ADD THE FOLLOWING SUBCLAUSES:*

**“PSHC 6.5.1    Individual Coatings**

At least 90% of all thicknesses measured shall comply with the minimum thickness of the system specification. Up to 10% of all readings may be below the specific minimum thickness, but no individual reading shall be less than 70% of the specified minimum thickness.

**PSHC 6.5.2    Total Dry Film Thickness**

Not more than 10% of readings shall be less than the minimum specified and no reading shall be less than 90% of the specified minimum. For immersion conditions no reading shall exceed the mean specified thickness by greater than 60% of the minimum unless a concession is granted by the Engineer.”

**PSHC 7        TESTING**

**PSHC 7.2      INSPECTION BY ENGINEER**

*REPLACE THE HEADING OF SUBCLAUSE 7.2 WITH “INSPECTIONS”.*

*REPLACE THE CONTENTS OF SUBCLAUSE 7.2 WITH THE FOLLOWING:*

**“7.2.1      Inspection by Engineer**

Inspection by the **Engineer** (or his representative) will be carried out timeously. The inspector shall be given reasonable advance notice of the availability of steel for inspection.

The Contractor shall make arrangements for the inspector to inspect the items at the following stages:

- a) On completion of fabrication and before HDG.
- b) After HDG and before priming.
- c) After priming.
- d) After topcoat but before dispatch to site.

**7.2.2      Independent Inspectorate**

The Contractor shall nominate an independent inspectorate to carry out any tests to verify compliance with the corrosion protection Specifications.

The **Inspectorate** shall inspect the work to verify that at least the following are in accordance with the Specifications:

- a) Surface preparation prior to painting,
- b) Coating thicknesses,
- c) Holiday testing, and
- d) Paint quality, type, and method of application.

The Contractor shall:

- i) Draw up a quality control programme together with the independent inspectorate,
- ii) Contact the inspectorate timeously to make arrangements for him to inspect the various items to be tested both prior to and after painting or HDG,

- iii) Submit copies of the quality control programme to the **Engineer**, and
- iv) Submit all the inspectorate's reports to the Engineer."

**PSHC 8            MEASUREMENT AND PAYMENT**

**PSHC 8.1        PRINCIPLES**

*REPLACE SUBCLAUSE 8.1 WITH THE FOLLOWING:*

"Unless otherwise indicated, corrosion protection shall not be measured and paid for separately, and rates and sums tendered for steel items under Subclause 8.3 of SANS 1200 H shall include all costs related to corrosion protection (inclusive of all costs related to 8.2 below).

Measurement and payment for items as detailed under 8.2 shall only be applicable for steel items not provided by the Contractor, unless otherwise indicated."

**PSHC 8.2        SCHEDULED ITEMS**

*ADD THE FOLLOWING SUBCLAUSES:*

**"PSHC 8.2.5     Inspection by The Engineer**

Where scheduled for a steel item, the unit of measure shall be as scheduled, and the rate or sum shall cover all costs associated with 7.2.1.

**PSHC 8.2.6     Independent Inspectorate**

Where scheduled for a steel item, the unit of measure shall be as scheduled, and the rate or sum shall cover all costs associated with 7.2.2."

**PSL MEDIUM-PRESSURE PIPELINES (SANS 1200 L)****PSL 3 MATERIAL****PSL 3.1 GENERAL**

*ADD THE FOLLOWING TO SUBCLAUSE 3.1 :*

"Each type of pipe delivered to the Site shall have a standard length corresponding with the standard lengths offered by the pipe manufacturer in his catalogue, with a maximum permissible variation in length of  $\pm 2\%$ .

A pipe that is a shorter or longer than the defined standard will be rejected by the Engineer, except when such non-standard lengths are required in terms of the Contract and have been specifically manufactured or cut as such by the pipe manufacturer or supplier."

**PSL 3.4 STEEL PIPES, FITTINGS AND SPECIALS****PSL 3.4.2 Pipes of nominal bore up to 150 mm**

*ADD THE FOLLOWING TO SUBCLAUSE 3.4.2 :*

"The pipes shall be 'normalised' or seamless steel pipes and shall be used with malleable cast-iron fittings complying with the requirements of SANS 14."

**PSL 3.7 OTHER TYPES OF PIPES****PSL 3.7.2 Polyethylene pipes**

*REPLACE THE CONTENTS OF SUBCLAUSE 3.7.2 WITH THE FOLLOWING :*

"Polyethylene pipes shall be HDPE type IV pipes with compression fittings and shall comply with SABS 533 Part II / SANS 4427."

*ADD THE FOLLOWING SUBCLAUSE:*

**"PSL 3.7.3 Glass Reinforced Plastics (GRP) pipes**

See Particular Specification PP : Glass Reinforced Plastic (GRP) Pipes, Fittings and Joints."

**PSL 3.9 CORROSION PROTECTION****PSL 3.9.2 Steel pipes****PSL 3.9.2.1 Steel pipes of nominal bore up to 150 mm**

*ADD THE FOLLOWING TO SUBCLAUSE 3.9.2.1:*

"Steel pipes shall be galvanised where shown on the Drawings."

**PSL 3.9.2.2 Steel pipes of nominal bore over 150 mm**

*ADD THE FOLLOWING TO SUBCLAUSE 3.9.2.2:*

"Steel pipes shall be Fusion Bonded Epoxy lined and coated as shown on the Drawings and as specified in Subclause PSL 3.9.7."

**PSL 3.9.6 Corrosive Soil**

*ADD THE FOLLOWING TO SUBCLAUSE 3.9.6 :*



"All stainless steel or steel pipes and fittings in contact with soil shall be wrapped with Densopol 80 HT or equivalent, strictly in accordance with the manufacturer's instructions."

*ADD THE FOLLOWING SUBCLAUSE:*

"PSL 3.9.7 See Particular Specification PQ : General Corrosion Protection."

**PSL 3.10 VALVES**

*REPLACE THE CONTENTS OF SUBCLAUSE 3.10 WITH THE FOLLOWING :*

"Valves shall comply with the following requirements:

- (a) Valves in the network, underground and in valve chambers shall close anti-clockwise (left-hand closed), and valves in pump stations only shall close clockwise (right hand-closed) and all valves shall have a non-rising spindle and handwheel.
- (b) The direction of closing shall be clearly indicated on valve and handwheel.
- (c) They shall be class 16 valves.
- (d) Valves shall comply with the requirements of SANS 664.
- (e) Valves shall be the resilient seal type.
- (f) All buried valves shall be Denso Tape (or equivalent)-wrapped at the connections flanges or couplings."

**PSL 5 CONSTRUCTION**

**PSL 5.6 VALVE AND HYDRANT CHAMBERS**

**PSL 5.6.1 General**

*REPLACE THE WORDS "drawing L-1" IN THE SECOND LINE WITH "the Drawings".*

**PSL 5.6.2 Construction of chambers**

*REPLACE THE WORDS "drawing L-1, L-2 and L-3" IN THE FOURTH LINE WITH "the Drawings".*

*ADD THE FOLLOWING SUBCLAUSES:*

**"PSL 5.11 STANDPIPES**

Standpipes shall be erected in the positions and to the details shown on the Drawings.

**PSL 5.12 MARKER BLOCKS**

Type 1 and Type 2 marker blocks shall be manufactured and positioned as shown on the Drawings.

**PSL 5.13 PIPELINE ROUTE MARKERS**

Route markers for the various water pipelines shall be erected in the positions and shall be manufactured according to the details shown on the Drawings."

**PSL 7 TESTING**

**PSL 7.3 STANDARD HYDRAULIC PIPE TEST**

**PSL 7.3.1 Test Pressure and Time of Test**

*ADD THE FOLLOWING TO SUBCLAUSE 7.3.1.2 :*

"The maximum working pressure for the different pipes is indicated by the class of the pipe."

**PSL 8                    MEASUREMENT AND PAYMENT**

**PSL 8.1                GENERAL**

*ADD THE FOLLOWING TO SUBCLAUSE 8.1 :*

"The rates quoted for pipe specials shall all include full compensation for preparing their ends to receive VJ-couplings or for welding, as this is not shown for all individual specials on the Drawings and is not reflected in the documentation.

Where the letter W forms part of an Item description on the Drawings, they indicate welded joints on the pipes or fittings scheduled. These welded joints are measured separately and the rate tendered for such items shall include full compensation for preparing the end of the pipe or fitting for welding, and repairing all corrosion protection linings and coatings.

All equipment required by the Contractor to alter pipes and to manufacture fittings on Site shall be provided by the Contractor. Allowance for this shall be made in the tendered rates.

All Viking Johnson flange adaptors and couplings shall be coated with FBE powder on interior and exterior surfaces."

**PSL 8.2                SCHEDULED ITEMS**

**PSL. 8.2.1            Supply, lay and bed pipes complete with couplings**

*ADD THE FOLLOWING:*

"In the case of concrete pipes, the rate tendered shall also cover the cost of providing and testing the HDPE liner."

**PSL 8.2.11          Anchor/Thrust Blocks and Pedestals**

*INSERT "concrete" BEFORE "and" IN THE LAST LINE OF THE LAST PARAGRAPH.*

*ADD THE FOLLOWING TO SUBCLAUSE 8.2.11 :*

"The tendered rates shall also include the wrapping of uPVC pipes and fittings with Densopol 80 or equivalent material where the pipes and fittings come into contact with concrete."

*ADD THE FOLLOWING SUBCLAUSES:*

**"PSL 8.2.16        Standpipes complete:**

- (a)    (Give description with reference to drawing) ..... Unit : number  
 (b)    Etc for other descriptions

The tendered rate shall include full compensation for all excavations for the pipe, for the drain, if required, and for the base of the concrete pedestal (for the tap), for the supply and installation of all pipework and fittings including a 1,2 m long section of the supply pipe measured from the rising pipe, for the supply and installation of the taps, for backfilling the drain with stone and the trench with approved backfill material, for all formwork and concrete and for all equipment, labour and diverse material required to complete the standpipe as shown on the Drawings.

**PSL 8.2.17          Marker blocks/Pipeline Route Markers:**

- (a)    (Give description with reference to drawing) ..... Unit : number  
 (b)    Etc for other descriptions

The tendered rate shall include full compensation for all excavation and backfill, labour, equipment and materials to manufacture and install the blocks as shown on the Drawings.

**PSL 8.2.18     Connection to existing main potable water supply pipe or existing reticulation within the site ..... Unit : number**

The tendered rate shall include full compensation for the cost of excavation, connection to existing main supply pipe, removal of surplus material, all labour and equipment necessary to make the connection and all liaison with the local authorities.

**PSL 8.2.19     Lowering of Valve and Hydrant Chambers ..... Unit : number**

The rate shall cover all costs for lowering the cover of the chamber to tie in with the new road/verge levels. This item does not include for the lowering of the water pipe.

**PSL 8.2.20     Temporary bypasses**

Measurement of the temporary bypass to keep the irrigation system operational will be subdivided into three items as follows:

- (a) The provision of the temporary bypass will be paid by the sum.

The sum tendered shall cover the cost of supplying and maintaining all the pipes and ancillary equipment required to construct a temporary bypass to the length required by the Engineer up to 100 m in length, including one take-off point and temporary valves where necessary.

- (b) The provision of additional piping will be measured by the number of standard 12 m lengths of piping used.

The rate tendered shall cover the cost of supplying and maintaining the additional standard 12 m lengths of piping required to construct bypasses in excess of 100 m in length.

- (c) The bypasses will be measured by the number constructed.

The rate tendered shall cover the cost of all labour, materials and equipment (not covered by (a) and (b) above) required to break into the existing main, isolate the relevant sections, construct the bypass including connections, temporary thrust blocks and the like, and the removal of the equipment when no longer required.

Where the Engineer authorises the use of new materials other than those damaged through the Contractor's fault or negligence, they shall be measured on dayworks or at rates to be agreed by the Engineer, unless a suitable item has been scheduled.

**PSL 8.2.21     Corrosion protection to external surfaces of pipes, fittings, specials and valves installed above ground or in chambers and pump stations by preparing the surfaces and applying aliphatic cured, dual component polyurethane enamel paint on coatings or bare pipes as indicated and colour as specified to:**

- (a) (Pipeline number and location):  
       (i) (Pipe diameter and material stated) ..... Unit : m  
       (ii) Etc. for other pipe diameters  
 (b) Etc for other pipelines

The tendered rates shall include full compensation for the cost of all materials, equipment and labour and for the cost of carrying out the work strictly in accordance with the requirements of the applicable specifications and of the manufacturer of the corrosion protections system.

**PSL 8.2.22     Miscellaneous field work to pipes:**

- (a) (Description of work stated):  
 (i) (Diameter of pipe stated) ..... Unit : m or number  
 (ii) Etc. for other pipe diameters  
 (b) Etc for other types of work

The tendered rates shall include full compensation for the cost of materials, equipment and labour and for the cost of carrying out the work strictly in accordance with the requirements of the applicable specification.

All site work instructed by the Engineer on Site to alter, change or modify pipework and fittings will be evaluated under this item and work done will be paid for at these rates tendered.

**PSL 8.2.23      Carefully dismantle, remove, clean, prepare, re-install and lay existing pipes in new positions in trenches in diversions of pipeline routes:**

- (a) (Description of pipe):  
 (i) (Diameter of pipe stated) ..... Unit : m  
 (ii) Etc. for other pipe diameters ..... Unit: m

The tendered rates shall include full compensation for the cost of materials, equipment and labour needed to dismantle and relay as described the existing pipes, complete with fittings and specials in a similar new position. (Excavations, backfill, bedding and all new material needed shall be paid for separately.)

**PSL 8.2.24      Pipe support at pipe joints as per detail drawing ..... Unit : number**

The unit of measurement shall be the number of pipe supports provided in accordance with the Specifications.

The tendered rate shall include full compensation for excavation, formwork, concrete, reinforcement, pipe straps, backfilling, etc. necessary for providing the pipe supports as shown on the drawing.

**PSL 8.2.25      Pipe support between pipe joints as per detail drawing ..... Unit : number**

The unit of measurement shall be the number of pipe supports provided in accordance with the Specifications.

The tendered rate shall include full compensation for excavation, formwork, concrete, reinforcement, pipe straps, backfilling, etc. necessary for providing the pipe supports as shown on the drawing."

**PSL 8.2.26      Extra-over 8.2.1 for laying pipes in dam wall ..... Unit : m**

The unit of measurement shall be the metres of pipe laid in the existing dam wall.

The tendered rate shall include full compensation for additional plant, labour and material to lay the pipes within the restricted space on the dam wall. The rate shall also include the handling of the bedding from commercial sources within the restricted area."

**PSLB BEDDING (PIPES) (SANS 1200 LB)****PSLB 3 MATERIALS****PSLB 3.1 SELECTED GRANULAR MATERIAL**

*REPLACE THE CONTENTS OF SUBCLAUSE 3.1 WITH THE FOLLOWING :*

"Selected granular material shall have a PI not exceeding 6 and shall be free from sharp-edged particles exceeding 19 mm."

**PSLB 3.2 SELECTED FILL MATERIAL**

*ADD THE FOLLOWING TO SUBCLAUSE 3.2 :*

"Selected fill material used for bedding shall be stabilised with 5% cement as specified under Subclause PSDB 3.5(c)."

**PSLB 3.3 BEDDING**

*ADD THE FOLLOWING TO SUBCLAUSE 3.3 :*

"uPVC and HDPE pipes are deemed to be flexible pipes for the purposes of this subclause."

**PSLB 3.4 SELECTION****PSLB 3.4.1 Suitable material available from trench excavation**

*REPLACE THE WORDS "(but is not required)" IN THE FIFTH LINE WITH THE WORDS "(at his own cost)".*

**PSLB 5 CONSTRUCTION****PSLB 5.1 GENERAL****PSLB 5.1.2 Details of bedding**

*ADD THE FOLLOWING TO SUBCLAUSE 5.1.2 :*

"The dimension "X" for flexible and rigid pipes as indicated on drawing LB-1 and LB-2 will be 150 mm unless otherwise indicated on the drawing. The dimension "X" will be measured from the invert of the pipe."

**PSLB 5.1.4 Compacting**

*REPLACE "90%" WITH: "90% (100% for sand)".*

**PSLB 8 MEASUREMENT AND PAYMENT****PSLB 8.1 PRINCIPLES****PSLB 8.1.5 Disposal of displaced material**

*REPLACE THE CONTENTS OF SUBCLAUSE 8.1.5 WITH THE FOLLOWING :*

"Material displaced by the pipeline and by imported material from sources other than trench excavation, shall be disposed of off-site by the Contractor. No haulage is payable for such material."

**PSLB 8.1.6     Free-haul**

*DELETE THE WORDS "of 0,5 km" IN THE FIRST LINE OF SUBCLAUSE 8.1.6..*

**PSLB 8.2     SCHEDULED ITEMS****PSLB 8.2.1     Provision of bedding from trench excavation**

*REPLACE THE PARAGRAPH "the rate shall ..... " WITH THE FOLLOWING :*

"The rates shall cover the cost of acquiring from within site boundaries, bedding that complies with the relevant requirements of the Specifications, of delivering it to the points alongside the trench spaced to suit the Contractor's method of working, and of disposing of displaced material outside the site boundaries."

**PSLB 8.2.2     Supply only of bedding by importation****PSLB 8.2.2.2     From borrow pits**

*DELETE THE WORDS IN BRACKETS IN THE FIRST FOUR LINES.*

*ADD THE FOLLOWING TO SUBCLAUSE 8.2.2.2 :*

"The opening up of borrow pits and the removal of overburden are paid for under item 8.3.4 of SANS 1200 D."

*ADD THE FOLLOWING SUBCLAUSES :*

**"PSLB 8.2.6     Extra over items PSLB 8.2.1 and PSLB 8.2.2 for bedding stabilised with 5% cement Unit : m<sup>3</sup>**

The tendered rate shall include full compensation for selecting, mixing, backfilling and compacting the stabilised material to 90% of modified AASHTO density."

**PSLB 8.2.7     Provision of stone/geofabric to deal with water ..... Unit : m<sup>3</sup>/m<sup>2</sup>**

If in the opinion of the Engineer, the Contractor complied with the requirements for dealing with water as specified in PSA 8.8.7, the Engineer may instruct the installation of crushed stone and filter fabric. Payment for these items will only be made where instruction was given in writing by the Engineer.

The provision of crushed stone bedding material will be measured by volume based on the specified trench width and a maximum layer thickness of 300 mm unless a greater depth has been specified by the Engineer.

The unit rate shall cover the cost of supplying and laying the crushed stone.

The filter fabric will be measured separately by area based on the specified trench width, a stone bedding thickness of 300 mm and an overlap of 300 mm.

The rate shall cover the cost of the supply, delivery and laying of the filter fabric."

**PSLC CABLE DUCTS (SANS 1200 LC)****PSLC 2 INTERPRETATIONS**

ADD THE FOLLOWING AFTER "e) SANS 1200 DB."

"f) SANS 1200 GA

**PSLC 3 MATERIALS****PSLC 3.1 DUCTS**

*DELETE THE FOLLOWING WORKINGS IN THE SUBCLAUSE:*

"Except that the GPO will supply all pipes for cable ducts required for GPO purposes,"

*ADD THE FOLLOWING AFTER ITEM d):*

"e) Kabelflex or similar approved in the case of HDPE pipes, complying with SANS 61386-24 (Type N 450)."

*ADD THE FOLLOWING TO THE END OF THE SUBCLAUSE:*

"Ducts shall be supplied by the Contractor complete with end caps, joints, sealing and draw wires.

Unless otherwise specified on the drawings or in the Bill of Quantities, cable ducts shall be Kabelflex or similar approved HDPE ducts."

*ADD THE FOLLOWING TO SUBCLAUSE 3.1 :*

**"PSLC 3.1.1 Split uPVC pipes**

Split pipes shall only be used to provide ducts for existing services that cannot be severed and threaded through the ducts. The pipes shall be cut accurately in the middle, and opposite halves shall be matched as sawn. Split pipes shall be placed around the service, firmly bound by steel straps, and encased in concrete."

**PSLC 3.2 BEDDING**

*DELETE SUB-CLAUSES 3.2.1 AND 3.2.2 AND REPLACE WITH THE FOLLOWING:*

"The requirements and specifications of PSLB 3.1 shall apply."

**PSLC 3.3 BACKFILL**

Notwithstanding the provisions of this subclause, the material to be used for backfilling in areas subject to road traffic loads shall be subbase quality material complying with the requirements of subclause 3.2.1 of SABS 1200 ME and PSME 3.2.1.

**PSLC 3.4 CABLE DUCT MARKERS**

*ADD THE FOLLOWING TO SUBCLAUSE 3.4 :*

"A cable duct marker shall consist of a 300 mm x 300 mm x 100 mm deep, class 20 MPa/19 mm concrete block, connected by means of a non-ferrous metal strip to a temporary plug to seal the end of the duct. The plug shall prevent moisture or soil from entering the duct. The metal strip shall be firmly connected to both the plug and the concrete block. The concrete block shall be positioned not further than 0,5 m horizontally from the end of the cable duct. The face of the concrete block shall be clearly marked "E" to indicate electricity cables."



Temporary markers shall be provided at each duct end. The ends of all ducting pipes shall be temporarily marked with a 300x100x75 clay brick planted 200mm vertically into the ground directly above the end plugs. The ends of the draw ropes shall be attached to this brick marker. The exposed part of the brick marker shall be painted as follows:

Electricity	Red
Telkom	Green
Communication	Yellow

Permanent markers shall be provided in accordance with the requirements of PSLC 5.10.

**PSLC 5      CONSTRUCTION**

**PSLC 5.1      EXCAVATION OF TRENCHES**

Notwithstanding the contents of this subclause, the requirements of PSDB and SANS 1200 DB shall apply."

**PSLC 5.1.3      Excavation for trenches at road crossings**

The requirements of PSDB 5.4 shall apply with the additional proviso that the minimum depth of cover over ducts shall be 300mm where construction traffic is liable to cross them. Road crossings shall therefore be constructed after the construction of the roadworks has reached the stage where the required cover is available.

**PSLC 5.2      BEDDING AND COMPACTION OF BEDDING**

Notwithstanding the contents of this subclause, the requirements of PSLB and SANS 1200 LB shall apply."

**PSLC 5.3.3      DRAW WIRE**

Notwithstanding the requirements of this Subclause, the nominal diameter of draw wire shall be 3mm.

*ADD THE FOLLOWING NEW SUBCLAUSES:*

**"PSLC 5.3.5      LAYING TO GRADE**

Where two or more Telkom ducts of internal diameter greater than 75mm are laid together in the same trench, the ducts shall be laid to a minimum grade of 1:400.

**PSLC 5.3.6      SEALING OF ENDS**

The ends of electrical ducts shall be sealed with end caps or suitable ingress and moist protection."

**PSLC 5.6      LAYING OF TELECOMMUNICATIONS AND DATA DUCTS WITH OTHER SERVICES**

The horizontal separation between telecommunications ducts and other services shall be the maximum possible but in the case of electricity cables at least 300mm. Where the latter cannot be attained the ducts shall be separated from the cables by means of concrete protection slabs (see below) placed vertically.

No service other than telecommunications ducts shall be laid directly above and parallel to a telecommunication duct.

The concrete protection slabs mentioned above shall be 400mm square by 50mm thick and shall be reinforced with welded mesh ref. 193. The concrete used shall be 20mPA/13 and the slabs shall be finished off to the satisfaction of the Employer's Agent.

*REPLACE THE HEADING AND CONTENTS OF SUBCLAUSE 5.7 WITH THE FOLLOWING:*

**PSLC 5.7      CROSSING OF TELECOMMUNICATION DUCTS WITH OTHER SERVICES**

Telecommunications ducts should preferably cross above other services. The radial separation at such crossings shall be the maximum possible but in the case of electricity cables at least 300mm. Where the latter cannot be attained, concrete protection slabs as specified in PSLC 5.6 shall be placed above the electricity cable for a distance of 800mm on either side of the crossing (or below as the case may be)."

**PSLC 5.8      ROAD CROSSINGS**

*DELETE THE LAST SENTENCE AND REPLACE WITH:*

"The duct(s) shall extend a distance of at least 1m beyond the rear of kerb or walkway as applicable.

*ADD THE FOLLOWING TO SUBCLAUSE 5.8:*

"Duct ends must be blanked off with endcaps, and all ducts laid are to be provided with galvanized draw-wires for subsequent cable-pulling operations by others."

**PSLC 5.10     POSITION TO BE MARKED**

Marking is required on both sides of the carriageway.

Delete in the second line: "...the letters "GPO or ESC", as applicable, ..." and replace with "...the letters "T" and "E", as applicable."

Add: "The height of the letter shall be at least 100 mm."

**PSLC 8        MEASUREMENT AND PAYMENT**

**PSLC 8.2     SCHEDULED ITEMS**

**PSLC 8.2.2   EXCAVATION**

*AND ADD THE FOLLOWING TO SUBCLAUSE 8.2.2(b) :*

"(i)      Hard rock excavation Unit : m<sup>3</sup>

The unit of measurement shall be the cubic metre of material, measured in place according to the authorised dimensions, which was excavated by hand on the specific prior written instructions of the Employer's Agent; provided always that the Employer's Agent said instruction shall have stated that measurement and payment for such hand excavation will be in accordance with this item.

The tendered rate shall include full compensation for the additional cost, effort and time resulting from excavating in the respective materials using hand methods only.

The Employer's Agent shall not be obliged to authorise payment under this item in respect of any hand excavation carried out (whether ordered in writing or otherwise), which hand excavation was in any case necessary to achieve compliance by the Contractor of his obligations under the Contract to:

- 1) utilise construction appropriate to the nature of the specific parts of the Works and/or

- 2) protect existing structures and/or services; and/or
- 3) comply with all prevailing legislation and regulations.

(ii) Hand excavation and backfill where directed by the Employer's Agent ..... Unit : m<sup>3</sup>

The rates shall cover the cost of excavating by means of hand tools within authorised dimensions, for all precautionary measures necessary to protect the services from damage during excavation and backfilling and for subsequent backfilling and compacting. Compaction of material in all areas except in roadways shall be to 93% of modified AASHTO density.

The rate for hand excavation in roadways shall also include compensation for compacting excavated or selected backfill material to 100% of modified AASHTO density. Reinstating layerworks and surfacing shall be measured and paid for under SANS 1200 DB.

The tendered rates shall also include for keeping excavations safe, for dealing with surface and subsurface water and for removal of surplus excavated material from the site."

(iii) Soilcrete backfill where directed by the Employer's Agent ..... Unit : m<sup>3</sup>

The unit of measurement shall be the cubic metre of soilcrete placed on the Employer's Agents instructions in accordance with Subclause PSDB 3.5(d), measured in place according to the authorised dimensions.

The tendered rate shall include full compensation for supplying the cement and for selecting, mixing and placing the soilcrete as well as for the cost of shuttering if required.

#### **PSLC 8.2.5 Supply, lay, bed and prove duct**

*REPLACE THE CONTENTS OF THIS SUBCLAUSE WITH THE FOLLOWING:*

"Separate items will be scheduled for each diameter of duct.

The per meter rate shall be per meter of cable duct and not per meter of trench (i.e. for a 10m long trench with 4 ducts, it shall be 40m) and the rate shall cover the cost of providing the ducts (complete as specified in 3.1) and the cost of laying, jointing, bedding, building into draw pits, proving, and installing draw wire as specified. The rates shall also include for all costs involved in sealing and marking duct ends and the re-excavation and backfilling for marking purposes."

*REPLACE THE HEADING AND CONTENTS OF SUBCLAUSE 8.2.6 WITH THE FOLLOWING:*

#### **PSLC 8.2.6 Provision of selected granular material complying with PSLC3.2**

(i) From commercial or off-site sources located by the contractor.....Unit: m<sup>3</sup>

The rate tendered for shall cover the cost of acquiring, regardless of distance, the required bedding from commercial or off-site sources located by the Contractor, delivering it to points alongside the trench spaced to suit the Contractor's method of working and disposing of material displaced by each operation at an approved site furnished by the Contractor. No haulage shall be payable for such material."

*ADD THE FOLLOWING NEW PAYMENT ITEMS:*

#### **"PSLC 8.2.10 Break in existing duct manhole and connect new duct up to 160mm dia. and make good ..... Unit : No**

The tendered rate shall include full compensation for excavation, making an opening in the existing manhole, installing new duct in the new opening, for breaking out, ensuring the

watertightness of the new connection, supplying all the necessary materials, removing surplus material and debris, all labour and equipment required to make the connection, and liaison with the local authorities."

**"PSLC 8.2.11    Joining new duct to existing duct .....Unit : No**

The rate shall cover all costs for joining the two ducts, including the supply of any necessary couplings."

**"PSLC 8.2.12    Imported backfill (source and quality stated) ..... Unit: m³**

The provisions of Clause 8.3.3.1 of SABS 1200 DB shall apply, except that the trench width shall be determined in accordance with PSLC 5.1.1 or that called for in terms of 5.6.

**PSLC 8.2.13    Compaction in road crossing ..... Unit: m³**

The provisions of PSDB 8.3.3.3 shall apply, except that the trench width shall be determined in accordance with PSLC 5.1.1 or that ordered in terms of PSLC 5.6 and payment will be extra over that covered by 8.2.2(a).

**PSLC 8.2.14    Supply and installation of concrete protection slabs.....Unit: No**

The rate tendered shall cover the cost of all labour, plant and material required to manufacture the protection slabs as specified in PSLC 5.6, as well as placing and bedding the slabs."

**PSLD SEWERS (SANS 1200 LD)****PSLD 2 INTERPRETATION**

*ADD TO "AC: ASBESTOS CEMENT" THE FOLLOWING:*

"Now referred to as FC"

**PSLD 3 MATERIALS****PSLD 3.1 PIPES, FITTINGS AND PIPE JOINTS**

*REPLACE THE CONTENTS OF SUBCLAUSE 3.1.5 WITH THE FOLLOWING :*

**"PSLD 3.1.5.1 uPVC Pipes**

uPVC solid wall pipes shall comply with SABS 791 with a pipe stiffness of 300 kPA (class 34 heavy duty), complete with integral sockets, joints, and rubber seal rings.

**PSLD 3.1.5.2 Fittings**

Fittings for structured wall pipes shall comply with the requirements of SANS 791."

**PSLD 3.5 MANHOLES, CHAMBERS, ETC.****PSLD 3.5.12 Bricks**

*ADD THE FOLLOWING:*

"The requirements and specifications of PSGA 5.6 shall apply."

**PSLD 3.5.2 Precast concrete sections**

*ADD THE FOLLOWING:*

"Sectional spun-concrete cylinders shall be manufactured from dolomitic aggregate."

**PSLD 3.5.7 Step irons**

*DELETE THE CONTENTS OF THIS SUBCLAUSE AND REPLACE WITH THE FOLLOWING:*

"Step irons shall be of the copolymer polypropylene type with a 12 mm dia. high tensile steel reinforced core and shall be of length suitable for fixing in brick, precast concrete or reinforced fibre cement as applicable.

**PSLD 3.5.8 Manholes covers and frames**

*DELETE THE CONTENTS OF THIS SUBCLAUSE AND REPLACE WITH THE FOLLOWING:*

**"PSLD 3.5.8.1 Precast concrete elements**

Precast concrete roof slabs and covers shall comply with the applicable requirements of SABS 1294 and the strength requirements specified on the drawings. The elements shall be manufactured in accordance with the details shown on the drawings using concrete consisting of dolomitic aggregate.

Precast concrete roof slabs and covers shall be used throughout the works except in roadways, or where otherwise ordered by the Employer's Agent."

**PSLD 3.6      MARKER POSTS**

*REPLACE THE WORDS "Project Specification" WITH "Drawings".*

*TO THE END OF THIS SUBCLAUSE, ADD THE FOLLOWING:*

"Where no drawings exist, the Contractor shall propose marker posts that are suitable for the purpose, for approval of the Employers Agent."

**PSLD 5      CONSTRUCTION****PSLD 5.2      LAYING AND BEDDING****PSLD 5.2.2      Alignment**

*ADD AFTER "SANS 1200 LB" IN THE FIRST SENTENCE, THE FOLLOWING:*

"and the details shown on the drawings."

*REPLACE THE LAST SENTENCE WITH THE FOLLOWING:*

"Pipes that have any deviation from straightness shall be so laid that preference is given to level over line."

*ADD THE FOLLOWING NEW SUBCLAUSES:*

**PSLD 5.2.6      Jointing**

Jointing shall be carried out strictly in accordance with the manufacturer's instructions.

**PSLD 5.2.7      Depth of cover beneath roadways and vehicular trafficked areas during construction**

"The minimum depth of cover during construction shall be 750mm."

**PSLD 5.6      MANHOLES, INSPECTION CHAMBERS, ETC.****PSLD 5.6.2      Benching**

*ADD TO THE END OF SUBCLAUSE 5.6.2.1 THE FOLLOWING:*

"Notwithstanding the requirements of this subclause, pipes shall be prepared and built into manholes as shown on the drawings."

*REPLACE "1:3 CEMENT MORTOR" IN THE FIRST LINE OF SUBCLAUSE 5.6.2.3 WITH THE FOLLOWING:*

"concrete topping consisting of 1 part cement, 2 parts sand and 3 parts 7mm concrete stone, by mass. The sand proportion may be varied between 1 ½ and 2 ½ to obtain ideal workability."

**PSLD 5.6.5      Precast concrete manholes**

*REPLACE THE CONTENTS OF THIS SUBCLAUSE WITH THE FOLLOWING:*

"Precast concrete manholes shall be constructed in accordance with the details shown on the drawings. Joints between chamber sections shall be caulked from the inside with 3:1 sand cement mortar or other sealing method approved by the Engineer."

*ADD THE FOLLOWING NEW SUBCLAUSES:*

**“PSLD 5.6.7    Rectification of water infiltration**

Any infiltration visible in the manhole channels, pipe ends, or benching shall be rectified by demolishing the base and rebuilding.

Rectification of infiltration through the walls and/or joints may be attempted only by externally applied measures, failing which the manhole shall be demolished and re-constructed.”

**PSLD 5.6.8    Finished cover level**

“Unless otherwise shown on the drawings or ordered, the level of the top surface of the cover shall be:

- for manholes within carriageways; flush with the final surface of the roadway.
- for manholes within road reserves; 50mm above finished ground level.
- for manholes within midblock; 250mm above finished ground level.
- for manholes within open spaces; 500mm above the finished ground level.”

**PSLD 5.9    CONNECTING SEWERS****PSLD 5.9.1    Location and Details**

*DELETE THE FOLLOWING FROM THE FIRST PARAGRAPH:*

"or required in terms of the Project Specifications."

*DELETE THE SECOND PARAGRAPH.*

**PSLD 5.9.2    Marker posts**

*REPLACE THE CONTENTS OF SUBCLAUSE 5.9.2 WITH THE FOLLOWING :*

“Unless otherwise specified, the Contractor shall supply and accurately place marker posts on the centreline of buried pipelines, or as instructed by the Employer’s Agent. Marker posts shall be placed at all points of intersection, chambers and at a maximum spacing of 250 m. Marker posts shall be placed only once the pipelines, or any sections thereof, have been successfully tested and the trenches backfilled.

The coordinates, level, and centreline distance (as determined from the as-built survey and drawings) of each marker post shall be accurately determined and recorded by the Contractor. All details shall be given to the Employer’s Agent in writing.”

*ADD THE FOLLOWING NEW SUBCLAUSE:*

**“PSLD 5.9.4    Connection of new to existing reticulation**

The contractor shall under no circumstances connect the new reticulation into the existing without the prior written instruction of the Employer’s Agent. This instruction will only be given after acceptance, by the Engineer, of the sewer lines and manholes of the new reticulation upstream of the connection point. Connections will usually be made just prior to the start of the Defects Liability Period.”

*ADD THE FOLLOWING NEW SUBCLAUSE:*

**" PSLD 5.11    Installation of conservancy tank**

Each tank shall be carefully lowered into its excavation and orientated. Thereafter the inlet pipe shall be fitted, and the leakage test carried out (fill tank completely with water and allow to stand and if after three hours there are no signs of leakage, the tank will be deemed to have satisfied the requirements of the test). If tank does not comply with leakage test, it shall be repaired, or removed and replaced with a tank that does comply, as directed by the Employer's Agent.

After acceptance of the tank by the Employer's Agent the excavation shall be backfilled with selected material to the level of the top of digester tank. The material shall be adequately moistened prior to placing and shall be compacted in layers not exceeding 250mm, care being exercised not to cause any local indentations in the skin of the tank.

The remaining backfill over the top of the tank may comprise of any excavated material and the surface shall be finished off to the shape and level as directed on site.

#### **PSLD 5.12      Backfilling around manholes**

Material used to backfill around manholes that fall within the road reserve must comply with SANS 1200 LB Subclause 3.1. Material used to backfill around other manholes must comply with SANS 1200 DB subclause 3.5.

Material adjacent to the walls of the manholes must be watered and mixed to its optimum moisture content, and compacted in layers not exceeding 150 mm in the compacted state. Compaction must be minimum 100% MOD AASHTO for non-cohesive material, and minimum 93% of MOD AASHTO density for cohesive materials.

Backfilling around the structure must be carried out in even layers to avoid uneven side forces."

#### **PSLD 6      TOLERANCES**

##### **PSLD 6.2      OVERALL CENTRELINE CONTROL AND MANHOLE LOCATIONS**

*REPLACE "±300mm" IN THE SECOND LINE OF THIS SUBCLAUSE WITH "±100mm".*

*REPLACE "plus or minus half a pipe length" IN THE LAST LINE OF THIS SUBCLAUSE WITH "±200mm".*

*ADD THE FOLLOWING TO THE SUBCLAUSE:*

"The Contractor shall note that the positions in plan of manholes are critical. No deviation in excess of the tolerances specified will be accepted without the prior authorization of the Employer's Agent."

*ADD THE FOLLOWING NEW SUBCLAUSE:*

##### **"PSLD 6.6      AS-BUILT INFORMATION**

The Contractor shall after completion of a section of pipeline submit the following as-built information:

- Co-ordinates of manholes,
- Invert levels at manholes, and
- Distance between manholes"

#### **PSLD 7      TESTING**

##### **PSLD 7.2      TESTS AND ACCEPTANCE/REJECTION CRITERIA**

##### **PSLD 7.2.1      Air Test**



*ADD THE FOLLOWING:*

"After the completion of a successful air test the pipes shall be flushed out to remove all dirt, grit and the like."

**PSLD 7.2.6 Watertightness of Manholes***ADD THE FOLLOWING TO THE END OF THE SUBCLAUSE:*

"Manholes will be inspected at the end of the first winter after completion. No ingress of groundwater into the manhole will be allowed.

Should any manhole fail to pass the inspection to the satisfaction of the Employer's Agent, the fault or faults shall be made good by the Contractor at his own expense according to methods approved by the Employer's Agent and the work shall be inspected again. The cost of all extra work and inspection shall be borne by the Contractor."

*ADD THE FOLLOWING NEW SUBCLAUSE:***"PSLD 7.2.7 Torch and Mirror Test**

The equipment for the test shall comprise of the following:

- A torch capable of emitting a strong beam of light.
- A mirror.
- A wooden plug covered on one side with suitable reflector material. The diameter of the plug shall suit the diameter of the pipe being tested.

The test shall be carried out by plugging one end of the pipe with the plug reflector and reflecting the torch beam off the mirror down the pipe from the other end. For the pipeline to be acceptable at least 80% of the plug's reflected area shall be visible."

**PSLD 7.2.8 Acceptance Criteria**

The acceptance of the pipe length or manhole shall depend upon whether it satisfies the criteria set out in SANS 1200 LD clauses 6, 7 and the PS clauses above.

Only tests carried out on the pipelines after completion of the backfilling to ground level (excluding surface restoration) and construction of manholes to roof height and benching will be considered for acceptance purposes.

**PSLD 8 MEASUREMENT AND PAYMENT****PSLD 8.2 SCHEDULED ITEMS****PSLD 8.2.1 Supply, lay, joint, bed and test pipeline .....Unit: m***ADD THE FOLLOWING:*

"The rate tendered shall further cover the cost of providing the water and for flushing out the pipeline as called for in terms of PS LD 7.2.1, as well as for the disposal of the water.

The measured quantity of completed pipe length will only be included in the payment certificate when pipeline has satisfied the test after the completion of the backfill to ground level – see PS LD 7.2.8. Prior to this, payment will be made as materials on site."

**PSLD 8.2.2 Extra over item 8.2.1 for specials**

All specials shall include for the provision of couplings as required.

**PSLD 8.2.3     Manholes .....Unit:**  
No.

*ADD THE FOLLOWING TO SUBCLAUSE 8.2.3 :*

"The rates tendered for the manholes shall cover the supply and installation of the complete manhole, castings, step irons, benching, frame and concrete footings for the prevention of filtration where applicable.

For the purpose of measurement and payment, the depth of a manholes is defined as the depth from the top of the cover to the invert level of the manhole.

**PSLD 8.2.5     Inspection Chambers, etc .....Unit: No.**

*REPLACE THE CONTENTS OF SUBCLAUSE 8.2.5 WITH THE FOLLOWING :*

"Separate items will be scheduled for manholes, backdrops, and inspection chambers, etc of each type and of each depth in increments of 0,5 m. The rate shall cover the cost of dealing with any excavation (in all materials including disposal of surplus) and backfilling with suitable material in accordance with PSLD 5.11 (including import of material if required) additional to what is measured under SANS 1200 DB Subclauses 8.2.2 and 8.2.3. The rate shall cover the cost of construction of manholes complete with channels, benching, short pipes (1 m long) and all flexible connections in accordance with the detail shown on the drawings.

The depth category of manholes shall be measured as the difference between the cover level and the deepest invert level of the manhole."

**PSLD 8.2.6     Erf Connections (Types stated) .....Unit: No.**

*REPLACE THE CONTENTS OF THE TWO PARAGRAPHS IN SUBCLAUSE 8.2.6 WITH THE FOLLOWING :*

"(a) Connections to sewer ..... Unit : No.

Separate items will be listed for connections measured at different depths. The depth will be that of the main sewer at the point of connection. The size, type, class and treatment of the junction and bend shall be the same as for the connection pipe.

The rate shall cover the cost for excavation in all materials, bedding and backfilling (including importation of suitable material if required), disposal of surplus, supply and installation of a junction with erf connection entering the main sewer line flush with the soffit of the main sewer, 45 degree bend and the end cap.

(b) Connections to sewer manhole ..... Unit : No.

The rate shall cover the cost for adapting a standard manhole to accommodate the erf connection pipe, and the supply and installation of the end cap."

**PSLD 8.2.11     Connection to existing sewer at .....Unit: Sum**

*REPLACE THE HEADING AND CONTENTS OF SUBCLAUSE 8.2.11 WITH THE FOLLOWING :*

**"PSLD 8.2.11     Connection to existing sewer at sewer / inlet works sump ..... Unit : No.**

The tendered sum shall include full compensation for excavation, making an opening in the existing manhole, installing new pipes in the new opening, for breaking out and modifying the channelisation inside the manhole to suit the new pipe layout, ensuring the watertightness of the new connection, supplying all the necessary materials, removing surplus material and

debris, all labour and equipment required to make the connection, and liaison with the local authorities."

ADD THE FOLLOWING NEW SUBCLAUSES :

- PSLD 8.2.13

**Breaking into existing sewer and building a new manhole**

..... Unit : No.

The tendered rate shall include full compensation for excavation, building a new manhole over the sewer, breaking into the existing sewer, building the channelisation under wet conditions, ensuring the watertightness of the new connection, supplying all the necessary materials, removing surplus material, all labour and equipment required to make the connection, and liaison with the local authorities."
- PSLD 8.2.14

**Watertightness of Manholes**

..... Unit : No.

The tendered rate shall include full compensation for ensuring the manholes are watertight after the connections have been made, including all materials/products required to ensure total sealing/waterproofing around the pipe inlets into the structure and all testing as may be required by the contractor to verify the watertightness of the manhole."
- PSLD 8.2.15

**Construction of Rodding Eye concrete surround 500mm diameter x 200mm thick**

..... Unit : No.

The rate shall cover all costs for the supply and installation of the complete rodding eye as per the detail drawings, including all excavation, materials, labour, backfill material (as required), compaction around the structure and ensuring the necessary safety requirements are adhered to."
- PSLD 8.2.16

**Provide, test, and install conservancy tank complete with internal specials (Tank type specified)**

..... Unit: No.

The rate tendered shall cover the additional cost, extra over that provided for under 8.2.3, to construct a manhole on an existing line, the breaking and trimming of the existing pipe, any additional work involved to construct the benching, dealing with existing flow, preventing foreign material entering the sewer as well as making good any work disturbed."

**PSLE            STORMWATER DRAINAGE (SANS 1200 LE)****PSLE 3            MATERIALS****PSLE 3.1        CULVERT UNITS AND PIPES**

*ADD THE FOLLOWING TO THE END OF SUBCLAUSE 3.1c :*

"Precast concrete units shall comply with the requirements of the latest SANS 986:2006 specification.

Prior to the manufacture of any units the manufacturer shall submit his Quality Plan to be approved by the Employer's Agent before delivery of any units to site. As part of the Quality Plan submitted for approval copies of calibration certificates of both gauges used for proof loads and cover meters used at the factory shall be supplied to the Employer's Agent. The originals of these certificates shall at all stages also be available for inspection at the factory premises. The manufacturer shall check each precast unit for cover compliance, and random checking of units shall not be permitted. The Employer's Agent representative may visit the factory at any stage to ascertain adherence to the quality plan as well as to check covers before delivery to site. Any substandard cover shall result in the batch being rejected. Should the manufacturer not be adhering to their Quality Plan the Employer's Agent may exercise the right to reject the use of products from the manufacturer concerned. The employer shall also be informed in all such cases."

*ADD THE FOLLOWING TO THE END OF SUBCLAUSE 3.1d :*

"Skewed ends for pipe culverts may be cut on Site."

**PSLE 3.4        MANHOLES, CATCHPITS, AND ACCESSORIES****PSLE 3.4.1      Bricks**

*ADD THE FOLLOWING TO SUBCLAUSE 3.4.1 :*

"Bricks shall be engineering bricks complying with the requirements of SANS 227."

*ADD THE FOLLOWING SUBCLAUSE :*

**"PSLE 3.6        MATERIALS FOR SUBSURFACE DRAINS****(a)    Pipes and fittings**

Pipes for subsurface drains shall be normal duty, perforated or slotted uPVC pipes complying with SANS 791. Fittings shall be heavy duty and shall also comply with SANS 791.

The size of the perforations in perforated pipes shall in all cases be 8 mm in diameter  $\pm$  1,5 mm, and the number of perforations per metre shall not be less than 26 for 100 mm pipes and 52 for 150 mm pipes. Perforations shall be spaced in two rows for 100 mm pipes and in four rows for 150 mm pipes, as shown on the Drawings.

Slotted pipes shall have a slot width of 8 mm with a tolerance of 1,5 mm in width. The arrangement of the slots is subject to the Employer's Agent's approval, but the total slot area shall not be smaller than that specified for perforations.

**(b)    Crushed stone**

Crushed stone shall be 19 mm single-sized and shall comply with the requirements of SANS 1083.

**(c)    Geotextiles**

Geotextiles shall be a non-woven, spun or thermic-bonded continuous filament fabric consisting of at least 85% by mass of polypropylene, polyester or other approved material and manufactured for civil-engineering applications by a recognised manufacturer."

**PSLE 5      CONSTRUCTION**

**PSLE 5.1      TRENCH BOTTOM**

**PSLE 5.1.4      Width of excavation**

*ADD THE FOLLOWING TO THE END OF SUBCLAUSE 5.1.4a :*

The base width of rectangular portal culverts shall be used to determine the side allowance as per SANS 1200 DB 5.2.

**PSLE 5.2      BEDDING AND LAYING**

**PSLE 5.2.1      General**

With reference to the last sentence of the second paragraph of this Clause and without limiting the Contractor's responsibility in this regard, the minimum depth of cover during construction shall be as specified by the pipe manufacturer.

**PSLE 5.2.2      Pipe culverts**

*ADD THE FOLLOWING:*

"Unless otherwise stated in the Bill of Quantities or indicated on the drawing, spigot and socket pipes with rubber ring seals shall be used.

Pipes with ogee joints shall be wrapped with two layers of Hessian soaked in cementitious grout. The wrapping shall be 400mm wide and placed centrally over each joint.

Where pipes are cut, the ends shall be made good with an epoxy concrete mix so as to prevent rusting of the reinforcement or deterioration of the concrete.

Lifting holes should be suitably closed off to prevent the ingress of soil."

**PSLE 5.2.5      Portal and rectangular culverts**

Add the following to the end of Subclause 5.2.5b):

Where rectangular portal culverts are inverted, a 300mm selected granular material shall be placed at the base of the inverted culvert.

"Rectangular culvert joints shall be sealed with a 500 mm wide strip of Bituthene 3000 or an approved equivalent material glued symmetrically around the joint, using an adhesive recommended by the manufacturer of Bituthene. A 150 mm wide strip of adhesive shall be applied to the edges of the Bituthene."

**PSLE 5.5      CATCHPITS, MANHOLES, INLETS, AND OUTLET STRUCTURES**

**PSLE 5.5.6      Benching**

Delete "granolithic plaster" and replace by "concrete topping consisting of a 1:2:3 cement, sand and 7mm stone mix by weight. The sand proportion may be varied between 1,5 and 2,5 to obtain ideal workability.

*ADD THE FOLLOWING SUBCLAUSES :*

**"PSLE 5.8      CONSTRUCTION OF SUBSURFACE DRAINS**

Subsurface drains shall be constructed where shown on the Drawing or as ordered by the Employers Agent to the detail as shown on the Drawings.

After the completion of the excavations, the bottom portion of the trench shall be lined with geotextile sheeting as shown on the Drawings. The top edges of the vertical portions of the geotextile sheeting shall be tacked to the sides of the excavations with nails or by another suitable approved means. An overlap of at least 200 mm shall be provided at each joint. Geotextile sheeting damaged during the installation or construction shall be replaced at the Contractor's cost.

A layer of crushed stone of the thickness shown on the Drawings shall be placed on the geotextile and be lightly tamped and finished to the required gradient.

Pipes of the required size shall be firmly bedded on the permeable material, true to level and grade, and coupled where required. The trench shall then be backfilled with crushed stone to the height above the pipes shown on the Drawings or as directed by the Employer's Agent.

Crushed stone shall be placed in layers of not more than 300 mm at a time and shall be lightly compacted. Care shall be taken to prevent the contamination of crushed stone during construction of the subsurface drains and all material contaminated by soil or silt shall be removed and replaced by the Contractor at his own expense.

Perforated and slotted pipes shall be joined by couplers. Perforated pipes shall be laid with the perforations at the top or at the bottom, as directed. The higher end of subsurface drain pipes shall terminate at an inspection chamber or rodding eye, as shown on the Drawings and at the lower end of the pipe shall be built into a concrete head wall providing a positive outlet, or it shall be connected to the storm water pipes or culverts.

After all the crushed stone filter material has been placed and the protruding vertical filter material has been placed, the protruding vertical sections of the geotextile sheeting shall be folded back across the filter material so that the filter material will be completely enwrapped in the geotextile. An overlap of at least 200 mm shall be provided between the portions folded back.

The remainder of the trench shall be immediately backfilled with approved impermeable material preferably obtained from the excavations, in layers not exceeding 150 mm and compacted to 90% of modified AASHTO density, unless otherwise ordered by the Employer's Agent. The trench shall be specially protected against the ingress of water, soil and silt until the backfilling with impermeable material has been completed.

Permeable material in subsoil drains shall not be taken to the surface but shall be discontinued at such heights as will be determined by the Employer's Agent.

Any section of a subsurface drain constructed with pipes without perforations or slots shall be backfilled with impermeable backfill material as described above. Suitable excavated material may be used for backfilling. Payment for excavations as well as for backfilling with impermeable material will be made under SANS 1200 DB.

**PSLE 5.9      BACKFILLING AROUND STRUCTURES**

Material used to backfill around manholes that fall within the road reserve must comply with SANS 1200 LB subclause 3.1. Material used to backfill around other manholes must comply with SANS 1200 DB subclause 3.5.

Material adjacent to the walls of the manholes must be watered and mixed to its optimum moisture content, and compacted in layers not exceeding 150 mm in the compacted state. Compaction must be minimum 100% MOD AASHTO for non-cohesive material, and minimum 93% of MOD AASHTO density for cohesive materials.

Backfilling around the structure must be carried out in even layers to avoid uneven side forces.”

**PSLE 6      TOLERANCES**

*ADD THE FOLLOWING NEW CLAUSE:*

**“PSLE 6.6      PIPES INTO MANHOLES / CATCHPITS**

Pipes may protrude up to 300mm into a manhole / catchpit. This relaxation will only be permitted if the pipe does not have to be cut. The “dead space” formed at the end of the manhole is to be suitably benched off to prevent the collection of silt and rubbish.”

**PSLE 6.7      AS-BUILT” DETAILS**

The Contractor shall submit as-built levels, distances between manholes and the grades of pipelines for which he requires payment, at the time he submits his monthly payment claim. A sample form can be obtained from the Employer’s Agent.”

**PSLE 8      MEASUREMENT AND PAYMENT**

**PSLE 8.2      SCHEDULED ITEMS**

**PSLE 8.2.1      Supply and Lay Concrete Pipe Culverts:**

*REPLACE THE HEADING OF CLAUSE 8.2.1 WITH THE FOLLOWING:*

**“PSLE 8.2.1      Supply, lay, joint, bed and test pipeline:**

- (a) Reinforced concrete pipes type SC Spigot & Socket pipe with rubber ring joints on sand bedding of diameters & class as indicated ..... Unit: m
- (b) Heavy Duty (HD) type UPVC pipe laid, inclusive of all necessary fittings on flexible bedding of diameter and class as indicated ..... Unit: m

**PSLE 8.2.8      Supply and Install Manholes, Catchpits and the Like**

In the heading of this Subclause, replace the words “and the Like” with “field inlet, grid inlets, headwalls, inspection chambers, rodding eyes, and the like as indicated on the drawings”

*ADD TO THE CONTENTS OF CLAUSE 8.2.8 THE FOLLOWING:*

**“(d)      Inlets (type and depth range stated)**

The rate shall cover the cost and dealing with any excavation (as if in sort excavation including disposal of surplus) that is additional to the measured under the item for pipe trench excavation, the supply of all labour, plant and materials required to complete the structures as inlet channelling, building in connecting pipes, any benching required and backfilling structures.”

**“(e)      Headwalls (type and depth range stated)**

The rate shall cover the cost and dealing with any excavation (as if in sort excavation including disposal of surplus) that is additional to the measured under the item for pipe trench excavation, the supply of all labour, plant and materials required to complete the structures as inlet channelling, building in connecting pipes, any benching required and backfilling structures.”

**“(f)      Gulleys (type and depth range stated)**

The rate shall cover the cost and dealing with any excavation (as if in sort excavation including disposal of surplus) that is additional to the measured under the item for pipe trench excavation,



the supply of all labour, plant and materials required to complete the structures as inlet channelling, building in connecting pipes, any benching required and backfilling structures.”

“(g) Variable outlet structures (type and depth range stated)

The rate shall cover the cost and dealing with any excavation (as if in sort excavation including disposal of surplus) that is additional to the measured under the item for pipe trench excavation, the supply of all labour, plant and materials required to complete the structures as inlet channelling, building in connecting pipes, any benching required and backfilling structures.”

*REPLACE THE CONTENTS OF THE SUBCLAUSE WITH THE FOLLOWING:*

“For the purpose of measurement and payment, the depth of a manhole, catchpit, etc., is defined as the depth from the top of the cover to the invert level of the manhole, catchpit, etc. (where the invert level for larger manholes, catchpits, etc. is that of the main floor area and not the invert of a localized recess used for draining the manhole, catchpit, etc.).

Separate items are listed for manholes, catchpits, etc. with depth increments (if applicable) and type. The rate shall cover the cost of any excavation in all material (including disposal of surplus) and backfilling with suitable material (including importation of material if required), additional to what is measured under the relevant pipe trench item (refer to Subclauses 8.2.2 and 8.2.3 of SANS 1200 DB). The rate shall further cover the cost of building the manholes, catchpits, etc., complete as shown on the relevant drawings, including step irons, cover and frames (Type 2 A unless otherwise shown on the drawings), benching, vents, brickwork, concrete work, grids, other accessories, and the building in of pipework and valves (but excluding supply of the main pipework and valves), along with all materials, plant and labour.”

*ADD THE FOLLOWING SUBCLAUSES :*

**“PSLE 8.2.14 Supply and install subsurface drains ..... Unit: m**

The rate shall cover all costs for the supply and installation of the complete subsurface drains as per the detail drawings, including excavation, backfill, spoiling excess material, geotextile, fittings, stone, sand and pipework.

**PSLE 8.2.15 Supply and install rodding eye for subsurface drains ..... Unit: No.**

The rate shall cover all cost for the supply and installation of the complete rodding eye as per the detail drawings or engineer’s instruction.

**PSLE 8.2.16 Break into existing stormwater pipe, install new pipe and build new manhole:**

(a) (State new pipe diameter and type) ..... Unit: number

(b) Etc for other new pipe diameters and types ..... Unit: number

The tendered rates shall include full compensation for the supply of all labour, plant and materials, for removing a section of the existing stormwater pipe, for installing the new pipe, for the complete construction of the new manhole and /or inlets, for sealing around the pipes, for disposal of all debris to the dumping site and for backfilling around the manhole with selected material.

**PSLE 8.2.17 Replace existing cover slab with new Inlet cover 1.22x1.22 as per detail drawings Unit: No**

The rate shall cover all necessary costs for the supply and installation of the complete inlet cover as per the engineer’s instruction.

**PSLE 8.2.18 New fibre reinforced polymer grating (Medium Duty) as instructed by the engineer as per detail drawings ..... Unit: m<sup>2</sup>**



The rate shall cover all necessary costs for the supply, cutting on site fitting and installation of the complete polymer grating as instructed by the engineer.

**PSLE 8.2.19    300mm wide Half Round Precast concrete channel as instructed by engineer ... Unit: m**

The rate shall cover all necessary costs for the excavation, compaction, backfill, lay, supply, grouting, channel slope to fall and installation of the complete half round channel as instructed by the engineer.

**PSLE 8.2.20    450mm wide rectangular cast-in-situ concrete channel with medium duty grating as per detail drawing ..... Unit: m**

The rate shall cover all necessary costs for the excavation, compaction, backfill, concrete, formwork, vibrating, grating, channel slope to fall, fittings and installation of the complete rectangular concrete channel with medium duty grating as per detail drawings.

**PSLE 8.2.21    300mm wide rectangular concrete channel with heavy duty grating as per detail drawing Unit: m**

The rate shall cover all necessary costs for the excavation, compaction, backfill, concrete, formwork, vibrating, grating, channel slope to fall, fittings and installation of the complete rectangular concrete channel with medium duty grating as per detail drawings.

**PSLE 8.2.22    Pipe protection 150mm thick Concrete cover slab (25Mpa) as instructed by engineer, inclusive of Ref 395 mesh as per detail drawings..... Unit: m<sup>2</sup>**

The rate shall cover all necessary costs for the excavation, compaction, backfill, concrete, formwork, vibrating, steel reinforcement and installation of the complete cover slab as per detail drawings.

**PSLE 8.2.23    Regrade existing half round precast concrete channels ..... Unit: m**

The tendered rates shall include full compensation for the careful removal of half round precast concrete channels, the temporary stockpiling thereof and the reinstatement with a fall of 0.5%, including all necessary excavation, backfilling, bedding, compaction and mortar. In the event of the contractor damaging any of the half round channels, he will replace them at his own cost.

**PSLE 8.2.24    Repairs concrete of for all types of concrete channels..... Unit: m<sup>2</sup>**

The tendered rates shall include full compensation for the repair concrete channels, including all necessary equipment, materials, backfilling, concrete shaping with 15 MPa concrete.

**PSLE 8.2.25    Repair concrete with 250mm thick 30Mpa concrete as specified by engineer .... Unit: m<sup>2</sup>**

The tendered rates shall include full compensation for the repair concrete, including all necessary equipment, materials, reinforcing, backfilling, concrete, bedding and formwork as instructed by the engineer."

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**PSM           ROADS (GENERAL) (SANS 1200 M)****PSM 6           TOLERANCES****PSM 6.4        DIMENSION AND LEVEL CONTROL OF ROAD LAYERS**

*ADD THE FOLLOWING NEW CLAUSE:*

The Contractor shall submit at the time of requesting acceptance of a road layer a record of the surface levels of that section, taken at intervals to coincide with the level pegs. A sample form is obtainable from the Employer's Agent.

**PSM 7           TESTING****PSM 7.1        GENERAL**

*ADD THE FOLLOWING TO SUBCLAUSE 7.1:*

"The random sampling method of TMH 5, for the spotting of positions, for field density testing will not necessarily be applied by the Employer's Agent's Representative. Density testing shall be carried out where, in his opinion, the density of the compacted layer is suspect."

The Contractor shall further present the full width of the layer between the stated linear stake values for acceptance - only in exceptional cases may partial widths be presented.

**PSM 7.2        PROCESS CONTROL**

*ADD THE FOLLOWING TO SUBCLAUSE 7.2:*

"Process control to be carried out by the Contractor shall be done by an independent testing laboratory approved by the Employer's Agent."

**PSM 7.3        ROUTINE INSPECTION AND TESTING**

*ADD THE FOLLOWING TO SUBCLAUSE 7.3.1:*

"All requests for acceptance control testing shall be submitted in writing to the Engineer. Each request shall clearly specify the location of the section and the description of the layer and shall be accompanied by the dimension and level control data for the section under consideration (refer PSM 6.4), as well as the results of the Contractor's process control testing (refer 7.2). On receipt of the aforementioned the Engineer will undertake, or arrange as the case may be, for the necessary inspection and acceptance control tests to be carried out to satisfy himself that the layer complies with the specification.

Testing will be carried out as expeditiously as possible and the results of tests made available within 48 hours from the time the request was made, plus the normal time required doing the test.

The written approval of the submitted section of a layer shall be obtained from the Engineer before the Contractor may proceed with the placing of material for the following layer. The Contractor shall also, before proceeding with the placing of the material for the following layer, make good any test holes left in the layer using material complying with the specification for that layer and compacting it to the specified density for that layer, concrete shall not be used."

Substitute PSM 7.3.3 with the following:

"Statistical evaluation of test results shall not be allowed, and all tests shall meet the specified minimum requirements."

**PSM 8            MEASUREMENT AND PAYMENT****PSM 8.2        ACCEPTANCE CONTROL TESTING**

Should the layer submitted for acceptance control testing fail to comply with the specification, the Contractor shall, in the case where the tests arranged for by the Engineer were carried out by a designated laboratory (refer PSA 7.2), bear the invoiced cost of the tests. Conversely if the layer is found to comply with the specification the cost of the acceptance control tests will be borne by the Employer. The cost of refilling and compacting the test holes shall be covered by the rate tendered for the construction of that layer.

**PSME SUBBASE (SANS 1200 ME)****PSME 1 SCOPE**

*ADD THE FOLLOWING:*

"All the requirements as specified for the construction of subbase shall, except where otherwise stated or ordered, apply to the stabilization of the in situ material as new subbase."

**PSME 3 MATERIALS****PSME 3.2 PHYSICAL PROPERTIES****PSME 3.2.1 Subbase material**

*REPLACE THE CONTENTS OF PARAGRAPH (a) WITH THE FOLLOWING:*

"(a) The maximum particle dimension of the gravel shall not exceed 63 mm."

*REPLACE THE CONTENTS OF PARAGRAPH (d) and (e) WITH THE FOLLOWING:*

"(d) The CBR at specified density shall be 45 for unstabilised material as well as for stabilised material prior to stabilisation."

The UCS at 7 days of each cement-stabilised material shall at 100% modified AASHTO maximum dry density be as follows:

- For C3 cemented natural gravel: 1.50 MPa minimum and 3.00 MPa Maximum
- For C4 cemented natural gravel: 0.75 MPa minimum and 1.50 MPa Maximum

"(e) The ITS (Indirect Tensile Strength) for cement-stabilised material shall at 100% modified AASHTO maximum density be as follows:

- For C3 cemented natural gravel: 250 kPa minimum
- For C4 cemented natural gravel: 200 kPa minimum

**PSME 3.2.2 Gravel shoulder and gravel wearing course material**

*REPLACE THE CONTENTS OF SUBCLAUSE 3.2.2 WITH THE FOLLOWING :*

"The material used for gravel shoulders and gravel wearing course shall comply with the following:

- (a) the PI shall not be less than 6 and not more than  $(3 \times GM) + 10$
- (b) the maximum particle dimension of the gravel shall not exceed 40 mm and
- (c) the CBR shall be greater than 15 at 93% of modified AASHTO density."

**PSME 3.3 STABILISING AGENT (S)****PSME 3.3.1 General**

*ADD THE FOLLOWING TO THIS SUBCLAUSE:*

"Where reference is made in this specification or the Standard Specifications to the cement specifications, e.g., SABS 471: Portland cement and rapid hardening Portland cement, it shall be replaced with the new specification:

SABS ENV 197-1: Cement-composition, specifications, and conformity criteria.

## Part 1: Common cements.

Furthermore, where reference is made in this specification or the Standard Specifications to different cement types, the following new names shall be used as a guide but must be confirmed by the Employer's Agent.

Cement Grade	Cement Type	Approximate old product name	New Alpha	New Blue Circle	New NPC	New PPC	New Slagment
52.5	CEM I	Rapid hardening	Rapid Hard	Duracast	Eagle Super		-
42.5R	CEM I	Rapid hardening	-	-	-		-
42.5	CEM I	OPC*	Portland Cement	Duratech	-	OPC	-
	CEM I	LASRC	-	-	-	LASRC	-
	CEM II A-S	PC15SL	-	-	Eagle Plus	-	-
	CEM II B-S	RH30SL		-	Eagle Plus	-	-
32.5R	-	-	-	-	-	-	-
32.5	CEM II A-V	PC15FA	All – purpose cement	-	-	Surebuild	-
	CEM II A-W	PC15FA	-	-	-	Surebuild	-
	CEM II A-L	-	All purpose cement	-	-	Surebuild	-
	CEM II B-V OR W	PC25FA/PFAC* *	-	Structcrete	-	Surecrete	-
	CEM II B-V OR W	PC25FA/PFAC* *	-	Duracrete	-	Surecrete	-
	CEM III A	PBFC	-	BFC	Eagle Pro	-	PBFG
	CEM III A	RHSL	-	-	-	-	RHSL
22.5	MC 22.5X	PFAC***	Multi-purpose cement	Durabuild	-	-	-
	MC 22.5X	PFAC***	-	Buildcrete	-	-	-
12.5	MC 12.5	Walcrete	Mortar cement	Walcrete	-	Masonry	-
	MC 12.5	Mortacem	-	-	-	-	-

**PSME 5 CONSTRUCTION****PSME 5.1 PRECAUTIONS**

*ADD THE FOLLOWING TO THIS SUBCLAUSE:*

“No stabilization shall be carried out during falling temperatures when the ambient air temperature falls below 7°C or during rising temperatures when the ambient air temperature is below 3°C.

The surface temperature of a compacted stabilized layer shall not be allowed to fall below 1°C during the first three (3) days after stabilization. The Contractor shall be responsible for taking the necessary measures in this connection, and especially to refrain from stabilizing when such temperatures become probable.

When a sudden unforeseen temperature drop to a level below this limit occurs, the stabilized layer shall be covered with the material required for the next layer to be constructed.

All stabilized layers damaged by frost or by the formation of ice in the layer shall be removed and replaced by the Contractor at his own expense.

The Contractor shall make allowance for these requirements in his construction programme, and no claims in this connection will be considered."

The Contractor shall at all times supply all workers exposed to chemical stabilizing agents with approved protective apparel, eyewear and masks, and no person without such apparel, eyewear and masks shall be permitted to work with or be exposed to the chemical agents. Precautionary measure shall also be taken to ensure that any livestock and the public will not be exposed to the chemical agents blown by the wind or under similar circumstances"

## **PSME 5.2      EXCAVATION**

### **PSME 5.2.2      Borrow pits**

*INSERT THE WORDS "designated by the Employer's Agent and" BETWEEN THE WORDS "pits" AND "established" IN THE FIRST LINE.*

## **PSME 5.4      PLACING AND COMPACTION**

### **PSME 5.4.1      Placing**

The compacted thickness of the subbase for the various areas shall be that shown on the drawings.

### **PSME 5.4.4      Compaction**

Notwithstanding the requirements of Clause 5.4.4.2 the subbase shall be compacted to 95% of modified AASHTO maximum density, as the case may be.

## **PSME 5.7      TRANSPORT**

*REPLACE THE CONTENTS OF THIS SUBCLAUSE WITH THE FOLLOWING:*

"All movement of material shall be regarded as free-haul. No haulage shall be paid."

*ADD THE FOLLOWING NEW SUBCLAUSE:*

## **PSME 5.8      WEED KILLER**

The subbase layer shall be treated before compaction by applying and mixing in an approved weed-killer in accordance with the manufacturer's instructions.

## **PSME 6      TOLERANCES**

### **PSME 6.3      STABILISATION**

*ADD THE FOLLOWING TO THIS SUBCLAUSE:*

Add the following to this Clause:

"The coefficient of variation shall not exceed 0,3 (30%) for mixing in place and 0,2 (20%) for plant mixed material, calculated as follows:

$$\frac{S_n}{\bar{x}} \times 100$$

$X_n$

Where:

$X_n$  is the average and

$S_n$  is the standard deviation of stabilizing content per lot"

**PSME 6.4      DIMENSION AND LEVEL CONTROL**

*AMEND THE CONTENTS OF THE CLAUSE TO READ AS FOLLOWS:*

"The Contractor shall carry out tests on the stabilized material at the frequency specified in 7.2.1 and 7.2.2 and check that the material complies with PSME 3.2.1 (d) and (e).

**PSME 7      TESTING**

**PSME 7.1      STABILIZATION**

**PSME 7.3.3      Strength tests for stabilized material**

Amend the contents of this clause to read as follows:

"The Contractor shall carry out tests on the stabilized material at the frequency specified in 7.2.1 and 7.2.2 and check that the material complies with PSME 3.2.1 (d) and (e).

**PSME 8      MEASUREMENT AND PAYMENT**

**PSME 8.1      BASIC PRINCIPLES**

*INSERT A SEMI-COLON IN THE FIRST LINE OF PARAGRAPH (b) AFTER THE WORDS "will be paid for once only" AND DELETE THE REST OF THE PARAGRAPH.*

*REPLACE THE CONTENTS OF SUBCLAUSE 8.1(d) WITH THE FOLLOWING:*

"(d) that in the case of material from a commercial source or from borrow pits selected by the Contractor, no additional payment will be made for the class of excavation, method of processing (except stabilising), or overhaul.

(e) The requirements of PSM 8.2 shall apply. The Contractor shall further make provision in the rates tendered for the construction of the subbase, for the cost of his own process control testing and the cost of complying with PSME 6.4.

**PSME 8.3      SCHEDULED ITEMS**

Replace the heading and contents of Clause 8.3.2 with the following:

**PSME 8.3.2      Construct the subbase using material from stockpile**

The rate tendered shall cover the cost of basic selection, loading from stockpiles, transporting, spreading, watering, compacting, final grading, complying with the tolerances, and testing.

No additional payment will be made for difficult work or hand operations in confined areas."

**PSME 8.3.3      Construct the subbase course/shoulders/gravel wearing course with material from commercial sources or designated borrow areas**

*REPLACE THE HEADING OF SUBCLAUSE 8.3.3 WITH THE FOLLOWING :*

**"PSME 8.3.3      Construct the subbase course/shoulders/gravel wearing course with material from commercial sources"**

---

ADD THE FOLLOWING TO SUBCLAUSE 8.3.3 :

"No additional payment will be made for difficult work or hand operations in confined areas."

**PSME 8.3.4     Extra over item 8.3.1 for class of excavation**

Replace both "a) Intermediate excavation" and the corresponding unit of measure with "a) Not applicable (VOID)".

No extra-over payment will be made for excavation in material classified as intermediate excavation.

**PSME 8.3.7     Screened-out material not used in the subbase**

*Remove the words "within the free haul distance of 2 km" from the last sentence of this Subclause.*

**PSME 8.3.9     Overhaul (haul exceeding 2 km):**

REPLACE THE CONTENTS OF SUBCLAUSE 8.3.9 WITH THE FOLLOWING :

"No overhaul will be paid on material for the purposes of this contract and all the costs for transporting material must be included in the applicable tendered rates and amounts."

**PSME 8.3.11    Treatment of subbase with:**

(a) Weed killer ..... Unit: m<sup>2</sup>

(b) Insecticide..... Unit: m<sup>2</sup>

The tendered rates shall include full compensation for the supply, spreading and mixing-in or application of the poison.

Only areas that were treated on the written instructions of the Employers Agent will be measured for payment.



**PSMF BASE (SANS 1200 MF)****PSMF 3 MATERIALS****PSMF 3.3 PHYSICAL AND CHEMICAL PROPERTIES****PSMF 3.3.1 Natural gravel (stabilised or unstabilised)**

*REPLACE THE CONTENTS OF PARAGRAPH (a) WITH THE FOLLOWING:*

"(a) The maximum particle dimension of the gravel shall not exceed 63 mm."

**PSMF 3.3.2 Graded crushed stone**

*Add the following to Clause 3.3.2 after the words SABS 1083 ..... "for 37,5mm stone".*

**PSMF 5 CONSTRUCTION****PSMF 5.4 PLACEMENT AND COMPACTION OF A BASE OTHER THAN A WATER-BOUND MACADAM BASE****PSMF 5.4.1 Placing**

Add the following:

"The compacted thickness of the base shall be as indicated on the drawings."

**PSMF 5.4.4 Compaction**

Replace "98% of modified AASHTO maximum density" with "102% of modified AASHTO maximum dry density."

**PSMF 5.9 TRANSPORT**

*REPLACE THE CONTENTS OF SUBCLAUSE 5.9 WITH THE FOLLOWING:*

"All movement of material will be considered as free-haul. No haulage cost will be paid."

**PSMF 6 TOLERANCES****PSMF 6.1 DIMENSIONS, LEVELS, ETC.****PSMF 6.1.2 Grade**

Delete the contents of Subclauses (a) and (b) and replace by "The height of the edge of the channel above the top of the completed base is not less than the minimum thickness of asphalt surfacing, i.e., 5mm less than the specified thickness." (See SABS 1200 MH 6.3.4)

**PSMF 6.1.5 Cross section**

Replace "25mm" in the second line of this Clause with "10mm".

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**PSMF 8        MEASUREMENT AND PAYMENT**

**PSMF 8.3        SCHEDULED ITEMS**

**PSMF 8.3.3        Construct base with material from commercial sources or designated borrow areas**

*REPLACE THE TITLE OF ITEM 8.3.3 WITH THE FOLLOWING:*

"Construct base with material from commercial sources and compact to the specified density"

Add the following:

"No additional payment will be made for difficult work or hand operations in confined areas."

**PSMF 8.3.4        Extra over 8.3.1 and 8.3.1, as applicable, for class of excavation**

Replace both "a) Intermediate excavation" and the corresponding unit of measure with "a) Not applicable (VOID)". No extra-over payment will be made for excavation in material classified as intermediate excavation.

**PSMF 8.3.9        Overhaul:**

*REPLACE THE CONTENTS OF SUBCLAUSE 8.3.9 WITH THE FOLLOWING :*

"No overhaul will be paid on material for the purposes of this Contract and all the costs for transporting material must be included in the applicable tendered rates and amounts."

**PSMH ASPHALT BASE AND SURFACING (SANS 1200 MH)****PSMH 3 MATERIALS****PSMH 3.1 PRIME**

With reference to Clause 3.1 the prime to be used shall be Colprime E TM at 1.0l/m<sup>2</sup>.

**PSMH 3.3 TACK COAT**

The tack coat to be used shall be a 30% anionic stable grade bituminous emulsion.

**PSMH 3.5 AGGREGATES****PSMH 3.5.1 General**

*ADD THE FOLLOWING:*

"The fine aggregate for the asphalt wearing course and asphalt base shall consist of crushed aggregate only. Natural sand shall not be permitted.

Aggregates used in the approved production mix shall only be taken from stockpiles that are sufficient in size for the production of a minimum of three days' work and shall have been tested for conformance and uniformity. The test results shall be presented to the Employer's Agent. In cases where drum mixing is used the aggregate stockpiles shall be tested every second day or whenever new material is delivered. The test results must be presented to the Employer's Agent."

**PSMH 3.5.4 Bituminous binder absorption**

*REPLACE "shall be 1,0%" at the end of this Subclause with "shall not exceed 0,5% by mass."*

*ADD THE FOLLOWING:*

"When tested in accordance with TMH1 method C4 the bituminous binder absorption of the combined coarse and fine aggregate blend shall not exceed 0,5%"

**PSMH 3.5.6 Grading**

*ADD THE FOLLOWING TO THE END OF THE FIRST SENTENCE:*

The tack coat to be used shall be a 30% anionic stable grade bituminous emulsion.

**PSMH 3.6 MINERAL FILLER****PSMH 3.6.1 Base and continuously graded and gap-graded surfacing**

*ADD THE FOLLOWING TO THE END OF THE SUBCLAUSE:*

*Notwithstanding* this subclause, the mineral filler which, with the approval of the Employer's Agent, may be used to make up deficiencies in fines of the grading of the aggregate, shall be a powdered limestone or other suitable inert material approved by the Employer's Agent. All its particles shall pass a 0,600 mm sieve while not less than 65% by mass of the particles shall pass a 0,075 mm sieve.

**PSMH 3.6.3 Quality active mineral filler**

*ADD THE FOLLOWING TO THE END OF THE SUBCLAUSE:*

"Separate payment for active filler added on the instruction of the Employer's Agent, for the purposes of improving adhesion, shall only apply in respect of increases or decreases in the active filler content from that specified for the nominal mix for tender purposes.

The active filler for the asphalt base and surfacing layers for the nominal mix design for tender purposes shall be hydrated lime at a proportion of 1% by mass."

*ADD THE FOLLOWING SUBCLAUSE:*

**"PSMH 3.7      AGGREGATE FOR BLINDING**

The aggregate used for blinding the primed surface shall consist of crushed rock or river sand, with 100% passing the 6,7 mm sieve and not more than 10% passing the 2,36 mm sieve. The aggregate shall be clean, hard and free from excessive dust and flaking. It shall contain no clay, loam or other deleterious matter."

**PSMH 4      PLANT AND EQUIPMENT**

**PSMH 4.2      BINDER DISTRIBUTOR**

*ADD THE FOLLOWING TO THE END OF THE SUBCLAUSE:*

"The Employer's Agent may authorize the application of the prime or tack coat by means of a hand operated sprayer. Prior to allowing the latter the Contractor shall submit in writing for the Employer's Agent approval his intended method to ensure that the spray temperature and rate of application will meet the specified requirements. The continuation of this authority will be dependent upon satisfactory results being achieved."

**PSMH 5      CONSTRUCTION**

**PSMH 5.1      GENERAL REQUIREMENTS**

**PSMH 5.1.1      Preparation of surface**

*ADD THE FOLLOWING TO PARAGRAPH (a):*

"The Contractor shall make every endeavour to protect the surface of a primed area and shall employ measures, such as the packing of stones across the area at regular intervals, to limit the passing of traffic over the primed surface. Where in the opinion of the Employer's Agent a primed surface has become unsuitable for the direct placement of the asphalt, a tack coat at the rate ordered shall be applied."

**PSMH 5.1.5      Weather limitations**

*ADD THE FOLLOWING SUBCLAUSE :*

(d) When the moisture content of the upper 50mm of the base layer is greater than 50% of optimum moisture content.

**PSMH 5.1.7      Rates of application and Tolerances**

*ADD THE FOLLOWING TO THE END OF THE SUBCLAUSE:*

The Colprime E TM shall be applied at a rate of 1.0l/m².

**PSMH 5.5      DESIGN OF ASPHALT**

**PSMH 5.5.1      General**

*REPLACE THE CONTENTS OF SUBCLAUSE 5.5.1 WITH THE FOLLOWING :*

"The design of the asphalt mixes shall be in accordance with the design guidelines of TRH 8."

**PSMH 5.5.2 Marshall criteria**

*DELETE THIS SUBCLAUSE.*

*ADD THE FOLLOWING NEW SUBCLAUSE:*

**"PSMH 5.11 BLINDING LAYER**

When roads are constructed under traffic conditions, the prime shall be applied and allowed to penetrate for as long as is practicable before a blinding layer is applied at a rate of 0,0035 m<sup>3</sup>/m<sup>2</sup>. 'Caking' of the aggregate that may take place and cause problems during the surfacing process shall be removed before the final surfacing commences."

**PSMH 6 TOLERANCES**

**PSMH 6.3 DIMENSIONS, LEVELS, ETC.**

**PSMH 6.3.1 Grade**

*ADD THE FOLLOWING:*

"Notwithstanding the stated tolerances, the grade shall be such that no ponding will occur."

**PSMH 6.3.5 Cross Section**

*ADD THE FOLLOWING:*

"Notwithstanding the stated tolerances, at no point on the surfacing shall the level be below that of the adjacent low side concrete channel or edge strip."

**PSMH 6.3.6 Smoothness**

"Degree of accuracy 1 is applicable."

**PSMH 7 TESTING**

**PSMH 7.1 MIX DESIGN**

The requirements as stated shall be submitted to the Employer's Agent at least 1 week before the programmed date of the start of production.

**PSMH 7.2 CONTROL DURING CONSTRUCTION**

**PSMH 7.2.4 Density Testing**

*REPLACE THE SECOND SENTENCE OF THIS CLAUSE "Not more than ..... specified density." with:*

"The density of all cores shall be equal to or greater than 96% of the RICE density."

**PSMH 8 MEASUREMENT AND PAYMENT**

**PSMH 8.1 RATES OF APPLICATION AND BITUMINOUS BINDER CONTENT**

**PSMH 8.1.2 Prime**

*ADD THE FOLLOWING:*

*"The prime coat shall be Colprime E TM applied at a rate of 1,0 litre/m<sup>2</sup> for AE-2 binder"*

**PSMH 8.1.4    Tack coat**

*REPLACE THE CONTENTS OF SUBCLAUSE 8.1.4 WITH THE FOLLOWING :*

*"The tack coat shall be a 30% spray grade emulsion applied at a rate of 0,55 litre/m<sup>2</sup>."*

**PSMH 8.4    COMPUTATION OF QUANTITIES**

*ADD THE FOLLOWING TO THE END OF SUBCLAUSE 8.4.2:*

Notwithstanding the provisions of Clause 8.4.2, the unit of measurement for asphalt shall be the square metre of asphalt laid and compacted in accordance with the specifications.

**PSMH 8.5    SCHEDULED ITEMS**

**PSMH 8.5.1    Prime coat**

*ADD THE FOLLOWING:*

*"The rate tendered shall also provide for applying the prime using a hand operated sprayer, where required."*

**PSMH 8.5.3    Tack coat**

*ADD THE FOLLOWING:*

*"The rate tendered shall also provide for applying the tack coat using a hand operated sprayer, where required."*

**PSMH 8.5.4    Asphalt (nominal thickness indicated) ..... Unit : m<sup>2</sup>**

Change the unit of measurement from Ton (t) to Square metre (m<sup>2</sup>).

The unit of measurement shall be the square metre of asphalt laid and compacted.

The rate shall cover the cost of preparing an approved design mix, the supply of all materials as per stated minimum contents including filler, the mixing and manufacture of asphalt in accordance with the specifications and approved design mix, hauling, placing and compacting the asphalt, any additional operations, the supply of hand operated equipment and handwork for working in areas inaccessible to normal plant, as well as for process control testing, protecting and maintaining the work as specified."

*ADD THE FOLLOWING SUBCLAUSES :*

**"PSMH 8.5.9    Variations in active mineral filler content ..... Unit : t**

Separate items will be scheduled for each type of mineral filler to be used.

The rates shall cover the cost of the additional or reduced amount of filler to be used in terms of 8.2., and the rates will be added to or deducted from the rates applicable to 8.5.1 – 8.5.4 as appropriate.

**PSMH 8.5.10    Allowance for trial/testing ..... Unit : m<sup>2</sup>**

The unit of measurement shall be the square metre.

**PSMH 8.5.11**    **Blinding layer** ..... Unit : m<sup>2</sup>

The tendered rate shall include full compensation for procuring, furnishing and applying the aggregate for blinding as directed by the Employer's Agent.

**PSMJ SEGMENTED PAVING (SANS 1200 MJ)****PSMJ 3 MATERIALS. (SUBCLAUSE 3.1.2)****PSMJ 3.1 PAVERS**

Pavers for use to the carriageway/sidewalk shall be as indicated on the relevant Landscape plan and meet the requirements as stated in Structural Design of segmented block pavements, UTG2.

The pavers shall comply with SANS 1058 (2012):

The 80 mm shall be Class 40 with a Tensile Splitting Strength of 2,6 MPa.

For control testing the Contractor shall provide test results, by an independent SANAS accredited laboratory, in accordance with Table 3 of SANS 1058.

As a minimum, the Contractor shall provide test results at 1 lot per 1000 m<sup>2</sup> of paving.

The cost of control testing shall be borne by the Contractor.

The Employers Agent may elect for additional check testing to be done. The Contractor shall be reimbursed for additional check testing which passes.

**PSMJ 5 CONSTRUCTION****PSMJ 5.1 PREPARATION**

Notwithstanding the provisions of this Clause, the construction of the earthworks and controlled layers shall be completed in accordance with the applicable requirements of SABS 1200 DM and SABS 1200 ME, and any amendments thereto, as well as the details shown on the drawings.

**PSMJ 5.2 EDGE RESTRAINTS**

*ADD THE FOLLOWING TO SUBCLAUSE 5.2 :*

"Edge Restraints shall be constructed with expansion joints of width at least 12 mm at intervals not exceeding 10 m. These joints must be filled with a compound such as flexcell or similar approved product and sealed with a polysulphide sealant."

**PSMJ 5.4 LAYING OF UNITS**

Notwithstanding the provisions of this Clause, filler units shall be cut such that they are close fitting. No chopping or breaking of the units will be permitted.

**PSMJ 5.5 FILLING GAPS IN UNIT PATTERN**

Delete the contents of this Clause. Clause 5.4 and PSMJ 5.4 shall apply.

**PSMJ 5.6 COMPACTION OF UNITS**

*INSERT IN SUBCLAUSE 5.6.1, AFTER THE FIRST SENTENCE, THE FOLLOWING:*

"A suitable vibrating-plate compactor operating at a frequency of 65 Hz to 100 Hz and a low amplitude shall be used. Its plate surface shall be 0,2 m<sup>2</sup> to 0,4 m<sup>2</sup> and it shall develop a centrifugal force of 7 kN to 16 kN."

**PSMJ 5.7 JOINT FILLING**



*REPLACE THE LAST TWO PARAGRAPHS OF SUBCLAUSE 5.7 WITH THE FOLLOWING:*

"A mixture of sand that complies with clause 3.3(b) and cement (Ratio 5:1) shall be broomed into the joints until they are full, and sufficient passes of a plate compactor shall be made to settle the joint filling. The procedure shall be repeated until the joints remain full after compaction.

All excess shall be washed off and care shall be taken not to contaminate the stormwater system. Damage caused during compaction shall be made good by the Contractor at his own expense."

**PSMJ 8      MEASUREMENT AND PAYMENT**

**PSMJ 8.2      SCHEDULED ITEMS**

**PSMJ 8.2.1      Provision of edge restraints**

*ADD THE FOLLOWING TO SUBCLAUSE 8.2.1 :*

"The rates shall cover all the costs for excavating, bedding, laying (including expansion joints), jointing, compacting and backfilling, including the removal of excess material."

**PSMJ 8.2.2      Construction of paving complete**

*ADD THE FOLLOWING TO SUBCLAUSE 8.2.2 :*

"The tendered rate shall also include full compensation for cutting units to fit edge restraints and for the removal of waste material from the Site."

**PSMJ 8.2.3      Cutting units to fit edge restraints**

Delete the contents of this clause and replace with the following:

"Cutting units to fit edge restraints will not be measured separately but be included for in the rate for 8.2.2."

"The cutting of units to suit radii > 1,0m shall be classified as straight cutting."

*ADD THE FOLLOWING SUBCLAUSE :*

**"PSMJ 8.2.8      Demarcating Parking Bays, Centreline using rustic blend paving units ..... Unit : m**

The unit of measurement shall be the actual meter length of paving units installed.

The rate shall include for cutting of the newly installed paving, supply and installing the rustic blend paving units and for disposing of all demolished material to a site provided by the Contractor."

**PSMK KERBING AND CHANNELLING (SANS 1200 MK)****PSMK 1 SCOPE**

Add the following definitions:

"This specification shall also cover the construction of concrete lined channels."

**PSMK 2 DEFINITIONS**

Add the following definitions:

"Backing The supporting concrete behind the edge of the precast kerb, as shown on the drawings.

Bedding material, The material on which precast kerbs and channels are bedded shall consist of crushed stone, cinders, slug, sand, or other approved porous material having a maximum particle size of 13,2mm. Commonly referred to and shown on the drawings, kerb, and channel details."

**PSMK 3 MATERIALS****PSMK 3.1 CONCRETE**

*ADD THE FOLLOWING TO SUBCLAUSE 3.1 :*

"The Contractor shall timeously submit the concrete mix design for cast-in-situ kerbing to the Employer's Agent for approval and no kerbing shall be placed before the mix design has been approved."

**PSMK 3.2 PRECAST KERBING AND CHANNELLING****PSMK 3.2.1 General**

*ADD THE FOLLOWING TO SUBCLAUSE 3.2.1 :*

"The profile/dimensions of precast kerbs and channels must be in accordance with the details shown on the Drawing."

**PSMK 3.2.2 Curved Kerbing**

*IN THE HEADING, REPLACE THE WORD "KERBING" WITH:*

"Kerbing and Channelling".

*REPLACE THE REFERENCES TO "KERBING" THROUGHOUT THIS SUBCLAUSE WITH:*

"kerbing and channelling".

**PSMK 3.7 CONCRETE FOR EXTRUDED IN-SITU KERBING AND CHANNELLING****PSMK 3.7.2 Concrete**

Notwithstanding the requirements of this Clause, the Contractor shall take note that the acceptability of extruded kerbing and channelling will be evaluated on the basis of the compressive strengths of cores taken. The Contractor shall therefore at his own discretion increase the grade of concrete used.

**PSMK 3.8 CURING COMPOUND**

Notwithstanding the provisions of this Clause, the requirements of PSGA 3.8 shall apply.

**PSMK 3.9      BEDDING MATERIAL**

*REPLACE THE CONTENTS OF SUBCLAUSE 3.9 WITH THE FOLLOWING :*

"The concrete on which the kerbing and channelling will be placed must be of the strength and thickness specified in the Drawings."

*ADD THE FOLLOWING NEW SUBCLAUSE:*

**PSMK 3.10      CONCRETE FOR EDGING STRIPS**

The requirements of Clause 3.7 and PSMK 3.7.2 shall apply to concrete for edging strips."

**PSMK 5      CONSTRUCTION**

**PSMK 5.1      EXCAVATION AND BEDDING**

*DELETE THE FIRST PARAGRAPH viz. "Trenches for ..... grade."*

Notwithstanding the provisions of this Subclause, open drains outside the bounds of road reserves shall be trimmed to the lines and levels given on the drawings or ordered and the surface area of the drain compacted to 90% of modified AASHTO maximum density. The compacted depth shall be 150mm. Where in the opinion of the Employer's Agent the in-situ material is unsuitable, the Employer's Agent may order that it be removed to the depth required and replaced with selected material compacted to a density of at least 90% of modified AASHTO maximum density, or 15MPa/19 concrete.

*ADD THE FOLLOWING:*

"Excavations for roadside channels shall be trimmed to the lines and levels given on the drawings or ordered, so as to permit the accurate construction of the concrete linings, and the surface area of the channels compacted to 90% of modified AASHTO maximum density. The compacted depth shall be 150mm. Where in the opinion of the Employer's Agent the in-situ material is unsuitable, the Employer's Agent may order it to be removed to the depth required and replaced with selected material compacted to a density of at least 90% of modified AASHTO maximum density, or 15MPa/19 concrete.

The excavations for channel cross drains shall be completed in accordance with the requirements stated in the paragraph immediately above, except that provision shall be made for the accommodation of the selected layer detailed on the drawings."

*REPLACE "90%" WITH "93% (100% for sand)"*

**PSMK 5.2      PRECAST CONCRETE KERBING AND CHANNELLING**

*REPLACE THE FIRST SENTENCE OF SUBCLAUSE 5.2 WITH:*

"Kerbing and Channelling of precast concrete must be placed on a concrete bedding as required in PSMK 3.9".

**PSMK 5.2.1      Precast concrete kerbing and cast in-situ concrete channeling**

After the precast kerbs have been laid the formwork for the channelling shall be set up. Expansion joints shall be allowed for at approximately 8 metres intervals, i.e. opposite the joint between the kerbs. The principles of Clause 5.4 shall apply to the construction of cast-in-situ channelling.

**PSMK 5.8      MACHINE-LAID CAST IN-SITU (EXTRUDED) KERBING AND CHANNELLING**

Before commencing kerb laying on the site, the first 50m length of kerb and channel to be constructed shall be regarded as trial kerb and channel. The Contractor shall demonstrate in the trial length the methods he proposes to use for the construction of the kerb and channel, including joints, texturing, the achievement of a smooth surface and dense fully compacted concrete. It may be constructed either in the recognised position in a road or elsewhere on the site in which case it shall be demolished, broken out and removed at the Contractor's expense.

The trial kerb and channel shall be constructed with the plant and equipment to be used on the works and the equipment's motion forwards and the handwork carried out on the extruded section shall be so controlled and used as to produce a kerb and channel to the shape, lines and levels specified.

The time taken to lay the test strip shall be recorded, which in the event of acceptance, shall be used to calculate a rate of extrusion which shall not be exceeded without the permission of the Employer's Agent.

If the concrete in the trial strip fails to meet the test requirements, the Contractor may, at his own cost, cut further cores from the kerb and or channel up to a maximum of one core per 100m length. The strengths obtained on such cores, together with those tested on the instruction of the Employer's Agent, shall be used to test compliance with the strength requirements.

The Contractor may, unless advised of any deficiencies in the trial kerb and channel, proceed with kerbing as soon as acceptable core test results are obtained.

In the event of deficiencies in the trial kerb and channel, the Contractor shall, at his own expense, demolish the rejected sections and remove to the designated tip site and repeat the 50m long trial strip. This process shall be continued until the Contractor has produced kerb and channel in accordance with this specification. He may then proceed with kerb and channel construction proper. Any unacceptable trial length shall be broken out and removed to spoil, at the Contractor's expense before any subsequent trial length is permitted to commence.

Core test holes shall be filled with 30 MPa concrete mixed with a suitable adhesive compound.

No other means of testing the concrete will be considered and any kerb or channel not complying with all the requirements of the specification shall be broken out, removed to spoil and replaced at the Contractor's own expense.

The Contractor shall ensure that no change of circumstances or conditions is made to jeopardise the quality of the kerb and channel under construction. If, in the opinion of the Employer's Agent, this does occur, he may order the construction of a further trial length of 50m of kerb and channel in accordance with the requirements of this specification. Work on the kerb and channel proper shall not proceed until a trial strip has been constructed in accordance with the requirements of this specification. No claims for delays will be considered by the Employer's Agent on account of further trial lengths of kerbing being ordered.

**PSMK 5.8.3      Subbase preparation**

*Delete in the first line from: "500mm beyond" to "as relevant" and replace by "150mm beyond the back face of the kerb". Note this dimension applies to the compaction width required for the road layer.*

Notwithstanding the provisions of this Clause, where kerbing and channelling is to be constructed along existing travelled ways, the material at the founding level shall be trimmed to the required line and level and compacted to give a firm surface.

**PSMK 5.8.5      Curing**

Notwithstanding the provisions of this Clause, curing shall be carried out in accordance with the requirements of PSG 5.5.8.

**PSMK 5.11     TRANSITION SECTIONS AND INLET AND OUTLET STRUCTURES**

*DELETE THE WORDS "and with the requirements of the Project Specification" IN THE SECOND PARAGRAPH.*

*ADD THE FOLLOWING SUBCLAUSES :*

**"PSMK 5.13     EXISTING KERBING**

The kerbs to be removed shall be inspected by the Employer's Agent in the presence of the contractor prior to their removal to determine the number of kerbs suitable for re-use.

The contractor is advised to use the greatest care when removing those kerbs earmarked for re-use, for should the kerbs be damaged and be subsequently rejected, he shall replace them with new kerbs at his own cost.

**PSMK 5.14     WATERTESTING OF KERBS**

After the kerbs, channels inlets etc. have been constructed the kerbs, channels, etc must be cleaned and tested with water to ensure that no water is standing in any channel. This test must be done after the base has been completed but before the placing of the surface seal. Any adjustments to kerbs, channels etc must be completed before the surface seal is applied.

**PSMK 5.15     EXPANSION JOINTS**

These joints shall be provided at 10 m intervals. These joints shall be 12 mm wide, filled with a compound such as flexcell or similar product and sealed with a polysulphide sealant. Costs of furnishing the materials and construction of the joint are deemed to be included in the laying rate."

**PSMK 5.16     EDGING STRIPS**

Edging strips shall be constructed in accordance with the details shown on the drawings and the applicable requirements of Clauses 5.2 through to 5.10.

The edging strips shall be cast in alternate sections approximately 2m in length and the construction joints so formed shall coincide with joints in the precast kerbing, except that an expansion joint in lieu of a construction joint shall be provided at approximately 8m intervals. Where applicable, expansion joints in the channelling shall coincide with those in the precast kerbing.

**PSMK 6     TOLERANCES****PSMK 6.1     CONCRETE KERBING AND CHANNELLING**

*Replace the permissible deviation "0, -10" applicable to item b (1) with "±10".*

*Add to item b (1):*

*"provided the base layer thickness is not prejudiced and no adverse grade results."*

**PSMK 6.2     CONCRETE-LINED CHANNELS AND CONCRETE CHUTES**

*ADD THE FOLLOWING:*

*"The requirements of this clause shall also as relevant apply to concrete lined road side channels and channel cross drains.*

*With respect to unlined open drains outside road reserves the following shall apply:*

ITEM	PERMISSIBLE DEVIATION
(a) <u>Horizontal alignment</u> Deviation from the specified position of each edge or the centreline	±150mm
(b) <u>Vertical alignment</u> Deviation from designated depth, subject to there being no adverse grade	± 50mm
(c) <u>Trueness of exposed surfaces</u> Surface irregularities on each exposed surface when tested with a 3m straight edge	± 15mm
(d) <u>Cross-sectional dimensions</u> Deviation from specified side slopes	± 10%

**PSMK 7      TESTING****PSMK 7.2      CAST IN-SITU AND EXTRUDED KERBING AND CHANNELLING****PSMK 7.2.1      General test**

*DELETE THIS SUBCLAUSE.*

**PSMK 7.2.2      Alternative tests**

*REPLACE THE HEADING AND CONTENTS OF THE HEADING OF THIS SUBCLAUSE WITH THE FOLLOWING:*

The Contractor shall carry out a minimum of three cube crushing tests per 300 m of kerbing placed. The cost of such tests shall be deemed included in the rates tendered for kerbing.

One cube crushing test shall consist of a set of six cubes made with concrete taken from the mixer, the kerbing machine or from any part of the work as ordered.

If, after 28 days in an approved laboratory, after three cubes of any set of six cubes have been tested, the average crushing strength is found to be more than 3 MPa below the specified strength, the kerbing represented by the cubes will be rejected. The numerical value of the compressive strength of the core used for adjudication shall be that value determined in accordance with Clause 6.3 of SABS Method 865.

The Contractor may apply for resubmission of the rejected section on the basis of cores drilled from this section and tested for the estimated actual crushing strength in accordance with SABS method 865 (excluding Annexure A).

The cost of drilling and testing the cores is for the Contractor's account, regardless of the outcome of the tests on the cores. The number of cores required will be determined by the Employer's Agent and the criterion for rejection or acceptance of the section represented by the cores shall be as specified above for cubes."

**PSMK 7.3      RESPONSIBILITY FOR THE COST OF TESTING**

*DELETE THIS SUBCLAUSE.*

**PSMK 8      MEASUREMENT AND PAYMENT****PSMK 8.1      BASIC PRINCIPLES**

The rate for precast concrete kerbing shall include for the concrete bedding and backing as shown on the drawings.

## **PSMK 8.2 SCHEDULED ITEMS**

### **PSMK 8.2.1 Concrete kerbing**

In the heading, replace the word "Kerbing" with "Concrete Kerbing".

Add after "and for bedding" in the second line of clause (b) with "irrespective of variations to the thickness of the bedding".

Add at the end of Clause (b) "as well as for the installation of expansion joints, as detailed on the drawings, and the supply and placing of class 20/13 continuous backing, irrespective of variations to the thickness of the backing".

Replace "5.8.2" in the third line of paragraph (e) with "5.8.3".

Replace "1000m" in the second last line of Clause (e) with "600m"

Delete the following in the second last line of Clause (e):

"and as specified in clause 7.2"

*Replace the word "kerbing" throughout this subclause with "Concrete Kerbing".*

### **PSMK 8.2.2 Concrete kerbing and channelling combined as per detail drawings**

Add: "Acceptance of work that is substandard in measured compressive strength shall be subject to reduced payment at the following percentages of the tendered rate for the item.

<b>Measured compressive strength of individual core</b>	<b>% of full payment</b>
15 MPa up to 20 MPa	20
Less than 15 MPa	Nil"

### **PSMK 8.2.3 Variations of tests on extruded kerbing**

- |                         |          |
|-------------------------|----------|
| (a) Core strength tests | Unit: No |
| (b) Set of three cores  | Unit: No |

The rate tendered shall cover the cost of preparing a test specimen, despatching to an approved laboratory, testing and making good.

A test, the results of which show that the kerbing fails to comply with the requirements of the specification will irrespective of whether the kerbing is accepted for payment in terms of PSMK 8.2.2, not be measured for payment.

Note:

The Employer's Agent reserves the right to arrange for testing if the Contractor fails to expeditiously do so, or to undertake all testing, in which case the rates tendered shall not apply. If the coring and testing is carried out via the Employer's Agent, the Contractor will be debited with the cost of the test when the measured compressive strength is less than 20 MPa."

### **PSMK 8.2.6 Ancillaries**

In Subclause 8.2.6.2, replace both "2) Extra-over for intermediate material" and the corresponding unit of measure with "2) Not applicable (VOID)". No extra-over payment will be made for excavation in material classified as intermediate excavation.

Replace the heading and contents of subclause 8.2.7 with the following:

**PSMK 8.2.7     Trimming and compaction to 90% of modified AASHTO maximum density of surface area of unlined drains and areas to be concrete lined in:**

- |                      |                      |
|----------------------|----------------------|
| (a)    Soft material | Unit: m <sup>2</sup> |
| (b)    Hard material | Unit: m <sup>2</sup> |

The unit of measurement shall be the area of the surface trimmed and compacted. The rate tendered shall cover the cost of all labour (including hand operations), plant and other incidentals necessary to trim and compact the areas to the standard specified.

No extra payment will be made in respect of any soil or gravel backfilling, additional concrete or mass concrete backfilling required because of overbreak or unavoidable unevenness of excavations in difficult ground. The cost thereof shall be deemed to be covered by the rates tendered.

All excavation, including the removal of unsuitable material where ordered and backfilling using selected material or concrete, will be measured for payment under the appropriate subclauses of SABS 1200D, PSD, SABS 1200DM and PSDM”

*ADD THE FOLLOWING SUBCLAUSES:*

**"PSMK 8.2.8     20MPa/19mm Concrete lining to ..... Unit: m<sup>2</sup>**

The unit of measurement shall be the area of the surface to be concrete lined, irrespective of shape, cross-sectional slope or longitudinal grade.

The rate tendered shall cover the cost of all labour, plant, materials and incidentals required to construct the lining complete as detailed in the positions and to the extent shown on the drawings, or directed on site, including sprayed bitumen emulsion primer or polyethylene sheeting, formwork, mesh reinforcement, bitumen painted joints (expansion joints measured elsewhere) and finishing, as well as in the case of stormwater outlets, the building in of concrete pipe culverts.

Further, notwithstanding the requirements of PSMK 7.2.2, work that is substandard in measured compressive strength may be accepted, subject to the Contractor accepting reduced payment at the following percentages of the tendered rate:

Measured compressive strength of individual core	Percentage of full payment
15MPa up to 20MPa	50
Less than 15MPa	Nil”

Delete subclause 8.2.9.

**PSMK 8.2.10     Sealed joints in concrete lining of open drains (type or description stated) .... Unit: m**

**"PSMK 8.2.14     Remove existing kerbing and:**

- |  |         |
|--|---------|
| (a) <u>Dispose of them off the Site</u> .....      | Unit: m |
| (b) <u>Re-use them elsewhere on the Site</u> ..... | Unit: m |

The tendered rates shall include full compensation for providing all labour and equipment, for excavations, for lifting the kerbs and, in the case of subitem (a), for loading and transporting the kerbs from the Site and, in the case of subitem (b), for cleaning the kerbs, for temporary storage and for re-laying them elsewhere on the Site.



**PSMK 8.2.16    Kerb markings ..... Unit: No**

Road crossing ducts, valves and hydrants shall be marked with a 3 mm deep, 100 mm high saw cut on the face of each kerb. These cuts must be painted with road marking paint (200 mm wide). The following saw cut notation and colour shall be used.

Valve	WV	Blue
Hydrant	WH	Orange
Electricity	E	Red
Telkom	T	Green

**PSMM      ANCILLARY ROADWORKS (SANS 1200 MM)****PSMM 3      MATERIALS****PSMM 3.2      ROAD SIGNS****PSMM 3.2.1      General**

Replace "South African" with "SADC" in the first sentence.

Replace "Council for Scientific and Industrial Research" in footnote 1 with "Government Printer".

**PSMM 3.2.2      Structural steel**

*DELETE THE WORDS "except that they shall be of D-shape cross-section" IN THE FIRST PARAGRAPH.*

*ADD THE FOLLOWING TO SUBCLAUSE 3.2.2 :*

"All steel sign supports shall be hot-dip zinc coated (galvanised) in accordance with SANS 763 for type A1 or B2 articles, as may be applicable."."

**PSMM 3.2.4      Steel plate**

*REPLACE THE ENTIRE CONTENTS OF THIS CLAUSE WITH THE FOLLOWING:*

"Steel plate for road signs shall be 1,4mm thick pre-painted galvanised steel plate (Isco grade G275 Chromadek), which has been treated on both sides with an epoxy primer followed by a silicon polyester top coat. The total dry thickness of the treatment shall be at least 25µm."

**PSMM 3.2.8      Paints and protective coatings****PSMM 3.2.8.1      Structural steel sign supports and sign face frames**

*REPLACE THE CONTENTS OF SUBCLAUSE 3.2.8.1 WITH THE FOLLOWING :*

"The sign supports and the backs of all road sign faces shall be painted grey. The colour code of the paint shall be code No D36 according to the CKS 279 classification.

Newly galvanised surfaces shall be thoroughly scrubbed down with an approved galvanised iron cleaner to remove all traces of the resinous protective coating. The surface shall be washed down and scrubbed to remove all traces of grease, oil, dirt, etc. Two coats of calcium plumbate primer shall be applied to a dry film thickness of not less than 0,028 mm. The undercoat shall follow within one week of the primer."

**PSMM 3.2.9      Retro-reflective material**

In paragraph 3.2.9 (a) replace "CKS191" with "Class 1 in accordance with SANS 1519-1".

Delete paragraph 3.2.9(b) and replace with the following:

"High intensity grade complying with Class III in accordance with SANS 1519-1".

**PSMM 3.3      ROAD MARKING MATERIALS****PSMM 3.3.1.1      Non reflectorised paint**

*REPLACE "SANS 731" with "SANS 731-1 : 1995"*

Add “The paint shall be Type 1, 2 or 3 and shall be of a drying classification Class 1 in accordance with SANS 731-1”. The paint shall be Plascon Hysheen Road and Runway Marking Paint Products TP24, 41 or 88 or similar approved. The possible use of Plascon Hysheen Aquafest Road Marking Paint WTP1 as the final application on-site shall be considered at the end of the Defects Liability Period”.

#### **PSMM 3.3.1.2 Reflectorised paint**

*REPLACE THIS CLAUSE WITH THE FOLLOWING:*

“Reflectorised paint shall comply with the requirements of PSMM 3.3.1.2 as well as the retro-reflectivity requirements set in SANS 731-1 paragraph 4, 17.3 for new markings.”

### **PSMM 5 CONSTRUCTION**

#### **PSMM 5.2 ROAD SIGNS**

##### **PSMM 5.2.1 Manufacturing**

##### **PSMM 5.2.1.2 Backing plates and boards**

*ADD IN THE FIRST SENTENCE AFTER “DRAWINGS” THE FOLLOWING:*

“and SADC Road traffic signs manual, Volume 4 to comply with the National Road Traffic Regulations, 2000.”

##### **PSMM 5.2.1.5 Painting of road signs**

*DELETE THE ENTIRE CLAUSE AND REPLACE WITH THE FOLLOWING:*

“Road sign boards shall be manufactured by a recognised manufacturer of road signs.

Retro reflective material shall be affixed to the road sign board face in strict accordance with the requirements and specifications of the retro reflective sheeting manufacturer. No silk-screening of road sign faces shall be acceptable other than the screening of black symbols on Regulatory or warning signs.”

### **PSMM 5.3 ROAD MARKINGS**

#### **PSMM 5.3.2 Surface preparation**

Insert the following before the last sentence: “The areas where new markings shall be painted shall be thoroughly cleaned by acid pickling with a diluted product like Aquasolv Degreaser or similar, scrubbing with a steel brush and rinsing it with fresh water. All run-off shall be intercepted and treated prior to wasting into a stormwater system. No paint shall be applied on wet or untreated concrete surfaces. The need to apply a primer prior to the application of the paint shall be assessed before the final markings are applied.”

Add the following: “At the end of the Defects Liability Period the markings shall be repainted on cleaned and degreased surfaces in accordance with the paint manufacturer’s specifications.”

#### **PSMM 5.3.3 Setting out of road markings**

In the second paragraph, replace “Road Traffic Ordinance”, and “South African” with (National Road Traffic Regulations, 2000” and “SADC” respectively.

### **PSMM 8 MEASUREMENT AND PAYMENT**

*REPLACE ALL “km” UNITS WITH “km or m”*

**PSMM 8.1      ROAD MARKINGS (SUBCLAUSE 8.4.1)**

Notwithstanding the requirements of Subclause 8.4.1 painted road lines will be measured by net length and special markings by number.

The rates shall cover the cost of supplying all materials and equipment necessary and for painting and reflectorizing, protection, setting out, premarking of the road markings and remarking at the end of the defects liability period.

Note:

The Contractor shall note that the various materials have been scheduled in the Bill of Quantities. The payment provisions as specified shall none the less apply as appropriate."

**END OF SECTION**

### **C3.7.3 PARTICULAR SPECIFICATIONS**

Particular Specifications for work not covered by the SANS 1200 Standardized Specifications are also included hereunder.

**PDB : GENERAL BUILDING WORK****PDB 01**      **SCOPE**

This Particular Specification covers the various construction activities associated with the erection of buildings which form part of this Contract.

Building work shall be carried out in accordance with the National Building regulations, SAS 10400, the applicable clauses of the SABS Standardised Specifications and the information contained in this Specification.

Work appurtenant to the erection of buildings such as earthworks, concrete work, structural steelwork, etc, shall be carried out as specified in the appropriate Standardised Specifications and will be measured and paid for under those Specifications.

**PDB 02**      **BRICKWORK, PLASTERWORK AND FLOOR FINISHES****PDB 02.1**      **MATERIALS****PD 02.1.1**      **Bricks**

Burnt clay bricks shall comply with SABS 227 and shall be of the class and strength scheduled or shown on the Drawings. Unless otherwise specified, brickwork below ground shall be 14 MPa NFX solid engineering units in class I mortar (mortar with minimum 10 MPa compressive strength) and brickwork in superstructures shall be 7 MPa NFX solid engineering units in class II mortar (mortar with minimum 5 MPa compressive strength).

Face bricks shall, unless otherwise specified, be FBS solid engineering units in class II mortar. Face bricks shall be in the style and colour as specified on the drawings.

All load bearing bricks shall be at least 14 MPa bricks.

Concrete bricks, where specified or approved by the Engineer, shall comply with SANS 1215, and shall meet the same compressive strength and mortar class requirements as indicated above for burnt clay bricks.

Satisfactory proof of the load-bearing capacity of the bricks offered shall be submitted before deliveries are made to the Site.

Unless otherwise specified or approved, bricks shall measure 222mm long x 106mm wide x 73mm high (South African Imperial brick size).

Brick lintels shall be of the 'special solid' type that are solid on all sides (i.e., has no core holes).

Air bricks shall be well-burnt terracotta (or concrete for concrete brickwork) and shall be free from cracks and blemishes and lined with a durable, non-corrosive, non-degrading insect gauze.

Three samples of each type of brick shall be submitted to the Engineer for approval. All subsequent deliveries shall be of a standard equal to or better than that of the approved samples.

**PDB 02.1.2**      **Cement**

Cement shall comply with the requirements of SABS 471 and shall be stored under cover. The use of Portland blast-furnace cement (PBFC) which complies with the requirements of SABS 626 will only be allowed if approved by the Engineer.

**PDB 02.1.3     Aggregate**

Fine aggregate shall consist of natural sand, or crushed rock or gravel, and shall be hard, clean, and free from adherent coatings or other deleterious matter. Sand for plaster and mortar shall comply with the requirements of SABS 1090.

**PDB 02.1.4     Water**

Water shall be clean and free from clay, silt, oil, acid, alkali, organic or other matter which would impair the required strength and durability of the mortar, plaster, or screed.

**PDB 02.1.5     Wall Ties and Brickwork Reinforcement**

Wire ties shall be of galvanized steel of the single wire type for solid walls and either the "Butterfly" or Modified PWD type for hollow walls. Ties shall be of sufficient length to allow not less than 75 mm of each end to be built into brickwork or embedded in concrete. Vertical twist ties shall be used where specified on the drawings.

Brickwork reinforcement shall be manufactured from hard drawn steel wire conforming to BS 785 and shall consist of two 2,8 mm diameter main wires with 2,5 mm diameter cross wires at 300 mm centres welded at intersections.

Brickwork reinforcement shall be lapped not less than 300 mm at end joints and for a length equal to the width of the widest reinforcement at intersections.

**PDB 02.1.6     Damp-Proof Sheetting**

Damp-proof sheetting shall comply with SABS 248, type FV for fibre felt, or SABS 952, type B for embossed polyethylene sheetting.

**PDB 02.1.7     Expansion/Control Joints**

Expansion joints, masonry-to-concrete joints and the like shall be constructed as indicated on the drawings. Unless otherwise specified, the following shall apply:

- a) All hoop-irons/straps/concertina ties shall consist of 750mm long by 30mm wide by 1.2mm thick galvanized steel strips.
- b) For vertical masonry-to-concrete joints, each hoop-iron/strap shall be built 500mm deep into the brickwork after fixing one end to the concrete using 2x Fischer Hammerfix N6x40 anchors (or equivalent, installed as per manufacturer's instructions). Each brick leaf abutting concrete shall have hoop-irons/straps built into the brickwork at approximately 255mm vertical centres (every third course)
- c) For vertical masonry-to-masonry joints, each brick leaf shall have a concertina tie built into the brickwork at every fourth course.
- d) All expansion/control joints shall be 10mm wide and consist of 10mm thick Jointex (or equivalent) compressible membrane, sealed (after being thoroughly cleaned) along the perimeter with a suitably approved polyurethane or polysulphide joint sealer of colour matching the wall finish. The sealant shall be applied against a full backing to ensure it is forced against the sides of the joint to obtain good adhesion, and the finished profile shall be no less than 12mm deep across the 10mm joint width, with the completed joint sealant face recessed 15mm for face brick or flush with brickwork/concrete to still receive plaster.

**PBD 02.2     CONSTRUCTION OF BRICKWORK****PDB 02.2.1     Cement Mortar**

Cement mortar shell, unless otherwise specified, consist of one part Portland cement to four parts sand (1:4) by volume for foundation brickwork and one part Portland cement to six parts sand (1:6) by volume for superstructure brickwork. The ingredients for cement mortar shall be measured in proper gauge boxes on a boarded platform and thoroughly mixed. Alternatively, mixing may be by means of an approved mechanical batch mixer. Only when the dry ingredients have been thoroughly mixed, and a mixture of uniform colour has been obtained may the water be added in sufficient quantity to obtain mortar with the required consistency. The Engineer shall be present when the first batch of mortar is mixed and used.

Cement mortar shall be used within two hours of adding water to the mix and shall not be used after two hours or if it has begun to set. Mortar shall be turned over frequently to prevent it from setting until it is used.

#### **PDB 02.2.2 Brickwork**

Dimensions of all the brickwork shall be set out and built as shown on the Drawings and shall, unless otherwise indicated, not include plaster thickness. Wall thicknesses indicated in the BOQ and dimensioned on the drawings shall also, unless otherwise stated, exclude the thickness of the plaster (plaster not included for in the thickness given).

Bricks shall be kept wet before laying and the top of brickwork shall be wetted before any further bricks are laid. Bricks shall be well buttered with mortar before being laid and all joints shall be thoroughly flushed up as the work proceeds. All joints to face brickwork shall be neatly made and key-drawn with a 6 mm key.

Face brick units shall be 'blended' by properly sorting and mixing the masonry units to ensure even distribution of colour, shape and texture across the entire finished wall. Clustering of variations will not be accepted.

Brickwork shall be carried up in a uniform manner with no portion being raised more than 1 m above an adjacent portion. Advanced work shall be raked back and toothing-in of masonry units shall not be permitted. All perpends, quoins, etc, shall be kept strictly true and square and the whole properly bonded together.

Brickwork shall be built in stretcher bond, unless otherwise specified, and bats shall not be used except where required for the bond. All joints shall be 10 mm wide, and four courses shall measure 340 mm.

All brickwork shall be constructed with galvanized brickwork reinforcement build-in at every fourth course in superstructure brickwork and every second course in foundation brickwork.

Brickwork for cavity walls and solid walls built in stretcher bond shall be tied with wall ties at 255 mm vertical and 690 mm horizontal centres in foundations and at 340 mm vertical and 690 mm horizontal centres in superstructure brickwork and shall be staggered vertically. At openings, the ties shall be positioned not more than 300 mm apart along the periphery of the opening and 150 mm from the opening.

Face brickwork shall be kept perfectly clean and rubbing down of the brickwork shall not be allowed. Scaffold boards shall be turned back during heavy rain to avoid splashing. Soiled brickwork shall be cleaned at the Contractor's expense, and the cleaning method shall be approved by the Engineer.

#### **PDB 02.2.3 Reinforced Brickwork**

Unless otherwise shown on the drawings, brickwork over door and window openings shall be reinforced with steel rods, welded, or expanded mesh, etc. Reinforcement shall be placed in each course of brickwork for a minimum of five (5) courses unless specified otherwise on the Drawings. Reinforced brickwork shall continue at least 600 mm on each side of the openings.

#### **PDB 02.2.4 Lintels**

Brick lintels (lintols) shall be built upon rigid temporary supports left in position for not less than seven (7) days after bricklaying. Brick lintels shall be of the 'special solid' type that are solid on all sides (has no core holes).

Pre-stressed concrete lintels be used where approved by the Engineer.



**PDB 02.2.5     Key for Plaster**

Joints of all brickwork receiving plaster shall be raked out, or the brick surfaces shall otherwise be prepared with an acrylic slurry or any other approved bonding agent.

**PDB 02.2.6     Damp-Proofing**

A damp-proof course/membrane shall be bedded in mortar (dry laying is not acceptable), laid over the full width of all the walls at a minimum height of 150 mm above the final ground level or wherever else it may be required, and it shall be lapped for at least 150 mm at angles and joints. A damp-proof course shall also be laid and stepped up under all external sills, and above all doors and windows that are not protected within 750mm above by a roof with overhang of at least 750mm.

In some cases, torch-on waterproofing may, instead of damp proof course, be specified on the drawings. Torch-on shall comply with the "Torch-on Waterproofing" clause of this specification.

**PDB 02.2.7     General**

Rough and fair cutting shall be performed as required, and the brickwork shall be fitted around any steel work. Face brickwork shall be carefully cut and fitted to suit fittings.

Chases shall be left or formed for edges of concrete floors, staircases, etc. Chases shall also be provided wherever they may be required for pipes, conduits, switch boxes, distribution boards, and the like. Joints shall be raked out for flashings.

**PDB 02.2.8     Expansion/Control Joints**

Unless otherwise specified, expansion joints shall be made, with prior approval of the Engineer, at all masonry-to-concrete interfaces. In addition, where vertical expansion/control joints shown on the drawings exceed 9m centres for 220mm or thicker collar-jointed walls, 7m centres for cavity walls, 4m centres for external 110mm single-leaf walls or 5.5m for internal 110mm single-leaf brick walls, additional joints shall be constructed (with the prior approval of the Engineer) such that the centre-to-centre distances do not exceed those indicated above.

Expansion/control joints shall not be plastered over, with the plaster neatly finished on either side of the joint.

**PDB 02.2.9     Face Brick Reference Panel**

Prior to commencing with face brick masonry work, a 1.2 m long by 1 m high by 280 mm thick (or equivalent) cavity reference panel (mock-up) shall be constructed in the presence of the Engineer using the proposed materials and tooling required for the final work.

The reference panel shall be constructed on a firm concrete base in a readily accessible area where it can be viewed in good natural light, and it shall be protected against moisture ingress. The panel shall match:

- a) the proposed size, colour and texture of the masonry units,
- b) the joint profile and the colour of the mortar,
- c) the agreed bond pattern,
- d) any special features.

The panel shall also incorporate:

- e) the required reinforcing,
- f) a damp proof course with weep hole,
- g) a control joint (expansion joint) through the centre.

Face brick masonry work shall only commence after the panel has been accepted by the Engineer. The panel shall be the standard of workmanship to which the Contractor will be held but shall not supersede the requirements indicated on drawings or specified.

The brick panel shall not be altered, damaged, or moved until the masonry work is complete and has been accepted by the Engineer.

## **PDB 02.3      PLASTERWORK**

### **PDB 02.3.1      General**

Plasterwork shall meet the requirements of SANS 2001-EM1, unless otherwise indicated. Prior to commencing with plasterwork, the Contractor shall submit, for approval by the Engineer, a plasterwork method statement.

### **PDB 02.3.2      Substrate Preparation**

In addition to preparing surfaces in accordance with SANS 2001-EM1:

- substrates shall be at least as rough as coarse sandpaper or rough-sawn timber,
- and masonry joints shall be raked to a depth of 10mm to provide a good mechanical key for plastering.

The Engineer shall be called to inspect all prepared surfaces prior to receiving plaster.

### **PDB 02.3.3      Plaster Coats**

The Engineer shall be notified and witness the mixing and use of the first batch of mortar. A plastered finish shall consist of a single coat comprising one application of a 1:6 cement sand mixture with a wood or steel-float finish, except where otherwise indicated.

Plaster shall be dampened by means of a light spray for a period of not less than 3 days after being applied to the substrate. Successive coats of plaster shall only be applied after the substrate coat has hardened sufficiently to bear a new la

er or to enable a new layer to adhere to it and limit drying shrinkage crazing and cracking.

### **PDB 02.3.4      Thickness**

The total thickness of the plaster finish shall be 13 mm minimum and 20 mm maximum, except where otherwise indicated. Plaster thickness is, unless otherwise stated, not incorporated in brick wall dimensions shown on the drawings or indicated in the BOQ.

### **PDB 02.3.5      Workmanship**

All plasterworks shall be finished smooth and ready to receive paint. Plaster shall be flush with the faces of all switches and plug boxes, the interiors of which shall be kept free from plaster. Plastered surfaces shall be plumb and jambs and reveals shall be formed square.

Plaster shall be discontinuous across the line of a damp-proof course, a butt joint, a movement joint or at the interface between masonry and concrete elements. Unless otherwise indicated, the plaster at such interfaces shall be cut back to the substrate with a steel trowel to form a V-joint in accordance with SANS 2001-EM1.

The plasterer shall cut out and make good all cracks, blisters, and other defects, ensuring that the plasterwork remains in a state which is acceptable to the Engineer. Delaminating plasterwork shall not be accepted.

## **PDB 02.4      ROOF FINISHES**

### **PDB 04.1      Roof Screeds**

This screed specification is only applicable to screeds applied to roofs, unless otherwise indicated. Granolithic screeds are specified in SANS 1200 G.

Where the type of screed required is not stated, the screed shall comply with:

- a) this roof screed specification if applied to roof tops, or
- b) the granolithic screed specification in SANS 1200 G if applied anywhere else.

**PDB 02.4.1.1 Mix Design**

Roof screeds shall have a mix proportion by mass consisting of one (1) part Portland cement and three (3) parts fine aggregate (1:3). A minimum amount of water is to be used, but it shall be sufficient to allow adequate compaction.

**PDB 02.4.1.2 Preparation of Base Concrete**

Preparation of base concrete shall be as specified for granolithic screeds/floor screeds in SANS 1200 G.

**PDB 02.4.1.3 Placing**

Placing shall be as specified for granolithic screeds/floor screeds in SANS 1200 G, but with the following two amended requirements:

- a) The falls specified shall be increased to 1:80.
- b) Instead of finishing the screed to Degree of Accuracy I, Degree of Accuracy II shall apply.

**PDB 02.4.1.4 Curing**

Curing shall be as specified for granolithic screeds/floor screeds in SANS 1200 G.

**PDB 02.4.1.5 Joints**

Joints shall be as specified for granolithic screeds/floor screeds in SANS 1200 G, but with the following two amended requirements:

- h) Additional joints are only to be made in the screed if, when matching the base concrete joints, the screed panel size will exceed 14m<sup>2</sup>. These additional joints shall be construction joints as defined for concrete in 1200G.
- i) Additional joints shall be made such that joints are no more than 4.5m apart. These additional joints shall also be construction joints as defined for concrete in 1200G.

**PDB 02.4.1.6 General**

Screeds found to be delaminating shall not be accepted. No moisture-sensitive roof finishes or waterproofing shall be laid on screeds unless a reliable moisture test shows that the screed is sufficiently dry to receive the covering.

**PDB 02.4.2 Crushed Stone on Roof Slabs**

Where required, crushed stone shall be placed on roofs in thicknesses indicated on the Drawings (or 50mm where not indicated). The crushed stone shall be 19mm nominal stone complying with SANS 1083 grading criteria (including passing through a 25mm mesh sieve and retained on a 12mm mesh sieve). The crushed stone shall further be hard wearing and resistant to degradation and fouling.

The crushed stone shall be delivered to site clean and washed and shall not be placed without the permission of the Engineer and not until the concrete of the roof slab has reached the design strength. The Contractor shall, prior to placing, submit for approval a method statement indicating how the roof will be protected from damage during placing and spreading. During placing, the stone shall be immediately spread into position on the roof and no heaping-up of the stone will be allowed. Repairs to any damages caused by placing and spreading of the crushed stone shall be for the Contractor's cost.

If applicable, watertightness testing of roofs shall be done after the crushed stone has been placed and spread into position. The Contractor may, to satisfy themselves and at their own cost, conduct preliminary water tightness testing prior to crushed stone placement.

**PDB 02.4.3     Torch-on Waterproofing**

Unless otherwise indicated, torch-on waterproofing membranes shall be applied in accordance with manufactures instructions. A trial panel consisting of at least two overlapping membranes and covering what is considered by the Engineer as the most complex section of the roof or wall (as applicable) shall be prepared in advance by the Contractor for the Engineer's approval.

The Engineer shall be called to inspect all prepared surfaces prior to applying the waterproofing.

**PDB 03            DOORS, WINDOWS, LOUVRES, ETC.****PDB 03.1        MATERIALS****PDB 03.1.1     General**

All steel and iron work shall be delivered clean and free from rust, pitting or other defects. Shop primers shall be applied before delivery and shall consist of a coat of red oxide paint, or any other approved anti-rust paint on all surfaces.

Unless otherwise specified, all materials shall conform at least to the appropriate SABS or BS standards where such standards apply to ironmongery, or steel, cast iron and any other related materials.

**PDB 03.1.2     Pressed-Steel Door Frames**

Pressed-steel door frames shall comply with SABS 1129 and shall be manufactured from 1,6 mm thick mild-steel sheeting, pressed to the required shapes, properly mitred, welded, and reinforced, with all welding neatly cleaned off.

Frames shall be of the widths required to suit the thickness of the walls into which they are built and shall be fitted with suitable tie bars and braces at the bottom. Three lugs to be built into the brickwork shall be provided on each jamb.

Rebates in frames and transoms for doors shall be of the widths required to suit the thicknesses of the doors and shall be fitted with a pair of approved steel butt hinges set flush into recesses in the frames. 4,5 mm thick reinforcing plates shall be welded to the backs of the frames at hinge positions.

Heads of frames over double doors shall be drilled where required to form keeps for bolts and shall be fitted with one rubber buffer for each leaf of the door.

Frames for single doors shall be fitted with approved chromium striking plates and an adjustable striking-plate keeper boxed in at the back of the frame by a welded-on sheet-metal box. The frames shall be fitted with a minimum of two rubber buffers.

Frames shall be protected against twisting and damage during transit and erection.

**PDB 03.1.3     Pressed-Steel Doors**

Pressed-steel doors shall be manufactured from 1,6 mm thick steel plate. The doors shall be of standard design, pressed to shape with 40 mm reveals all round. The doors shall be strengthened with full-length vertical V-shaped or other approved sectional strengthening ribs projecting to the outer face. Two horizontal stiffening rails shall also be welded to the inner face of the doors.

A door shall be hung on a pair of 100 mm long steel butt hinges with loose pins. The leaves of the hinges shall be welded to both the door and the door frame, and a 1,6 mm thick steel plate shall be welded to the inner face of the door to protect the lock.

One leaf of double doors shall be fitted at the top and bottom with approved 150 mm cast brass barrel bolts in an approved manner and the other leaf shall be fitted with a lock, the striking plate of which shall be fixed to the first leaf.

Where indicated on the drawings, doors shall be fitted with louvred ventilation grills of approved design, backed with insect and vermin-proof gauze screening.

**PDB 03.1.4 Wooden Doors**

External wooden doors shall, unless otherwise specified, be 44mm thick hardwood, face-boarded, framed, ledged and braced tongue-in-groove batten doors with 3mm tempered hardboard (high-density fibreboard) on the inside.

Internal wooden doors shall, unless otherwise specified, be 44mm semi-solid doors with 3mm tempered hardboard (high-density fibreboard) both sides and a core consisting of chipboard strips.

**PDB 03.1.5 Steel Window Frames**

All steel window frames shall comply with SABS 727 and shall be of the types and sizes shown on the Drawings.

Standard industrial types of steel window frame shall be constructed from rolled mild-steel industrial sections, 35 mm wide by 3 mm thick, with opening sections constructed from standard residential sections, 25 mm wide by 3 mm thick, welded at angles and properly jointed at intersections.

**PDB 03.1.6 Aluminium Doors, Windows, Louvres, Etc.**

The Contractor for the manufacturing and installations of the aluminium doors, windows, louvres, etc. is to submit proof of AAAMSA membership and doors, windows, louvres shall comply with AAAMSA design criteria.

The following certificates shall be provided prior to commencement of site work:

- a) A copy of the relevant AAAMSA Performance Test Certificate from the manufacturer/contractor supplying the architectural aluminium product.
- b) A Certificate of Conformance confirming that anodizing or powder coating has been processed in accordance with SANS 999 and SANS 1796 respectively.
- c) A Certificate of Conformance confirming that glazing has been installed in accordance with SANS 10137, ensuring that safety glazing materials have been installed in the mandatory areas and that each individual pane of safety glazing materials has been permanently marked.
- d) A warranty from the manufacturer of the laminated safety glass and/or hermetically sealed glazing units guaranteeing the products against delamination and colour degradation for a period of not less than five years.

The successful tenderer shall provide full shop drawings for the approval by the Engineer prior to the manufacturing of any work.

**PDB 03.1.7 Roller Shutter Doors**

Roller shutter doors shall be suitable for external use in all-weather including periodic extreme wind loading conditions. They shall include all components required for a fully operating door, including but not limited to the door curtain, channel guides, revolving spring-loaded shaft barrel with fully enclosed canopy, lugs and fasteners, components for operating the doors and heavy-duty locks.

The curtain shall be manufactured from 1mm thick machine rolled galvanised interlocking solid slats with steel

end locks' spot welded to alternate strips and 'wind locks' fitted at manufacturer approved intervals. The bottom slat shall be an aluminium T-bar (T-section) with integrated EPDM weather seal, unless the door is over 7m wide in which case a hot dip galvanised T-bar with manufacturer-approved weather seal will be accepted.

The vertical edges of the curtain shall glide in hot-dip galvanised channel guides formed of steel not less than 2.5mm thick. The channel guides shall be mounted securely to sides of the

door opening with SS316 fasteners, with fixing details and spacing approved by the manufacturer. The channel guides shall be no less than 76mm deep for doors below 6m in width and no less than 120mm deep for doors 6m and wider.

The door shall either be manually operated with crank and gearbox system or automated, whichever is specified. The canopy covering the opening mechanism shall be manufactured from 0.8mm (minimum) thick galvanised mild steel in a continuous length.

The door shall be finished with a UV resistant polyester powder coating if painting, powder coating or a finished colour is specified.

#### **PDB 03.1.8      Door Locks and Handles**

Unless otherwise specified, locks shall comply with the following requirements:

All door locks shall comply with the requirements of SABS 4 and shall be of approved manufacture and pattern. All locks shall be supplied with two keys. Keys shall be distinctly numbered with consecutive numbers and each key shall be stamped with the same number as that of the lock which it controls. No two locks in anyone building may have the same key.

External doors shall be fitted with master-keyed four-lever heavy duty mortice locks or cylinder locks as indicated.

All locks shall be properly installed, and, after completion, striker plates shall be adjusted, and the locks serviced.

Door handles shall be of cast zinc of approved manufacture and pattern.

#### **PDB 03.1.9      Miscellaneous Fittings**

All retaining devices for doors and windows as well as fittings such as coat hooks, retaining hooks, etc shall be of solid brass unless otherwise indicated. All fittings shall be secured by screws or set screws of the same material and finish as the fitting.

Fittings to be fixed to plastered walls, masonry or floors shall be fixed direct by means of patent plastic or fibre plugs fitted into drilled holes.

Doorstops shall be provided at every external door and shall generally be 40 mm diameter rubber stops.

Patented precast concrete window surrounds or blocks shall be as scheduled in the bill of quantities.

#### **PDB 03.2      INSTALLATION OF DOORS AND WINDOWS**

All built-in door and window frames shall be set straight, plumb, and level, and shall operate to the satisfaction of the Engineer after fixing has been completed.

Fittings shall be either removed, or wrapped and protected from damage, until all rough trades have been completed.

#### **PDB 04      GLAZING**

##### **PDB 04.1      MATERIALS**

##### **PDB 04.1.1      Glass**

Glass shall comply with the requirements of SANS 1263-1, unless otherwise specified otherwise. The quality of all window glass shall be such that surface deterioration will not develop after glazing.

All glass shall be free from bubbles, waviness, scratches, stains, or other imperfections.

Unless otherwise specified, sheet glass for glazing shall be flat-drawn clear glass of ordinary glazing quality and of the thicknesses indicated below:

For panes not exceeding 1,5 m<sup>2</sup> in area: 4 mm.

**PDB 04.1.2     Putty**

All putty shall comply with the requirements of SABS 680.

Putty shall not be too hard or soft or caked when used and shall dry evenly without crazing or cracking.

Defective putty shall be cut out and replaced by the Contractor at his own expense, and any broken glass shall also be so replaced and putty so repainted.

**PDB 04.2     GLAZING**

Glass shall be cut in panes to suit all glazed openings with sufficient clearance all round to prevent cracking by expansion, contraction, or vibration.

In all cases the glass shall be well bedded and back-puttied and installed as specified in SABS Code of Practice 0137.

All putty shall be carefully trimmed, cleaned off and neatly finished off straight with smooth surfaces and sharp mitres. A paint primer shall be applied as soon as the putty has dried out sufficiently to prevent shrinkage cracks from forming.

The entire glazing operation shall be cleaned before the premises are handed over for occupation.

**PDB 05     CARPENTRY AND JOINERY**

**PDB 05.1     GENERAL**

**PDB 05.1.1     Materials**

All timber used for structural purposes shall be of merchantable grade and shall comply with the requirements of SABS 563 and SABS 1245. Structural timber shall be carefully selected and of the best quality, free from large or dead knots, shakes, waney edges or other defects. Purlins and bracing shall comply with the requirements of SABS 653. Finger-jointed structural timber shall comply with the requirements of SABS 096 and laminated timber with the requirements of SABS 1089.

Hardwoods and softwoods for joinery shall comply with SABS 1099 and SABS 1359 respectively and suitable species shall be used for the various purposes.

Unless otherwise specified, all materials shall conform to the appropriate SABS or BS Specification where such standards exist for nails, screws, bolts, adhesives, etc.

**PDB 05.1.2     Preservative Treatment**

All structural timber shall be given a preservative treatment suitable for the duty for which the timber is intended in accordance with SABS 05, and no untreated timber shall be used. The preservative treatment shall not impair the final finish. The timber shall be impregnated throughout. When surface coating is specified, the compounds applied on the surfaces of the timber shall form an unbroken film.

**PDB 05.1.3     Priming**

The jointing surfaces of all joints exposed to the weather and built-in portions of frames shall be thickly primed except where adhesives are specified.

Carpentry and joinery items which are prepared for painting by the manufacturer, shall be knotted and primed before being dispatched to the Site.

Primed surfaces shall be touched up where necessary during the progress of the work or where site adjustments have been made.



**PDB 05.2      CARPENTRY WORK****PDB 05.2.1      Scope of Work**

Carpentry work shall be carried out in a manner consistent with good workmanship and in compliance with the Drawings.

The carpenter shall perform all cutting away and making good in attendance upon all other trades and he shall provide and maintain temporary coverings required for the protection of any finished work that might be damaged if left unprotected during the progress of the work.

**PDB 05.2.2      Dimensions**

Unwrought timber shall be as sawn and shall be to the dimensions and within the tolerances specified in the relevant SABS Standard Specifications mentioned in subclause 5.1 (1).

**PDB 05.2.3      Jointing**

Unless otherwise specified, all joints shall be secured by means of a suitable type and a sufficient number of approved connectors. All joints shall be carefully made in such a way that they will not impair the strength and stiffness of the beams or members.

**PDB 05.2.4      Timber Roof Construction**

The plates, joists, rafters, purlins, bracing and other pieces used for the construction of the roof and trusses shall be of the dimensions, spacing and construction as shown on the Drawings.

All the joints in the framework shall be of the most appropriate type, accurately formed and adequately secured with fasteners as specified.

**PDB 05.3      JOINERY WORK****PDB 05.3.1      Scope of Work**

Joinery work shall consist of the manufacture, delivery to the Site, and fixing in the buildings, of all joinery shown on the Drawings.

Except where a special finish is specified, the Contractor shall have all stairs, landings, doors, shelves, and other joinery work cleaned and scrubbed down and shall leave all his work in a good order to the satisfaction of the Engineer.

**PDB 05.3.2      Dimensions**

All wrought timber shall be sawn, planed, drilled, or otherwise machined or worked to the correct sizes and shapes shown on the Drawings.

Reasonable tolerances shall be provided at all connections between joinery works and the building structure to compensate adequately for any irregularities, settlements, or any other movements.

**PDB 05.3.3      Manufacture**

The joiner shall perform all the necessary mortising, tenoning, grooving, matching, tonguing, housing, rebating and all the other works necessary for correct jointing. He shall also provide all metal plates, screws, nails, and other fixings that may be necessary for doing the specified joinery work properly.

**PDB 05.3.4      Joints**

Where joints are not specifically indicated, they shall be the recognised forms of joints for each position. The joints shall be so made as to comply with Part 2 of BS 1186.

**PDB 05.3.5      Doors and Frames**



Door frames, linings, panel doors, framed, ledged and braced doors, flush doors, sliding doors, etc shall be supplied or made by the joiner and shall be installed, fitted, or hung as detailed on the Drawings.

All timber shall be wrought and prepared for oiling, staining, varnishing, or painting.

**PDB 05.3.6 Skirtings, Cornices, Etc**

Skirtings, cornices, etc shall not be installed until after the wall coverings have been applied, the flooring laid and ceilings installed, unless otherwise specified.

**PDB 05.3.7 In-Situ Joinery**

In-situ joinery work shall not be executed until after all floor, wall and ceiling surfaces have been formed or constructed, unless otherwise instructed.

**PDB 05.3.8 Ceilings**

Ceilings shall unless otherwise specified of scheduled consist of plaster board or fibre-cement panels as shown on the Drawings and shall be nailed to the bracker or suspended from the roof structure. The panels shall be separated by exposed tees and insulated with a 50 mm thick fibreglass wool blanket were shown on the Drawings.

The maximum permissible deviations for ceilings shall be as follows, with no abrupt changes accepted:

flatness of the ceiling soffit : 5 mm measured over a 2 m distance.

level of soffit : +-10mm

**PDB 05.3.9 Timber Flooring Panels for Trench Covers**

Timber flooring panels (for trench covers) shall consist of meranti planks or laminated meranti panels (as specified) and shall be supplied and installed complete with the steel top hat sections, neoprene strips and support frames indicated on the drawings. Work shall be carried out in a manner consistent with good workmanship and in compliance with the Drawings. The actual dimensions and details measured on site shall be accommodated, and all dimensions to be verified before commencing with any manufacturing or construction.

Steel support frames and top hat sections shall, unless otherwise indicated, be of HDG mild steel and shall meet the requirements of SANS 1200 H. All steel joints (aside from top hat sections which are to remain unfixed) are to be fully welded with no crevices (continuous welding on all sides of any joint).

The gap between the edge of timber flooring and the support frame, top hat section or abutting structure (as applicable) shall be at least 1mm and no greater than 5mm on each side. No gaps shall be left between adjacent panels.

Timber shall meet the semi-clear grade requirements of SANS 1783-3, unless otherwise approved. All timber to be sanded smooth (>240 grit) and sealed all round with Woodoc deck or equivalent sealer (applied in accordance with the manufacturer's instructions). Corners of loose timber planks and complete panels shall be rounded ( $r \approx 5\text{mm}$ ).

Laminating (gluing) timber planks together to create panels (as applicable) shall be done in accordance with the relevant clauses of SANS 1460. Timber panels are to be machine planed and sanded after laminating to achieve a smooth finish and uniform and correct panel thickness.

Flooring panels shall be mounted firm and level, orientated uniformly and shall be of neat and workmanlike appearance, solidly and evenly supported, true to line, level, plumb and in proper working order. Panel/plank depth shall be within 1mm of the specified depth and adjacent panels/planks shall have vertical edge alignment of

within 2 mm of each other.

In cases where the motor control centre (MCC) or variable frequency controllers (VFC) cover parts of the trench, supports and top hat sections shall continue under the MCC/VFC, however the timber flooring panels shall not. Where flooring is supplied with top hats, 40x5mm

neoprene strips shall be placed under all flooring edges not supported by a top hat section and adhered with contact adhesive to the angle support.

The tendered rate for timber flooring shall be for the timber flooring, complete and installed with sealer, supports, top hat sections, neoprene strips, etc.

**PDB 06      ROOF SHEETING AND ACCESSORIES**

Roof sheeting and accessories shall comply with and will be measured and paid for under SABS 1200 HB.

**PDB 07      ELECTRICAL WORK**

Electrical work shall be as specified and scheduled by the Electrical Engineer.

The electrical Contractor shall work in close co-operation with the building Contractor to ensure that all conduits, switchboards, plug boxes and switch boxes are installed in their correct position.

**PDB 08      PLUMBING**

**PDB 08.1      MATERIALS**

**PDB 08.1.1      General**

All materials shall be of the best quality and shall be approved by the Engineer before installation. Cracked, chipped, dented or faulty items or materials shall be replaced at the Contractor's expense. Glazed ceramic sanitary ware shall comply with the requirements of SABS 497 and all other materials shall comply with the standards as specified, scheduled or shown on the Drawings.

**PDB 08.1.2      Water Closet (WC) Suites**

WC suites shall unless otherwise specified or scheduled consist of a glazed vitreous china closet with an S or P trap and seat lugs, a 14-litre low-level matching flat-bottomed flushing cistern placed and fixed on the closet, or a suspended enamelled cast-iron cistern with the flush pipe connected to the flushing rim of the closet with rubber cone joints, and a solid heavy-duty plastic seat with cover, hinges and buffers.

**PDB 08.1.3      Urinals**

Urinals shall be of the type specified or scheduled, of glazed vitreous china, wall mounted, with an automatic or a manual flushing system, and chromium-plated fittings.

**PDB 08.1.4      Wash-Hand-Basins**

Wash-hand-basins shall unless otherwise specified or scheduled be of glazed vitreous china or enamelled cast iron, wall mounted on a pair of cast-iron brackets and fitted with chromium-plated fittings consisting of two taps, outlet and chain, and supplied with a plug and an anti-siphon trap.

**PDB 08.1.5      Sinks**

Sinks shall comply with the requirements of SABS 242 and shall be complete with cabinet, chromium-plated outlet, anti-siphon trap, plug, chain and two bib taps or one mixer tap, all as detailed or as scheduled.

**PDB 08.1.6      Pipes and Tubing**

Cast-iron and steel pipes used in plumbing work shall comply with the requirements of SABS 746 and SABS 62 respectively. Copper tubing shall comply with the requirements of SABS 460 and malleable cast-iron fittings with SABS 509.

**PDB 08.2      CONSTRUCTION**

Plumbing shall be carried out strictly in accordance with the Drawings and with the National Building Regulations, with specific reference to Government Notice R1875 dated 31 August 1979.

Steel pipes and their malleable cast-iron fittings shall be joined with red lead and hemp, lead pipes shall have wiped soldered joints, and cast-iron pipes shall be joined by caulking with hemp and metallic lead.

Soil pipes from WC's shall have an internal diameter of at least 100 mm and shall be fitted with a pan connector and an access bend (or an access junction where a vent pipe is used) and carried through walls and into the ground for connection to the sewer. Vent pipes shall be fitted with approved balloon gratings.

Waste pipes from basins and sinks shall have an internal diameter of at least 32 mm and shall discharge into gulley's. Bends for waste pipes shall incorporate cleaning eyes.

Cisterns, basins, and sinks shall be connected to the pipe system with 12 mm diameter copper service pipes, and chromium-plated stopcocks shall be installed for isolation and maintenance purposes.

**PDB 09      PAINTING****PDB 09.1      GENERAL**

No paint shall be applied to any surface containing traces of dust, grit, grease, oil, loose rust, millscale or corrosion products of any kind or to any surface that is not free from moisture. Where necessary, surfaces shall be thoroughly washed to remove all traces of soluble salts and/or corrosive air-borne contaminants prior to painting, and the surfaces shall be dried and painted immediately thereafter.

Welding shall be completed in so far as it is possible before painting commences, but in cases where welding can be done only at a later stage, no paint shall be applied to within 75 mm of the proposed weld position unless otherwise specified. Welds and adjacent parent metal shall be abrasive blasted and/or ground and all contaminants such as flux shall be removed prior to painting.

Surfaces of members which are to rest on concrete or other floors, or which will be otherwise inaccessible after erection shall receive the full paint system prior to erection.

Damaged paint areas on metal surfaces shall be cleaned, rust spots removed where applicable and the surrounding paint which is still intact shall be feathered for a distance of 20 mm beyond the damaged area. Spot priming and repair shall consist of all the coats previously applied and shall overlap the damaged area.

Damaged galvanised areas shall be cleaned and any rust spots and any flakes of the coating surrounding the damaged area removed. The coating shall then be restored by zinc spraying or soldering

or painting with a zinc-rich epoxy primer, as may be approved by the Engineer.

Where the shop coat is allowed to age for a few months before the final painting is done, light sanding or rubbing with steel wool or scrubbing with clean water using a bristle brush shall be carried out.

Steel to be embedded in concrete shall not be painted below 50 mm from the final level of the concrete.

Each priming coat and each undercoat of paint shall be inspected and approved by the Engineer before any subsequent undercoat or finishing coat is applied.

All finishing colours shall be as shown on the Drawings, or as directed by the Engineer.

**PDB 09.2      MATERIALS**

Paints shall comply with the requirements of the appropriate Specifications below:

**PDB 09.2.1    Primers**

SABS 678	:	For wood
SABS 679	:	Zinc chromate for steel
SABS 723	:	Etch-wash primer for metals.
SABS 912	:	Calcium plumbate for galvanized iron
SABS 926	:	Zinc-rich epoxy for steel

**PDB 09.2.2    Undercoats**

SABS 681	:	For all undercoats
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**PDB 09.2.3    Finishing Coats**

SABS 515	:	For interior use, flat and egg-shell finish
SABS 630	:	For interior and exterior use, high-gloss enamel
SABS 631	:	For interior and exterior use, oil gloss paint
SABS 633	:	For interior use, emulsion paint
SABS 634	:	For exterior use, emulsion paint
SABS 684	:	For exterior use on structural steel
SABS 801	:	For interior and exterior use, epoxy-tar paint
SABS 802	:	For interior and exterior use, bituminous aluminum paint
SABS 887	:	For interior use, glossy and egg-shell varnish

The Contractor shall furnish the Engineer with the following information and details regarding the paints and decorative materials for the painting system he proposes to use, for written approval:

- a) The name of the manufacturer and trade name
- b) The brand, type or grade of paint and the appropriate SABS Specification
- c) Manufacturer's data sheets, colour references, instructions for use, including surface preparation, sealers, primers, undercoats, finishing coats, coat thicknesses and curing periods, which shall all be considered as being part of these Specifications if approved by the Engineer.
- d) Safeguards to protect the applied paint from damage until the work is accepted by the Engineer.
- e) The shelf or pot life of materials, if applicable
- f) An undertaking that the proposed paint system is suitable for its intended use and that the various coats of paint are compatible with one another.

Where proprietary brands are used, the manufacturer's priming and all subsequent coats of paint suitable for that particular brand shall be employed in accordance with the manufacturer's instructions.

No other materials of a similar nature and quality or from another manufacturer may be used instead of those approved, unless written permission to do so has been obtained from the Engineer.

All materials shall be brought onto the Site in containers sealed by the manufacturer. Paints of a different quality, type, brand or colour shall not be mixed. Paint shall not be thinned nor adulterated in any way but shall be used as supplied by the manufacturer. Any mixing or tinting required shall be carried out by

he manufacturer.

Tinting of paint on the Site by the Contractor will only be allowed with the written permission of the manufacturer and the Engineer.

**PDB 09.3      INSPECTION AND PRELIMINARY WORK**

Before commencing paintwork, the Contractor shall carefully inspect the surfaces to be painted to satisfy himself that the surfaces are in a satisfactory or acceptable condition to receive the paint system specified.

All metal fittings and fastenings shall be removed where applicable before the preparatory processes are commenced. On completion, the metal fittings and fastenings shall be cleaned and refitted in position.

**PDB 09.4      WORKMANSHIP AND FINISHES**

Paint may be applied by spray, brush or roller depending on the materials used, the surface to be painted, and the manufacturer's instructions.

Every coat of paint, irrespective of the method of application, shall be adequately and permanently keyed or bonded to the base material or previously applied coat, and shall be evenly distributed, continuous, free from sags, runs, brush marks, pin holes or other imperfections, and shall dry to a smooth finish.

An approved water trap and air-regulating valve shall be furnished and installed on all equipment used in spray painting.

Before painting the interiors of buildings, they shall be cleaned and the floors shall be washed and kept free from dust during the progress of the interior work.

The Contractor shall protect all nearby surfaces against disfigurement by spatters, splashes and smirches of paint or paint materials. The Contractor shall be responsible for any damage by paint or dirt caused by his operations to vehicles or property or injury to persons and he will be required to provide protective measures to prevent any such damage or injury and make good, where required, at his own expense.

If passing traffic creates dust which may harm or spoil the appearance of external painted surfaces, the Contractor shall sprinkle the adjacent areas with water, at his own cost, for a sufficient distance on each side of the location where painting is being done.

Undercoats shall be tinted by the manufacturer to distinguish between successive coats.

The final coats or finishing coats of paint shall be applied after all the other work in the vicinity has been completed.

The painter shall keep some of the final paint in reserve in the event of his having to make good any patching which may be required as a result of damage or unforeseen circumstances.

Upon completion, the Contractor shall, in the case of buildings, clean all glass, remove all paint spots from walls, floors and fittings, and leave the premises clean and fit for occupation.

All inflammable materials, comprising solvents, thinners, wiping cloths, etc, shall be placed in tightly closed containers and properly disposed of.

**PDB 09.5      PAINTING OF PLASTER, CONCRETE OR BRICK SURFACES**

**PDB 09.5.1      Surface Preparation**

Surfaces for painting shall be prepared by sandpapering, scraping or wire-brushing to remove loose material, dust, laitance, scum or other deleterious materials or high spots. Defective areas shall be cut out where necessary and made good with an approved non-shrink filler. Cracks shall be cut out, suitably keyed, and given a coat of an approved bonding agent before the filler is applied. All patches shall be rubbed down to an even surface. Surfaces shall be washed and allowed to dry.

Surfaces shall be treated with neutralising liquid for walls, and if the surface is coarse or textured, either one full coat of pigmented wall sealer or one full filler coat shall be applied in addition to the neutralising liquid.

**PDB 09.5.2     Paint Application**

Prior to the emulsion paint being applied, the surface shall be sealed with an approved clear sealer and primed with an undercoat diluted to 50%. Emulsion paint (PVA or acrylic) shall then be applied in two finishing coats.

Egg-shell finish (alkyd oil-based), oil gloss paint or enamel gloss paint shall be applied as follows: one coat of universal undercoat shall be applied, and it shall be followed by one coat of a mixture comprising 50% of the undercoat and 50% of the paint to be used for the finishing coat. A finishing coat of semi-gloss eggshell, or oil gloss paint or enamel gloss paint shall then be applied.

**PDB 09.6     PAINTING OF WOODWORK**

**PDB 09.6.1     Surface Preparation**

The surfaces shall be cleaned, sandpapered and rubbed down to a smooth, even face before painting. The moisture content of the timber shall not be more than 20% at the time when the first coat is applied. All cracks, shakes or scars shall be filled flush with a filler approved by the Engineer before painting. The surface shall then be washed with cleaner and allowed to dry.

**PDB 09.6.2     Primer Application**

One coat of an approved wood primer shall be applied.

After timber has been prepared and primed, stopping and filling shall be done in accordance with SANS 10305-2, followed by sanding the stopped and filled areas with a fine-grit sandpaper to smooth the surface. Careful attention shall be paid to stopping and sealing rough, open-textured or coarse-grained surfaces, and sealing joints, that may lead to water ingress, with a flexible sealer. Stopper/filler/sealer manufacturer's instructions should be strictly followed.

All new woodwork shall be properly primed on all surfaces and edges before being fixed in position. All woodwork not previously painted shall be given a prime coat, well brushed in.

**PDB 09.6.3     Paint Application**

One coat of universal undercoat shall be applied followed by one coat of a mixture of 50% of the undercoat and 50% of the paint to be used for the finishing coat. A finishing coat of oil gloss paint or enamel gloss paint or semi-gloss eggshell (alkyd oil-based) paint shall then be applied.

**PDB 09.6.4     Varnish Finish**

Two coats of gloss varnish or egg-shell varnish shall be prepared, stopped and applied.

**PDB 09.7     PAINTING OF METAL SURFACES**

**PDB 09.7.1     General**

Wherever possible, all painting shall be done at the manufacturer's works, but where this is not feasible, the Engineer may permit the application of the undercoat and finishing coats to be carried out on the Site, in which case a prime coat shall be applied at the manufacturer's works prior to the members being despatched to the Works.

**PDB 09.7.2     Surface Preparation**

The preparation of metal surfaces shall comply with SABS Code of Practice 064 and shall receive the greatest care to ensure rust-free conditions prior to the paint system being applied.

All surfaces shall be prepared by removing loose paint, rust, plaster, scale, dust, dirt, grease, etc and by repairing or patching defective paint surfaces before painting or repainting. Damaged shop-primed surfaces shall be thoroughly cleaned of rust and patched with a prime coat.

### **PDB 09.7.3     Paint Application**

#### **j)     Iron and steel work**

All iron and steel work shall be properly primed with a red-lead-based primer where steel work is likely to be exposed to the elements for longer than 30 days. Zinc-chromate primer may be used where overpainting will be completed within 30 days of priming. Metal-etch wash primers may be used under dry conditions where overpainting will be completed within 24 hours of priming. The dry-film thickness of the prime coat shall not be less than 0,300 mm.

After priming, one coat of universal undercoat shall be applied. If necessary, the undercoat shall be tinted to a shade just lighter than the desired finish with approved liquid stainers. The dry-film thickness shall not be less than 0,250 mm.

The two finishing coats shall either be of alkyd resin-based synthetic enamel, gloss or matt oil paint, or as specified elsewhere. The dry-film thickness shall not be less than 0,250 mm per coat.

When mating surfaces are brought together, both surfaces shall have been given the full treatment specified, but where this cannot be done, each surface shall be given a copious coating of primer and the surfaces drawn together while the paint is still wet.

The portion of structural steel members to be buried in soil, and all bases to a height of 500 mm shall be given two coats of an epoxy-tar primer instead of the zinc-chromate primer specified for other surfaces.

The surfaces of steel and cast-iron articles, such as floor gratings, grids and manhole cover, shall, after a thorough brushing to remove loose rust, be painted with two coats of epoxy-tar paint, each at least 0,230 mm thick.

#### **k)     Galvanized iron and steel**

All traces of protective coating shall be removed with galvanized iron cleaner, and two coats of calcium plumbate primer shall be applied. One coat of tinted universal undercoat and two finishing coats of alkyd resin-based synthetic enamel gloss paint shall be applied.

#### **l)     Non-ferrous metals**

Surfaces of aluminium, copper, etc shall be prepared and cleaned, and one coat of self-etch zinc-chromate wash primer shall be applied. One coat of universal tinted undercoat and two finishing coats of enamel gloss paint shall then be applied. Where non-ferrous metals are not to be painted, the surfaces shall be cleaned, polished and two coats of lacquer applied.

### **PDB 09.8     PAINTING OF FLOOR SCREEDS**

Where chemicals could cause damage to floors or where specified, such floors shall, unless otherwise indicated, be painted with an approved epoxy paint. The type of paint to be used will be shown on the Drawings and will depend on the types of chemicals that are used.

The preparation of such floor screeds for painting and the subsequent application of paints shall be carried out strictly in accordance with the manufacturer's instructions.

### **PDB 09.9     PAINT THICKNESS**

Unless otherwise specified, all coats of paint, whether prime coat, undercoat or finishing coat, shall have a dry-film thickness of not less than 0,200 mm, irrespective of the method of application.

### **PDB 09.10     INSPECTION**



The Contractor shall provide the necessary equipment to establish whether the primers, undercoats and finishing coats have been applied to the correct thickness according to the correct applications. The Engineer may take samples of the paints during painting operations for testing and quality control.

## **PDB 10      MEASUREMENT AND PAYMENT**

### **PDB 10.1      BRICKWORK**

- 1) Indication of thickness, type, class, and if plastering and painting is required).....Unit: m<sup>2</sup>
- 2) Etc for other thicknesses, types, classes and plastering, painting requirements.

The unit of measurement shall generally be the square metre of each type of brickwork built, calculated from the leading dimensions of the brickwork. Deductions will be made for doors, windows and other openings of similar dimensions. At corners and intersections common to more than one brick wall, the areas shall be measured only once.

The tendered rates shall include full compensation for the construction of the brickwork complete as specified, including pointing, lintels, weepholes, waterproofing to cavity walls (i.e. sloping infill adjacent weepholes with damp-proof course or torch-on etc.), expansion/control joints, masonry-to-concrete joints, wall ties, brick force reinforcement, the raking-out of joints, etc., and, when scheduled, shall also include plasterwork, facings, paintwork, concrete infill, etc. The rates shall further include the building-in of pipework, conduits, sleeves, doors, windows, etc. The reference panel shall not be measured or paid for separately but shall be deemed to be included in the brickwork rates.

### **PDB 10.2      PLASTERWORK**

- 1) Thickness                      of                      plaster                      and                      finish                      indicated)  
.....Unit: m<sup>2</sup>
- 2) Etc for other thicknesses and finishes

The unit of measurement shall be the square metre of each type of coat completed as specified.

The tendered rates shall include full compensation for the construction of the plasterwork, including supplying all materials, mixing, applying, finishing, forming reveals, joints, narrow widths, rounded angles, V-joints, etc complete as specified.

Where brickwork is scheduled to include plasterwork (i.e., plasterwork is to be included in the brickwork rate, see 10.1), then plasterwork will not also be measured here.

Note: Where brickwork is scheduled to include plasterwork (i.e., plasterwork is to be included in the brickwork rate (see 10.1), then plasterwork will not also be measured here. Other rates may similarly also include plasterwork, in which case plasterwork will not also be measured here.

### **PDB 10.3      ROOF FINISHES**

- 1) Roof                      screed                      (fall                      and                      avg.                      thickness                      if                      applicable)  
.....Unit: m<sup>2</sup>
- 2) Crushed                      stone                      to                      roof                      slab                      (avg.                      thickness                      if                      applicable).  
.....Unit: m<sup>2</sup>
- 3) Torch-on                      Waterproofing                      (description                      as                      applicable).  
.....Unit: m<sup>2</sup>



## 4) Etc

.....  
 .....Unit: m<sup>2</sup>

The unit of measurement shall be the square metre of roof finish applied, as specified, on areas shown on the Drawings or as designated by the Engineer.

Different roof finishes shall be scheduled separately. The tendered rates shall include full compensation for constructing and completing the roof finish, including supplying all materials, mixing, laying, placing finishing, curing and forming joints and edges, etc.

Floor screeds and finishes shall not be measured here but under the relevant Subclause of SANS 1200 G.

**PBD 10.4****DOORS, WINDOWS, LOUVRES, ETC.**

- 1) Type and size indicated)  
 .....Unit  
 : number

## 2) Etc for other types and sizes

The unit of measurement shall be the number of doors, windows and louvres installed complete as specified.

The tendered rates shall include full compensation for manufacturing and installing the door, window and louvre, complete, whether of wood, steel, aluminium or other materials. The rate shall include the frames, hinges, handles, locks, keys, barrel bolts, door closers, retaining devices, door stops, stays and any other work or ironmongery necessary to complete the work as specified or as shown on the Drawings. The tendered rate for doors, windows, louvres, etc. shall further include full compensation for any coatings/finish required (oiling, staining, varnishing, painting, calking, sealing, etc.), corrosion protection, glazing, windowsills (unless scheduled separately), thresholds as specified and all necessary subframes.

**PDB 10.5****CEILINGS AND BULKHEADS**

## 1) Plaster-board ceiling (type and thickness indicated):

- a) Fixed ceiling  
 .....  
 .....Unit: m<sup>2</sup>

- b) Suspended ceiling  
 .....  
 .....Unit: m<sup>2</sup>

## 2) Fibre-cement ceiling (thickness indicated):

- a) Fixed ceiling  
 .....  
 .....Unit: m<sup>2</sup>

- b) Suspended ceiling  
 .....  
 .....Unit: m<sup>2</sup>

## 3) Etc for other types of ceilings

- 4) Bulkheads (description of material and indication of vertical or horizontal  
 .....Unit: m<sup>2</sup>

- 5) Cornices  
(description).....  
.....Unit: m

The unit of measurement shall be the square metre of fixed or suspended ceiling or bulkheads installed complete as scheduled. The unit of measurement for cornices shall be linear metre.

The tendered rates shall include full compensation for the construction of the ceilings, bulkheads and cornices as scheduled. The rate shall also include for, as applicable and not limited to, the exposed tees, grids, frameworks, hangers, trap doors, taping and filling joints, skimming, painting, insulation blanket and brandering as specified, as well as the suspension system where applicable.

**PDB 10.6      CARPENTRY AND JOINERY**

- 1) Cupboards and countertops (details indicated)
- 2) Skirtings (details indicated)
- 3) Timber flooring, complete with supports (details indicated)
- 4) Shower/toilet cubicles (details indicated)
- 5) Timber roof structure (details indicated)
- 6) Etc for other items

The unit of measurement shall be as scheduled.

The tendered rates shall include full compensation for supplying all materials, and manufacturing, cutting, wasting, applying the required finish (i.e., painting, varnishing, etc.), fixing, building-in and installing the items, and shall include all required fasteners, clips, tie-downs and straps, etc. Tendered rates shall also include for all ancillaries and accessories specified, such as specified ironmongery, granite tabletops, glass viewing panels in cupboard doors, etc.

Timber flooring shall be measured as the total area covered by the timber flooring panels (excluding areas covered by the MCC or VFCs). The rate for timber flooring shall further include the cost of supplying the specified or scheduled steel top hat sections (unfixed), angle support frames (including added flat bars where required) and neoprene strips as indicated on the drawings and the cost of all fixings, installing, fixing, grouting/casting in, etc. The rate shall further include for the production of

hop drawings/details for the steel items (where required), all procurement costs, fabrication, cutting, welding, corrosion protection (such as galvanizing and painting) as specified, transportation and erection, all plant, labour and materials (including fasteners) necessary for proper completion of the flooring, support frames, top hat sections, etc.

**PDB 10.7      MISCELLANEOUS WORK**

- 1) Plumbing
- 2) Etc

The unit of measurement shall be as scheduled.

The tendered sums or rates shall cover all costs required to complete the work and activities as scheduled and specified and are to include for items and activities ancillary to the work. This shall, for example, include full compensation for the supply of all materials (including anchor fasteners and corrosion protection), manufacturing/providing, delivery to site, storage, all equipment and plant, labour, preparation, application, installation, applying finishes, testing, all temporary work and safety pr

cautions, replacement of defective work, protection of completed work and clean-up after completion.

Note: Where brickwork is scheduled to include paintwork (i.e., paintwork is to be included in the brickwork rate (see 10.1), then paintwork will not also be measured here. Other rates such as ceilings and bulkheads may similarly also include paintwork, in which case paintwork will not also be measured here.

**PDB 10.8****MISCELLANEOUS ITEMS**

(a) Items measured by number:

- i. (Description ..... of  
Item).....  
.....Unit: number
- ii. Etc.

(b) Items measured by length:

- iii. (Description ..... of  
Item).....  
.....Unit: metre (m)
- iv. Etc.

(c) Items measured by area:

- i. (Description ..... of  
Item).....Unit:  
square metre (m<sup>2</sup>)
- ii. Etc.

(d) Items measured by volume:

- i. (Description ..... of  
Item).....Unit:  
cubic metre (m<sup>3</sup>)
- ii. Etc.

The unit of measurement shall be the number, linear metre, square metre and cubic metre as applicable to each item.

The tendered rates shall include full compensation for all labour, plant, equipment, transport, etc, manufacturing or providing and installing each item complete as scheduled and shown on the drawings and shall include all corrosion protection (paintwork) where applicable.

**END OF SECTION**

**PF : FENCING****PF 01        SCOPE**

This Particular Specification covers the erection of new fencing.

**PF 02        TYPE OF FENCE**

The fence shall be a security fence with a vandal resistant wire panel and post system with advanced anti-corrosion properties and shall be erected in accordance with the specification and instructions of the manufacturer in order to maintain and achieve a 10 year guarantee against corrosion.

**PF 03        MATERIALS****PF 03.1      POSTS, STAYS AND STANDARDS**

Posts, stays and standards shall be of the type and size indicated on the Drawings. Posts shall include gate posts, straining posts and corner posts.

Metal posts, stays and standards shall comply with the requirements of CKS 82 and SANS 280. "Acceptable" in CKS 82 means "acceptable to the Engineer".

Tubular posts, standards and stays shall be galvanized in accordance with SANS 121:2011 / ISO 1461:2009 Table 1 for type B articles. All rail and Y-sections shall be provided with a protective coating of tar or other approved material.

Corner, gate and straining posts shall be suitably pre-drilled for stay bolts or gate fittings as indicated on the Drawings.

**Angle Iron Posts:**

100 x 75 x 8mm Hot dipped Galvanised in accordance with ISO-1461, pre-drilled with holes for fixing panels, including (70x6mm) cover plate section with pre-drilled holes for fixing panels to posts. Panels should be fixed to posts with stainless steel (M8x40mm) countersunk flushlock bolts and shear nuts.

- a) Intermediate posts (100x75x8mm) and coverplates for horizontal fencing, including 75 mm thick 19mm stone drainage layer below footing.
- b) Corner posts (80x80.6x6mm) and coverplates for horizontal fencing, including 75 mm thick 19mm stone drainage layer below footing.
- c) Top Rails (40x40x5 angle iron), hot dipped galvanized in accordance with ISO- 1461 to minimum coating thickness of 55 µm, pre-drilled with holes for fixing panels and fitted with 32x2mm serrated comb.
- d) Bottom Rails (40x40x5mm angle iron), hot dipped galvanized in accordance with ISO- 1461 to minimum coating thickness of 55 µm, pre-drilled with holes for fixing panels

**PF 03.2      BOLTS FOR STAYS**

Bolts shall be stainless steel. The length and diameter of the bolts shall be as shown on the Drawings. All the necessary bolts, together with nuts and washers, shall be supplied with each post.

**PF 03.3      WIRE**

All wire shall conform to the requirements of SANS 675 and shall be class B galvanized, except where otherwise specified below.

(a) Barbed-tape concertinas:

Barbed-tape concertinas shall comply with the requirements for type A in CKS Specification 592 and shall consist of close-coiled high-tensile wire with a continuous strip of flat steel barbs (barbed tape) crimped to the wire along the entire length of the wire. The coils shall further be attached to each other by clips to give a concertina configuration when pulled apart. The coils shall be of the diameter as shown on the Drawings. Each concertina shall have a minimum of 55 coils, and the maximum effective length of open concertina, when pulled apart, shall depend on the diameter of the roll, but shall be at least 12 m.

The high-tensile wire shall be class B galvanized and the barbed tape shall be made of cold-rolled carbon steel galvanized to class Z450. The concertina clips shall be manufactured from steel strip galvanized to class Z450.

(b) Barbed Wire:

Barbed wire shall comply with the requirements for type A in CKS Specification 592 and shall consist of double strand twisted type. The wire shall be IOWA, CAMPEON or similar approved. Wires shall be galvanized mild steel. Strand wires shall have a minimum diameter of 2.5mm and wire of barbs shall have a minimum diameter of 2.0mm and have four points. Spacing between barbs shall not exceed 150mm. Wire shall have a breaking strain of no less than 3.5 kN.

**PF 03.4      WIRE PANELS**

Wire Diameter: 4mm  
 Apertures: 76.2mm x 12.7mm (centre to centre) Standard widths: 3050mm  
 Height: 2385mm  
 Coating: Galvanised 30g/m<sup>2</sup> with Zincalu coating – Zincalu coating = 95% Zinc and 5% Aluminium according to SANS 10244-2: 2011  
 Tensile Strength of wire: 650 – 750 N/mm<sup>2</sup> Solidity: 35%  
 Weld Strength: 60 – 80%  
 Weight: 10.61 kg/m<sup>2</sup>  
 Guarantee: 10 year guarantee against corrosion

**PF 03.5      GATES**

Gates shall comply with the requirements of CKS 146 and shall be manufactured to the dimensions shown on the Drawings.

Gates shall be complete in every respect, and shall include hinges, washers, bolts and the locking mechanism shown on the Drawings.

**PF 03.6      CONCRETE**

Concrete used for fencing shall comply with the requirements of SABS 1200 G.

**PF 04      CLEARING FENCE LINE**

Strip clearing for the fence shall be carried out in accordance with SABS 1200 C and will be measured and paid for under Section 1200 C of the Schedule of Quantities.

**PF 05      INSTALLING POSTS AND STANDARDS**

Posts shall be accurately set in holes and, where indicated, shall be provided with concrete bases to the dimensions shown on the Drawings.

Holes shall be dug to the full specified depth. Where, due to the presence of rock, the holes cannot be excavated by hand or by pneumatic tools and the Contractor has to resort to the use of blasting, he will be paid separately for the drilling and blasting operations required.

Standards shall be firmly planted in the ground at the spacing shown on the Drawings or as directed by the Engineer. The spacing of standards between any two straining posts shall be uniform. In rock or hard material standards shall either be driven or set in holes drilled into the rock. The size of drilled holes shall be such that a tight fit is obtained. Care shall be taken not to buckle or damage the standards when driven. Where indicated, standards shall be provided with concrete bases to the dimensions shown on the Drawings.

All posts and standards shall be accurately aligned and set plumb. After posts and standards have been firmly set in accordance with the foregoing requirements, the fencing wire shall be attached thereto as described below.

Installation to be done all according to the manufacturer's instructions and specifications to achieve and maintain a 10 year guarantee against corrosion.

**PF 06      INSTALLING WIRE PANELS**

Installation to be done all according to the manufacturer's instructions and specifications to achieve and maintain a 10 year guarantee against corrosion.

**PF 07      INSTALLING BARBED-TAPE CONCERTINAS**

Barbed-tape concertinas shall be positioned on the fence as shown on the Drawings. The concertinas shall be fastened to the appropriate fencing wires at each standard as well as at 1,0 m maximum intervals between standards.

Rolls of barbed-tape concertinas shall be joined with galvanized binding wire at four points, spaced at equidistant intervals around the circumference of the loop. Joints shall be made to coincide with the positions of standards.

**PF 8      INSTALLING GATES**

Swing gates shall be installed at the positions indicated on the Drawings or pointed out on Site. The gates shall be hung on gate fittings in accordance with the details shown on the Drawings. Gates shall be so erected that they swing in a horizontal plane at right angles to the gate posts and clear of the ground in all positions. Double swing gates shall close to have a gap of not more than 25 mm between them, and other gates shall close to be not further than 25 mm from the gate post.

Sliding Gates shall be installed at the positions indicated on the Drawings or pointed out on Site. The gates shall be installed in accordance with the details shown on the Drawings. Gates shall be so erected that they slide to the left or as indicated on the drawings.

**PF 9      GENERAL REQUIREMENTS AND TOLERANCES**

The completed fences shall be plumb, taut, true to line and to the ground contour, and with all posts, standards and stays firmly set.

The height of the lower fencing wire above the ground at posts and standards shall not vary by more than 25 mm from that shown on the Drawings. Other fencing wires shall not vary by more than 10 mm from their prescribed relative vertical positions.

Anchoring of a fence to structures shall be done as shown on the Drawings.

The Contractor shall, on completion of each section of fence, remove all cut-offs and other loose wire or mesh so as to leave the fence with a neat and finished appearance without compromising the corrosion resistance.

**PF 10                    MEASUREMENT AND PAYMENT**

**PF 10.1                Angle iron fencing posts**

a) **Intermediate posts and cover plates for horizontal fencing** ..... Unit: No.

Supply and installation of intermediate fencing posts complete with hot dipped galvanised coating in accordance with ISO-1461, pre-drilled with holes for fixing panels, including cover plate section of specified size with pre-drilled holes for fixing panels to posts, and stainless steel countersunk flush lock bolts and shear nuts for fixing panels to posts. Unit price also includes stone drainage layer below footing of specified dimensions and material as per the drawings and particular specification PF.

b) **Corner posts and cover plates for horizontal fencing** ..... Unit: No.

Supply and installation of corner fencing posts complete with hot dipped galvanised coating in accordance with ISO-1461, pre-drilled with holes for fixing panels, including cover plate section of specified size with pre-drilled holes for fixing panels to posts, and stainless steel countersunk flush lock bolts and shear nuts for fixing panels to posts. Unit price also includes stone drainage layer below footing of specified dimensions and material as per the drawings and particular specification PF.

**PF 10.2                Mesh fencing panels** ..... Unit: No.

Supply and installation of double vertical wire mesh panel fencing with zinc aluminium coating (specify dimensions) as per the drawings and particular specification PF.

**PF 10.3                Horizontal rails to panels**

a) **Top rail** ..... Unit: No.

Supply and installation of top horizontal rails to fencing panels complete with hot dipped galvanised coating in accordance with ISO-1461 and pre-drilled with holes for fixing panels (specify dimensions and details) as per the drawings and particular specification PF.

a) **Bottom rail** ..... Unit: No.

Supply and installation of bottom horizontal rails to fencing panels complete with hot dipped galvanised coating in accordance with ISO-1461 and pre-drilled with holes for fixing panels (specify dimensions and details) as per the drawings and particular specification PF.

**PF 10.4                Flat wrap razor wire to top section** ..... Unit: No.

Supply and installation of flat wrap razor wire which shall tie onto top extension and barbed wire strands with stainless steel grade 304 strands of minimum 1.6 mm as per the drawings and particular specification PF.

**PF 10.4                Barbed wire to top section** ..... Unit: No.

Supply and installation of double strand barbed wire which shall tie onto top extension with stainless steel grade 304 strands of minimum 1.6 mm as per the drawings and particular specification PF.

**PF 10.6                Swing gates** ..... Unit: No.

Supply and installation of swing gates (specify opening width) including posts, cover plates, straining posts, hinges, locking device complete, barrel bolt, top extension, serrated comb, flat wrap razor wire and barbed wire all complete as shown on the drawings and as specified in the particular specification PF (Excavation and concrete for footings, measured elsewhere).

**PF 10.7      Sliding gate ..... Unit: No.**

Supply and installation of sliding gates (specify opening width) including posts, cover plates, straining posts, hinges, locking device complete, barrel bolt, top extension, serrated comb, flat wrap razor wire and barbed wire all complete as shown on the drawings and as specified in the particular specification PF (Excavation and concrete for footings, measured elsewhere).



**PP : GLASS-REINFORCED PLASTIC (GRP) PIPES, FITTINGS AND JOINTS****PP 01        GENERAL****PP 01.1      SCOPE**

This Particular Specification covers the design, manufacture, testing and construction of underground pressure pipes, fittings and joints machine made of thermosetting polyester resin reinforced with filament-wound glass fibre rovings and sand for the conveyance of potable and aggressive raw water at ambient temperatures. It is applicable to pipes and associated fittings having nominal diameters from DW 200 to DW 2 000 for use at pressures of up to WP 2,5 MPa.

**NOTE:**

- (a) All manufacturers of GRP pipes, fittings and joints must be quality listed by the South African Bureau of Standards to comply with SABS ISO 9002.
- (b) The GRP pressure pipelines should not be constructed above the ground due to their uncertain resistance to ultra-violet degradation, unless they are suitably protected against exposure to direct sunlight.
- (c) Proper bedding and backfill procedures are essential to the performance of the pipe and must be thoroughly understood and carefully observed during installation.

**PP 01.2      REFERENCES**

The following documents form a part of this Specification to the extent specified herein. In any case of conflict, the requirements of this Specification shall prevail. The latest issues shall apply.

SABS 4633	Rubber seals – Joint rings for water supply, drainage and sewerage pipeline – Specification for materials
SANS 1200	Standardized Specification for civil engineering construction - Section DB: Earthworks (pipe trenches) Section L: Medium-pressure pipelines Section LB: Bedding (pipes)
SANS 10102-1	The selection of pipes for buried pipelines Part 1: General provisions Part IV: Flexible pipes (refer to Engineer if not published yet)
BS 2782	(ISO 75) Methods of testing plastics; Part 1: Method 121A
BS 2815	Compressed asbestos fibre jointing
BS 3532	Unsaturated polyester resin systems
BS 4504	Circular flanges for pipes, valves and fittings Section 3.1 Specification for steel flanges
BS 5480	Glass-reinforced plastic (GRP) pipes, joints and fittings for use for water supply or sewerage
BS 6920	Suitability of non-metallic products for use in contact with water intended for human consumption with regard to their effect on the quality of water Part 1 : Specification
BS 8010	Pipelines Part 1: Pipelines on land: General

## Part 2: Section 2.5: Glass-reinforced thermosetting plastics

ANSI/AWWA	C950 Fibreglass pressure pipe
SABS ISO 9002	Quality systems: Model for quality assurance in production and installation
ASTM D2996	Filament-wound reinforced thermosetting resin pipe

**PP 01.3      COMPONENTS**

The following materials are used for the manufacture of GRP pipes:

- (a) Polyester thermosetting resin, isophthalic type; Orthophthalic resins shall not be used for Works with a technical life exceeding 10 years.
- (b) Continuous glass fibre roving reinforcement
- (c) Silica sand (aggregate) or other similar inert fillers
- (d) Resin additives, such as pigments, dyes or other colouring agents if used, shall in no way be detrimental to the performance of the product.

**PP 01.4      WALL COMPOSITION**

The wall of the GRP pipe is made of a monolithic structure produced with three (3) different layers:

- (a) Liner, an inner layer in contact with water which provides maximum resistance to chemicals and corrosion and ensures impermeability of the pipe wall
- (b) Intermediate (structural) layer that determines the strength and stiffness/rigidity of the pipes
- (c) Outer protective layer (gel-coat) of pure resin without glass reinforcement which protects glass fibres from environments and handling and it contains ultra-violet ray absorber

**PP 01.5      SAFETY**

Safety precautions to avoid risk to the health and safety of the public, and to prevent damage to the Works (pipework) and private property, must be observed at all times. All personnel shall be informed of the nature of the product being handled. The manufacturer shall provide the Engineer with a list of all important points needing attention during all stages of handling, installation, the Defects Liability Period and operation.

To give an example: Dust created by grinding and polishing of pipes and fittings may present a health hazard, therefore, operators should wear suitable eye protection, mask and gloves.

**PP 01.6      INSPECTION**

The integrity of a properly designed pipeline depends mainly on the standards applied and quality of inspection at all stages.

Particular emphasis is laid on the inspection for possible damage to pipes, fittings and joints before installation and for the correct bedding of the pipeline, jointing, anchoring, and testing. Any substandard materials or workmanship should be rejected.

Factory inspection of the Plant, manufacturing processes, supervision and adjudication of test records shall be carried out by an independent inspectorate appointed by the Employer to act on behalf of the Engineer. The manufacturer shall make available for the inspector's use, without additional charge, all necessary facilities required for inspection.

**PP 01.7      WORKMANSHIP**

The pipe shall be free from all defects including indentations, delaminations, bubbles, pinholes, foreign inclusions, and resin-starved areas which, due to their nature, and/or extent, detrimentally affect the strength and serviceability of the pipe. The pipe shall be as uniform as practicable in colour, opacity, density and other physical properties. The pipe shall be round and straight, and the bore of the pipe shall be smooth and uniform. All pipe ends shall be cut at right angles to the axis of the pipe, and any sharp edges removed.

**PP 02      MATERIALS****PP 02.1      GENERAL**

The materials used to make pipe products shall contain no ingredient in an amount that can migrate into water in quantities that are considered to be toxic. The materials shall comply with the requirements of BS 6920: Part 1.

**PP 02.2      RESINS**

The resin shall be a thermosetting polyester resin and shall comply with the requirements of BS 3532. The resin shall be such that when used according to a schedule representative of that to be used for the finished pipework and then tested in accordance with BS 2782: Method 121A, the temperature of deflection of the resin shall be not less than 20°C higher than the maximum service temperature at which the pipework component is to be used, if known, and otherwise not less than 50°C.

**PP 02.3      FIBROUS REINFORCEMENT**

In a continuous fibre-reinforced composite, the fibres (also referred to as filaments) provide virtually all of the load-carrying characteristics of the composite, the most important of which are strength and stiffness.

The fibrous reinforcement shall be manufactured from the glass compatible with polyester resin of the following commercial grade:

C-glass: A soda-lime borosilicate glass, chemical-resistant, used for the inner layer of the pipes and fittings in direct contact with the water

E-glass: A calcium alumino-borosilicate glass containing other oxides, incorporated for enhanced corrosion resistance, and having a useful balance of structural, chemical and electrical properties; It is used for the intermediate (structural layer).

**PP 02.4      AGGREGATE**

Inert granular material, size 0,05 - 4,75 mm, such as graded and washed silica sands, may be incorporated where they are a designed part of the composite structure to increase the stiffness of the pipe and thus its resistance to external loads and negative pressure, if it exists.

**PP 02.5      GASKETS****PP 02.5.1      Joint-ring gaskets**

Joint-ring gaskets shall be made from non-cellular synthetic rubber material and shall comply with the requirements of SABS 4633, class 70. The finished rings shall not contain any reclaimed rubber, vulcanized waste or any substance which will cause the rubber to impart a taste or smell to the water.

**PP 02.5.2      Flange gaskets**

Gaskets for flanged joints shall be full-faced and in one piece, with the inner diameter of the gasket 6 mm larger than the inner diameter of the flange and the outer diameter not exceeding the outer diameter of the flange. The gasket shall be of compressed asbestos fibre complying with BS 2815: Grade A. For pressures up to and including 1,6 MPa, cloth-inserted rubber may be used.

Note: Gaskets should be protected from unnecessary exposure to the effects of ultra-violet radiation, light and ozone.

**PP 03      DESIGN**

**PP 03.1      PIPE DESIGN**

**PP 03.1.1      General**

The design and testing of the pipes and fittings shall be in accordance with BS 5480 and BS 8010: Part 2, Section 2.5.

**PP 03.1.2      Design pressure**

The design pressure in the system due to working pressure plus surge pressure shall not exceed 1,5 times the pressure class of the pipe. Excessive surge pressure should be anticipated in the design phase and the causative condition should be eliminated or automatic surge pressure relief provided.

**PP 03.1.3      Dimensions**

**PP 03.1.3.1      Diameter of pipes**

- (a) Nominal size (DN) pipes shall be designated by a nominal size.
- (b) The work size (DW) shall be declared by the manufacturer and shall not differ from the value of the nominal size of the pipe by more than + 3,5 % or -3,5%.

The manufacturing tolerance on the work size shall comply with the permissible deviations as follows:

- (i) For pipes of nominal size up to and including 600:  $\pm 3,0$  mm
- (ii) For pipes over 600 nominal size:  $\pm 0,5\%$

**PP 03.1.3.2      Lengths**

The pipe effective length shall be preferred 6 m with a tolerance of  $\pm 25$  mm. Other effective lengths are permissible and may be supplied by agreement between the manufacturer and the Engineer. A maximum of 5% of the total length supplied in any one nominal size and class may be supplied in random lengths where the random length shall not be less than 1,5 m, except for special orders.

**PP 03.1.3.3      Wall thickness**

When measured to an accuracy of 0,1 mm, the wall thickness shall not be less than the figure declared and used by the manufacturer in the calculations for the design of the pipe.

**PP 03.1.4      End squareness**

All pipe ends shall be square to the axis. The tolerances on out-of-squareness shall be (2 mm + 0,005 DW) with a maximum of 10 mm, where DW is the work size of the pipe.

**PP 03.1.5      Straightness**

The deviation from straightness of the bore of the pipe shall not exceed 0,3% of the effective length of the pipe or 15 mm, whichever is the smaller.

**PP 03.1.6      Head losses**

The hydraulic head loss due to pipe friction is lower for GRP pipe than for other types of pipe due to smoother inner surface and freedom from tuberculation and erosion. Taking into account the losses at the joints, the Colebrook-White roughness coefficient  $k = 0,05 - 0,10$  mm.

**PP 03.1.7      Classification**

**PP 03.1.7.1      General**

The following classification relates to sustained service temperature up to 30 °C.

**PP 03.1.7.2      Pressure**

The pressure rating of the pipes shall be equal to or less than the maximum internal hydrostatic pressure, in bar, which the pipe is capable of withstanding for a design life of 50 years.

**PP 03.1.7.3      Stiffness**

The stiffness class range for enhanced resistance to distortion shall be:

1 250; 2 500; 5 000; 10 000; 15 000 and 20 000  $\text{Nm}^{-2}$

**PP 03.1.8      Fittings**

**PP 03.1.8.1      Fittings made from GRP**

GRP fittings are not subject to tests for strength and it is essential that external restraint shall be provided on installation. GRP fittings shall be equal or superior in performance to pipe of the same classification and shall be smoothly finished internally.

Fittings shall be one piece contact moulded or manufactured from the straight pipe suitably mitred.

**PP 03.1.8.2      Steel fittings**

In selecting the most economic fittings, steel fittings should be considered as an alternative to GRP.

Steel fittings shall meet the requirements of BS 534, be adequately protected against internal and external corrosion and shall comply with BS 5480.

**PP 03.1.9      Joints**

The following types of joint are acceptable to the Employer. Other types may receive consideration.

**PP 03.1.9.1      Flanged joints (rigid)**

Flanges shall be of steel, welding type plate and shall have flat joint faces, with dimensions in accordance with BS 4504: Section 3.1

**PP 03.1.9.2      Flexible joints**

The angular deflection limits relative to nominal size of the pipework shall be as follows:

DN 500 .....- 3°  
500 - 900.....- 2°

900 - 1 800.....- 1°  
over 1 800.....- 0,5°

The flexible joints are:

- (a) Spigot and socket joints with double rubber sealing O-rings, installed in the circumferential grooves, machined on the spigot end and with the nipple hole on the socket end between the O-rings for testing the seals by applying air pressure.
- (b) Slip-on bolted pipe coupling without centre register with rubber sealing rings, bolts and nuts. The pipe ends shall be machined to receive coupling.
- (c) Flange adaptors with flat joint face of flange, rubber sealing rings, bolts and nuts. The required thickness of the adaptor's flange shall be less than the thickness of the standard mating flange due to the reduction of end and side thrust which is absorbed by the flexibility of the rubber sealing rings. The flange adaptors do not provide the rigidity or anchorage of standard flange joints and should be anchored accordingly.

#### **PP 03.1.10     Marking**

Each pipe and fitting shall be marked with the following information in such a manner that it remains legible under normal handling and installation practices:

- (a) The manufacturer's name (or identity code)
- (b) The nominal size
- (c) The pressure rating
- (d) The stiffness rating in  $\text{Nm}^{-2}$
- (e) The date of manufacture
- (f) The angle of bend (in degrees) of fittings

### **PP 03.2     PIPELINE DESIGN**

#### **PP 03.2.1     General**

The necessary hydraulic, economic and structural assessments shall be made in accordance with recognised practice. The factors taken into account should include service, environmental considerations, pipeline protective devices to control the pressure and the flow, joints and external and internal corrosion resistance.

#### **PP 03.2.2     Access to pipeline**

Internal access shall be provided at intervals for inspection, maintenance and the removal of obstructions, giving consideration to the need to provide a safe working environment at all times.

#### **PP 03.2.3     Anchors and thrust blocks**

Anchors and thrust blocks are required at changes of pipe sizes, direction of the pipeline and isolating and scour valves, to withstand the forces developed by the internal pressure.

The safe bearing pressure of the surrounding soil should be determined from field tests and taken into account in the design of the structure.

Where fittings are manufactured in GRP, they should be completely encased in reinforced concrete.

Where GRP pipes enter manholes or pass through solid structures, anchor blocks or valve chambers, it is essential to provide flexibility to the pipeline at either side of the structure. This shall be effected by introducing two flexible joints to the pipeline on each side of the structure so that the first joint is no more than one pipe diameter or 600 mm, whichever is the greater, from the structure and the second is approximately 1,5 diameter from the first.

At the point of pipe entry into the structure, the circumference of the pipe shall be wrapped with a 10 to 20 mm thick (depending on the pipe diameter) and 200 mm wide band of a non-degradable compressible material (rubber) to help the pipe to absorb the stresses resulting from pipe deflection outside the structure. In addition, at this point it is necessary to increase the bed depth not less than one (1) pipe diameter for a length not less than two (2) pipe diameters and trench width to a minimum of three (3) pipe diameters for a length of three (3) to five (5) pipe diameters.

Where water tightness between pipe and structure is required, pipes should be supplied with puddle flanges laminated into the pipe. Puddle flanges should not be used to anchor the pipe against thrust unless specifically designed to do so. The external surface of the pipe shall be treated to improve its bond with the concrete by painting with a suitable resin and blending with sand to give a roughened surface prior to placing the concrete. The pipe manufacturer's advice should be sought when determining suitable resins.

## **PP 04            CONSTRUCTION**

### **PP 04.1        REQUIREMENTS PRIOR TO MANUFACTURE**

Following the ordering of pipes and prior to production, the Manufacturer shall supply the following information:

- Quality Assurance Plan and testing procedures
- Hydrostatic field testing plan (to be agreed with purchaser)
- Details for nesting and packaging of pipe together with methods for denesting and unpacking of pipes
- Instructions for the storage and handling of pipes and couplings
- Installation instructions

### **PP 04.2        TRANSPORT, HANDLING AND STORAGE**

Transport, handling and storage shall be as specified, where applicable, in SANS 1200 L: Medium-pressure pipelines.

Care must be exercised at all stages during the transportation, handling and laying of GRP pipe to minimise the possibility of overstraining, point loading or otherwise damaging the pipe wall, since this can have a deleterious effect on its long-term performance. GRP pipes shall always be lifted with fabric straps or hemp rope and not cables or chains. They should not be subjected to impact loads or rolled over rough or hard ground.

If straw is used for protecting pipes and fittings in transit, it should be collected and burnt in a safe area immediately after use to avoid any possible agricultural contamination.

Pipes shall be stored on cradles and away from inflammable liquids or other aggressive materials. Pipes can be stored in the open for a period of six (6) months without any detrimental effects being caused by ultra-violet exposure. However, the manufacturer shall be consulted regarding longer periods of storage in the open.

### **PP 04.3        TRENCHING, BEDDING AND BACKFILL**

The GRP pipes fall into the category of flexible pipes. As such, in the buried condition, they rely on the pipe-soil structure interaction for their load-bearing capacity. Therefore, it is important that the pipes are bedded and surrounded in a material which is capable of

transmitting lateral thrust from the pipe to the soil forming the trench wall and that this soil does not become over-stressed.

The minimum thickness of the bedding shall not be less than 150 mm, and the selected backfill material shall be to a height of 300 mm over the crown of the pipe. The minimum depth of cover to natural ground level over the crown of the pipe shall be 1 m. Where high water tables are encountered, precautions should be taken to prevent floatation when the pipeline is empty. Such precautions should not induce localised stress in the pipes. No concrete slabs shall be placed directly onto the pipe.

Where ground water conditions are such that there is a risk of the trench backfill being washed away, suitable impermeable stops (e.g. clay dams) shall be provided at appropriate intervals to prevent longitudinal drainage.

Where ground water is present, the geotextile fabric shall be laid in the excavated trench such that it fully encases the pipe bedding and pipe zone of granular material preferred of single-size compacted 20 mm aggregate. This is to prevent the fines migrating from the adjacent soil of the trench bottom and walls.

For guidance on design and construction, reference is made to the following Specifications as applicable:

SANS 1200 : Section DB: Earthworks (pipe trenches)  
Section L: Medium-pressure pipelines  
Section LB: Bedding (pipes)

BS 8010 : Part 2 Section 2.5: Pipelines; Glass-reinforced thermosetting plastics

#### **PP 04.4 PIPE INSPECTION, REPAIR AND CUTTING**

##### **PP 04.4.1 Inspection**

Prior to installation, each pipe, fitting and joint shall be visually inspected both externally and, where practicable, internally for all defects, including indentations, delaminations, bubbles, pinholes, blisters, foreign inclusions and resin-starved areas.

Damage showing the star cracking on the inner surface or any external damage which cannot be inspected (on assumption that the damage extends through the pipe wall), the pipe shall be rejected and replaced as directed by the Engineer. Areas of imperfection to the pipe inner surface shall not be accepted.

##### **PP 04.4.2 Repair**

Owing to the difficulties of controlling the quality, any repair under site conditions shall not be carried out without the Engineer's prior approval.

##### **PP 04.4.3 Cutting**

GRP pipes can be cut with a power-driven, abrasive-wheel cutting machine. Burrs and sharp edges shall be removed by filing or grinding and, where required, a chamfer shall be provided. The cut ends shall be resealed to prevent moisture absorption, using a repair resin recommended by the pipe manufacturer and approved by the Engineer. The repair resin must be suitable for contact with potable water (see clause 2.1).

#### **PP 04.5 CLEANING, TESTING AND STERILIZATION**

##### **PP 04.5.1 Cleaning**

Before a pipeline can be considered ready for service it shall be cleaned internally as thoroughly as possible to ensure that no foreign matter remains inside the pipe.



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**PP 04.5.2      Hydrostatic testing**

The complete pipeline shall be tested in accordance with SANS 1200 L: clause 7.3, where applicable. A test duration shall be 24 hours.

The GRP pressure pipeline shall be hydrostatically tested in lengths of about 1,0 m to 1,5 km, as approved by the Engineer. Sections of pipeline to be tested shall be carefully filled with water so as to ensure that all air is eliminated from the test length prior to the application of site test pressure. The site hydrostatic test pressure at any point along the test section shall not be less than 1,1 times nor greater than 1,4 times the design (working plus surge) pressure.

The leakage of the pipeline under test, taken as the total quantity of water added over a 24-hour period to reinstate required test pressure, shall not exceed 20 litres per metre nominal diameter per kilometre length per 24 hours per bar (10,2 m) of pressure head applied.

Where joints are left uncovered until after testing, each pipe shall be backfilled and compacted to prevent movement.

**PP 04.5.3      Sterilization**

Pipelines intended to convey potable water shall be sterilized.

The chlorinated water shall receive treatment to dilute the chlorine to an acceptable level before discharging to a waste.

The pipeline should not be brought into service until the water at each sampling point, having stood in the pipeline for 24 hours, has maintained a satisfactory potable standard.

**PP 05              MEASUREMENT AND PAYMENT**

The measurement and payment shall be in accordance with SANS 1200 L (as amended) where applicable.

**END OF SECTION**

**PQ : GENERAL CORROSION PROTECTION****PQ 01        SCOPE**

This Particular Specification covers corrosion protection in general and is additional to any corrosion protection that may be covered under any of the other sections of these Specifications. In the case of discrepancies between this section and other sections or between this section and the Drawings, this section shall have precedence.

**PQ 02        NATIONAL CODES OF PRACTICE, STANDARDS AND TEST METHODS****PQ 02.1      DOCUMENTS TO BE READ**

The documents listed below shall apply to this Contract and shall be read in conjunction with these Specifications:

**PQ 02.2      CODES OF PRACTICE**

SABS 044	-	Welding
SABS 0121	-	Cathodic protection of buried and submerged structures
SANS 1117	-	Plastics tape wrapping of steel pipelines
SANS 9000	-	Quality - Vocabulary
SANS 10064	-	The preparation of steel surfaces for coating
SANS 10102	-	The Selection of Pipes for Buried Pipelines / Part 2 - Rigid Pipes
SANS 10120	-	Codes of Practice for use with standardised specifications for civil engineering construction and Contract Documents
SANS 10140	-	Identification colour marking
SANS 14713	-	The design, fabrication and inspection of articles for hot-dip galvanizing
SABS ISO 9000	-	Quality systems

**PQ 02.3      STANDARD SPECIFICATIONS**

SABS 1158	-	Two-pack epoxy-resin-based primers
SANS 121	-	Hot dip galvanized coatings on fabricated iron and steel articles specifications and test methods
SANS 630	-	Decorative high gloss enamel paint for interior and exterior use
SANS 681	-	Undercoats for paints
SANS 719	-	Electric welded low carbon steel pipes for aqueous fluids (ordinary duties)
SANS 723	-	Wash primer (metal etch primer)
SANS 801	-	Epoxy-tar paints
SANS 999	-	Anodised coatings on aluminium (for architectural purposes)
SANS 1117	-	Plastics wrappings for the protection of steel pipelines
SANS 1150	-	Glass-reinforced polyester (GRP) laminated sheets (profiled or flat)
SANS 1178	-	The production of coated steel pipes using reinforced bituminous materials
SANS 1198	-	The manufacture of rubber sheeting for rubber lining
SANS 1217	-	Internal and external organic coating protection for buried steel pipelines
SANS 1274	-	Coatings applied by the powder-coating process
SANS 1319	-	Zinc phosphate primer for steel
SANS 1407	-	Anodised coatings on aluminium (for general applications)
SANS 2063	-	Thermally sprayed metal coatings
SANS 3575	-	Continuous hot-dip zinc-coated carbon steel sheet of commercial and drawing quantities
SANS 4998	-	Continuous hot-dip zinc-coated carbon steel sheet of structural quality

SANS 10244 - Hot-dip (galvanized) zinc coatings on steel wire

**PQ 02.4      STANDARD TEST METHODS**

SABS Method 140 -Dry film thickness of paints by means of a mechanical dial-indicator-type gauge  
 SABS Method 141 -Dry film thickness of paints by means of a magnetic flux or eddy current type gauges  
 SABS Method 159 -Adhesion of paint and varnish films (cross-cut test)  
 SABS Method 767 -Cleanliness of blast-cleaned steel surfaces for painting (assessed by pictorial standards)  
 SABS Method 769 -Cleanliness of blast-cleaned steel surface for painting (assessed by freedom from dust and debris)  
 SABS Method 772 -Profile of blast-cleaned steel surfaces for painting (determined by micrometer profile gauge)  
 SABS Method 776 -Adhesion of coatings (direct pull-off method)

**PQ 02.5      BRITISH STANDARDS**

BS 1449 - Steel Plate, Sheet and Strip  
 BS 4870 - Specification for approval testing of welding procedures Part 1 - Fusion welding of steel  
 BS 4994 - Specification for design and construction of vessels and tanks in reinforced plastics  
 BS 6496 - Powder organic coatings for application and stoving to aluminium alloy extrusions, sheet and preformed sections for external architectural purposes, and for the finish on aluminium alloy extrusions, sheet and preformed sections coated with powder organic coatings  
 BS 5480 - Specification for Glass Fibre Reinforced Plastic (GRP) pipes, joints and fittings for use for water supply or sewerage

**PQ 02.6      USA SPECIFICATIONS**

ASTM-D638 - Standard test method for tensile properties of plastics  
 ASTM-D2310 - Classification for machine made fibre glass (glass fibre reinforced thermosetting resin pipe)  
 ASTM-D2996 - Standard Specification for filament wound fibre glass (glass fibre reinforced thermosetting resin pipe)  
 ASTM-G8 - Standard test methods for cathodic disbonding of pipeline coatings  
 ASTM-G14 - Standard test methods for impact resistance of pipeline coatings (falling weight test)  
 ASME-IX - Coded Welders (takes precedence over SABS 044)

**PQ 02.7      INTERNATIONAL ORGANISATION FOR STANDARDISATION**

ISO 8501-1 - Preparation of steel substrates before application of paints and related products - Visual assessment of surface cleanliness : Part 1 : Rust grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings.

**PQ 03      GENERAL**

**PQ 03.1** The Contractor shall ensure that he has the latest edition available on the date of closure of the Tender of all the relevant Specifications and Codes of Practice, both SANS (SABS) and others, and the latest issues of manufacturer's data sheets for the materials to be used.

**PQ 03.2** All paints in a paint system shall be purchased from one paint manufacturer. Identical paints used at one time or on one item shall be of the same batch number.

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- PQ 03.3** The Contractor shall proceed with purchase of the paints only upon receipt of written approval from the Engineer.
- PQ 03.4** Where relevant, the materials and procedures shall comply with the appropriate standards referenced in Clause PQ 02.3 above.
- PQ 03.5** Strict attention shall be paid to fettling of surfaces by the Fabricator prior to coating. Surface preparation requirements, and the need for strict cleanliness and adherence to the specification requirements are emphasised.
- PQ 03.6** Areas which are or potentially may be inaccessible after assembly shall be prepared and fully coated with the specified system and to the specified requirements before assembly. The coating shall be fully hard dry before assembly.
- PQ 03.7** Mating surfaces shall be coated with primer or first coat only. The coating shall be uniform in thickness and shall not interfere with the mechanical tolerances. After assembly the outside surface of the joint shall be fully coated and sealed where necessary in accordance with the relevant specification.
- PQ 03.8** The painting Subcontractor shall provide evidence of his competence to apply the specified materials in the specified manner and to apply the necessary Quality Control procedures.
- PQ 03.9** The Contractor shall provide a Quality Plan to show the stages at which Quality Control will be carried out.
- PQ 03.10** The Contractor shall furnish material suppliers with the specified descriptions of materials to be used and shall receive from them a written assurance that the materials to be supplied do comply with the requirements specified in the Detail Specifications.
- PQ 03.11** The Contractor shall ensure that his Subcontractors receive copies of all the relevant sections of this Specification.
- PQ 03.12** When stainless steel nuts, bolts and washers are to be used on mild steel or cast iron equipment, suitable electrical insulation shall be fitted between stainless steel and mild steel or cast iron.
- PQ 04** **DESIGN**
- PQ 04.1** **GENERAL**
- All items shall be so designed to minimise corrosion in outdoor environments, under immersion conditions and in interior aggressive situations such as in chlorination rooms.
- PQ 04.2** **WATER RETENTION AREAS**
- Avoid water retention areas wherever possible. For example, angle or U section steel shall be used with the toes pointing downwards and the concrete base of columns shall be sloped away from the steel. Where water retention cannot be avoided, drain holes, suitably radiused, shall be fitted at the lowest point.
- PQ 04.3** **CREVICES**
- Accelerated corrosion results from crevices when water is present. Crevices may be avoided by using:
- (a) Continuous welding, not spaced welding
  - (b) Mastics or sealants to seal unavoidable crevices such as bolted connections
  - (c) Insertion rubber or suitable plastic between mating surfaces.

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**PQ 04.4      BIMETALLIC COUPLES**

Electrical contact between dissimilar metals gives rise to a corrosion cell when an electrolyte such as water is present. Joints between dissimilar metals shall be suitably insulated, or effectively sealed to prevent the ingress of water.

**PQ 04.5      ACCESSIBILITY**

Whenever possible, the surfaces of corrodible materials such as mild steel shall be accessible for maintenance. The use of angles, back to back, partially open box sections or inaccessible stiffeners shall be avoided.

**PQ 04.6      DIFFERENTIAL AERATION**

Posts buried in soil are subject to accelerated corrosion due to differential aeration. Additional protection shall be given to that part which is buried and up to at least 100 mm above ground. Similarly, tanks should not stand on the ground or on a concrete bed but shall be fitted with legs to ensure that there is no contact between the tank base and its bed. Where legs cannot be used, the tank shall stand on a concrete base, the edges of which shall be sloped away from the tank. The joint between tank and base shall be sealed with a suitable mastic or sealant.

**PQ 04.7      SHARP EDGES, WELD SPATTER AND WELD SLAG**

The designer shall specify that all sharp edges shall be ground to a radius not less than 2 mm and that all weld spatter and weld slag shall be removed by the fabricator.

**PQ 04.8      HOT DIP GALVANIZING**

The design of articles to be galvanized shall be referred to the galvanizer and shall comply with SANS 14713.

**PQ 04.9      CATHODIC PROTECTION**

Where cathodic protection is required, the components to be protected shall be of all-welded construction, or shall be fitted with bonding lugs to enable bonding cables to be cadwelded on Site.

**PQ 05      COATING MATERIALS**

**PQ 05.1** No variation in materials to be used shall be permitted without the approval of the Engineer in writing.

**PQ 05.2** All coating materials shall be delivered in the manufacturer's original sealed containers, clearly marked with the following:

- (a) Manufacturer's name
- (b) Product Brand Name and Reference Number
- (c) Batch Number which may incorporate the date of manufacture
- (d) Date of manufacture, unless already incorporated in the batch number
- (e) Abbreviated instructions for storage and use of the material, which shall include mixing ratios of components of multi-component materials, hard dry times, the minimum and maximum temperature of application, the method of application and overcoating times.
- (f) The SABS/SANS mark, where applicable.

**PQ 05.3** Coating materials shall be kept in a store approved by the Engineer, which shall be dry and enclosed and in which the temperature is unlikely to exceed 40°C or drop below -5°C.

**PQ 05.4** Usage of materials shall be on a first in, first out basis and no materials may be used which have exceeded the shelf life for that material that is recommended by the manufacturer.

**PQ 06** **FETTLING OR DRESSING BY THE FABRICATOR**

**PQ 06.1** Before any surface preparation or painting is carried out, dressing shall be carried out to remove projections, sharp edges, weld slag and spatter that will interfere with the corrosion protection.

**PQ 06.2** Remove all weld flux and weld spatter. Flux is best removed by washing with clean water whilst weld spatter is normally removed by grinding to a smooth finish.

**PQ 06.3** Sharp edges shall be ground to a radius not less than 2 mm.

**PQ 06.4** Welds shall be continuous and shall have a smooth contour. Rough welds shall be ground where necessary to achieve the required smooth profile. Undercuts shall not be permitted. Discontinuous welds shall not be permitted except by written approval of the Engineer.

**PQ 06.5** Articles for hot dip galvanizing shall not have any overlapping joints. Closed sections shall be suitably vented.

**PQ 07** **SURFACE PREPARATION FOR PAINTING**

**PQ 07.1** **MILD STEEL, MINIMUM 2 mm THICKNESS**

Oil and grease contamination, when present, shall be removed by degreasing before blast cleaning.

Mild steel shall be blast cleaned in accordance with Section 5.3 of SANS 10064. An additional requirement is that water soluble salts present in the steel after blast cleaning shall not exceed the values given in Table 07.1.1. Should these values be exceeded, the steel shall be cleaned by washing with clean potable water or by water shrouded or water injected blast cleaning until the soluble salts are within the limits specified in Table 07.1.1. The steel shall then be allowed to dry, after which it shall be flash blast cleaned to achieve the required degree of cleanliness.

The required standard of blast cleaning is given in Table 07.1.1.

**TABLE 07.1.1 STANDARDS FOR BLAST CLEANING**

Property	Above-water surfaces	Immersed surfaces	Tape wrapping	Inorganic zinc
Cleanliness to ISO 8501-1 (min)	Sa 2 ½	Sa 3	Sa 2	Sa 2 1/2
Residual dust and debris (SABS Method 769) (max)	0,5%	0,3%	0,5%	0,3%
Oil grease and perspiration	Nil	Nil	Nil	Nil
Surface profile min, micrometres max, micrometres	25 50	50 100	- -	50 100
Water soluble iron salts - maximum at any point	500 mg/m <sup>2</sup> 100 mg/m <sup>2</sup>	100 mg/m <sup>2</sup>	500 mg/m <sup>2</sup>	500 mg/m <sup>2</sup>

Average of any test area 250 cm <sup>2</sup>		10 mg/m <sup>2</sup>	100 mg/m <sup>2</sup>	100 mg/m <sup>2</sup>
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The time interval between blast cleaning and application of the first coat of paint shall not exceed that given in Table 07.1.2.

**TABLE 07.1.2 MAXIMUM TIME INTERVALS**

Ambient relative humidity (RH)	Maximum time (hours)
Below 50%	6
50 - 70%	4
70 - 85%	2
Over 85%	Coating not permitted - reblast and coat when RH below 85%

**PQ 07.2 MILD STEEL, LESS THAN 2 MM THICKNESS**

Mild steel less than 2 mm thickness may distort when blast cleaned. Such steel shall be cleaned by degreasing, pickling and phosphating in accordance with SABS 10064, Section 6, or by a proprietary process approved by the Engineer. The specified primer shall be applied immediately after completion of phosphating, rinsing and drying (see Table 07.1.2).

**PQ 07.3 CAST IRON AND CAST ALLOYS**

Cast surfaces shall be blast cleaned with iron slag, copper slag, or platinum slag abrasives designed for blast cleaning. The abrasive shall not be recycled or re-used. Cast iron shall be blast cleaned until all sand particles, residual burnt on sand and casting skin have been completely removed. When castings are required to be painted, especially for immersion applications, all blowholes and omegas shall be opened up and filled with a suitable solvent free epoxy filler or putty, finished level and smooth with, or proud of the surrounding surface. Proud putty, after curing, shall be abraded to be flush with the surrounding surface.

**PQ 07.4 GALVANIZED STEEL SURFACES**

Galvanized steel surfaces shall be thoroughly degreased prior to painting, using either a water rinsable solvent degreaser used in accordance with the manufacturer's instructions, or a mild acid-detergent degreasing solution. In both cases care shall be taken to avoid entrapment of cleaning agent in recesses, overlaps or other retention areas and in both cases the surfaces shall be thoroughly washed until a water break free surface is achieved. If necessary, the process shall be repeated until a water break free surface is obtained. A water break free surface is one on which a continuous film of water is obtained when potable water is brushed thereon. The film of water shall not break up into islands or globules.

After degreasing, the surface shall be lightly abraded by one of the following methods:

- (a) The use of abrasive paper not coarser than grade 120, or by using non-metallic abrasive pads.
- (b) By "sweep blast cleaning", using a nozzle having a pressure not greater than 300 kPa and a very fine abrasive. Cracking, flaking, or any form of delamination of the zinc coating due to excessive blast cleaning shall not be permitted. The thickness of zinc removed by blast cleaning shall not exceed 10 micrometres.

Finally, all dust and debris shall be removed by vacuum cleaning, or by dry brushing to attain a level of residual dust and debris not exceeding the values given in Table 07.1.1.



**PQ 07.5      STAINLESS AND CORROSION RESISTING STEEL**

Components fabricated from stainless or corrosion resisting steel shall be supplied in the fully passivated condition. Sheared edges, welds or surfaces subjected to any form of heat treatment or contamination with iron or mild steel, shall be pickled and passivated.

Surfaces shall be thoroughly degreased with a water rinsable solvent detergent, then rinsed with potable water to obtain a water break free surface.

When it is required to paint stainless steel exceeding 1,5 mm thickness, the surface shall be blast cleaned in accordance with the parameters given in Table 07.1.1, using non-metallic abrasives such as iron slag, copper slag or platinum slag. The use of steel shot, steel grit or cast iron grit is strictly prohibited. Any contamination with iron or mild steel is prohibited. Dust and debris shall be removed before painting to achieve residual values not greater than those given in Table 07.1.1.

Where blasting is impractical, the surface shall be cleaned with detergent solution and roughened manually by the use of non-metallic abrasive pads, followed by washing with clean potable water to a water break free surface. If a water break free surface is not obtained, detergent cleaning shall be repeated until the surface is water break free. Allow the surface to dry before coating.

**PQ 07.6      ALUMINIUM**

Generally, aluminium surfaces will be anodised or powder coated and will require no further treatment. Where painting is required, the aluminium surface shall be thoroughly degreased then rinsed with clean potable water. If the surface is not water break free, repeat the degreasing process until a water break free surface is obtained. Allow to dry completely, then apply a thin coat (8 to 13 micrometres dry film thickness) of wash primer which complies with SANS 723, mixed and applied in accordance with the manufacturer's instructions.

**NOTE:** Wash primer is an adhesion promoter and does not replace the primer specified in the paint system.

**PQ 07.7      PAINTED SURFACES****(a)      Fully painted surfaces to be repaired or overcoated**

Exposed metal shall be cleaned with abrasive paper not coarser than 220 mesh to a bright metal surface. The surrounding paint, which must be intact, shall be feathered for a distance of 20 mm beyond the damaged area. Dust and debris shall be removed by the use of a clean rag dampened with water or clean solvent that will not attack the coating. Damaged areas shall be allowed to dry, after which spot repairs shall be carried out with all the coats previously applied and shall overlap the undamaged area by 20 mm. The requirements of the spot repair shall be not less than that specified for the undamaged coating.

Where additional coats are required over the entire surface, the entire surface shall be abraded to a uniform matt finish, the dust and debris removed, and the surface allowed to dry. All further coats shall then be applied as specified to give a uniform finish.

**(b)      Shop applied primers to be overpainted**

Primers shall be thoroughly sanded with fine abrasive paper to achieve a uniform matt surface, then scrubbed with a solution of suitable water based detergent-degreaser using a bristle brush, followed by clean water rinses to remove all grease and water soluble matter. The surface shall be allowed to dry completely before application of the specified coating system over the whole surface.

**PQ 07.8      PLASTIC SURFACES SUCH AS uPVC AND POLYESTER GRP**

Treat as specified for painted surfaces with shop applied primers to be overpainted.



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**PQ 07.9      CONCRETE AND PLASTER SURFACES**

Concrete and plaster surfaces to be painted shall be clean, dry and free from laitance, dust or similar friable surface layers and from mould oil or similar contaminants that will interfere with the adhesion of the coating.

Loose surface dust is one of the main causes of poor adhesion to concrete.

Mould oil shall be removed by the use of a water based detergent such as Shell Teepol Lensex (or equivalent), followed by high pressure water washing. When all contaminants have been removed, the surface shall be allowed to dry either to a damp condition or to a completely dry condition, depending on the coating to be applied.

For immersion or other heavy duty applications laitance shall be totally removed by water blast cleaning, with abrasive injection, or by mechanical scabbling of the surface, or by acid pickling, followed by very thorough washing with potable water.

Off shutter concrete usually shows surface blowholes or omegas. Omegas shall be drilled or chipped open to the full hole diameter. Blowholes and opened omegas shall be filled with a suitable filler such as acrylic or solvent free epoxy. The use of gypsum or cellulose based fillers is not permitted for underwater or humid conditions. Shutter kicks and similar projections shall be removed by grinding to a smooth surface.

For coatings of low water permeability, such as solvent borne epoxies, vinyls and chlorinated rubber, the moisture content of the concrete or plaster shall be not more than an indicated 5% when tested with an approved electrical conductivity meter, designed for use on concrete or plaster (such as the Delmhorst meter). The pins of the meter shall penetrate the concrete or plaster to a depth not less than 5 mm.

The first coat of the coating system may require thinning with the manufacturer's recommended solvent to assist in penetration of the substrate.

**PQ 08      THE APPLICATION OF PAINTS****PQ 08.1      ENVIRONMENTAL CONDITIONS**

Paint shall not be applied in dusty conditions, nor when the steel surface temperature is less than 3°C above dew point, nor higher than that advised by the paint manufacturer, nor when humidity is greater than 85%, nor when the ambient temperature is less than the minimum or greater than the maximum specified by the manufacturer of the coating material.

**PQ 08.2      MIXING**

All coating materials shall be very thoroughly mixed until they are completely homogeneous. In the case of two-pack materials, each component containing pigments shall be thoroughly mixed. The two components shall then be mixed together in the proportions supplied by the manufacturer until the mixture is completely homogeneous. In the case of solvent based epoxy materials, it is recommended that the mixed material be allowed to stand for an induction period of 20 to 30 minutes before use.

For two pack materials, the use of part of the contents (split packs) is strictly forbidden.

**PQ 08.3      METHOD OF APPLICATION**

Application shall be by brush, roller, airless spray, or other suitable equipment as appropriate for the surfaces to be coated and in accordance with the recommendations of the manufacturer. Application equipment shall be maintained in clean condition and in good working order. The use of equipment not maintained in good clean condition may lead to rejection of the coating.

**PQ 08.4      OVERCOATING**

Overcoating times shall be not less than the minimum nor greater than the maximum specified by the manufacturer relevant to the ambient temperature. Strict adherence to overcoating times is particularly important for coatings which are subsequently immersed. The Contractor will be held responsible for blistering of paint coatings on immersed surfaces.

All coats shall be clean and free from dust, oil, moisture and perspiration before overcoating. Operatives handling blast cleaned or partially painted surfaces shall wear clean gloves to avoid contamination of the surfaces.

**PQ 08.5**      **PERMISSIBLE VARIATIONS OF FILM THICKNESS**

Minimum film thickness      :      Not more than 10% of readings shall be less than the minimum specified and no reading shall be less than 90% of the specified minimum.

Maximum film thickness      :      Unless otherwise agreed by the Engineer, no reading shall exceed the mean specified thickness by more than 50%.

**PQ 08.6**      **HANDLING**

Coated components shall not be handled earlier than the hard dry time recommended by the manufacturer, relevant to the ambient temperature. Coated components shall be handled with broad band slings and suitable packing to minimise damage to the coating. All damage caused in handling, transportation, and erection, shall be repaired to the satisfaction of the Engineer and at no extra cost.

**PQ 09**      **HOT DIP GALVANIZING**

**PQ 09.1**      **DESIGN AND FABRICATION**

Components for hot dip galvanizing shall be designed and fabricated in accordance with the recommendations of SANS 14713, with the exception that the use of lead plugs is not permitted.

It is recommended that the manufacturer consults the galvanizer or the Executive Director of the South African Hot Dip Galvanizer's Association before design and fabrication to ensure that the fabrication will be suitable for galvanizing.

The main requirements are as follows:

- (a) Overlapping joints shall be avoided wherever possible. If essential, such overlap joints shall be thoroughly degreased before assembly and shall be vented by holes being drilled through one or both overlapping materials.
- (b) Closed sections shall be suitably vented. If the inside of a closed section is not to be galvanized, a snorkel vent tube of suitable length and bore shall be attached to the vent hole.
- (c) Gussets and internal baffles in tanks shall be cropped to allow free flow of zinc and air.
- (d) Joints shall be continuously welded, using balanced welding techniques to avoid stresses. Welds shall be free from cavities, undercutting, weld slag and spatter.
- (e) A symmetrical design shall be used whenever possible and the use of thin gauge steel adjacent to heavy sections shall be avoided.
- (f) Openings and flanges of manholes and bosses shall finish flush on the inside to ensure complete drainage.

- (g) Castings shall be designed to be of as uniform section as possible and shall be blast cleaned in accordance with the relevant clause before they are despatched to the galvanizer.

**PQ 09.2      THE HOT DIP GALVANIZING PROCESS**

Hot dip galvanizing shall comply with the appropriate SANS specifications, such as SANS 121 for fabricated articles, SANS 3575 for pregalvanized sheet, or SANS 10244 for wire.

Mating surfaces on fabricated or cast iron components shall be wiped or centrifuged immediately after they are removed from the galvanizing bath to remove blobs, runs, or excess metal that may impair the air/gas/water tightness of the joint.

Bolts, nuts and washers used for fixing shall be hot dip galvanized to SANS 121. Electroplated fasteners will not be accepted unless otherwise agreed by the Engineer in writing.

**PQ 09.3      MECHANICAL TREATMENT OF GALVANIZED ARTICLES**

Welding, flame cutting, or other heat processes shall not be carried out on galvanized articles unless permission has been granted by the Engineer.

**PQ 09.4      REPAIR OF GALVANIZED ARTICLES**

If such permission is given, or if mechanical damage has occurred, repairs shall be carried out as follows:

All scale, spatter and flux shall be removed by grinding and washing with clean water. Edges shall be ground to a radius not less than 2 mm.

The repair process shall be by blast cleaning of the surface to bare steel and applying zinc by the thermal spray process in accordance with SANS 2063, Grade Zn150. On completion of metal spraying, the surface shall be burnished by means of a mechanical wire brush to give a uniform appearance. Such burnishing shall remove not more than 10 micrometres of zinc.

Where small areas are to be repaired, the surface shall be thoroughly cleaned with fine abrasive paper, all debris removed with a damp cloth and the surface allowed to dry. An approved one pack zinc rich primer containing not less than 90% by mass of zinc in the dry film shall then be applied. A sufficient number of coats (usually 3 or 4) shall then be applied such that the repair coating thickness is not less than the average zinc thickness specified in SABS 121, 3575 or 10244, as appropriate. The repair shall extend not less than 5 mm beyond the damaged area.

On completion of the repair and when the zinc rich primer is completely dry, one coat of alkyd resin based aluminium paint may be applied to obtain a uniform appearance.

**NOTE:** The repair of galvanized surfaces by application of aluminium paint alone IS NOT PERMITTED.

**PQ 09.5      THE STORAGE OF GALVANIZED COMPONENTS**

Galvanized components shall be so stored as to avoid the formation of "white rust" or other forms of storage staining.

Components shall be separated and supported on wooden battens to ensure adequate ventilation of all surfaces and in such a manner as to avoid "ponding" of rainwater.

If storage staining does occur, repairs may not be necessary if the residual zinc thickness meets the requirements of the specification. When necessary to meet the requirements of the specification, or when so instructed by the Engineer, repairs shall be carried out as specified in the relevant clause above.

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**PQ 10            STAINLESS STEEL FABRICATIONS****PQ 10.1        GRADES AND WELDING TECHNIQUES**

The grade of stainless steel to be used shall be as specified in the appropriate section of the mechanical specification or on the Drawings.

Where welding is necessary, the appropriate "L" grade (low carbon content) shall be used. Welding procedures shall be only those recommended by the manufacturer of stainless steel or by the South African Stainless Steel Development Association (SASSDA). Only suitably coded welders shall be employed (Refer BS 4870 or ASME IX).

The fabrication of stainless steel components shall be carried out in clean workplaces where contamination by mild steel does not occur. Grinding and polishing equipment shall be used for this purpose only and shall not be contaminated with iron or mild steel.

Stainless steel shall be suitably handled to avoid any scratching of the surface.

**PQ 10.2        PICKLING AND PASSIVATION**

The cut edges, welds and heat treated surfaces of all stainless steel components shall be pickled and passivated to remove all discolouration. Proprietary pickling and passivating pastes shall be used in accordance with the manufacturer's recommendations. Care shall be taken not to exceed the maximum recommended contact time.

After passivation, surfaces shall be very thoroughly washed with clean potable water to remove all traces of acid. The surface shall be allowed to dry, then polished where necessary, using polishing compounds recommended by the manufacturer of stainless steel or the SASSDA.

**PQ 11           CORROSION RESISTANT STEEL 3CR12****PQ 11.1        WELDING TECHNIQUES**

Welds shall be full penetration welds, using 309 austenitic electrodes or filler wire, as recommended by the manufacturers.

Welders shall be suitably coded for welding similar thickness of austenitic stainless steel (Refer BS 4870 or ASME IX).

Welding procedures shall comply with the recommendations of the manufacturers of 3CR12.

Welds shall be smooth and free from blowholes, undercuts, sharp projections and similar visual defects.

**PQ 11.2        PICKLING AND PASSIVATING**

After completion of welding, both weld and heat affected zones shall be cleaned, pickled and passivated. Heat scale on steel shall also be pickled and passivated.

The procedure shall be as follows:

- Blast clean with non-metallic grit, or grind or wire brush, using dedicated grinders or stainless steel wire brushes to achieve the required smooth profile or remove scale.
- Pickle with a thixotropic paste containing 15-20% nitric acid and 1-2% hydrofluoric acid, for a contact time of 15 to 20 minutes.
- Rinse copiously with clean water.
- Repeat the above process, if necessary to remove all discolouration.
- Passivate with 10% nitric acid solution, or a proprietary passivating paste, for a contact time of 10-15 minutes, keeping the surface wet during this period.
- Rinse copiously with clean potable water until the washings are neutral.

**PQ 11.3        SAFETY PRECAUTIONS**

Operatives shall wear protective aprons, gloves and safety glasses during pickling and passivating operations, since the solutions used are strongly acidic.

Splashes on skin shall be washed with copious quantities of clean water immediately after contact. A weak solution of sodium bicarbonate shall be kept available for neutralisation.

Seek medical attention if in doubt.

**PQ 11.4      EFFLUENT**

Disposal of effluent shall be in accordance with the by-laws or requirements of the local authority in whose area the work is being carried out and any relevant legislation of the Republic of South Africa. Generally, the effluent is stored in drums containing an excess of lime (calcium carbonate) before disposal at an approved disposal site.

**PQ 12        ALUMINIUM**

**PQ 12.1      ANODIZING**

Aluminium components, specified as anodized shall be natural anodized and sealed in accordance with SANS 999 or SANS 1407, in both cases to Grade AA25 or AG25. The corrosion resistance of the coating shall be not less than 8 when tested in accordance with section 4.6 of SANS 999. Anodizing shall be carried out after completion of all welding.

When coloured anodizing is specified, the aluminium components shall be anodized in accordance with SABS 999, Grade AA25.

**PQ 12.2      POWDER COATING**

When specified by the Engineer, aluminium handrails may be coated with polyurethane powder. Such coating shall only be carried out by Contractors with the necessary plant, equipment and experience to pretreat and powder coat aluminium effectively. The coating shall comply with BS 6496.

**PQ 12.3      FIXING**

Fixing of aluminium components shall be carried out with Stainless Steel 304 bolts, nuts and washers. When fixed to steel components such as bridges, there shall be an effective insulation layer between aluminium and steel, such as PVC or polyethylene tape, not less than 0,25 mm thickness between aluminium base and steel. A nylon washer of adequate size shall be used between the steel main component and the nut in order to insulate aluminium from steel.

Whenever aluminium components, such as stop log frames, come into contact with concrete, the surface of the aluminium in contact with concrete shall be coated with two coats of epoxy tar composition, as specified in Subclause PQ 13.3.1(c) for System C2. The epoxy tar coating shall be fully cured before grouting in to the concrete.

**PQ 13            COATING SYSTEMS****PQ 13.1        SYSTEM A - ALKYD SYSTEMS****PQ 13.1.1      General**

Alkyd systems are intended for use in environments of low corrosivity, where a good decorative finish is required. Materials shall therefore be applied with due cognizance of appearance and protection. Defects such as runs, sags, curtaining, shrivelling or wrinkling will not be permitted.

**(a)    System A1 - Alkyd system on to bare steel surfaces**

- (i) The surface to be coated shall be prepared as specified in the relevant clause.
- (ii) Apply one coat zinc phosphate primer complying with SANS 1319, to a film thickness not less than 30 micrometres. Allow to dry for a minimum of 16 hours.
- (iii) Apply one coat alkyd based undercoat complying with SANS 681 Type 2, to give a dry film thickness of not less than 30 micrometres. Allow to dry for a minimum of 16 hours.
- (iv) On interior surfaces, apply one coat alkyd enamel complying with SANS 630 Type 2, in the colour specified by the Engineer, to give a dry film thickness of not less than 25 nor greater than 40 micrometres. Allow to dry for a minimum of 16 hours.
- (v) On exterior surfaces, apply a second coat of alkyd enamel, within 30 hours, to give a dry film thickness of not less than 25 nor greater than 40 micrometres in the final colour as specified by the Engineer. Allow to dry for a minimum of 16 hours.

**(b)    System A2 - Surfaces already cleaned and primed**

- (i) Clean and prepare the surface as specified in the relevant clause.
- (ii) Touch up bare areas with zinc phosphate primer complying with SANS 1319. Allow to dry for a minimum of 16 hours.
- (iii) Apply one coat all over of zinc phosphate primer to SANS 1319.
- (iv) Continue the system as given in System A1 (iii) to (v) inclusive.

**(c)    System A3 - Factory finished components**

- (i) The Contractor shall ensure that the existing coating is compatible with the system to be applied.
- (ii) Prepare the surface as specified in the relevant clause.
- (iii) On interior non aggressive surfaces apply one coat alkyd enamel complying with SANS 630 Type 1, in the colour specified by the Engineer, to give an applied dry film thickness of not less than 25 micrometres. Total dry film thickness to be not less than 75 micrometres.
- (iv) On interior surfaces in an aggressive environment, use System D2 (Vinyl) rather than an alkyd system.
- (v) On exterior surfaces, apply two coats alkyd enamel complying with SANS 630 Type 2, to give an applied dry film thickness not less than 50 micrometres. Total thickness shall not be less than 100 micrometres.

- (vi) If the total dry film thickness is less than the appropriate value given above, apply a further coat of alkyd enamel.

(d) System A4 - Galvanized surfaces - above water and in non-corrosive environments

- (i) Prepare the surface as specified in the relevant clause.
- (ii) Apply one coat of an approved water based vinyl chloride-vinylidene chloride copolymer primer containing zinc phosphate to give a dry film thickness of not less than 30 and not greater than 60 micrometres. Allow a minimum of 16 hours to cure in dry conditions before overcoating. Since this material is water based, drying time will be extended under humid conditions.
- (iii) Continue the system as given in A1 (one undercoat, one enamel coat).

(e) System A5 - Plastic surfaces

If required to paint for identification or decorative purposes, the following system shall be used:

- (i) Prepare the surface by thorough abrasion as specified in the relevant clause.
- (ii) Apply water based primer as specified in System A4 (ii).
- (iii) Apply alkyd undercoat and finish as specified in System A1 (iii) and (iv).

(f) Requirements of the finished Alkyd system

The finished system shall be smooth, glossy, free from excessive runs, sags, blisters, wrinkling, dirt, occlusions or other visual defects.

The total dry film thickness shall not be less than 75 micrometres in the case of interior surfaces and not less than 100 micrometres in the case of exterior surfaces.

(g) Site repair of Alkyd systems

- (i) It is anticipated that alkyd systems will generally be applied on Site, either on to bare steel (see System A1), or on to prepared and primed steel (see System A2), or on to fully coated components (see System A3), or on to galvanized steel (see System A4), or on to plastic surfaces for the purpose of colour coding (see System A5).
- (ii) Any Site repair required by the Engineer shall be carried out in accordance with surface preparation method given in the relevant clause followed by all the coats required to restore the damaged area to the original system requirements.
- (iii) Since patch application of the final coat rarely gives an acceptable uniform finish, the whole area in which damage has occurred shall be cleaned, abraded with fine wet or dry abrasive paper (not coarser than 200 mesh) and given one coat of enamel all over, unless otherwise accepted by the Engineer.

**PQ 13.2      SYSTEM B - TWO PACK EPOXY SYSTEMS FOR USE ON SURFACES TO BE SUBMERGED**

**PQ 13.2.1      General**

Two pack epoxy - polyamide materials in System B1, contain solvent. It is important to note that this solvent must be allowed to escape and the chemical reaction to complete fully before being subjected to water immersion.

For these reasons it is imperative that the applicator does not exceed the maximum film thickness per coat applied, nor must overcoating be carried out earlier than the minimum time specified by the manufacturer. Since overcoating times are frequently quoted at 20°C or 25°C, longer overcoating times shall be allowed at lower temperatures. As a rough guide, increase



time by 50% for a 5° decrease (or by 100% for a 10° decrease) in the ambient temperature below the temperature quoted in the data sheet.

These materials shall not be applied when the ambient temperature is below 10°C.

All solvent based epoxy resin based materials shall be allowed 28 days to cure before immersion. At temperatures below 20°C longer periods shall be allowed, as in the case of overcoating times.

Since solvent free epoxies do not have to allow solvent to escape, the overcoating and immersion time intervals are shorter than those quoted for System B1. As a guide, the period between completion of coating and immersion in water can be as short as 7 days.

However, solvent free epoxy materials require special equipment for application.

Only experienced applicators may be used.

(a) System B1 - On bare steel or cast iron surfaces

- (i) Material used shall be based on epoxy-polyamide resins and shall comply with the performance requirements of SABS 1217 Type 1A - solvent borne chemically cured coating material.
- (ii) Prepare the surface as specified in the relevant clause.
- (iii) Apply three or four coats of the epoxy polyamide material, mixed as recommended by the manufacturer and as required to give a total dry film thickness not less than 250 micrometres.
- (iv) Each coat shall differ in colour from the preceding and succeeding coats in order to identify the number of coats applied.
- (v) Each coat shall be applied to a thickness not less than the minimum nor greater than the maximum recommended by the manufacturer.
- (vi) The time interval between coats shall be not less than the minimum time nor greater than the maximum recommended by the manufacturer for the prevailing ambient temperature. This requirement is very important to avoid solvent entrapment. Solvent entrapment may give rise to blistering, corrosion and poor adhesion on immersion.

(b) Requirements of the finished system

- (i) The coating system shall be smooth, glossy and free from orange peel effect, or bubbling or excessive runs and sags.
- (ii) The total dry film thickness shall be minimum 250 micrometres, maximum 400 micrometres.
- (iii) The coating shall be free from electrical insulation defects when tested with a wet sponge detector set to operate at 90 Volts, 2 Megohms. Repair of defects is permissible provided that the repaired area complies with all the requirements of this specification.

(c) System B2 - Galvanized steel surfaces

- (i) Prepare the surface as specified in Subclause PQ 07.4.
- (ii) Apply a two pack epoxy primer specifically designed for use on galvanized steel, to a thickness of 25 - 30 micrometres.
- (iii) Apply two coats of solvent borne epoxy-polyamide as specified for System B1 to give a total dry film thickness of minimum 150 micrometres and maximum 250 micrometres.



(iv) All other requirements shall be as for System B1.

(d) System B3 - Solvent free epoxy on bare steel or cast iron surfaces

Material used shall be based on solvent free epoxy resins and shall comply with the performance requirements of SABS 1217 Type 1C - solvent free chemically cured coating material.

- (i) Prepare surface as specified in the relevant clause.
- (ii) Apply one or two coats by means of a two component hot airless spray machine suitable for the material to be used and as recommended by the manufacturer. Alternatively, where recommended in the manufacturer's data sheet, a high ratio airless spray machine may be used. The machine shall be maintained in a clean condition and in good working order. The Contractor may be required to demonstrate to the Engineer that the machine is delivering components in the correct mixing ratio.

The Engineer may require application onto test substrates which can be subsequently tested for correct mixing ratio. Should the mixing ratio be found to be incorrect, all coated components will be rejected, after which the surfaces shall be blast cleaned and recoated.

For lining of pipes, the spray head shall be mounted on a boom of sufficient length to traverse the full pipe length and the pipe shall be constantly and uniformly rotated during application.

(e) Requirements of the finished system

- (i) The coating system shall be smooth, glossy and free from orange peel effect, or bubbling or excessive runs and sags.
- (ii) The dry film thickness shall be not less than 250 micrometres nor greater than 500 micrometres.
- (iii) The coating shall be free from electrical insulation defects when tested with a wet sponge pinhole detector set to operate at 90 volts 10 Megohms. Repairs of defects are permissible provided that the procedure given below is followed and that the repaired area meets all the requirements of the specification.

(f) Repair of epoxy systems

Fully cured epoxy coatings are more difficult to repair due to chemical cure of the coating. Careful attention to the following repair procedure is therefore necessary to ensure adequate adhesion of the material used for repair.

Prepare the surface by abrasion as specified in the relevant clause, wiping the surface with methyl ethyl ketone solvent, to give a contact time of approximately 30 seconds. Wipe off any surplus solvent with a clean rag, then apply as many coats of repair material as are necessary to achieve the specified film thickness. When using solvent borne materials, note the need for adequate time between coats as specified under System B1.

(g) System B4 - Epoxy with acrylic modified aliphatic polyurethane topcoat

(i) General

All epoxy resin based materials show severe "chalking" when exposed to ultra violet light. This problem may be minimised by the application of a topcoat of aliphatic isocyanate cured polyurethane. The pure polyurethanes are difficult to recoat once they are fully cured. Acrylic modified polyurethanes, whilst slightly less water resistant than the pure polyurethanes, have the advantage of facilitating subsequent maintenance.

(ii) Material

The material to be used shall be approved two component acrylic modified aliphatic isocyanate cured polyurethane.

(iii) Procedure

Prepare the surface and apply two pack polyamide as specified in System B1.

Within the overcoating time specified by the manufacturer, apply one or two coats of polyurethane, as required to achieve the colour specified by the Engineer. Each coat shall be applied to a dry film thickness not less than 30 micrometres nor greater than 50 micrometres.

(iv) Sensitivity to moisture

Polyurethanes are sensitive to moisture in the uncured state. Containers shall be kept in a dry store. Application shall be carried out in dry conditions with dry compressed air for spray application.

(h) Requirements for the finished system

The coating shall be smooth, glossy and free from orange peel effect, bubbling, excessive runs or sags.

The total dry film thickness (epoxy plus polyurethane) shall be not less than 250 micrometres nor greater than 450 micrometres.

For immersion conditions, the coating shall be free from electrical insulation defects when tested with an approved wet sponge detector set to operate at 90 volts, 2 Megohms. Repair of defects is permissible provided that the repaired area complies with all the requirements of SABS 1217.

**PQ 13.3 SYSTEM C - COAL-TAR EPOXY FOR USE UNDERWATER**

**PQ 13.3.1 General**

Coal-tar epoxy materials are two-pack chemically cured epoxy coatings containing special coal-tar. The function of the latter is to improve the water and acid-resistance of the epoxy composition and to reduce cost.

The presence of coal-tar has disadvantages in that the composition is available only in black or dark brown. It is not recommended for exposure to South African sunshine as it chalks rapidly and may show more severe actinic degradation by crocodiling.

It can be recommended as a relatively low-cost coating for underwater or underground use.

As in the case of solvent-borne two-pack epoxies, care shall be taken to strictly observe the film-thickness limitations and overcoating times specified by the manufacturer to avoid solvent retention, blistering and delamination in service.

These materials shall not be applied when the ambient temperature or that of the steel surface is below 12°C.

Solvent-borne epoxy-tar compositions shall be allowed a minimum of 28 days to cure before immersion.

(a) System C1 - On bare steel or cast iron surfaces

(i) Materials used shall comply with the requirements of SABS 801 Type 1 or Type 2, solvent-borne chemically cured epoxy tar.

(ii) Prepare the surface as specified in the relevant clause, as may be appropriate.

- (iii) Apply three or four coats of the epoxy-tar composition, mixed as recommended by the manufacturer, and as required to give a total dry film thickness of not less than 250 micrometres.

Each coat shall differ in colour from the preceding and succeeding coats so that the number of coats applied can be identified. The sequence of black-brown-black is acceptable.

Each coat shall be applied to a thickness of not less than the minimum or greater than the maximum recommended by the manufacturer,

The time interval between applying the coats shall be not less than the minimum time or greater than the maximum time recommended by the manufacturer in respect of the prevailing ambient temperature. These requirements are very important in order to prevent entrapment or poor adhesion.

(b) Requirements of the finished system

- (i) The finished coating system shall be smooth, glossy and free from orange-peel effect, bubbling or excessive runs and sags.
- (ii) The dry-film thickness shall be a minimum of 250 micrometres and a maximum of 400 micrometres.
- (iii) The coating shall be free from electrical-insulation defects when tested with a wet-sponge detector set to operate at 90 volts 2 megohms. The repairing of defects is permissible provided that the repaired area complies with the requirements as set out in SABS 1217.

(c) System C2 - On galvanized steel, galvanized cast-iron or aluminium surfaces

- (i) Materials as specified in System C1 shall be used.
- (ii) Prepare the surface as specified in the relevant clause, as appropriate.
- (iii) Apply System B1, except that the dry-film thickness shall be a minimum of 200 micrometres and a maximum of 300 micrometres.

(d) Site repair of epoxy-tar systems

Fully cured epoxy-tar coatings are especially difficult to repair on account of the chemical curing of the coating. Careful attention to the following repair procedure is therefore necessary to ensure the adequate adhesion of the material used for repair work.

Prepare the surface by very thorough abrasion as specified in the relevant clause, followed by wiping the surface with the manufacturer's epoxy solvent, using clean rags or with a clean brush, to give a contact time of approximately 10 seconds. Wipe off any surplus solvent with a clean rag, then apply as many coats of repair material as are necessary to achieve the specified film thickness. When using solvent-borne materials, the need for adequate time between the coats as specified in System B1 shall be taken into account.

## **PQ 13.4      SYSTEM D - VINYL RESIN BASED SYSTEMS**

### **PQ 13.4.1      General**

Single component vinyl resin based paints have excellent resistance to water, chemicals, dilute acids and hypochlorites. Their resistance to heat is poor and must never be used on surfaces continually subjected to a temperature of 70°C or higher. They are not resistant to solvents and should not be used where there may be contact with oils, grease, kerosene, petrol etc.

The main advantage of vinyls is their easy maintainability. Whereas epoxies are difficult to recoat after about one month's exposure, vinyls may be recoated after any period of time, provided that the surface is cleaned by the removal of chalking, dust, grease and general grime.

Vinyls are therefore recommended for use above water and for interior and exterior use where they will be subject to chemical fumes, as in chlorination rooms.

For exterior use the topcoat may be modified with acrylic resin for improved colour retention. Such modified types usually have a semi-gloss rather than full-gloss finish.

(a) System D1 - On bare steel or cast iron surfaces

- (i) The material used shall be based on polymerised vinyl-chloride copolymer, adequately plasticised and containing sufficient UV stabiliser for South African conditions.

The final coat may be acrylic modified to give improved colour and gloss retention when exposed to ultra violet light.

- (ii) Prepare surfaces as specified in the relevant system as may be appropriate.
- (iii) Apply one coat of the manufacturer's recommended primer to a dry film thickness of not less than 30 micrometres and not greater than 60 micrometres. Allow at least 16 hours for curing, or longer in humid conditions.
- (iv) Apply one or two coats of high build vinyl intermediate coat, in different colours, to a dry film thickness of not less than 75 micrometres and not more than 125 micrometres per coat. Do not allow less than 16 hours to lapse between coats. One coat will be used for mildly corrosive conditions, two coats for highly corrosive conditions.
- (v) Apply one coat of vinyl enamel to a dry film thickness of not less than 25 micrometres or greater than 35 micrometres.

(b) Requirements of the finished system

The finished system shall be smooth, glossy or semi-glossy, free from excessive runs, sags, blisters, wrinkling or other visual defects. The total dry film thickness shall be not less than 200 micrometres nor greater than 300 micrometres in the case of the system for highly corrosive conditions, or minimum 125, maximum 225 micrometres for the milder conditions.

(c) System D2 - On painted or plastics items in chlorination rooms

Material used as a primer/barrier coat shall be a water-based vinyl-chloride-vinylidene-chloride-copolymer primer which contains zinc phosphate. Being water-based, the drying time is extended in humid conditions. Care shall be taken to avoid excessive film thickness and to allow adequate drying time before overcoating. Full drying and coalescence throughout the thickness of the film is essential. Do not apply any coats at temperatures below 5°C or where such temperatures are likely to be encountered before full curing has taken place. Do not apply to any wet surfaces.

- (i) Prepare the surfaces as specified in the relevant clause.
- (ii) Apply one coat of water-based vinyl-chloride-vinylidene-chloride-copolymer primer which contains zinc phosphate to give a dry film thickness of not less than 30 micrometres and not greater than 60 micrometres. Allow a minimum of 16 hours for curing before the overcoat is applied. Since this material is water-based, the drying time shall be longer under humid conditions.
- (iii) Apply two coats of vinyl enamel. The medium shall not contain any alkyd resin or other saponifiable matter. Pigments used shall be light fast and shall not be affected by bleach solutions. The dry film thickness of each coat shall not be less than 25 micrometres or

greater than 35 micrometres. The time interval between coats shall be not less than 16 hours.

**NOTE:** The paint manufacturer shall be consulted before specifying the colour, as the range of pigments which meet the above requirements are limited and strong colours may be costly.

(d) System D3 - On galvanized steel

(i) General

Material used as a primer shall be either an approved water-based vinyl-chloride-vinylene-chloride-copolymer which contains zinc phosphate (for above-water use only), or a two-pack epoxy-resin-based primer specifically designed for use on galvanized steel and suitable for underwater service.

(ii) Surface Preparation

Prepare the surfaces as specified for above-water surfaces or for underwater surfaces or highly corrosive environments as set out in the relevant clauses.

(iii) Application

Apply the appropriate primer, as specified above, to the clean surface at a thickness within the range specified by the paint manufacturer.

Apply one coat of vinyl high-build intermediate coat which complies with that specified in System D1 at a dry film thickness of not less than 75 micrometres or greater than 125 micrometres, followed by one coat of vinyl enamel at a dry film thickness of not less than 25 micrometres or greater than 35 micrometres. The time interval between coats shall be not less than 16 hours.

(e) Requirements of completed system

The completed system shall be smooth, uniform, glossy or semi-glossy, free from runs, sags, bubbles and other visible defects. The dry film thickness of the vinyl system over the galvanized surfaces shall be 125 micrometres to 180 micrometres.

(f) Site repair of vinyl systems

Since vinyl systems are not chemically cured, only the abrasion of exposed steel is required for preparation. Abrasion of the coating and solvent wiping are unnecessary.

Prepare the surface as specified in the relevant clause and remove all debris by brushing it with a clean dry brush.

Apply the specified primer to the bare steel, followed by the required number of coats to restore the damaged area to meet the requirements of the appropriate specification.

**PQ 13.5      SYSTEM E - TWO COMPONENT SOLVENT FREE POLYURETHANE**

**PQ 13.5.1      General**

The solvent free polyurethanes constitute a relatively new class of coating with some outstanding properties. They may be divided into two main types, each of which is subject to a wide variation in properties which depends on the particular formulation.

(a) Elastomeric types

These are similar to rubber in that they have an elongation up to 300%, with good recovery. They have very high resistance to abrasion but need a primer with good water barrier

properties when used on steel, on account of their relatively high water permeability. As the coating has a low coefficient of friction and high resilience, it is suitable for lining containers for stones, grit and similar abrasive materials.

(b) Elastoplastic types

These are less like rubber but are still very much more flexible than epoxies, and have an elongation at break of about 25%. Their water permeability is much lower than that of the elastomeric types, and hence they are more suitable for underwater use.

The method of application of the elastomeric types is by their being cast in a mould or, in the case of pipes, by their being spin cast.

The elastoplastic types are applied by brush, trowel or by a special two component hot airless spray unit in which the two components are metered to the spray head. It is imperative that the equipment be stripped and thoroughly cleaned periodically during use. Frequent checks shall be carried out to ensure that the correct mix ratio is maintained.

Both types must be applied to dry surfaces under dry conditions.

(c) System E1 - Elastoplastic polyurethane on mild steel, underwater, mildly abrasive

(i) Materials

(1) Primer for steel

The primer shall be a suitable primer for steel supplied by the manufacturer of the coating material and shall be applied at the manufacturer's specified thickness and shall be overcoated within the specified overcoating time.

(2) Coating material

The coating material shall be a solvent-free two component polyurethane hybrid based on polyether type polyol and aromatic isocyanate. The cured coating shall comply with the following requirements:

- Tensile strength at a 3 mm thickness (ASTM D 638) - not less than 15 MPa.
- Adhesion to correctly primed steel (SABS Method 776) - not less than 10 MPa.
- Impact resistance direct - (ASTM G 14) - not less than 8 joules.
- Dielectric strength - not less than 10 kV/mm.
- Elongation at break - not less than 25%.
- Compressibility - not less than 25 MPa.
- Surface hardness of 5 mm thick sample - not less than 60 or greater than 80 Shore 'D'.
- Water vapour permeability - not greater than 0,5g/24h/m<sup>2</sup>/mm.
- Cathodic disbanding - when tested in accordance with ASTM G8 Method A, for 60 days, the disbanded area shall not exceed 500 mm<sup>2</sup>.

(ii) Procedure

- (1) Prepare surface as specified in the relevant clause.
- (2) Prime the surface with the coating manufacturer's primer for steel.

- (3) Within the minimum and maximum overcoating time interval specified for the primer by the manufacturer apply one coat or two coats by means of an airless spray machine fitted with metering pumps that dispenses the correct mix ratio at the spray head. The machine shall be maintained in a clean condition and in good working order. The Contractor may be required to demonstrate to the Engineer that the machine is delivering components in the correct mixing ratio. Test panels shall be coated during the application to enable test to be carried out for adhesion and for Shore Hardness. Adhesion test panels shall be coated at the specified thickness but for Shore Hardness, the coating shall be not less than 5 mm in thickness.

(d) Requirements of the finished system

The coating shall be smooth, glossy, free from excessive orange peel effect, bubbling, or excessive runs or sags.

The dry film thickness shall be not less than 1,0 mm.

The coating shall be free from electrical insulation defects when it is tested with a high voltage Holiday detector set at 5 kV.

(e) System E2 - On mild steel in underwater highly abrasive conditions

As for System E1, except that the coating thickness shall not be less than 2 mm. No electrical insulation defects shall be detected when it is tested with a high voltage Holiday detector set at 10 kV.

(f) System E3 - On mild steel in underwater very abrasive or cavitation conditions

As for System E1, except that the coating or lining thickness shall be not less than 3 mm. No electrical insulation defects shall be detected when it is tested with a High Voltage Holiday Detector set at 15 kV.

(g) Repair procedure for polyurethane systems

Since polyurethane systems are chemically cured, very thorough abrasion of damaged or defective coating is required to ensure an adequate physical bond.

If repair is carried out within 16 hours of application of the last coat of polyurethane, the surface shall be abraded with abrasive paper. Wipe it free from dust and debris, then apply the brush grade polyurethane thoroughly mixed in the correct proportions, in as many coats as are required to achieve the specified thickness and freedom from holidays.

If repair is carried out later than 16 hours after application of the last coat, the surface shall be abraded as given above, the debris removed, then the manufacturer's adhesive, thoroughly mixed in the correct proportions applied to the abraded surface only NOT to any area which has not been abraded. Allow not less than 30 minutes nor more than 4 hours before the brushing grade polyurethane, thoroughly mixed in the correct proportions, is applied to achieve the total thickness and freedom from holidays as required by the specification.

## **PQ 13.6      SYSTEM F - POWDER COATING**

### **PQ 13.6.1      General**

Design is important when items are to be protected by powder coatings. Corners are difficult to coat and sharp edges shall be avoided. Powder coatings generally have very high cohesive properties and tend to suffer from undercreep starting at any weak spots such as sharp edges.



The Designer should aim at attaining a 'cocoon effect' which encapsulates the item in coating of an even thickness. Items to be coated by fluidized-bed techniques shall be designed so as not to trap a build-up of powder on horizontal surfaces and at corners.

For powder coating, a very wide range of materials may be utilized, which may be broadly classified as follows:

THERMOPLASTIC, such as PVC, polyethylene, ethylene vinyl acetate, nylon, etc.

THERMOSET, such as epoxy, polyurethane or epoxy polyester.

The thermoplastic materials are generally applied in thicker coats than the thermoset and have relatively poor adhesion properties, hence they are used primarily for articles which can be fully encapsulated.

The thermoset materials are harder and more resistant to higher temperatures, but correct application is essential to ensure full cure. Repair of thermoset materials is more difficult than with thermoplastics.

Incorrect curing temperatures are responsible for most defects in powder coating. High-mass articles, such as castings, are particularly susceptible, and the surface temperature of the article to be coated shall always be determined and controlled. Improper curing will show up as pinholes and bubbles in the coating, or it may not be visually detectable but results in poor performance. The improper curing of thermoset materials may be detected by sophisticated laboratory testing procedures applied to flakes of coating.

Polyurethane powders are preferred for exterior use. Epoxy powders are preferred for optimum water and chemical resistance.

Ethylene vinyl acetate (E.V.A.) has a good exterior exposure resistance and especially when it is applied by the fluidized bed technique, it is excellent for immersion use. It is, however, more expensive as it is generally applied in thicker coats and the material is imported. A new product in South Africa is a thermoplastic polyamide supplied under the trade name RILSAN, which may be used when approved by the Engineer.

(a) System F1 - Polyurethane powder coating on primed mild steel for exterior exposure

(i) General

The primer used shall be a solvent-based polyamide cured epoxy material containing strontium chromate as an anti-corrosive pigment designed for use as a primer for polyurethane powder coating, and which will withstand the maximum stoving cycle associated with the process.

The powder coating shall be a thermosetting polyurethane based material suitable for constant exterior exposure. The product shall comply with the requirements of SANS 1274 Type 6. The powder coating shall be suitable for application over the primer specified above.

(ii) Pretreatment prior to powder coating

Fettling and dressing by the fabricator shall be in accordance with the requirements of the relevant clause.

Surface preparation shall be in accordance with the relevant section as well as the following:

A recognized chemical pretreatment shall be carried out on the steel just prior to powder coating (See SANS 10064 Section 6). A cold phosphating process such as the following is acceptable.



The chemical pretreatment shall consist typically of a seven stage zinc (preferable) or an iron phosphate process comprising:

- (1) an alkaline degreaser
- (2) water rinse A
- (3) an acid pickle and derust
- (4) water rinse B (back rinse first to water rinse A)
- (5) zinc or iron phosphate
- (6) water rinse
- (7) chromate passivation (hot).

The process shall result in the complete removal of all foreign matter, e.g. scale, grease, cutting oil, soil, weld flux, rust etc. The pretreatment shall impart a uniform texture to the surface so as to render it suitable for the coating which is to be applied.

A fine grained crystalline zinc phosphate is recommended at a coating mass of 1,5 - 4,5 g/m<sup>2</sup>, or iron phosphate at a coating mass of 0,2 - 1,5 g/m<sup>2</sup>.

Great care shall be taken with water rinsing so as not to contaminate the next cleaning process.

After phosphating the articles shall be primed as soon as possible after drying. In any event this time shall not be longer than 16 hours if the phosphated items are kept under dry cover. Clean cotton gloves shall be used for any handling prior to coating.

#### (iii) Priming

The primer as described above shall, in accordance with the manufacturer's instructions, be applied by spray to a dry film thickness of 40 micrometres to 70 micrometres.

#### (iv) Curing time for primer

The primer shall be left for a period of four (4) days (at 25 °C and 50% RH) prior to the powder coating being applied to ensure that all solvents have evaporated from the paint film so as to prevent the solvent from bubbling when the items are exposed to the high stoving temperatures.

This period of time shall be increased for lower temperatures or higher relative humidities, or it shall be decreased for higher temperatures and lower relative humidities, in accordance with the manufacturer's recommendations.

#### (v) Application of Powder Coating

All dust shall be removed. The primer shall be cured as set out above. The powder coating shall be applied by the electrostatic spray application method to a dry film thickness of 40 micrometres to 70 micrometres.

#### (vi) Stoving

The powder coated items shall be exposed to a minimum stoving schedule equivalent to 10 minutes at 200°C and a maximum of 15 minutes at 200°C. The oven conveyor speeds or oven temperatures shall be adjusted to accommodate various metal thicknesses to ensure that every part is ultimately exposed to the minimum stoving schedule. To check the curing of the stoved coatings, sample chips of the coating shall, if necessary, be subjected to a differential scanning calorimetry (DSC) test.

#### (vii) Handling of Powder Coated Items

Powder coated items shall be packed and handled so as to prevent damage before installation.

### (b) Requirements of the finished system

The coating shall be smooth, glossy and free from excessive orange peel, bubbling, runs or sags, and shall comply with the requirements of SANS 1274, Type 6, table 7, in all respects.

The dry film thickness shall not be less than 80 nor more than 140 micrometres.

(c) Repair of polyurethane powder coating

Any chipped or damaged areas of the coating shall be repaired as follows:

The area shall be abraded to white metal or to a uniform matt finish of the powder by using a 350 - 220 grit waterproof paper and xylol as a lubricant. Dry the area with a clean cloth. Apply by brush or spray the epoxy-polyamide primer recommended by the manufacturer of the powder to a dry film thickness of minimum of 40 micrometres, maximum 70 micrometres to the abraded area. After the recommended minimum and before the recommended maximum overcoating time, apply a top coat of polyurethane acrylic, as recommended by the powder manufacturer and tinted to the same colour as the powder coating. Care shall be taken not to overlap the abraded area by more than 10 mm.

The aesthetic appearance of the patch shall be subject to approval by the Engineer. If not approved, the whole item shall be returned to the manufacturer for stripping and recoating.

(d) System F2 - Corrosion resistant powder coatings for interior and exterior use

(i) Materials

The powders to be used shall comply with the requirements of SANS 1274, Type 5.

(ii) Pretreatment

Refer to System F1, Pretreatment prior to powder coating.

(iii) Application of Powder coating

The powder shall be applied to the clean, dry, phosphated steel items, preferably by the electrostatic spray application method (or by the fluidized-bed process if approved by the Engineer) so as to produce a dry film thickness of 75 micrometres or 300 micrometres for thermosetting and thermoplastic coatings respectively, as specified in SABS 1274, Type 5.

(iv) Stoving

The stoving temperatures shall be such that the heat history of the final product will be in accordance with the manufacturer's recommendations, taking into account varying metal thicknesses. Preference shall be given to Sub-contractors with travelling oven recorders. The final coating shall comply with the relevant requirements of SABS 1274, Type 5.

(v) Requirements of the finished system

The coating shall be smooth, glossy and free from excessive orange-peel, bubbling, runs or sags and shall meet the requirements of SANS 1274, Type 5.

The dry film thickness shall not be less than 75 micrometres for thermosetting powders or not less than 300 micrometres for thermoplastic coatings.

(vi) Handling of Powder Coated Items

Powder coated items shall be packed and handled so as to prevent damage up to the point of completion of installation.

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(e) System F3 - Powder coating on aluminium for interior or exterior exposure

(i) Material

The powder to be used shall comply with the requirements of Section 2 of BS 6496.

(ii) Pretreatment

An approved chemical pretreatment dedicated only to the pretreatment of aluminium shall be carried out just prior to powder coating.

The pretreatment shall comply with the requirements of BS 6496, Section 3, Clause 8.

This is the only type of pretreatment acceptable prior to powder coating on to aluminium components.

**NOTE:** The conductivity of the demineralised water draining off the rinsed work pieces shall not exceed 10 mS/m at 20°C. The metal surface after the pretreatment and prior to coating shall be free from dust and powdery deposits.

After pretreatment the articles shall be powder coated as soon as possible after drying. In any event this time shall not be longer than 2 hours if the items are kept under cover.

(iii) Application of Powder Coating

The powder coating shall be applied to the clean pre-treated aluminium so as to result in a dry film thickness of minimum 50 micrometres. The thickness on any significant surface that requires a limited thickness of finish as indicated on suitably marked drawings, shall not exceed 120 micrometres.

The stoving temperatures shall be such that the heat history of the final product is in accordance with the manufacturer's recommendations, and takes into account the effect of varying metal thicknesses.

(iv) Requirements of the Finished System

The coating shall be smooth, glossy and free from excessive orange peel or bubbling runs or sags. The coating shall comply with the requirements of Section 3 BS 6496.

The dry film thickness shall be not less than 50 micrometres and where necessary, shall not be greater than 120 micrometres.

Tests for full cure of thermosetting materials shall be carried out. If full cure is not achieved, the articles shall be reheated or may be totally rejected, as determined by the Engineer.

(v) Touch up and repair of damaged areas

Polyurethane and epoxy powders, when fully cured, are hard and impervious and difficult to overcoat without risk of delamination. The following procedure shall be strictly adhered to.

The area to be touched up shall be abraded with waterproof grade 350-220 paper using water as a lubricant. Rusted steel shall be abraded to white metal. Sound coating shall be abraded to a smooth matt surface.

The abraded area shall be cleaned with an approved water soluble detergent degreaser and rinsed thoroughly with fresh potable water and wiped dry with a clean cloth.

A single coat of epoxy/polyamide white primer shall be brush applied strictly within the abraded area, as per the powder manufacturer's recommendations and shall be allowed to dry for 16 hours minimum and 48 hours maximum. It shall be protected from contamination.

A single coat of acrylic modified two component aliphatic polyurethane shall be brush applied, not overlapping the primer coat by more than 5 mm, as per the powder manufacturer's recommendations, tinted to the colour of the powder coating. It shall be protected from handling or contamination for 48 hours.

## **PQ 13.7      SYSTEM H - HEAT RESISTANT SYSTEMS**

### **PQ 13.7.1      General**

Systems given in this section are for application to surfaces which may become hotter than 100°C in service and which may remain at a high temperature or which may fluctuate between ambient and high operating temperature.

Corrosion only becomes a problem if the time at ambient temperature is long relative to the heated time. Since allowance must be made for thermal expansion and contraction, thin coats are preferred even though thick coats give the best corrosion protection. All heat resisting systems are therefore a compromise between flexibility and corrosion protection.

Since most organic media and most pigments discolour when heated, the most popular and practical finish is an aluminium paint, the medium of which may vary according to the maximum service temperature.

Blast cleaning is essential to ensure optimum adhesion to the substrate and so avoid peeling and flaking in service.

#### **(a)      System H1 - Phenolic aluminium for resistance up to 400°C maximum**

##### **(i)      General**

This system utilises the excellent corrosion and heat resistance of inorganic zinc silicate primer combined with the attractive appearance, relatively low cost and heat resistance of phenolic aluminium.

##### **(ii)      Materials**

The primer shall be a two component zinc silicate based on self-curing ethyl silicate medium.

The aluminium top coat shall be a specially formulated phenolic aluminium guaranteed by the manufacturer to be suitable for temperatures up to 400°C.

##### **(iii)      Surface Preparation**

The surface shall be prepared as specified in the relevant clause as appropriate, to the standards required for immersed surfaces given in Table 1.

##### **(iv)      Primer**

The primer shall be mixed and applied strictly in accordance with the manufacturer's instructions. Particular note shall be made of the following factors that can profoundly affect performance:

- (1) The whole of the zinc dust shall be mixed with the whole of the liquid component by slowly sifting the powder into the constantly agitated medium;
- (2) The mixed material shall be sieved to remove any unwetted lumps, which should be minimal in quantity;
- (3) The mixed material shall be constantly agitated during application;
- (4) The application of the primer to the prepared surface shall take place within the maximum times specified in Table 2.2;
- (5) The primer shall be applied uniformly by an applicator skilled and experienced in the application of the zinc silicate. The dry film thickness shall be not less than the minimum nor greater than the maximum given in the manufacturer's

- data sheet. In the absence of this information, the dry film thickness shall be not less than 50 micrometres nor greater than 100 micrometres. During application, the film shall appear wet. Dry spray is not permitted;
- (6) When relative humidity is below 60%, cure may be prolonged. In this case, allow not less than 4 hours after application, then spray the surface of the primer with a gentle mist of water;
  - (7) Overcoating of the zinc silicate shall not take place until the primer is cured sufficiently to resist 30 double runs with a pad soaked in methyl ethyl ketone (MEK test) and shall not show any fracture when scraped with the edge of a coin under pressure (coin test).

Care shall be taken to avoid damage to the primer during transportation and erection of the primed components.

(v) Top coat

Except where the component can be heat cured at the point of application, the top coat of heat resistant aluminium shall be applied on Site after erection, since the top coat does not fully harden until subjected to heat. It is therefore not suitable for transportation and erection in the partially cured or uncured state.

The primer shall be cleaned as specified in the relevant clause, except that abrasion is not necessary. However, it is imperative that the primer is completely dry before overcoating.

To clean, dry primer surface, apply the Heat Resistant Aluminium Paint strictly in accordance with the manufacturer's instructions.

(b) Requirements of the finished system

The finished system shall be smooth and uniform, with a metallic lustre, free from excessive runs, sags, blisters, bubbles, wrinkling or other visible defects.

The total dry film thickness shall be not less than 70 micrometres nor greater than 120 micrometres. Since the coating will not be fully cured until it is put into service, the dry film thickness shall be measured by the use of a plastic shim of known thickness placed between the painted surface and the probe of the electromagnetic thickness gauge, the thickness of the shim then to be deducted from the total thickness readings obtained.

**PQ 14 QUALITY ASSURANCE REQUIREMENTS**

**PQ 14.1 CONTRACTOR QUALIFICATION**

The Engineer may, at his discretion, require a Quality Audit of the painting Sub-contractor to ensure that he has the management, facilities, skilled staff, and quality control facilities and staff to carry out quality control during application of coatings to ensure compliance with the specification.

The Contractor shall accept full responsibility for the quality of his work and of materials used, irrespective of any quality surveillance that may be carried out by the Engineer or his representative.

**PQ 14.2 DATA SHEETS, SPECIFICATIONS AND CODES OF PRACTICE**

The Contractor shall have available the latest issues of manufacturer's data sheets for materials to be used, National Specifications and Codes of Practice relevant to the work to be carried out, as well as a copy of this specification, all of which shall be available to the Contractor's Quality Control Manager, who shall read the relevant documents and follow the relevant instructions.

**PQ 14.3 QUALITY CONTROL**

The Contractor shall have the necessary equipment and staff knowledgeable in test procedures to carry out all the quality control required to ensure compliance with the specification. The Contractor will be required to produce a quality plan and a program for carrying out the work. The Contractor shall maintain quality control records of all stages of the work, batch numbers of materials used, environmental conditions, as required by the specification. Quality control shall be inclusive in the Contractor's tender price.

**NOTE:** The SABS ISO 9000 series should be used to develop the required quality control procedures.

**PQ 14.4      QUALITY CONTROL RECORDS**

Proper and adequate quality control records shall be maintained by the Contractor for all stages of the work. These records shall be available for inspection by the Engineer or his representative at the time of quality surveillance. Incomplete, inaccurate or inadequate records shall be regarded as non-conformance with the specification.

**PQ 14.5      MATERIAL SUPPLIER**

Products equivalent to those specified may be submitted for approval and must be approved in writing by the Engineer. This approval will only be considered if the manufacturer provides adequate written evidence of equivalence.

**PQ 14.6      QUALITY SURVEILLANCE**

Independent surveillance - The Engineer may employ an independent technically qualified organization to carry out quality surveillance of the work.

Program - The Contractor shall advise the Engineer timeously, in writing, when and where the following processes will be carried out:

- (a) Completion of fettling or dressing prior to leaving the Fabricator's works.
- (b) Blast cleaning and application of the primer coat.
- (c) Completion of factory painting.
- (d) Commencement of Site painting.

Failure of the Contractor to advise the Engineer of his program may result in rejection of the work.

**PQ 14.7      ACCESS FOR SURVEILLANCE**

For the purpose of carrying out quality surveillance, the Engineer or his representative shall be granted access to any part of the Contractor's premises relevant to the work being carried out, at any reasonable time. The Contractor shall provide, at his own cost, any equipment or labour necessary to gain access to surfaces which are coated, to be coated, or are in the process of being coated.

**PQ 14.8      SAMPLES**

The Engineer or his representatives may remove any reasonable samples of materials to be used in the coating application. Rejection of the sample will place a hold on the use of materials of the same batch number and may lead to rejection of all that batch of material and the reworking of any components that have already been coated with rejected material.

**PQ 14.9      DESTRUCTIVE TESTING**

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The Engineer or his representative may carry out reasonable destructive tests to ascertain compliance with the specification. Areas thus damaged shall be repaired by the Contractor to the satisfaction of the Engineer at no additional cost.

**PQ 14.10      COST OF QUALITY SURVEILLANCE**

Cost of independent quality surveillance shall be borne by the Employer, except when surveillance results in rejection of the lot for non-conformance with specification or when notice by the Contractor results in a fruitless trip, in which cases the cost of the surveillance shall be debited against the Contractor's account.

**PQ 15      MEASUREMENT AND PAYMENT**

Full compensation for the Contractor's obligations regarding all corrosion protection as described in this section will be deemed to be included in the rates tendered for the relevant items of equipment specified in other sections of these Specifications and which are protected against corrosion.

TABLE PQ 13.1 : SUMMARY OF COATING SYSTEMS

SYSTEM A - ALKYD SYSTEMS

**SCOPE:** For application to surfaces in non-corrosive environments for attractive appearance or colour coding. **NOT** to be used for immersion, splash-zone protection or in very humid environments.

SYS- TEM NO	SUB- STRATE	SURFACE PREPARATION		COATING SYSTEM				NOTES
		METHOD	REQUIREMENTS	PRIMER	UNDERCO AT	FINISH	REQUIREMENTS	
A1	Bare steel	Degrease Blast clean  Degrease, pickle and passivate	Cleanliness Sa 2½. Dust & debris 0,5%. No oil or grease. Profile 25-50 µm.	Zinc phos- phate SANS 1319	GP undercoat SANS 681 Type 2	Enamel SANS 630 Type 2 (ext) Type 1 (int) 1 coat (int) 2 coats (ext)	Smooth, glossy finish, free from visible defects. DFT minimum 75 µm - interior 100 µm - exterior	Light fast pigments for exterior use. Colour as specified by the Engineer.
A2	Factory cleaned and primed steel sur- faces	Abrade the surface, degrease, wash and dry	Dust & debris 0,5%. No oil & grease. Water-break-free surface. Dry.	Zinc phos- phate SANS 1319. Touch up, plus 1 coat all over.	GP undercoat SANS 681 Type 2	As A1	As A1	As A1
A3	Factory finished surfaces	Sand surface. Touch up damaged areas Sand the entire surface	As above.	Touch up only.	Touch up only.	Enamel SANS 630 Type 1 (int) 1 coat (int) 2 coats (ext)	As A1 but total DFT not less than 50 µm - interior. Type 2 (ext) 75 µm - exterior.	Do not use in chlorination rooms - see specification D2.
A4	Galvaniz ed steel	Degrease, abrade or sweep-blast Remove debris	Zinc removal not more than 10 µm. Water-break-free surface. Allow to dry.	Special primer - see specificatio n	GP under- coat. One coat SANS 681 Type 2	As A1	As A1	Thorough degreasing necessary and complete drying of primer before



								applying undercoating.
A5	Plastic surfaces	Abrade the surface, degrease, wash and dry	Matt clean surface.	As A4	None.	Two coats SANS 630 Type 1 or Type 2	As A1. Alkyd enamel.	DO NOT USE SOLVENT DEGREASER - only water-based detergent type. Primer must be completely dry before applying enamel.

NOTE: These summary Tables are for convenient reference. Their use does not absolve the Contractor from compliance with all the requirements of the specification.

TABLE PQ 13.1 : SUMMARY OF COATING SYSTEMS (continued)

**SYSTEM B - TWO-PACK EPOXY SYSTEMS**

**SCOPE:** For application to surfaces to be submerged, in splash zone or in corrosive environments.  
Surfaces exposed to sunlight shall be protected from UV light by applying acrylic modified polyurethane - see B4.

SYS- TEM NO	SUB- STRATE	SURFACE PREPARATION		COATING SYSTEM				NOTES
		METHOD	REQUIREMENT	PRIMER	UNDERCO AT	FINISH	REQUIREMENTS	
B1	Bare steel	Blast clean	Sa 3	Three or four coats of solvent-borne Epoxy-Polyamide SANS 1217 Type 1A.  Each coat to differ in colour from the previous coat.			Smooth, glossy, free from visible defects.  DFT min 250 max 400 µm	Precautions required on overcoat times to avoid solvent retention.  Repairs permissible if correct procedure is followed.
	Cast iron	Blast clean (non re-used abrasive). Fill all blowholes.	Sa 3	Each coat to be applied within the thickness and time limits specified by the manufacturer.			Underwater surfaces free from EID at 90 volts 2 megohms.	Note overcoat times.
B2	Galvanized steel or cast iron	Degrease, abrade, remove debris.	Water-break free. Not more than 10 µm of zinc removed.	Special two pack epoxy primer followed by 2 coats epoxy polyamide as used in B1.			As B1, except that DFT shall be min 150 max 250 µm.	As for B1.
B3	Mild steel	Blast clean	Sa 3					

SYS- TEM NO	SUB- STRATE	SURFACE PREPARATION		COATING SYSTEM		NOTES
				One or two coats (wet on wet) of solvent free epoxy SANS 1217 Type 1C.	Smooth, glossy, free from visible defects.	Special spray equipment required. Contractor may be required to demonstrate that machine delivers the correct ratio of components
	Cast iron	Blast clean (non re-used abrasive)	Sa 3	Mix ratio of components is critical - machine must be frequently stripped to maintain cleanliness internally.	DFT min 250, max 500 µm  Free from EIDs at 90 volts 10 megohms	
B4	Mild steel	Blast clean	Sa 3	System B1 plus -	Smooth, glossy, free from visible defects.	Precautions required on overcoat times to avoid solvent retention.
	Cast iron	Blast clean (non re-used abrasive)	Sa 3	Topcoat - Acrylic modified Polyester Aliphatic Polyurethane enamel.	DFT min 250 max 450 µm	

**NOTE:** These summary Tables are for convenient reference. Their use does not absolve the Contractor from compliance with all the requirements of the specification.

TABLE PQ 13.1 : SUMMARY OF COATING SYSTEMS (continued)

SYSTEM C - TWO-PACK EPOXY-TAR SYSTEMSSCOPE: For application only to surfaces to be submerged and not exposed to UV light.

SYS- TEM NO	SUB- STRATE	SURFACE PREPARATION		COATING SYSTEM				NOTES
		METHOD	REQUIREMENT S	PRIMER	UNDERCO AT	FINISH	REQUIREMENTS	
C1	Mild Steel	Blast clean	Sa 3	Three or four coats of Epoxy-tar composition SABS 801 Type 1 or Type 2. Alternative colours for each coat.			Smooth, glossy, free from visible defects.	Precautions required on overcoat times to avoid solvent retention. Repairs permissible if correct procedure is followed.
	Cast Iron	Blast clean (non re-used abrasive)	Sa 3				DFT - minimum 250 µm maximum 400 µm Free from EIDs at 90 volts 2 megohms	
C2	Galvanized steel or aluminium surfaces	Degrease, abrade, remove debris.	Water-break free. Not more than 10 µm of zinc removed.	Two or three coats of Epoxy-tar composition - SABS 801 Type 1 or Type 2. Alternative colours each coat.			Smooth, glossy, free from visible defects. DFT - minimum 150 µm maximum 300 µm	Precautions required on overcoat times to avoid solvent retention.

**NOTE:** These summary Tables are for convenient reference. Their use does not absolve the Contractor from compliance with all the requirements of the specification.

TABLE PQ 13.1 : SUMMARY OF COATING SYSTEMS (continued)

**SYSTEM D - VINYL SYSTEMS**

**SCOPE:** For application to surfaces exposed to chemical pollution by chlorine, ferric-chloride solutions or similar corrosive environments.  
For immersed service, use epoxy systems, such as B1 or B4.

SYS- TEM NO	SUB- STRATE	SURFACE PREPARATION		COATING SYSTEM				NOTES
		METHOD	REQUIREMENTS	PRIMER	UNDERCOAT	FINISH	REQUIREMENTS	
D1	Mild Steel	Blast clean	Sa 2½	Vinyl	Two coats of high-build vinyl	Vinyl enamel	Smooth, glossy or semi-glossy, no visual defects. DFT 200 - 300 µm or 125 - 225 µm	Note definition of vinyl. Saponifiable matter not permitted.
	Cast iron	Blast clean (non re-used abrasive)	Sa 2½	Vinyl				
D2	Painted or plastic items in chlorination rooms	Degrease, abrade, remove debris.	Uniform matt grease-free surface.	Water-based vinyl.	None.	Two coats of vinyl enamel.	Smooth, glossy or semi-glossy, no visual defects.	Pigments shall be unaffected by chlorine or bleach solution.
D3	Galvanized steel	Degrease, abrade or sweep blast clean	Uniform matt grease free surface	Water-based vinyl high-build vinyl	One coat of high-build vinyl	One coat of vinyl enamel	Smooth, glossy or semi-glossy no visual defects DFT - 125 - 180 µm	See D1.

**NOTE:** These summary Tables are for convenient reference. Their use does not absolve the Contractor from compliance with all the requirements of the specification.

TABLE PQ 13.1 : SUMMARY OF COATING SYSTEMS (continued)

SYSTEM E - TWO COMPONENT SOLVENT FREE POLYURETHANESCOPE: For abrasive and acidic underwater conditions.

SYS- TEM NO	SUB- STRATE	SURFACE PREPARATION		COATING SYSTEM			NOTES
		METHOD	REQUIREMENT S	PRIMER	UNDERCOAT FINISH	REQUIREMENTS	
E1	Mild Steel	Blast clean	Sa 3	Special primer	One or two coats of solvent free polyurethane applied by special two-component hot spray machine.	Smooth, glossy, no visual defects. DFT - minimum 1 mm. Free from EIDs at 5 kV.	Surface and ambient conditions must be DRY. For MILD abrasive conditions.
E2	Mild Steel	Blast clean	Sa 3	Special primer	One or two coats of solvent free polyurethane applied by special two-component hot spray machine	Smooth, glossy, no visual defects. DFT - minimum 2mm. Free from EID's at 10 Kv	Surface and ambient conditions must be DRY. For HEAVY abrasive conditions.
E3	Mild Steel	Blast clean	Sa 3	Special primer	Multi coats of solvent free polyurethane applied by special two-component hot spray machine.	Smooth, glossy, no visual defects. DFT - minimum 3 mm. Free from EID's at 15 kV.	Surface and ambient conditions must be DRY. For VERY HEAVY abrasive conditions.

NOTE: These summary Tables are for convenient reference. Their use does not absolve the Contractor from compliance with all the requirements of the specification.

TABLE PQ 13.1 : SUMMARY OF COATING SYSTEMS (continued)

**SYSTEM F - POWDER COATINGS****SCOPE:** Powder coating of cable racks, handrails, control boxes, etc.

SYS- TEM NO	SUB- STRATE	SURFACE PREPARATION		COATING SYSTEM			NOTES
		METHOD	REQUIREMENTS	PRIMER	POWDER	REQUIREMENTS	
F1	Mild Steel	Chemical Phosphating.	Fine grain zinc or iron phosphate.	Special epoxy polyamide.	Polyurethane SANS 1274, Type 6.	Smooth, glossy. DFT 80 - 140 µm. See also SANS 1274, Type 6, Table 7.	For exterior use.
F2	Mild Steel	Chemical Phosphating.	As F1.	Nil	Thermoset or Thermoplastic	Thermoset - DFT min 75 µm. Thermoplastic - DFT min 300 µm. See also SANS 1274, Type 5.	Interior and exterior use.
F3	Aluminium	Chemical BS 6496, Section 3, Clause 8.	See BS 6496.	Nil	Special powder. See BS 6496, Section 2.	DFT min 50 max 120 µm. Full cure BS 6496, Section 10	For aluminium door and window frames, handrails and similar hardware.

**NOTES:** For Fusion Bonded Epoxy Powder Coating of pipes, valves and pumps, see Civil Specification S0105.

These summary Tables are for convenient reference. Their use does not absolve the Contractor from compliance with all the requirements of the specification.



TABLE PQ 13.1 : SUMMARY OF COATING SYSTEMS (continued)

**SYSTEM H - HEAT RESISTANT SYSTEMS****SCOPE:** Compressor heads, incinerators, mufflers and stacks Resistance up to 400°C maximum.

SYS- TEM NO	SUB- STRATE	SURFACE PREPARATION		COATING SYSTEM			NOTES
		METHOD	REQUIREMENTS	PRIMER	TOP COAT	REQUIREMENTS	
H1	Mild Steel or Cast Iron	Blast Clean in separate	Sa3 Profile 50 - 70 µm	Two pack Zinc Silicate	Heat resistant Phenolic Aluminium	Smooth, metallic lustre DFT 70 – 120 µm	Primer to be applied at works. Top coat may only be applied on site unless facilities are available for heat curing.

**NOTE:** These summary Tables are for convenient reference. Their use does not absolve the Contractor from compliance with all the requirements of the specification.

**S0105 FUSION BONDED EPOXY (FBE) POWDER COATING OF PIPES***General*

Fusion Bonded Epoxy (FBE) coating is tough and durable, with excellent adhesion and resistance to cathodic disbondment. It is only 300 to 500 micrometres in thickness, hence every care needs to be taken in handling, transportation and laying to prevent mechanical damage to the coating.

*Material*

*Powder used for the pipe coating shall be a special Pipe Coating Grade of Epoxy Powder. It shall comply with the requirements of SABS 1217, Type 2, except where otherwise specified in Table 1.*

**TABLE 1 – QUALIFICATION REQUIREMENTS OF EPOXY POWDER**

PROPERTY	REQUIREMENT	TEST METHOD
1. Dielectric Strength	Not less than 30 KV/mm.	SABS 1217, Section 8.10.
2. Cathodic Disbonding	Total disbonded area inclusive artificial holiday not to exceed 20 mm diameter average of 4 readings at 45° to each other after 30 days. This is equivalent to a disbonded area of 276 mm <sup>2</sup> . Current flow not to exceed 5 mA.	ASTM G8, Method B - Magnesium Anode - 20°C 7 mm diameter holiday.
3. Accelerated Cathodic Disbonding	Total disbonded area inclusive artificial holiday not to exceed 12 mm diameter, average of 4 reading at 45° to each other. This is equivalent to a disbonded area of 106 mm <sup>2</sup> .	Impressed current. -1,5 volts potential to calomel electrode, at 75°C for 48 hours. 3 mm diameter holiday.
4. Water Soak Test	Disbonded length not to exceed 5 mm from point of V-cut.	Immerse in water at 75°C for 48 hours. Remove and make V-cut at 30° angle. Test adhesion when cooled to 25°C.
5. Flexibility Tests	No electrical insulation defects after bending.	Bend at 0°C to 2% strain.
6. Impact Resistance	No electrical insulation defects after impact.	ASTM G-14 but using flat panel of 6mm steel rigidly clamped to a solid steel substrate, impacted at 4 joules.

**NOTES:**

- Tests 5 and 6 are carried out on 6mm thickness steel test panels, blast cleaned, prepared, coated and cured in accordance with the powder manufacturer's recommendations.
- Impact resistance is determined with the substrate solidly clamped such that when impactor strikes the coating it does so with a dull thud.

The impactor shall not rebound more than once. Three successive tests or 3 out of 4, shall show no electrical insulation defects after impact.

Surface Preparation

The exterior of the pipes shall be prepared as specified in clause 5.7 of the standard specification for general corrosion protection. The use of organic chromating solutions is permissible provided that they are used in accordance with the manufacturer's recommendations.

#### Application of Powder

The pipe shall be heated by induction heaters to the temperature specified by the powder manufacturer and fine adjusted to achieve all the requirements of Table 1 in the finished application. Having established the optimum temperature for each size pipe, the temperature shall not vary more than 5°C. Powder, which shall not contain recycled powder, shall be applied by fluidised transfer to a bank of electrostatic guns, set to the voltage recommended by the powder manufacturer, and adjusted to produce a uniform coating within the thickness range specified. Air used for fluidising the powder shall be free from water, oil or other contaminants. Powder shall pass through a magnetic separator in order to remove any steel contamination and through a sieve to remove oversize particles before reaching the spray guns. Coated pipes may be quenched with water spray provided that the powder is fully cured, free from defects and latent defects.

#### Requirements of the coated pipe

The coating shall be uniform and consistent in gloss and shall comply with all the requirements given in Table 2.

**TABLE 2 – REQUIREMENTS OF CURED EPOXY POWDER COATING**

PROPERTY	REQUIREMENT	TEST METHOD
1. Visual	Smooth, glossy or semi-glossy finish, free from excessive runs, sags, orange-peel, occlusions or other visible defects.	Use an experienced observer.
2. Coating Thickness	Minimum 300, maximum 500 µm.	SABS Method 141 Take a minimum of 2 readings per m <sup>2</sup> of surface up to 600 mm nominal bore, or 1 reading per m <sup>2</sup> over 600 mm.
3. Electrical Insulation Defects	Nil defects at 3500 volts applied DC voltage. For method of repair, see relevant section.	SABS 1217 Section 8.12.2. Applied voltage to be measured during corona discharge (not on open circuit) with an approved meter, calibrated regularly.
4. Impact Resistance	No defect at 2 joules.	SABS 1217 Section 8.7 but modified as given in Note below.
5. Degree of cure: (a) Static test (b) Dynamic Test (c) Thermal characteristics	No softening or discolouration.  No softening or discolouration.  Delta T <sub>g</sub> shall not exceed 3°C. Chemical conversion shall not be less than 90%.	SABS 1217 Section 8.9  50 double rubs with cotton wool swab soaked in MEK. Differential Scanning Calorimetry. Scan rate 20°C/min.
6. Adhesion (Hot Water Soak)	Not more than 5 mm disbonding from point of V.	Immerse in water at 75°C for 48 hours. Make V-cut at 30° angle. Test adhesion when panel has cooled to 25°C.
7. Cathodic Disbonding (accelerated)	Total disbonded area (including holiday) not to exceed 12 mm diameter.	Impressed current on a 3 mm artificial holiday. Apply a DC voltage to maintain the test surface at a potential of -1,5 to ±0,1 volts to a standard

		calomel electrode. Maintain at 75°C for 48 hours then dismantle, cool and test for disbondment.
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**NOTE:**

Impact resistance testing shall be carried out on a production pipe. The inside of the pipe shall be supported by a wooden block fitted vertically across the internal pipe diameter.

A solid steel rod approximately 40 mm diameter shall be placed on top of the block such that the length of the rod is parallel to the axis of the pipe and immediately below the point of impact.

The bottom of the block shall be chocked tightly to remain rigid when the impactor strikes the pipe. When the impact tool strikes the pipe, it shall produce a dull thud and shall not rebound more than once. Damage to the coating shall be assessed by measuring electrical insulation defects (as in 3) after the impact test. Three successive tests, or a minimum of 3 out of 4, shall show no electrical insulation defects after impacting at 2 joules.

Repair of Fusion Bonded Epoxy Coated Pipes (small areas)

When repairs are permissible, the following method shall be used.

- (a) Abrade an area at least 25 mm diameter around and beyond the defective area.

The abrasive paper shall not be coarser than 180 mesh and preferably 220 mesh. It shall preferably be used wet to avoid excessive removal of coating.

The repair area shall be smoothly feathered into the surrounding sound area. The repair area shall be abraded to a matt finish, free from deep scratches and excessive removal of coating.

After abrasion, the area shall be wiped clean with MEK or other suitable clean epoxy solvent and allowed to dry.

- (b) Repair material shall be a two component solvent free epoxy repair material approved by the Engineer. The colour shall differ from the colour of the epoxy powder. The mix material shall be sufficiently thixotropic that 500 micrometres dry film thickness can be achieved in one application in the vertical position without sagging. If this requirement is not achieved, the material shall be rejected.
- (c) Repair material shall be thoroughly mixed in the correct proportions as recommended by the manufacturer. No splitting of packs shall be permitted unless the material is supplied in self-metering containers.

The mixed repair material shall be applied to the clean, dry, abraded repair area so as to cover the defect and extend to within 1 or 2 mm of the edge of the abraded area. A "halo" of lightly abraded area shall be visible around the repair material.

- (d) Pipes shall not be moved until the repair material is cured and sufficiently hard to withstand the pressure of the pipes on the ramps. Cure may be accelerated by heating with infra-red lamps provided that the heat applied is insufficient to cause any damage to the surrounding coating, nor to cause bubbling, sagging or any other defect in the repair material.
- (e) After curing, the repair and at least 250 mm surrounding area shall be tested for electrical insulation defects specified in Table 2. There shall be no electrical insulation defects.

Repair of Fusion Bonded Epoxy (field welds)

FBE coated pipes shall be protected from weld spatter during site welding by suitable covers over the FBE. After welding, all weld protrusions, undercuts and weld spatter shall be removed.

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The bare area around the weld shall be blast cleaned with a Vacu-blast, Educt-omatic or similar vacuum blast equipment to prevent damage to the adjacent coating.

Alternatively, wire brushing and grinding may be permitted if a near-white metal finish is obtained. Abrade the adjacent FBE for at least 20 mm on each side. Remove all dust, then apply one or two coats of solvent free epoxy repair material to cover all the bare metal surface and the 20 mm strip of abraded FBE, to achieve a dry film thickness of not less than 500 micrometres.

Repairs shall be tested by High Voltage Spark Testing at a test voltage of 1500 Volts, which shall be maintained during corona discharge. No electrical defects shall be permitted.

**END OF SECTION**

## PHA : HIGH DENSITY POLYETHYLENE PIPES

### PHA 01 SCOPE

This specification applies to the furnishing of all labour, materials and services in connection with the manufacture, testing, delivery and installation of HDPE piping, joints, fittings and specials as specified in the documents and drawings.

### PHA 02 INTERPRETATIONS

#### PHA 02.1 SUPPORTING SPECIFICATIONS

Where this specification is required for a project, the following CODES AND STANDARDS shall, inter alia, apply.

All pipes, joints and fittings supplied under this specification shall, as a minimum, meet the requirements of the following specifications:

DIN DVS 2205-1	-	Welding Geometry
DIN DVS 2207	-	High Density Polyethylene pipelines
SANS 674	-	Steel reinforced spirally wound PE drainage and sewer pipes
SANS 1671 Part 1	-	Welding of thermoplastics - Machines and equipment – Heated tool welding
SANS 1671 Part 2	-	Welding of thermoplastics - Machines and equipment - Electrofusion welding
SANS 6269	-	Welding of thermoplastics - Test methods for welded joints
SANS 10268 Part 1	-	Welding of thermoplastics - Welding processes - Heated tool welding
SANS 10268 Part 2	-	Welding of thermoplastics - Welding processes – Electrofusion welding
SANS 10268 Part 10	-	Welding of thermoplastics - Welding processes - Weld defects
SANS 10269	-	Welding of thermoplastics - Testing and approval of welders
SANS 10270	-	Welding of thermoplastics - Approval of welding procedures and welds
SANS 21138	-	Plastic piping systems for non-pressure underground drainage and sewerage – Structured-wall piping systems of unplasticized poly vinyl chloride (uPVC), polypropylene (PP) and polyethylene (PE)
SANS 21138 Part 1	-	Material specifications and performance criteria for pipes, fittings and system
SANS 21138 Part 2	-	Pipes and fittings with smooth external surface, Type A
SANS 21138 Part 3	-	Pipes and fittings with non-smooth external surface, Type B

#### PHA 02.2 APPLICATION

This specification applies to medium-pressure high density polyethylene pipelines.

#### PHA 02.3 DEFINITIONS AND ABBREVIATIONS

For this purpose of this specification the definitions given in the specifications listed in 2.1 and the following definitions and abbreviations shall apply:

##### a) **Butt welding**

is the process for joining HDPE pipes by heating the planed ends of matching surfaces to the correct temperature and duration by holding them against a flat heating plate until the HDPE material reaches fusion temperature, and then quickly removing the heating plate and pushing the two softened ends against one another at the correct pressure and allowing it to cool down for the correct duration. Butt welding is also referred to as butt fusion welding and heated-tool butt welding.

**b) Electrofusion welding**

the welding process whereby the joining faces, i.e. the external surface of a pipe and the internal surface of a socket, are heated electrically to welding temperature by means of a resistance-wire heating coil that is an integral part of the socket.

**c) CCTV**

is Closed Circuit Television used for the internal inspection of pipelines.

**d) HDPE**

is High Density Polyethylene. Polyethylene materials of designation PE 80 and PE 100 are high density polyethylene materials.

**e) Special**

Any pipe other than a straight pipe. Under this definition are included all sizes of specials such as bends, tees, crosses, angle branches, tapers and purpose made pieces.

**f) Fittings**

A special, valve or any process of jointing (except welding) straight pipes to one another, or jointing straight pipes to specials and valves, or jointing of specials to one another.

**g) DIN DVS**

Is the Deutsches Institut für Normung e.V. (DIN); in English, the German Institute for Standardization develops standards for rationalization, quality assurance and safety.

DVS (Deutscher Verband für Schweißen und verwandte Verfahren e. V. ([www.dvs-ev.de](http://www.dvs-ev.de))) is specific guidelines from the German Society for Welding.

**PHA 03 REQUIREMENTS**

**PHA 03.1 MATERIAL**

**PHA 03.1.1 Pipes**

The raw material to be used in the manufacture of the HDPE pipe shall be PE100 and pipes shall be manufactured in accordance with SANS ISO 4427 and also include the following marking :

- Supplier
- ISO 4427
- Nominal Pressure (PN)
- Nominal Diameter (DN)
- Mechanical properties (PE)
- SABS

All pipes installed shall be Class PN12.5 HDPE or as specified on drawings or in the Bill of Quantities.

HDPE pipes shall be supplied in the maximum possible continuous lengths permitted by diameter and handling constraints.

The supplier of the pipes and fittings must have ISO 9002 accreditation; proof of this accreditation must be submitted to the Engineer prior to ordering of materials.

All materials supplied and installed shall be guaranteed to be free of defects arising from the manufacture, transportation, installation or any other process or factors.

**PHA 03.1.2 Couplings, Fittings and Sockets**

All couplings, fittings and sockets used shall have ISO 8085-1 and ISO 8085-2 accreditation and shall be of a rating equal to or greater than that of the pipe on which they are to be used.

All couplings and fittings installed outside chambers/structures must be protected by applying a double layer of Denso wrapping (or equivalent) around the fitting and 1 time the diameter either side of the fitting.

**PHA 03.1.2.1 Couplings**

The connection of HDPE pipes to fittings or to pipe sections of different material or dimension shall be completed by means of a HDPE flange adaptor with stainless steel backing ring continuously butt welded to pipe unless otherwise specified by the Engineer.

**PHA 03.1.2.2 Fittings**

Samples of fitting shall be submitted to the Engineer and Employer for approval prior to construction.

All stainless steel nuts and bolts must be installed with a copper-zinc anti seize compound approved by the Engineer.

Flanges, bends, gaskets, reducers, tees and other fittings shall, when installed, be capable of withstanding all operating and testing conditions of the application similar to the adjoining pipes.

All bends and T-pieces shall be moulded and connected by means of butt welding or electrofusion where butt welding is impossible.

**PHA 03.1.2.3 Sockets (Electrofusion fittings)**

All sockets used during the electrofusion shall be stored in original packaging and protected from environmental damage until installation and have melt indicators with appropriate labelling and barcode for welding purposes.

All fittings shall have:

- A Standard Dimension Ratio (SDR) of 11 and shall be PE100.
- Limited path fusion indicators
- Removable center stop
- Integrated screws sizes 20mm up to 63mm

**PHA 03.1.3 Packaging, handling and shipping**

Packaging, handling and shipping of the pipes shall be done in accordance with the Manufacturer's standards.

The Contractor shall submit these standards to the Engineer for acceptance prior to construction.

Damages to HDPE pipes may not exceed 10% of the wall thickness of the pipe. Extensive damage (more than 10% of the wall thickness) sections of the pipe shall be removed from site and rejoined by means of butt welding at the Contractors expense.



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**PHA 03.1.4     Testing and approval of Welders**

The welder shall have a Test Certificate for heated-tool butt welding issued by a South African Qualifications Authority (SAQA) accredited training facility and in accordance with SANS 10269. The welder's certificate shall not be older than three years for Installation and Fabrication Plastic Pipe Association (IFPA) members and not more than one year old for non-IFPA members.

Details of the operator's certification for this work are to be submitted to the Engineer for verification and approval before any welding work is carried out.

**PHA 04     PIPE JOINING****PHA 04.1     GENERAL**

Butt welding shall be used for joining of pipes and only under special circumstances and only after approval by the Engineer may electrofusion be used to joint pipes.

Welds shall be minimized as far as possible and standard pipe lengths must be supplied.

Pipe connections, specials, tees, reducers, etc. shall be butt welded and assembled within a controlled environment inside a building and thereafter transported to site and installed and connected to the pipelines at no additional cost to the Employer.

Before any production welding commences, the following shall be approved by the Engineer in accordance with SANS 10270 for heated-tool butt welding of pipe joints:

- A Welding Procedure Specification (WPS); and
- A qualification joint sample in accordance with paragraph 4.3.1 below.

The Contractor shall also provide a certificate of calibration for all welding equipment used in accordance with SANS 1671 (Machines and Equipment). The certificate shall bear the model and serial number of the welding machine, the name and address of the certifying agent, the date of the test and a statement as to the accuracy of the temperature and pressure gauges on the machine in question. The cost of the test shall be for the Contractor's account.

The Contractor shall advise the Engineer of the welding machine and of the welding parameters and tables to be used.

Butt welding of pipes must not be carried out in unsuitable weather conditions. If necessary, a shelter or tent must be used to protect the entire welding work area from extremes of temperature (-5 °C to +40 °C), humidity (<=75%), any precipitation and dirt especially during windy conditions.

Under no circumstances may any weld be conducted while a substance is flowing in pipe.

The strength of the weld must be similar to that of the parent pipe.

Both the welding procedure and testing shall be monitored continuously by the Contractor and the welding of pipes stopped if any deviation from the specification is detected, the Contractor shall make the necessary changes to the procedure in order to allow welding to continue. No additional time will be considered for such delays.

The tender price submitted for the work to be executed must include the cost of establishment, furnishing of all materials, plant, plant operations and equipment necessary to do the work during the period of the contract.

Any latent defects which will affect the integrity and strength if the new pipeline shall be repaired at the Contractor's expense in a manner to be mutually agreed to by the Engineer and the Contractor.

Under no circumstance shall a butt weld be constructed within 1500mm from another butt weld. Thus, the minimum pipe length between two welds shall be 1500mm

#### **PHA 04.2      PIPE DELIVERY INSPECTION**

Pipes shall be inspected upon delivery and may be rejected if damaged or deformed in any way. All pipes delivered to site and accepted shall be signed for on the delivery docket, including the date, time, name, and organisation of the person accepting delivery. Visual inspection shall satisfy the requirements in Table 1.

**Table 1 Visual inspection requirements**

<b>Condition</b>	<b>Requirement</b>
Ovality	1 % of mean diameter.
Eccentricity	Pipe wall thickness measured at any point must be such that the SDR calculated on the thickness is within the stipulated range.
Surface finish	There shall be no extrusion die marks or spider-lines, or evidence of crazing, flaking, or indication of disintegration.
Scratches	None on the internal surface. External surfaces shall be free from longitudinal or circumferential scratches deeper than 10 % of the pipe wall thickness.
Cracks	The pipe shall be completely free from cracks.
Voids or inclusions	There shall be no visible voids or inclusions of extraneous matter.
Protuberances	Ridges or ripples shall not exceed 0.5 mm in height.

#### **PHA 04.3      BUTT WELDING OF HDPE PIPES AND FITTINGS**

Pipe welding shall be carried out only by an experienced pipe welder, who must have current competency accreditation as set out in clause 3.1.4.

All butt welding of HDPE piping shall be as specified in SANS 10268 – Part 1 (Heated tool welding) and which will be subjected to acceptance testing in accordance with SANS 10268 Part 10, assessment class 1 (Weld Defects). All joints shall be watertight.

The Contractor shall provide a digital thermometer or equivalent for the accurate measurement of the weld temperatures.

All internal joint beads shall be removed to provide a smooth and flush pipe inner surface, without compromising the strength of the pipe joint if scheduled in the Bill of Quantities. No separate payment shall be made for the welding of pipes and for the removal of internal beads. The removed beads shall be retained for inspection and external beads shall be removed only if specifically requested by the Engineer.

##### **PHA 04.3.1      Butt welding test weld**

Before any welded joints are made on material which will be used in the pipeline, the operator shall prepare a sample weld, for each size and SDR rating as that which will be used to assemble the pipeline used in the contract, using:

- The welding machinery;

- The welding parameters;
- A section of the pipe from the batch, and of the same size and SDR rating;
- The same certified operator who will perform the welds used in the pipeline.

These samples shall be tested in accordance with SANS 6269 in a testing facility approved by the Engineer. No pipeline welding shall proceed until satisfactory test results have been produced.

If at any time in the Contract, any new combination of pipe batch, size, SDR, welding equipment, welding parameters, and operator is introduced, a further test weld series as specified in this clause will be required.

If pipe is supplied in batches exceeding 500m length, a separate test weld series will be required for each 500m or part thereof.

#### **PHA 04.4      ELECTROFUSION WELDING**

Electrofusion welding shall be avoided as far as possible and butt welding shall be done wherever possible.

Electrofusion welding may only be undertaken under special circumstances and only after approval by the Engineer.

Pipe welding shall be carried out only by an experienced pipe welder, who must have current competency accreditation as set out in clause 3.1.4.

All electrofusion welding of HDPE piping shall be as specified in SANS 10268 - Part 2 (Electrofusion welding) and in accordance with the manufacturer's instructions. All welds will be subjected to acceptance testing in accordance with SANS 10268 - Part 10 (welding defects) assessment class 1.

#### **PHA 04.5      CONSTRUCTION RECORD**

The Contractor must institute an acceptable quality control monitoring procedure so that accurate records are kept of welds. Weld records shall include:

- weld reference recorded and marked on pipe,
- date,
- pipe section information,
- weather,
- welding conditions,
- welding operator,
- welding times, (heating and cooling)
- final position of joint (GPS coordinate and level); and
- a record of inspections of completed welds.

The control of the welding procedure is solely the responsibility of the Contractor and adequate provision must be made in the priced rates to accommodate the quality control.

The contractor is to advise the Engineers Representative as soon as practicable in case of any significant non-conformance. Otherwise quality records are to be submitted within 5 working days after completion of the process to which they relate.

If the Contractor fails to comply with the provisions of this clause and not supply the records timely, notwithstanding the provisions of Clause 6 of the General Condition of Contract (GCC 2010), the Engineer may exclude HDPE pipes from the payment certificate next due and any subsequent payment certificates, until such time as the Contractor complies with the provisions of this clause.

**PHA 05      TESTING****PHA 05.1      TESTING PROCEDURE**

Testing of HDPE pipelines shall be in accordance with SABS 1200 L subject to the following :

**PHA 05.1.1      Testing**

The Contractor shall make allowance in his rates for the supply of any equipment necessary to allow for the testing of the continuously welded HDPE prior to installation, as well as for the inspection of pressurized water mains once it has been installed.

**PHA 05.1.2      Test pressure**

All Polyethylene pipes have reduced strengths at higher temperatures. Testing pressures must be reduced when the test section is tested at higher temperatures. The testing pressure must be multiplied by the fractions applicable in Table 5.1.2. (Ambient temperature)

**Table 5.1.2: Reducing factors when testing occurs at higher temperatures**

Test section temp (°C)	<= 27	<= 32	<= 38	<= 43	<= 49	<= 54	<= 60
Fraction	1.00	0.9	0.8	0.75	0.65	0.6	0.5

**PHA 05.1.3      Test duration**

The maximum test duration is eight (8) hours including time to pressurise, time for initial expansion, time at test pressure and time to depressurise the system below design pressure.

If the test is not completed due to leakage, equipment failure or any other reason, the entire tests section should be depressurised completely. Thereafter it must be allowed to relax for at least eight (8) hours before pressurising of the system can be commenced again.

**PHA 05.1.4      Phases of the Hydrostatic leak testing procedure**

The hydrostatic leak test procedure consists of filling, an initial expansion phase, a test phase and depressurising. There are two alternatives for the test phase.

**PHA 05.1.4.1      Filling**

Fill the restraint section completely with test liquid, usually clean water.

**PHA 05.1.4.2      Initial expansion phase**

During this phase the test section is gradually pressurised to test pressure. During the initial expansion phase, polyethylene pipes will slightly expand and additional test liquid will be required to reach and maintain the desired testing pressure. It is not necessary to monitor the amount of water added during this period.

**PHA 05.1.4.3      Testing phase**

Immediately following the initial expansion phase, monitor the amount of make-up water required to maintain test pressure of one (1) hour in accordance with SABS 1200 L.

**PHA 06      MEASUREMENT AND PAYMENT**

Measurement and payment shall be in accordance with SABS 1200 L (as amended) and the following additional scheduled items.

**PHA 06.1      SCHEDULED ITEMS**

**PHA 06.1.1**      Performing                      and                      Testing                      of                      weld  
 .....Unit :  
 No

Various pipe diameters will be scheduled. The tendered rate shall include full compensation for the cost of all labour, material and overheads to complete the weld including the testing (according to SANS 6269) of the welds by an independent laboratory approved by the Engineer.

**PHA 06.1.2**      Removal of internal beads ..... Unit : m

Various pipe diameters will be scheduled. The tendered rate shall include full compensation for the cost of all labour, material and overheads to remove the internal beads formed due to butt welding.

**END OF SECTION**

**WA : CONCRETE BLOCK PAVEMENTS****WA1. SCOPE**

This Particular Specification covers all the work in connection with the construction of cast in situ concrete pavements, applicable to the required work and for constructing the concrete pavement, where concrete is placed by hand and where side forms are used.

**WA2. INTERPRETATION****WA2.1 SUPPORTING SPECIFICATIONS**

The following specifications, shall, inter alia, be applied together with this Specification:

- a) Specification Data;
- b) SANS 1200 and applicable Amendments

The construction details are presented on the Project Drawings

**WA2.2 DEFINITIONS**

For the purposes of this Specifications the definitions and abbreviations given in the applicable Specifications listed in 2.1 shall apply.

**WA3. MATERIAL****WA3.1 CEMENT**

The cement shall be normal Portland cement which complies with the following:

“Where reference is made in this specification or the Standard Specifications to be cement specifications, e.g., SANS 471: Portland cement and rapid hardening Portland cement, it shall be replaced with the new specification:

SANS ENV 197-1: Cement-composition, specifications, and conformity criteria.  
Part 1: Common cements.

Furthermore, where reference is made in this specification or the Standard Specifications to different cement types, the following new names shall be used as a guide but must be confirmed by the Employer's Agent:

Cement Grade	Cement Type	Approximate old product name	New Alpha	New Blue Circle	New NPC	New PPC	New Slagment
52.5	CEM I	Rapid hardening	Rapid Hard	Duracast	Eagle Super		-
42.5R	CEM I	Rapid hardening	-	-	-		-
42.5	CEM I	OPC*	Portland Cement	Duratech	-	OPC	-
	CEM I	LASRC	-	-	-	LASRC	-
	CEM II A-S	PC15SL	-	-	Eagle Plus	-	-
	CEM II B-S	RH30SL			Eagle Plus	-	-
32.5R	-	-	-	-	-	-	-
32.5	CEM II A-V	PC15FA	All-purpose	-	-	Surebuild	-

			cement				
	CEM II A-W	PC15FA	-	-	-	Surebuild	-
	CEM II A-L	-	All-purpose cement	-	-	Surebuild	-
	CEM II B-V OR W	PC25FA/PFA C**	-	Structcrete	-	Surecrete	-
	CEM II B-V OR W	PC25FA/PFA C**	-	Duracrete	-	Surecrete	-
	CEM III A	PBFC	-	BFC	Eagle Pro	-	PBFG
	CEM III A	RHSL	-	-	-	-	RHSL
22.5	MC 22.5X	PFAC***	Multi-purpose cement	Durabuild	-	-	-
	MC22.5X	PFAC***	-	Buildcrete	-	-	-
12.5	MC 12.5	Walcrete	Mortar cement	Walcrete	-	Masonry	-
	MC 12.5	Mortacem	-	-	-	-	-

Note: \*OPC cements previously performed approximately as CEM I 32.5R products.  
 \*\*PC25FA cements under the old standards achieved lower compressive strengths than the OPS's of the time.  
 \*\*\*Some PFAC cements meet the new standard for MC 22,5X. Others required modification before meeting the requirements for MC 22,5X."

### WA3.2 WATER

Water shall be clean and free from harmful concentrations of acids, alkalis, salts, sugar or other organic or chemical substances. If the water used is not obtained from a public drinking-water main, the Employer's Agent may require the Contractor to have the suitability of the water proved by tests made by an approved laboratory. The costs of these tests or any subsequent tests ordered by the Employer's Agent shall be borne by the Contractor.

### WA3.3 AGGREGATE

The aggregates shall comply with SANS 1083 but shall be subject to the following:

- (a) The shrinkage of both fine and coarse aggregate shall each not exceed 130% of that of the reference aggregate referred to in the SANS standard.
- (b) Coarse aggregate shall comply with the 10% FACT values specified in the SABS standard for stone to be used in concrete which is subject to abrasion.

In addition, the aggregates shall comply with the following requirements:

- (i) The fine aggregate shall be either a natural or crusher-produced sand, or a blend of natural and crusher sands.
- (ii) Wherever feasible, the grading of the fine aggregate shall be such that not less than 8% is retained between the 4,75 mm and 2,36 mm sieves and not less than 12% between the 2,36 mm and 1,18 mm sieves.
- (iii) Aggregates shall not contain any deleterious amounts of organic materials such as grass, timber, or other similar materials.
- (iv) The nominal maximum size of coarse aggregate shall be 37,5 mm.
- (v) The coarse aggregate shall be supplied in two separate nominal sizes, the larger of which shall be 37,5 mm and the smaller size either 19,0 mm or 13,2 mm. The relative proportions of larger and smaller aggregate shall be determined by laboratory testing.
- (vi) Coarse aggregate produced from limestone, felsite, dolomite, or other calcareous rocks will not be permitted unless authorized by the Employer's Agent.

- (vii) The flakiness index of the fraction of the coarse aggregate smaller than 37,5 and larger than 26,5 mm, determined in accordance with SABS Method 847, shall not exceed 35.

#### **WA3.4      ADMIXTURES TO CONCRETE**

Admixtures shall not be used in concrete without the written approval of the Employer's Agent, who may require that tests be made before they are used to prove their suitability.

Admixtures, if allowed, shall comply with the following requirements:

- (a) Admixtures shall be used only in liquid form and shall be batched in solution in the mixing water by means of a mechanical batcher capable of dispensing the agent in quantities accurate to within 5% of the required amount.
- (b) Admixtures shall comply with the requirements of ASTM C-494 or AASHTO M-154 and shall be an approved brand and type.
- (c) Air-entraining agents shall comply with the requirements of ASTM C-260 or AASHTO M-194.

#### **WA3.5      REINFORCING**

Reinforcing shall comply with the relevant requirements of SANS 1200 G.

#### **WA3.6      CURING COMPOUND**

The curing compound used shall be a white-pigmented, resin-based curing compound which complies with the requirements of AASHTO M-148, except that the water loss as determined by the water-retention test shall not exceed 0,040 g/cm<sup>2</sup>.

A valid certificate from an approved testing laboratory shall be submitted, to certify that the curing compound complies with the specifications and that further testing shall be carried out at regular intervals.

The curing compound shall be capable of being sprayed onto a wet surface without loss of stability or performance. This characteristic shall also be certified by the approved testing laboratory.

#### **WA3.7      JOINT SEALERS**

- (a) Joint filler

The joint filler for the expansion joints shall be manufactured from a closed-cell polyethylene, and the filler strips shall be provided with a tear-off cover strip. The joint filler shall be of an approved brand, such as Sondor or an equivalent material, and the type used shall be subject to approval by the Employer's Agent.

- (b) Liquid sealant in joints between concrete and asphalt pavements

The liquid sealant used in joints between concrete and asphalt pavements shall be a hot poured type joint-sealing compound which complies with the requirements of US Federal Specification SS-S-1401B.

- (c) Polysulphide sealant

Two-component polysulphide sealant shall comply with the requirements of SABS 110.

#### **WA3.8      TIE BARS AND DOWELS**

- (a) Tie bars



Tie bars shall consist of deformed hot-rolled mild steel or deformed hot-rolled, high-yield-stress steel which comply with the requirements of SANS 920, except that any tie bars to be bent and later re-straightened shall be of mild steel.

Tie bars of the required dimensions and spacing shall be placed at right angles to the joints. The tie bars shall be free of paint, grease or other coatings that may affect bonding with the concrete.

At the construction joints, one half of the tie bar shall be supported by suitable stools placed on the subbase, while the other half shall project into the adjacent panel. Alternatively tie bars at longitudinal joints may be bent parallel to the edge of the first panel constructed and shall be straightened into their final positions before the concrete of the adjacent panel is placed, provided that the method of fixing and support is approved by the Employer's Agent.

At weakened-plane hinge joints the bars shall be firmly supported on steel supporting devices fixed to the subbase.

(b) Dowels

Dowel bars shall consist of plain, round mild-steel bars which comply with the requirements of SANS 920. The dimensions and spacing of dowel bars shall be as shown on the Drawings.

Dowel bars shall be straight, free from burred edges or other irregularities and with bevelled sliding ends. The free or unbonded end of the dowel shall be coated with a bond-breaking compound which consists of 200 penetration-grade bitumen blended hot with 14% light creosote oil and later, when cold, brought to the consistency of paint by the addition of 20% solvent naphtha.

Dowels shall be held rigidly in horizontal and vertical alignment by an approved dowel-supporting frame. The dowel shall not be tack-welded to the supporting frame but shall be held in position by soft binding wire.

A tolerance of not more than 2 mm in 300 mm (1 in 150) from the correct alignment, either vertical or horizontal, will be permitted prior to concreting. After concreting, the tolerance for dowels shall remain within 4 mm in 300 mm.

#### **WA4. CONSTRUCTION**

##### **WA4.1 PREPARATION OF UNDERLYING LAYERS**

###### **WA4.1.1 General**

The underlying layers shall be constructed in accordance with these specifications up to the level of the underside of the concrete pavement.

The Contractor shall note that the specified construction tolerances for any underlying layers shall not relieve him of his responsibility to construct the concrete pavement to the requirements for thickness, grade, cross-section, and smoothness specified in Clause 5.

As the Contractor has to work to stricter tolerances on the concrete pavement than those obtained or specified for the underlying layers, the costs of any additional work involved with a view to complying with the requirements specified for the concrete pavement shall be included in the tendered prices for the concrete pavement. Similarly, the costs of any additional thickness of concrete which may be required to provide the thickness of pavement slab within the specified tolerances shall be borne by the Contractor, irrespective of any tolerances specified for the construction of the subbase.

###### **WA4.1.2 Wetting of the subbase**

The surface of the subbase shall be kept continuously wet for a period of at least one hour before the concrete is placed. Immediately before the concrete is placed, the excess water shall be broomed off to ensure that the subbase is still damp but without puddles of water or pockets of mud when the concrete is placed. The wetting is of particular importance during hot, dry weather, and no concrete shall be placed on a subbase that has not been wetted or that has dried out.

## **WA4.2      SIDE FORMS**

### **WA4.2.1    General**

Side forms shall be L-shaped and of steel. The thickness of the steel used shall not be less than 5 mm. Forms 250 mm or more in height shall be at least 250 mm wide at the base; forms less than 250 mm in height shall have a base width at least as wide as the height. Flange braces shall extend outwards on the base for at least two thirds of the height of the form. The forms shall be free from warps, bends or kinks. The top face of the form shall not vary from a true plane by more than 3 mm in 3 m. The inside face of the upstanding leg shall not vary from a true plane by more than 6 mm in 3 m.

Side forms shall be of sufficient rigidity, both in the form and in the interlocking connection with the adjoining forms, so that deflection and springing will not occur under the weight of the wet concrete which is placed in the pavement.

### **WA4.2.2    Setting of forms**

The forms shall be supported over their entire length. They shall be set to the correct height by means of steel shims and wedges or by other approved methods, and over the full length of the forms the space between the forms and the supporting layer shall be caulked with a 1:3 cement: sand mortar. The mortar bed shall be trimmed flush with the inside face of the forms.

The side forms shall be set to line and secured with not less than three pins over each 3 m of length, and one pin shall be fixed at each side of a joint. The top surfaces of the forms at all joints shall be flush.

The side forms shall be so set and supported that the finished slab surface will comply with the requirements specified in Clause 5; the slab edge shall nowhere be more than 3 mm out of vertical alignment.

The forms shall be cleaned and oiled immediately before each use.

The forms shall be fixed in position within a reasonable time for the Employer's Agent to inspect them prior to paving.

### **WA4.2.3    Removal of forms**

The side forms shall be removed before any sawing of transverse joints can be commenced.

The concrete and projecting tie bars shall not be damaged in any way during the removal of the forms.

## **WA4.3      CONCRETE WORK**

### **WA4.3.1    Requirements of concrete**

(a)    General

The specifications for materials to be used for the concrete shall not limit the Contractor's responsibility to manufacture concrete which complies with the requirements of SANS 1200 G.

(b) Minimum cement: water ratio

The cement: water ratio of the mix shall not be less than 1,9.

(c) Minimum cement content

The cement content of the mix shall not be less than 320 kg/m<sup>3</sup>.

(d) Specified strength

The specified strength shall be a 28-day compressive strength which corresponds to a 28-day design flexural strength of 4,5 MPa.

(e) The workability of concrete

The mix proportions and consistency shall be such that, with the equipment in use, the concrete can be fully compacted without the materials segregating or the occurrence of excessive bleeding.

#### **WA4.3.2 Determining of mix proportions**

(a) General

The preliminary proportions of cement and aggregate required to produce concrete which complies with the requirements of these Specifications shall be determined by way of laboratory tests on concrete which is manufactured from the cement, coarse and fine aggregates, air-entraining agent (if any) and water as proposed for use in the Works.

(b) Preliminary tests

At least 15 days prior to the construction of the trial pavement, as specified in Subclause 4.7, the Contractor shall submit for approval samples of the materials he proposes to use and a report from an approved testing laboratory which shows the proportions proposed for the paving concrete. The report shall also show the relationship between the 28-day compressive and flexural strengths for at least three cement: water ratios.

The tests for determining the relationship between the compressive and flexural strength shall be based on not less than six compressive strength specimens and not less than twelve flexural strength specimens for each cement: water ratio. All strength tests shall be made in accordance with SANS Methods 863 and 864.

(c) Changes in proportions or materials

- (i) If, during the progress of the work, the requirements set out in Subclause 4.3.1 are not being met by the concrete being manufactured, the Contractor shall immediately stop the production of such concrete and shall make such changes as may be necessary in the mix proportions and/or the materials in order to meet these requirements.
- (ii) Any changes made shall be at the Contractor's expense and no extra payment will be allowed on the grounds of such change.

(d) Changes in requirements

The Employer's Agent shall have the right, at any time during the progress of the work, to amend the requirements set out in Subclause 4.3.1. In such case the Contractor shall be

compensated in accordance with the terms of the Contract for the additional costs of materials or additional handling and placing or for other costs, if any, entailed by such changes.

#### **WA4.3.3 Batching, mixing and transporting of concrete**

Concrete shall be batched, mixed, and transported as specified in the relevant Clauses of SANS 1200 G.

#### **WA4.3.4 Placing and compaction**

##### **(a) Time for placing and compaction**

The placing, compacting, and finishing of the concrete shall be carried out as rapidly as possible and the operations shall be so arranged that, in any transverse vertical section of the slab, the concrete shall be fully compacted and finished within 2½ hours of mixing. This time shall be reduced by half an hour for every 5 °C by which the concrete temperature is above 20 °C at the time of placing, unless otherwise permitted by the Employer's Agent.

Unless adequate lighting facilities approved by the Employer's Agent are provided by the Contractor, the placing of concrete pavement shall cease at a time when the finishing operations can still be completed during daylight hours.

##### **(b) Adverse weather conditions**

###### **(i) Protection against rain and hail**

No concrete shall be placed during rainy weather. For the concrete to be properly protected against the effects of rain and hail until it has hardened sufficiently, the Contractor shall at all times have frame-mounted waterproof covers available for the protection of the surface of the unhardened concrete. When rain appears to be imminent, all paving operations shall cease, and all personnel shall take the necessary steps for affording complete protection to the unhardened concrete.

###### **(ii) Paving in cold weather**

All reasonable precautions shall be taken to ensure that the temperature of the pavement concrete will not fall below 5°C during the first 48 hours after casting. When prevailing temperatures are low or when cold weather is forecast and there is danger of the temperature of the freshly cast pavement concrete falling below the prescribed limits, the Contractor shall either cease concreting operations or he may be permitted to carry on, provided that the Employer's Agent is satisfied that adequate protective measures are available and will be taken.

###### **(iii) Paving in hot weather**

Hot weather is defined as any combination of high air temperature, low relative humidity and a wind velocity which is liable to cause cracking in the pavement and/or the impairment of the quality of fresh or hardened concrete, or which will otherwise result in abnormal properties.

When paving during hot weather and when the temperature of the fresh concrete can be expected to exceed 24°C, the Contractor shall implement appropriate precautionary measures to maintain the concrete at the coolest temperature as may be practicable.

Paving shall cease when the concrete temperature, while being discharged from the mixer, exceeds 32 °C.

##### **(c) Responsibility for protection**

The Contractor shall be responsible for the quality and strength of the concrete placed and for its protection, and any concrete damaged by adverse weather conditions shall be removed and replaced at the Contractor's expense.

(d) Maintaining the continuity of placing

The Contractor shall make adequate advance arrangements to prevent a delay in the delivery and placing of the concrete. An interval of more than 30 minutes between the placing of any two consecutive batches or loads of concrete shall constitute a cause for stopping any paving operations, and the Contractor shall, at his own expense make a construction joint in the concrete already placed, at the location and of the type as may be directed by the Employer's Agent. Paving shall be continuous, and the rate of paving shall be adjusted to suit the supplying of concrete.

(e) Width of placing

The width of concrete pavement to be placed in a single operation shall be as shown on the Drawings.

(f) Placing and spreading

The concrete shall be placed and spread to a surcharge of about one-fifth of the pavement thickness and shall thereafter be compacted, struck off and finished to the level of the side forms.

(g) Compaction and finishing

The concrete shall be compacted with poker vibrators which are followed by a steel-shod hardwood compacting beam not less than 75 mm wide and 225 mm deep. The beams shall be provided with mounted vibrators with an energy input of not less than 0,25 kW per metre length of beam. Alternatively, a vibrating twin-beam compactor of an equivalent power may be used.

The beam shall be lifted and moved forward by increments which do not exceed the beam width. After every 2 m the beam shall be taken back 2 m and then drawn slowly forward whilst vibrating over the compacted surface to provide a smooth finish. The surface shall then be regulated by at least two passes of a scraping straight-edge with a blade length of not less than 2 m. If the surface is torn by the straight-edge on account of irregularities in the surface, a further pass of the vibratory beam shall be made, followed by a further pass of the straight-edge.

Poker vibrators shall not be permitted to come in contact with joint assemblies, the underlying layer or side forms.

A final surface finish of the concrete shall be obtained by means of hand-operated floats.

If necessary, more than one set of equipment consisting of a vibratory beam, a straight-edge and floats, shall be used to keep up with the concrete produced by the mixer.

#### **WA4.4 REINFORCED PAVEMENT**

##### **WA4.4.1 General**

In this context the term "reinforced pavement" shall mean isolated reinforced slabs incorporated within pavement which is generally unreinforced.

##### **WA4.4.2 Reinforcement**

Reinforcement shall comply with SANS 1200 G. The type, size, spacing and position of reinforcement in the slab shall be as shown on the Drawings or as directed by the Employer's Agent.

Reinforcement shall be supported on prefabricated metal stools or supports, or in any other manner approved by the Employer's Agent. The method of support for reinforcement shall maintain the reinforcement in the position and at the depth shown on the Drawings.

#### **WA4.5      TEXTURING, CURING AND PROTECTION**

##### **WA4.5.1      General**

After placing, compaction and finishing and before the curing membrane is applied, the surface of the concrete shall be provided with a transverse surface texture.

Texturing on the downgrade shall be at 80° to the longitudinal axis of the pavement. The surface texturing shall be made and completed before the concrete has set to an extent that the surface will be torn, and the coarse aggregate will be unduly loosened during texturing.

##### **WA4.5.2      Texturing**

The texturing shall be made with a wire brush. The wire brush shall have 100 mm long tufts which consist of approximately 0,25 mm of tape wire. The brush shall contain two rows of tufts at 20 mm centres, which two rows of tufts shall be offset 10 mm so that the tufts in one row will be exactly halfway between the tufts in the other row. The tufts shall average fourteen wires each. Brushes shall be replaced when the shortest tufts wear down to 85 mm.

Each succeeding sweep of the texturing brush shall overlap the previous sweep by not more than 15 mm and the average depth of texturing shall be not less than 0,80 mm.

In order to ensure straight brush marks, the brush shall be operated against a straight-edge laid downgrade at 80° to the pavement centre line.

##### **WA4.5.3      Curing**

The exposed surfaces of the concrete pavement, including the sides of the slab, shall be treated immediately after the texturing of the surface and after removal of the side forms with a white-pigmented curing compound, as specified in Subclause 3.6.

The curing compound shall be sprayed onto the surface at a rate of 0,30 litre/m<sup>2</sup>, or as directed by the Employer's Agent, by hand-spraying equipment which produces a fine fog-type of spray which will not damage the surface of the concrete. The curing compound shall be applied in two applications and coverage shall be uniform on all surfaces.

Care must be taken to control the spray rate of the curing compound, as a too thick application may cause difficulties when the compound has to be removed from areas which have to be painted with road-marking paint.

During spraying operations, the curing compound shall be continuously agitated or stirred to keep the pigmentation in suspension.

The curing membrane shall be maintained intact for seven days after the concrete has been placed. Any damage to the curing membrane on account of the Contractor's activities on the pavement shall be made good by the affected areas being resprayed.

##### **WA4.5.4      Protection of pavement**

No vehicles with an axle load exceeding 20 kN shall be run on the finished surface of a concrete pavement within a period of twenty-one days of its completion unless the Employer's Agent permits a reduction of this period to fourteen days when the pavement has been constructed during generally warm weather conditions. Rubber-tyred vehicles with an axle load of less than 20 kN which travel at speeds not exceeding 25 km/h may be permitted after a period of seven days from the completion of the concrete pavement.

No vehicle with an axle load in excess of 80 kN shall be run on the completed surface during any stage of the Contract.

#### **WA4.6 JOINTS**

##### **WA4.6.1 General**

Joints in concrete pavement shall be constructed at the positions and spacings indicated on the Drawings or ordered by the Employer's Agent.

The faces of all joints shall be at right angles to the surface of the pavement.

Should the joints not comply with the requirements of the specifications in every respect, it shall be sufficient reason for the Employer's Agent to stop the concreting operations until the Contractor can satisfy the Employer's Agent that he will be able to perform the work in accordance with the Specifications.

##### **WA4.6.2 Construction joints**

Construction joints are made by placing fresh concrete against hardened concrete at predetermined locations as detailed on the drawings.

###### **(a) Longitudinal construction joints (Joint Types A)**

Where the pavement is constructed in partial widths, the construction joint or joints shall be provided where shown on the Drawings.

Tie bars and dowels shall comply with Subclause 3.8 as relevant and shall have the dimensions and spacings indicated on the Drawings.

When longitudinal construction joints are to be sealed, the top portion of these joints shall be sawn to a nominal width of 15mm and to the depth shown on the Drawings, but not before seven days after construction of the pavement.

###### **(b) Transverse construction joints**

Transverse construction joints are made at the end of the day's work or where concreting has to be suspended on account of breakdowns or for other reasons.

These joints shall be formed where planned contraction joints are indicated on the drawings, in which case a dowelled butt joint type B shall be provided, or midway between contraction joints, in which case a keyed and tied construction joint type C shall be provided.

When the transverse construction joints are to be sealed, the top portion of these joints shall be sawn to a nominal width of 15mm and to the depth shown on the Drawings, but not before seven days after construction of the pavement.

##### **WA4.6.3 Weakened plane joints**

Weakened plane joints shall be formed by reducing the concrete thickness at the joint by sawing a groove in the hardened concrete.

###### **(a) Transverse contraction joints (Joint types A and B)**

Transverse contraction joints shall consist of planes of weakness created by the sawing of grooves in the surface of the pavement at the spacings shown on the Drawings.

###### **(i) General requirements**

Sawing shall be carried out as specified in Subclause 4.6.5.



Transverse contraction joints shall be sawn to the depth as shown on the drawings within 24 hours of the placing of the concrete. The correct time shall be determined by the Contractor, who must bear in mind the risk of cracking of the pavement and the risk of spalling when green concrete is sawn.

Where required, dowels shall be installed as specified in Subclause 3.8. Dowelled joints shall be at right angles to the longitudinal axis of the pavement.

(ii) Contraction joints left unsealed

Unsealed joints shall be sawn to a nominal width of 4 mm and to a tolerance of plus or minus 0,5 mm.

(iii) Contraction joints to be sealed

All joints shall initially be sawn not more than 4 mm wide. In sealed joints the top portion of the groove shall subsequently be reamed to the specified final width and depth not before four days after the initial sawing.

Joints shall be sealed with a two-component polysulphide joint sealant as specified in Subclause 3.7(c).

#### **WA4.6.4 Expansion joints**

Expansion joints shall be constructed with vertical preformed joint filler.

The joint filler shall comply with the requirements of Subclause 3.7(a). The filler for each joint shall be furnished in a single piece over the full depth and width required for the joint, unless otherwise authorized by the Employer's Agent. When the use of more than one piece is authorized for a joint, the abutting ends shall be fastened securely and held accurately to shape by stapling or by any other suitable means of fastening which the Employer's Agent regards as being satisfactory.

The joint filler, together with the sealing groove, shall completely separate adjacent slabs, and any loose-fitting dowel bars and spaces between the subbase and the filler shall be packed with joint filler material after assembly of the joint.

The sealing groove in the upper portion of expansion joints shall be sealed with a two-component polysulphide sealant.

#### **WA4.6.5 Sawing of joints**

The joints in the pavement slab shall be sawn by experienced personnel only.

Except in portions of pavement which incorporate dowelled contraction joints, no transverse contraction joint shall be constructed within 1,5 m of a transverse volunteer crack. If the planned spacing of transverse contraction joints in portions of pavement which do not incorporate dowels in transverse joints would result in locating a transverse contraction joint within 1,5 m of a transverse volunteer crack, the transverse contraction joint shall be relocated so that it is not within 1,5 m of the said transverse volunteer crack.

The transverse contraction joints shall be sawn in such a manner that transverse volunteer cracks will not occur.

Excessive spalling of the arrises will not be allowed and the Contractor shall use the type of blade and equipment best suited to the hardness of the concrete being sawn.

Sufficient standby power saws shall be kept available on the Site by the Contractor ready for use at all times when concrete is being placed in the pavement.



Where spalling exceeds 5 mm in depth at any point measured from the top surface of the pavement, joints shall be repaired with an epoxy-resin mortar as specified in Clause 4.8.

Immediately after sawing, the joint grooves shall be washed out with a jet of clean water to remove all fine material and the joints shall be sealed temporarily with an approved paper rope.

No traffic of any kind shall be allowed on the pavement until all joints have been temporarily sealed.

#### **WA4.6.6     Joint sealing**

##### **(a)     Liquid sealant in joints between concrete and asphalt pavement**

These joints shall be sealed with a hot-pour-type joint-sealing compound as specified in Subclause 3.7(b). Prior to application, the joints shall be clean without any free water being present. Curing compound on joint walls shall be removed by sand-blasting or with an abrasive wheel. Dirt, dust and laitance shall be blown out of the joint with oil-free compressed air at a pressure of approximately 600 kPa immediately before the sealing operation. The sealant shall be applied in accordance with the manufacturer's recommendations, particularly in regard to temperature, which shall be carefully controlled.

##### **(b)     Polysulphide sealant**

Polysulphide sealant of the grade scheduled or shown on the Drawings shall comply with the requirements of Subclause 3.7(c) and shall be mixed and applied in strict accordance with the manufacturer's instructions after the joints have been thoroughly cleaned as specified in Subclause 4.6.6(a) above.

#### **WA4.7     TRIAL PAVEMENT**

##### **WA4.7.1     General**

Prior to the commencement of full-scale paving, the Contractor shall construct a section of trial pavement, which is laid as part of the permanent pavement, to demonstrate his capability of constructing the pavement in accordance with the specifications. The Contractor shall also demonstrate the methods he proposes to use for the application of the required surface texture, the construction of joints and for the placement of tie bars, dowels, etc.

The size of the trial section of pavement for roads and parking areas shall in each case depend on the dimensions of the panels and shall be determined by the Employer's Agent on the Site.

##### **WA4.7.2     Proceeding with full-scale paving and further trial pavements**

Unless he has been advised of any deficiencies in the trial pavement, the Contractor may proceed with full-scale paving ten days after the completion of the trial pavement or at such earlier time as the Employer's Agent may allow. In the event of deficiencies occurring in the trial pavement, the Employer's Agent may order the Contractor to break up and reconstruct the trial pavement after repairing any damage to the underlying layers, or he may allow the Contractor to effect repairs, all as set out in Subclause 4.8 and at his own cost.

#### **WA4.8     REMEDIAL WORK**

##### **WA4.8.1     Removal of concrete**

Where any section of the pavement which does not comply with the specified requirements is to be removed and reconstructed, the entire portion of the slab between the longitudinal and transverse joints shall be removed and reconstructed.

**WA4.8.2 Removal of high spots**

Wherever the Employer's Agent so permits, high spots may be removed with approved power cutters or surface planers. Generally, this shall apply to spots not exceeding 10 mm in height. No hand-operated grinding wheels or chisels shall be used. After individual high spots have been removed, the Contractor shall, if required, grind the surface to the nearest longitudinal and transverse joint so that all the ground areas are neat rectangular areas with a uniform texture.

On all portions of the pavement where the surface texture has been destroyed or reduced by grinding, surface texture shall be restored by grooves being cut into the concrete surface. The grooves shall be approximately 3 mm deep and 10 mm apart.

**WA4.8.3 Repair of joints**

Joints along which spalls occur that exceed 5 mm in depth at any point measured from the top surface of the pavement, or any other joints which in the opinion of the Employer's Agent are not acceptable, shall be repaired with an approved epoxy-resin mortar. Some epoxy binder shall be used to prime the surface being repaired prior to placement of the mortar mix. The mix shall be shaped to the original proper joint configuration.

**WA4.8.4 Repairing of cracks**

The Contractor shall be responsible for constructing a pavement that will not show any cracks.

Where cracks occur in the pavement which, in the opinion of the Employer's Agent, do not warrant the removal and reconstruction of the pavement, the Contractor shall repair such cracks as specified hereafter.

The cost of repairing cracks or of breaking up, removing and replacing existing slabs shall be borne by the Contractor if the first cracks in any slab section between joints occur within 30 days of the casting. If the first cracks in any slab section between joints occur more than 30 days after casting, the Contractor will be paid for repairing the cracks or replacing the slab section.

All cracks, except as otherwise provided, shall be repaired by epoxy being injected over the entire length of the cracks under pressure. Cracks which do not require injection with epoxy shall be limited to single continuous cracks without branch or connecting cracks that -

(a) either begin or end at a longitudinal joint or an edge of the pavement and, at any point along the length of crack, are not within 1,5 m of a transverse joint or other crack that has not been injected with epoxy; or

(b) do not begin or end at a longitudinal joint or edge of pavement and, at any point along the length of crack -

(i) are not within 1,5 m of any transverse joint, or

(ii) are not within 300 mm of any longitudinal joint, edge of pavement or other crack that has not been injected with epoxy.

Where cracks cross or partly coincide with sawn joints, adequate protective measures shall be taken to prevent the entry of epoxy into saw cuts which will reduce the groove depth, or, at the option of the Contractor, accumulations of epoxy in saw cuts shall be removed by resawing to the specified depth prior to opening the pavement to any traffic, but not later than 72 hours after the epoxy has been injected. Epoxy injection shall be completed within 90 working days after the pavement has been placed.

In making epoxy-injection repairs, a surface seal shall be applied to prevent the escape of epoxy, and entry ports shall be placed at sufficiently close intervals to allow the entire length of the crack to be filled. Surface seal materials and injection procedures shall be such that

damage to the texture and appearance of the pavement surface will be prevented after the pavement has been opened to public traffic. Epoxy shall be injected with in-line mixing equipment. Pressure pots shall not be used. Th

epoxy shall conform to California State Specification 731-80-27, but other epoxy adhesives and injection methods will be considered if their use can be supported by conclusive proof of satisfactory performance in concrete roads.

The Contractor shall provide cores of epoxied cracks at the rate of five relatively evenly spaced cores for each 50 m of epoxied crack. If the total length of cracks to be epoxied exceeds 50 m, the rate of coring may be reduced to one core for each additional 30 m of epoxied crack, provided that the Contractor's methods and equipment are producing satisfactory results. Cores shall extend through the entire depth of pavement and shall include the full depth of crack. The locations of cores will be determined by the Employer's Agent. Cracks where epoxy has penetrated to less than 80% of the crack depth shall have additional epoxy injected until a minimum of 80% of the crack depth has been filled. Such cracks may require additional cores for verification as determined by the Employer's Agent.

All holes which result from coring shall be completely filled with concrete of the same quality as that used for constructing the pavement, but with a maximum coarse aggregate size of 13,2 mm.

Volunteer cracks which do not require epoxy injection shall be routed out and sealed with an approved two-component, cold-applied polysulphide sealant which complies with SABS 110, or a polyurethane liquid sealant which complies with US Federal Specification TT-S-00227E (3). The sealant shape factor shall be taken into account for the dimensions of the sealant groove which dimensions shall be approved by the Employer's Agent. Prior to sealing, the surfaces of the joint shall be cleaned of all traces of dust, laitance and other foreign material by wire brushing, followed by a blowing out with clean, dry compressed air. The joint faces shall be primed with primer recommended by the sealant manufacturer. The sealant shall be supported by an approved bond-breaking tape to prevent the underside of the sealant from adhering to the concrete.

## **WA5. TOLERANCES**

The work described in this section shall be constructed to the dimensional tolerances given below.

### **WA5.1 LEVEL AND GRADE**

The lot shall be deemed to comply with the requirements specified for surface levels if at least 90% of all surface levels are within " 15 mm of the level specified before any level corrections are made.

Individual spots where the surface level deviates by more than " 20 mm of the level specified shall be repaired to bring them to within the " 15 mm tolerance.

Deviations from the specified longitudinal grade for roads on account of deviations from the specified levels shall not exceed those given below.

Length of grade measured (m)	Maximum variation from specified grade (%)
2	0,34
5	0,27
10	0,21
20	0,13
30	0,08

### **WA5.2 WIDTH OF PAVEMENT AND THE POSITION OF PAVEMENT EDGES**

The width of the pavement shall be at least the specified width and the edge of the pavement shall not deviate by more than 25 mm from the specified position.

### **WA5.3 JOINTS**

Joints shall not deviate by more than 10 mm from their designated positions in the pavement or by more than 10 mm from the edge of a 3 m long straight-edge placed to touch the line of the joint. There shall be no discontinuities in the line of joints.

### **WA5.4 THICKNESS**

The layer shall be deemed to comply with the requirements specified for layer thickness if at least 90% of all thickness measurements taken are equal to or thicker than the specified thickness minus 21 mm before any thickness corrections are made, and the average layer thickness for the lot is not less than the layer thickness specified minus 5 mm.

Individual spots where the actual thickness is less than the thickness specified minus 27 mm shall be locally repaired to bring them to within the 21 mm tolerance.

The thickness of the slab shall be determined by accurate levelling in the same position at predetermined random points before and after construction of the slab, and also by measuring cores drilled from the slab (an average of three measurements per core).

### **WA5.5 CROSS SECTION**

When tested with a 3 m straight-edge laid at right angles to the construction joints, the surface shall not deviate by more than 6 mm from the bottom of the straight-edge.

### **WA5.6 SURFACE REGULARITY**

When tested with a rolling straight-edge as described in Subclause 5.7, the number of surface irregularities in excess of 4 mm shall not exceed the following:

(a) Average number of surface irregularities per 100 m  
 taken over 300 m - 600 m  
 lengths..... 5

(b) Number of surface irregularities  
 taken over 100 m at a  
 time..... 8

The maximum value of any individual irregularity when measured with the rolling straight-edge or with a 3 m straight-edge laid parallel to the construction joints shall not exceed 7 mm.

### **WA5.7 THE USE OF A ROLLING STRAIGHT-EDGE FOR MEASURING SURFACE IRREGULARITIES**

The rolling straight-edge to be used shall be the type designed by the Transport and Road Research Laboratory of Great Britain (TRRL) and manufactured by Messrs Farnel and Company, or any other type approved by the Employer's Agent.

The machine shall be calibrated on a purpose-made calibrating bed and the bell set to register exactly at the required deflection. During measuring care shall be taken to move the machine at a suitably slow speed and not so fast that it will register incorrectly as a result of vibrations, sway or other effects induced by movement over an irregular surface.

The number of irregularities exceeding the specified limit and the distance traversed shall be recorded, and the number of irregularities per 100 m shall be calculated for each run.

Further recommendations regarding the operation and maintenance of the rolling straight-edge are contained in the TRRL Report No 290/1970.

The surface irregularities on each carriageway shall be measured by two runs of the rolling straight-edge, suitably spaced over the width of the carriageway, as directed by the Employer's Agent. Where the Employer's Agent and the Contractor agree, one run instead of two runs may be made.

#### **WA5.8      TESTING**

Routine inspection and testing will be carried out by the Employer's Agent in accordance with SANS 1200 G.

#### **WA6.      MEASUREMENT AND PYAMENT**

Note:

No direct payment will be made for the cost of complying with Subclauses PS 8.6, PS 8.7, PS 10, PS 13, PSA 5 and PSD 5.1.6. No additional payment will be made for difficult work or hand operations in confined areas. Payment will be deemed to be covered by the rates and sums tendered and paid for under the various items of work included under the contract.

#### **WA6.1      CONCRETE PAVEMENT (THICKNESS AND DESIGN FLEXURAL STRENGTH INDICATED) EXCLUDING TEXTURING AND CURING**

(a) 220mm Thick 4.5MPa Flexural strength concrete  
Unit: m<sup>2</sup>

The unit of measurement shall be the square metre of pavement placed and finished in accordance with the specifications. No additional payment over the unit Contract price shall be made for any pavement with an average thickness in excess of that shown on the Drawings. The quantity shall be calculated from the authorized dimensions of the completed pavement surface, except when the drawings show, or the Employer's Agent requires local deviations from the specified thickness. The volume of the concrete, in such cases, shall be converted into an equivalent area in square metres based on the specified thickness of the slab.

The tendered rate shall also include full compensation for concrete test cubes and concrete beams and testing thereof for determining of mix proportions, for mixing, transporting, placing, and finishing of the concrete, including formwork, repairs to defective surfaces, grinding and retexturing if required, repairing joints and cracks, protecting the pavement against damage, construction joints and for process control.

#### **WA6.2      TEXTURING AND CURING OF CONCRETE PAVEMENT**

(a) Texturing Unit: m<sup>2</sup>

(b) Curing Unit: m<sup>2</sup>

The unit of measurement for texturing and for curing shall be the square metre of exposed completed pavement textured or cured as specified. The quantity shall be calculated from the specified horizontal dimensions of the completed pavement surface in the case of texturing or curing, plus the surface area of slab sides in the case of curing. The Employer's Agent shall determine which portions of the pavement will require wire brushing.

The tendered rate for texturing shall include full compensation for providing the required equipment and for applying the texturing as specified.

The tendered rate for curing shall include full compensation for providing the curing compound and for applying it at the specified nominal rate with an approved hand-operated sprayer, as

specified. The tendered price shall also include full compensation for the spraying of curing compound in unsealed joints.

#### **WA6.3      VARIATION IN THE RATE OF APPLICATION OF THE CURING COMPOUND**

(a) Variation in the rate of application of the curing Unit: litre

The unit of measurement in respect of increases or decreases in the rate of application of the curing compound shall be the litre.

#### **WA6.4      JOINTS**

(a) Isolation Joints (IJ)  
Unit: m

(b) Saw Cut Joints (SJ)  
Unit: m

(c) Protected Edge Joints (PEJ)  
Unit: m

(d) Diamond Plate Dowels (114.3 x 114.3 x 6.35mm thick diamond dowel plates spaced at 400mm centres with dowel pocket formers (DDJ)  
Unit: m

(e) Dowel bars (diameter, length, and joint type to be indicated)  
Unit: No

(f) Tie bars (diameter, length, and joint type to be indicated)  
Unit: No

(g) Extra over items (a) to (d) above for joint sealant  
Unit: m

The unit of measurement for joints shall be the metre length of completed and approved joint, except that dowel and tie bars across joints shall be measured separately by the number for each type installed.

The rate tendered for joints shall cover the cost of all labour, materials, plant, and incidentals required to construct and form the joints as detailed and specified on the drawings inclusive of joint filler, sealant, for sawing, for the supply and installation of any temporary sealing necessary, for cleaning the cavities and joints, for reaming, for priming and emulsions as well as polyester membranes.

The rate tendered for dowels and tie bars shall cover the cost of all labour, materials, plant, and incidentals required and necessary to construct, position and install the bars as detailed on the drawings inclusive of the supply, cutting, placing, holding in position, supporting framework where required, for coatings as well as for tubular foam fillers.

#### **WA6.5      CORING AND TESTING OF CORES**

(a) 100mm cores drilled from pavement  
Unit: No

(b) 150mm cores drilled from pavement and tested for Compressive Strength  
Unit: No

The unit of measurement shall be the number of cores drilled or drilled and tested on the instructions of the Employer's Agent. Cores drilled by the Contractor at his own initiative as part of his process control or for the resubmission of pavement sections which have been

rejected, or for testing cracks sealed at the Contractor's own cost, shall not be measured for payment.

The rate tendered shall include full compensation for drilling the test cores and for repairs to the pavement, where applicable, having them tested by an approved laboratory, inclusive of all labour, transport, drilling, and testing charges as well as for other incidentals.

**END OF SECTION**

## WL : DRY-LAID CONCRETE BLOCK RETAINING WALLS

### WL1. SCOPE

The Specification covers the construction of retaining walls using dry-laid proprietary precast concrete blocks of special shape and design.

Interpretations and variations of this specification are set out in the Specification Data.

### WL2. NORMATIVE REFERENCES

#### WL2.1 SUPPORTING SPECIFICATIONS

Where this Specification is required for a project the following specifications shall, inter alia, form part of the Contract Document:

- a) Specification Data;
- b) SANS 1200 Series of Standardized Specifications;
  - i) SANS 1200 A or SANS 1200 AA or SANS 1200 AD, as applicable;
  - ii) SANS 1200 D or SANS 1200 DA, as applicable;
  - iii) SANS 1200 G or SANS 1200 GA, as applicable; and
- c) Standards listed in Appendix A.

### WL3. DEFINITIONS AND ABBREVIATIONS

For the purposes of this specification the definitions and abbreviations given in the applicable specifications listed in 2.1 and the following definitions shall apply:

- Closed face** : A pattern of laying the blocks abutting adjacent blocks in a course.
- Geotextile** : A material in the form of a sheet, a blanket or a net that is permeable to water and typically has a hydraulic conductivity of  $1 \times 10^{-5}$  m/s to 1 m/s.
- Open face** : A pattern of laying the blocks with a horizontal space between the blocks in a course.

### WL4. REQUIREMENTS

#### WL4.1 MATERIALS

##### WL4.1.1 Footings

Concrete used in the footings shall comply with SANS 1200 G or SANS 1200 GA, as applicable.

##### WL4.1.2 Blocks

##### WL4.1.2.1 General

Precast concrete blocks shall be unreinforced and of an approved commercial design, shape, colour and surface texture. They shall be free from cracks that would adversely affect their general appearance or serviceability, or both. No unit shall have any chip of dimension exceeding 15 mm or covering more than 3 % of the length of the exposed edge, whichever is the lesser.

An initial number of blocks may be kept by the Engineer as samples against which further production will be checked. The surface texture and colour of the blocks shall fall within the range of texture and colour represented by the manufacturer's approved samples. The colour



shall penetrate to a depth of at least 5 mm below the exposed surface of each block and the coloured layer shall be integrally bound to the body of the block.

#### **WL4.1.2.2 Concrete**

Concrete used in the manufacture of the blocks shall be 35 MPa concrete which shall be vibrated and cured, all in accordance with SANS 1200 G or SANS 1200 GA, as applicable. Sulphate resistant cement shall be used if so specified in the Specification Data.

Additives may be used to facilitate the manufacturing process.

#### **WL4.1.2.3 Strength**

The ultimate shear capacity of the concrete interlocking key (or "up-stand") of the blocks, if any, shall be at least 14 kN/m of wall. The front face ultimate twisting strength shall be at least 60 kN/m (simulated wall loading).

#### **WL4.1.3 Block trough filling**

Unless the blocks are to be filled with concrete or left open, the material used to fill the blocks shall be topsoil or suitable approved material selected from excavations on site.

#### **WL4.1.4 Backfill behind blocks**

Unless otherwise specified in the Specification Data or approved by the Engineer, backfill material shall be a silty gravel and sand or better, i.e. it shall not have more than 35% by mass passing a 0,075 mm sieve, the PI shall not be greater than 10 and the group index shall be 0.

#### **WL4.1.5 Drainage**

##### **WL4.1.5.1 Drainage pipes**

Unless otherwise specified in the Specification Data, pipes for subsurface drains shall be perforated pitch fibre pipes complying with SANS 921 with a nominal diameter of either 100 mm or 150 mm as billed.

##### **WL4.1.5.2 Filter material**

The filter material used around the drainage pipe, in the drainage blanket or in the vertical (or sloping) drainage layer behind the blocks shall be either:

- a) an aggregate complying with the applicable requirement of SANS 1083 and conforming to an approved grading for a road base layer material except that the fraction passing the 0,42 mm and 0,074 mm sieves shall not exceed 15 % and 2 % respectively, or
- b) an approved free-draining sand,

as specified in the Specification Data, shown on the drawings or ordered.

##### **WL4.1.5.3 Geotextile**

A geotextile blanket shall be made of fibres consisting of at least 85 % (by mass) of polypropylene, polyethylene, a polyester, a polyamide, or a co-polymer of vinyl chloride and vinylidene-chloride, or any combination of these polymers, and the polymer(s) shall contain such additives as are necessary to render the filaments resistant to the effects of ultraviolet radiation and heat.

The amount of water absorbed by a geotextile after it has been soaked in water at 20 °C for 24 h shall be less than 1 % (by mass) and its equivalent open size (EOS), strength and other properties shall be as specified in the Specification Data.

The Engineer's approval of the make and grade of the geotextile shall be obtained by the Contractor before the Contractor orders or uses any geotextile in the Works.

#### **WL4.2      PLANT**

Except for the production of the precast blocks, the construction is predominantly labour-based. The Contractor shall provide such vehicles, cranes, compactors and pumps as are necessary to prepare foundations and to place materials in the manner specified.

#### **WL4.3      METHODS AND PROCEDURES**

##### **WL4.3.1      Excavation**

Excavation shall comply with SANS 1200 D or SANS 1200 DA, as applicable. Except that the footing shall be not less than 500 mm below finished ground level, the depth of excavation shall be such that there will be adequate bearing capacity and resistance to sliding forces on the footing. Excavations shall be to the approval of the Engineer.

##### **WL4.3.2      Footings**

For walls of height less than 1,2 m and elsewhere, where, in the opinion of the Engineer, the soil conditions permit, footings may be of stabilized soilcrete; in all other areas footings shall be of 20 MPa concrete.

Unless otherwise specified or shown on the drawings, footings shall be 250 mm deep by "block length + 200 mm" wide and shall be provided with a 100 mm by 100 mm wide upstand at the front and a 250 mm wide by 350 mm deep shear key at the back.

Footings shall be constructed level and, where the ground slopes along the line of the footing, stepped, taking into account the block height and the batter to which the wall is to be built or the set-back required by the particular block design.

The top surface of footings shall be given a wood-float finish.

##### **WL4.3.3      Laying of blocks**

Blocks shall be laid with their top and bottom concrete surfaces in full contact, i.e. the "down-stand", if any, shall not rest on the soil fill or concrete base in the block trough. Levelling of blocks shall be achieved by careful chipping off any high spots of the block rib.

Unless "open face" is specified, in the Specification Data, shown on the drawings or ordered, blocks shall be laid "closed face" i.e. with full contact between adjacent blocks in a course. Blocks shall be laid to the rotation and batter shown on the drawings or ordered. Where blocks are to be laid "open face" they shall be laid with the specified horizontal spacing between them.

For curved walls, a "re-start" in the block laying sequence shall be spread over at least five blocks.

##### **WL4.3.4      Block trough filling**

Except in the case of concrete, the material used to fill the block trough shall be lightly tamped.

##### **WL4.3.5      Backfilling behind blocks**

Backfilling behind blocks shall proceed with the placing of the blocks and shall not lag the placing of the blocks by more than one course of blocks. Placing and compaction of the backfill shall be carried out in layers of 85 mm maximum thickness when a plate compactor is used and 170 mm maximum thickness when a 1 ton vibrating roller is used. Backfilling shall be compacted at optimum moisture content to at least 90 % modified AASHTO maximum dry

density.

#### **WL4.3.6     Drainage**

Where specified, shown on the drawings or ordered, the Contractor shall construct a drain, drainage blanket and/or face wall drain behind the wall. The drain, drainage blanket and face wall drain shall conform to the details specified, shown on the drawings or ordered.

#### **WL4.3.7     Geosynthetic reinforcement**

Where specified, shown on the drawings or ordered, the wall shall include a geosynthetic reinforcement system. The geosynthetic reinforcement system shall be installed as the blocks are laid and the backfilling placed and compacted. It shall conform to the details specified, shown on the drawings or ordered.

A geotextile shall be placed either:

- a) with an overlap of at least 300 mm that is securely fastened to prevent any movement or slipping during placing, or
- b) provided that it is sewn or bonded in an approved manner, with an overlap of at least 75 mm.

### **WL5.     COMPLIANCE WITH REQUIREMENTS**

#### **WL5.1     TESTING**

When requested by the Engineer, the Contractor shall submit test certificates from an approved independent testing laboratory to show that the blocks comply with the relevant product specification.

#### **WL5.2     TOLERANCES**

The materials and the finish of the work shall be to Degree of Accuracy II and the permissible deviations (PD) (see clause 6 of SANS 1200 A or SANS 1200 AA, as applicable) shall be within the limits given below for Degree of Accuracy II:

1	2	3	4
Item	Permissible deviation		
	Degree of accuracy		
	III	II	I
	mm	mm	mm
a) <b>Footings</b> (see also (c) below)			
1) <b>Position on plan</b>			
PD from designated position of any point, measured from nearest grid line	±50	±35	±20
2) <b>Linear dimension on plan cast against excavation sides</b>			
PD from designated dimension	±60	±40	±20
3) <b>Finished level</b>			
PD from designated level	±30	±20	±10
b) <b>Walls</b> (see also (d) below)			
1) <b>Block spacing</b>			
PD from designated horizontal spacing	±7	±5	±3
2) <b>Position in plan of top edge of any wall course</b>			
PD from designated position of any point, measured from nearest grid line	±300	±200	±100
3) <b>Alignment of top edge of any wall course</b>			
PD from a line joining any two points 30 m apart on top of exposed edge	±20	±15	±10

1	2	3	4
Item	Permissible deviation		
	Degree of accuracy		
	III	II	I
	mm	mm	mm
4) <b>Bulging</b> PD of any block from a line determined from its adjacent blocks, horizontally and vertically	±15	±10	±10
5) <b>Level</b> PD from designated level of any course	±15	±10	±10
c) <b>Footings</b>	degree	degree	degree
1) <b>Rotation</b> PD from designated rotation	±2	±2	±2
d) <b>Wall</b>			
1) <b>Slopes</b> PD from designated batter	±2	±2	±2

**WL6 MEASUREMENT AND PAYMENT****WL6.1 BILLED ITEMS****WL6.1.1 Excavation**

Excavation and backfill to footings and wall will be measured and paid in terms of SANS 1200 D or SANS 1200 DA, as applicable.

**WL6.1.2 Construction of dry-laid precast concrete block retaining wall (state angle with the horizontal plane)**

Unit: .....square metre (m<sup>2</sup>)

Measurement will be by the projected vertical plane area of wall.

The unit rate shall cover the cost of the supply, handling, storage and laying of the blocks as specified, including for the supply, placing and compaction, if applicable, of the block filling and backfill behind the wall.

**WL6.1.3 Installation of geosynthetic reinforcement system to wall**

Unit: .....square metre (m<sup>2</sup>)

Measurement will be by the projected vertical plane area of wall.

The unit rate shall cover the cost of the supply, handling, storage and installation of the support system complete, including any additional excavation and backfill required for the reinforcement system.

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**PZ : REPAIR WORK TO STRUCTURAL CONCRETE****PZ 01      SCOPE**

This specification covers all repair/remedial/refurbishment/protective-lining work to concrete in connection with demolition, breaking, cutting, surface preparation, coating, lining, reprofiling, and the application of protective coatings to concrete.

**PZ 02      DEFINITIONS**

**Reprofiling:** Application of a re-building cementitious (or equivalent) mortar or micro-concrete to return a concrete surface (typically with exposed aggregate from deterioration/damage) to its original finish (line and quality/finish) and to reinstate the original concrete cover.

**Supplier:** The manufacturer of proprietary protective lining or concrete repair products.

**PZ 03      MATERIALS****PZ 03.1      GENERAL**

All materials used in respect of this specification shall be proprietary products from reputable Suppliers with a proven history of successful use for the purposes required in the environment in which they are to be installed. Where alternative products are proposed by the Contractor, the Engineer may request proof of successful use of such products in similar environments.

**PZ 03.2      GUARANTEES**

The systems installed shall be guaranteed by the Contractor and backed by the Supplier for a minimum of 10 years. The guarantee shall cover both the product and the workmanship for 10 years. Proof of the intention to supply such a guarantee shall be provided to the Engineer prior to the commencement of the works on site.

The installers of proprietary products shall be Supplier-approved applicators with a proven history of successful use of the products specified.

It is assumed that the Supplier's representative will play an active role in inspecting the works on site from time to time as may be deemed necessary to ensure compliance in terms of the guarantee to be provided.

**PZ 03.3      TRIAL PANELS**

The Engineer may instruct that trial-panels (1mx1m) of any of the systems described in this specification (or alternatives that the Contractor proposes) be prepared on site for the purpose of discussion, further testing, approval or as a basis of acceptance for surface finishes etc. The cost for such trial panels is to be measured and paid for as per the various measurement items in section PZ8 where the trial panel is deemed acceptable by the Engineer.

**PZ 04      EQUIPMENT****PZ 04.1      DEMOLITION EQUIPMENT**

All devices used to remove concrete, cut concrete or to demolish concrete members, shall be handled, stored and used strictly in accordance with the manufacturer's instructions and current safety regulations.

**PZ 04.2      MIXING AND PREPARATION EQUIPMENT**

All plant and equipment used for the preparation of concrete surfaces, batching of material and mixing operations shall be in good working order and suited for the intended use. The

plant shall be inspected, serviced and calibrated at regular intervals and tested to ensure proper functioning, all to the satisfaction of the Engineer.

**PZ 04.3     SPECIALIST SPRAYING/SHOTCRETING/PUMPING EQUIPMENT**

All spraying/shotcreting/pumping equipment shall be the proprietary product's recommended sprayer, and shall be inspected, serviced and calibrated at regular intervals and tested to ensure proper functioning, all to the satisfaction of the Supplier and Engineer.

**PZ 04.4     ACCESS EQUIPMENT**

All scaffolding or similar access equipment shall be suitable and safe for the intended use, and compliant with the local health and safety legislation/regulations.

**PZ 05     EXECUTION OF WORKS**

**PZ 05.1     STORING OF MATERIALS**

The Contractor shall provide a lock-up store for the all materials and observe all storage requirements and safety precautions recommended by the materials manufacturers (especially relating to temperature, moisture control and product life-span requirements).

**PZ 05.2     DEMOLITION OF CONCRETE**

The method and sequence of demolition (as well as temporary propping where necessary) shall be submitted to the Engineer for approval. Screening and protective measures shall be established around the work area as necessary to ensure acceptable environmental, health and safety conditions.

The contractor shall ensure that any nuisance associated with his work activity is minimised by implementing appropriate precautions and measures to the approval of the engineer. Common nuisances associated with demolition and concrete removal include fumes, noise, dust, flying fragments, heat and vibration.

All waste materials, rubble, scrap and rubbish arising from the contractor's presence on site and / or the execution of the works shall be disposed of weekly to a disposal site identified by the Contractor and approved by the Engineer.

**PZ 05.3     PREPARATION OF CONCRETE SURFACES/CONSTRUCTION JOINTS**

All surface laitance and damaged, loose and soft concrete, concrete containing aggressive ions (e.g. chlorides, sulphates), as well as all foreign materials such as oil, paint, grease, etc. shall be removed from the contact surface using a suitable method that may include:

- pneumatic chisels,
- sand blasting,
- wet-grit blasting,
- high-pressure water-jetting,
- Any combination of the above

The intention of the preparation is to leave a clean, sound, exposed aggregate finish to the concrete surface that is suitable for the bonding requirement of the subsequent layer/lining. Dust shall be removed from the final finish by water-jetting/washing. Care shall also be taken so as not to remove more concrete than is necessary (so as not to reduce existing cover unnecessarily).

Where required by the subsequent lining/layer, the pH of the prepared substrate shall comply with the lining-product's specification. Where the pH of the prepared surface is not suitable

after initial preparation, the surface is to be further prepared by means of the above method(s) until a suitable pH is achieved comprehensively.

The area to be repaired shall be bounded by straight line edges cut to the required depth (for the re-profiling mortars) using a diamond cutting saw, angle grinder or other approved equipment. The edges shall be recessed such that the repair/reprofile has a thickness at the edge of at least twice the maximum aggregate size of the patching material, but in any case not less than 10 mm.

It is expected that Contractors are familiar with the products that are specified and therefore the requirements of surface preparation as required by the Suppliers. The final prepared surface shall be to the approval of the Engineer and Supplier of subsequent linings.

The smooth cutting edge/surface of the saw-cut shall be roughened by wire-brushing to aid the repair-material bond.

#### **PZ 05.4      PREPARATION OF EXPOSED REINFORCING**

All exposed reinforcing in repair areas is to be wire-brushed (using an angle-grinder with a wire-cup brush) to remove loose surface corrosion and to provide a clean steel substrate free of corrosion product.

The Contractor shall at the beginning of the works prepare a sample for the Engineer's approval that shall serve as a basis of acceptance for prepared reinforcing.

Cleaned reinforcing is then to be coated with an approved anti-corrosion epoxy resin coating suitable for reinforcing.

Where significant pitting corrosion of the existing reinforcing is encountered (i.e. visible loss of cross-sectional area of reinforcing bar), this is to be brought to the attention of the Engineer for further instruction.

#### **PZ 05.5      BONDING AGENTS**

Where bonding agents are specified or proposed, they are to be used **strictly** within the active window-periods stated by the Supplier, taking note of site conditions (temperature, humidity etc.).

#### **PZ 05.6      CURING OF REPAIR LININGS**

Curing of all linings/repairs is to be done rigorously by an approved method to prevent moisture loss from the repair during the early age of the product. This may require physical covering and/or the application of mist-sprays until a period where the lining/repair is not susceptible to cracking. Cracked linings will not be accepted and will need to be removed/repared to a method acceptable to the Engineer. The curing periods of linings shall be as per the Supplier's specifications

#### **PZ 05.7      REPAIR MORTARS/CONCRETES**

##### **PZ 05.7.1      Epoxy resin repairs**

Surface repairs less than 5mm deep shall be repaired with a proprietary structural repair epoxy resin (Sikadur 31 DW or equivalent approved) to exact Supplier's specifications.

The structural repair epoxy shall achieve a compressive strength of at least 50MPa at 14 days.

The repair epoxy should be suitable for the trafficking of mechanical rotating bridge wheel loads where applicable.

The applied product shall achieve the specified strength prior to loading/watertightness testing.

##### **PZ 05.7.2      Shallow localised repairs (Up to 50mm deep)**

Shallow localised repairs (i.e. up to 50mm deep) shall be filled with an approved proprietary polymer-modified structural repair-mortar / grout (Sika MonoTop 615 HB, or ABE Durarep FR or equivalent approved) to exact Supplier's specifications. Bonding agents shall be used as per PZ 5.5.

Repairs should be carried out in a manner that ensures no sagging of the repair mortar (on vertical and overhead applications). Curing shall be rigorously applied to Supplier's specifications.

The structural repair mortar should be able to be applied in a single application only. Multiple layered repairs will not be accepted.

The structural repair mortar shall achieve a compressive strength of at least 35MPa at 28 days.

The repair area should be bounded by a 10mm deep sawcut to ensure no feathering of the repair mortar at the edge (Noting the requirements of PZ 5.3)

The applied product shall achieve the specified strength prior to loading/watertightness testing.

#### **PZ 05.7.3    Micro-concrete repairs**

Deep localised repairs (i.e. greater than 50mm deep) shall be filled with a proprietary micro-concrete (Sikagrout 212, or ABE Durarep FMC or equivalent approved) with 6mm or 13mm aggregate to exact Supplier's specifications.

The structural repair concrete shall achieve a compressive strength of at least 40MPa at 7 days.

No bonding agent shall be used, and formwork shall be applied to vertical and overhead applications. Compaction and curing shall be rigorously applied to Supplier's specifications.

The repair area should be bounded by a sawcut (at least twice the aggregate size in depth, noting also the requirements of PZ 5.3)

The applied product shall achieve the specified strength prior to loading/watertightness testing.

#### **PZ 05.7.4    Reprofiling of concrete surfaces**

Concrete shall be reprofiled using a structural polymer-modified reprofiling mortar (Sika Monotop 615 HB or equivalent approved) to exact manufacturer's specifications, but as a minimum requirement should be suitable for application thicknesses of 10 to 40mm thick (with localised thicknesses reducing to 5mm minimum thickness at protruding aggregate). Bonding agents shall be used as per PZ 5.5 and the minimum (and maximum) thicknesses of the product shall be adhered to.

The repair area should be bounded by 10mm deep sawcut to ensure no feathering of the repair mortar at the edge (noting also the requirements of PZ 5.3).

The applied product shall achieve the specified strength prior to loading/watertightness testing.

#### **PZ 05.7.5    Reprofiling with Calcium Aluminate Cement (CAC) lining**

Concrete shall be reprofiled using a 100% CAC lining (Imerys Fondag, or Sika Monotop 4400 MIC or equivalent approved) to an average thickness of 25mm (unless otherwise stated) by means of a low pressure wet shotcrete pump.

The repair area should be bounded by a 25mm deep sawcut to ensure no feathering of the repair mortar at the edge.

#### **PZ 05.8    PROTECTIVE POLYMER LININGS**

All protective polymer linings specified shall be applied strictly to all the Supplier's specifications, taking special note of the site and substrate conditions (moisture content of parent material, temperature, humidity etc.).



All matters relating to the successful application of the linings (Primers, day-joint preparation and positions, window periods, reactivation procedures etc.) shall be as per the Supplier's specifications.

**PZ 05.9      MIGRATING CORROSION INHIBITORS**

The suitability of migrating corrosion inhibitors shall be proven by the industry track-record provided by the Supplier. The concrete surface should be suitably prepared before the application of a migrating corrosion inhibitor, and should be washed down with clean water after the application.

The suitability of migrating corrosion inhibitors shall be proven by the industry track-record provided by the supplier. The ingress of migrating corrosion inhibitors shall be measurable. The concrete surface should be suitably prepared before the application of a migrating corrosion inhibitor, and should be washed down with clean water after the application.

**PZ 05.10      INSTALLATION OF SACRIFICIAL ANODES**

Where concrete patch-repairs are carried out, the adjacent (unrepaired) concrete shall be treated by means of sacrificial anodes installed at reinforcing level by a reputable supplier with a proven product (Sika Ferrogard Patch 62gm anode complete with Sika duocrete anchor mortar or equivalent approved).

Anodes should have a minimum influence radius of at least 750mm and should be installed around the repaired area to ensure 100mm overlapping of influence areas at the edge of the repair.

**PZ 05.11      CRACK INJECTION**

Crack-injection shall be low-viscosity epoxy inserted into cracks with pressure pumps/guns after sealing the outside edge of the crack(s) with an approved epoxy (Sikadur 52ZA or equivalent approved). Injection ports, port spacing and pumps are to be Supplier-approved.

**PZ 05.12      REPAIR OF LEAKS BY MEANS OF CRYSTALLISING CEMENTITIOUS REPAIR**

Cracks/defects shall be sealed by an approved proprietary cementitious crystallising waterproofing system that reacts with the leaking water to seal the leak. Cracks/defects shall ideally be treated from the dry side of the concrete element while the structure is filled to its service level. Products should be suitable to seal actively leaking cracks. The preparation of the crack/defect shall be strictly to the Supplier's guidelines.

**PZ 05.13      APPLICATION OF A JOINT-BRIDGING FLEXIBLE BANDAGE / WATERSTOP**

Flexible bandage / waterstops to seal joints should be epoxied to the concrete substrate on either side of the joint using a Supplier-approved epoxy. Preparation of the substrates should ensure good bond, and lapping shall be as per Supplier's details.

Flexible bandage / waterstop should be able to handle differential movement of 10mm in shear and tension (combined) unless otherwise noted, and shall be a minimum of 2mm thick and width as specified but minimum 200mm.

Flexible bandage / waterstops should be 100% UV stable (apart from discolouration) and suitable for the environment in which they are to be installed.

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**PZ 05.14    INSTALLATION OF EPOXY-DOWELS**

Reinforcing dowels shall be anchored using a suitable epoxy suitable for reinforcing steel. All dowelling works shall be to exact Suppliers specifications, noting especially the requirements of hole drilling, preparation, cleanness and moisture content.

When drilling into existing concrete, drill-bits capable of cutting reinforcing steel shall not be permitted.

The minimum anchorage depths for various bars shall be as follows:

Y/R10: 100mm

Y12: 150mm

Y16: 200mm

Y20: 250mm

**PZ 06        TOLERANCES**

Tolerances shall be as per the Supplier's specifications. Where not stated by the Supplier, tolerances shall be as per SANS1200G (as amended by PSG when applicable).

**PZ 07        TESTING****PZ 07.1      GENERAL**

The testing of repairs and linings shall be as per the Supplier's recommendations and shall be deemed to be included in the cost of the lining/repair if not separately measured in Section PZ 8.

Tests instructed by the Engineer as detailed in PZ 8 will only be paid for where successful (as far as it pertains to the Contractor's installed works).

**PZ 07.2      SOUNDING SURVEY**

All reprofiled/repared surfaces are to be tested by means of a comprehensive sounding survey.

This shall be done by means of tapping hammer of approximately 1kg mass on the reprofiled surface and recording the location of hollow sounding areas.

On plane areas of concrete, the surface shall be sounded at approximately 300 mm centres in each direction. On columns, beams or other similar members with faces less than 300 mm wide, each face shall be sounded near each edge or corner at approximately 300 mm centres along the member.

Where a hollow sounding area is detected its extent shall be determined by local sounding and its periphery marked on the surface of the member. Such defective areas are then to be removed and repaired. Defective/unbonded areas shall not be paid for until the sounding survey is successfully completed.

**PZ 07.3      HOLIDAY TESTING**

Holiday testing shall be carried out by a competent independent testing body with equipment suitable to test linings applied to reinforced concrete substrates. Problematic pinholes/areas are to be marked out for repair. Defective/unbonded areas shall not be paid for until the holiday test is successfully completed.

**PZ 07.4     REPAIR MORTARS/MICRO-CONCRETE**

The Engineer may request that repair products be tested by means of concrete compressive tests at 28 days to ensure compliance with Supplier's specifications.

**PZ 07.5     PULL-OUT TESTING OF DOWELS**

The Engineer may request that pull-out tests be performed on reinforcing bars that are epoxy-anchored into the concrete to confirm that the dowelling method/product is performed to the Supplier's specifications and achieves the Engineer's specified loads. The pull-out testing is preferably to be done by the epoxy Supplier. The Engineer shall select bars to be tested and shall state the pull-out test load in each case

**PZ 08     MEASUREMENT AND PAYMENT**

The payment items below shall include full compensation to complete the demolition, preparation, repair and lining activities described in this specification PZ.

The quantities indicated in the Schedule of Quantities under this section are based on inspections carried out as part of the preliminary and detail design phases, increased to allow for unforeseen work and defects that were not visible. The actual works to be executed may vary from the scheduled quantities and the Contractor shall be deemed to have

allowed in his tendered rates for such variations as far as can be reasonably expected.

All quantities are to be verified on site by the Engineer's representative prior to the placing of the repair products. Where products are measured by volume or mass, the Engineers' representative is to countersign the actual amount of material used on site for measurement and certification.

New reinforcement will be measured separately.

**PZ 08.1     Demolition of concrete elements.....Unit: m<sup>3</sup>**

The unit of measurement is the cubic metre of concrete (reinforced or unreinforced) demolished, measured in its original position and shape based on:

- (i) Full demolition
- (ii) Partial demolition

The tendered rate shall include full compensation for all labour, material, screening of the structure for safety and environmental protective measures, equipment and plant as well as for all work and incidentals required to complete the work as specified and required to demolish the concrete member and to load, transport and dump the concrete segments and rubble at the nearest approved dumping site.

**PZ 08.2     Dowelling of reinforcing into concrete (bar diameter stated).....Unit: No**

The unit of measurement shall be the number of dowels installed. The tendered rate shall include full compensation for all labour, materials, equipment, required for the drilling and anchoring of reinforcing bars into existing concrete with a suitable epoxy grout (Fischer EM Injection grout, Hilti HIT RE-500, Sika Anchorfix III or equivalent). Reinforcing bars will be measured elsewhere. All dowelling works shall be to exact manufacturer's specifications. The minimum anchorage depths for various bars shall be as per PZ 5.14 unless otherwise stated.

**PZ 08.3     Preparation of concrete surfaces/construction joints for reprofiling.....Unit: m<sup>2</sup>**

The unit of measurement shall be the square metres of concrete prepared.

The tendered rate shall include full compensation for all labour, materials, equipment, required for preparing concrete surfaces for reprofiling to specification, as well as removal of all waste materials from the site to the nearest approved dumping site.

- PZ 08.4     Preparation of exposed reinforcing (bar diameter stated).....Unit: m**  
The unit of measurement shall be the length in metres of reinforcing bar prepared.  
The tendered rate shall include full compensation for all labour, materials, equipment, required for cleaning and treating of old reinforcing bars with a bonding agent and anti-corrosion coating for structural repairs (Sika Armathec 110EC or equivalent approved).
- PZ 08.5     Application of a bonding agent for repair/reprofiling mortars.....Unit: m<sup>2</sup>**  
The unit of measurement shall be the square metres of bonding agent applied to a repair surface.  
The tendered rate shall include full compensation for all labour, materials, equipment, required for applying a bonding agent for structural repairs (Sika Armathec 110EC or equivalent approved).
- PZ 08.6     Application of a migrating corrosion inhibitor.....Unit: m<sup>2</sup>**  
The unit of measurement shall be the square metres of migrating corrosion inhibitor applied to a repair surface.  
The tendered rate shall include full compensation for all labour, materials, equipment, required for applying a migrating corrosion inhibitor to a repair surface (Sika Ferrogard 903+, or ABE MuCis mia 100, or equivalent approved).
- PZ 08.7     Installation of sacrificial anodes.....Unit: No.**  
The unit of measurement shall be the number of sacrificial anodes installed complete and connected to concrete reinforcing.  
The tendered rate shall include full compensation for all labour, materials, equipment, required for installing sacrificial anodes complete with anchor mortar to concrete reinforcing (Sika Ferrogard Patch 62gm anodes complete with Sika Duocrete anchor mortar, or equivalent approved system).
- PZ 08.8     Epoxy resin repairs to concrete (surface repairs).....Unit: ℓ**  
The unit of measurement shall be the litres of epoxy repair resin applied to concrete surfaces.  
The tendered rate shall include full compensation for all labour, materials, equipment, required for installing suitable epoxy resin mortar to shallow concrete surface repairs (Sikadur 31 DW or equivalent approved).
- PZ 08.9     Shallow localised repairs to concrete.....Unit: ℓ**  
The unit of measurement shall be the litres of structural repair mortar applied to (localised) concrete repair surfaces.  
The tendered rate shall include full compensation for all labour, materials, equipment, required for installing suitable structural repair mortar to shallow repairs (Sika MonoTop 615HB, or ABE Durarep FR, or equivalent approved).
- PZ 08.10     Micro-concrete repairs .....Unit: ℓ**  
The unit of measurement shall be the litre of structural micro-concrete applied to concrete repair surfaces.  
The tendered rate shall include full compensation for all labour, materials, equipment, required for installing suitable structural micro-concrete to deep repairs (Sikagrout 212, with added coarse aggregate, or ABE Durarep FMC, with added coarse aggregate, or equivalent approved).
- PZ 08.11     Reprofiling of Concrete surfaces (thickness stated).....Unit: ℓ**  
The unit of measurement shall be the litres of concrete reprofiled to a specified minimum thickness.  
The tendered rate shall include full compensation for all labour, materials, equipment, required for reprofiling of concrete surface using suitable cementitious reprofiling mortar (Sika MonoTop

615HB, or ABE Durarep FR, or equivalent approved). The tendered rate shall include all testing as described in this specification.

**PZ 08.12    Installation of crack-injection epoxy (wall thickness stated).....Unit: m**

The unit of measurement shall be the linear meter of crack-injection epoxy installed.

The tendered rate shall include full compensation for all labour, materials, equipment, required for installing suitable crack-injection epoxy for crack sealing (Sikadur 52ZA or equivalent approved).

**PZ 08.13    Installation of protective polymer linings to concrete (Product and thickness stated).....Unit: m<sup>2</sup>**

The unit of measurement shall be the square metres of surface treated. The rate shall include all primers/activation products specified by the Supplier.

The tendered rate shall include full compensation for all labour, materials, equipment, required for installing of the product stated (or equivalent approved) to the thickness stated.

**PZ 08.14    Installation of a Calcium Aluminate Cement (CAC) reprofiling lining to concrete.....Unit: m<sup>2</sup>**

The unit of measurement shall be the square metres of surface reprofiled to an average thickness of 25mm. The rate shall include all primers/activation products specified by the Supplier.

The tendered rate shall include full compensation for all labour, materials, equipment, required for installing suitable CAC lining to the thickness stated (Imerys Fondag, or Sika MonoTop 4400 MIC, or equivalent approved). The tendered rate shall include all testing as described in this specification.

**PZ 08.15    Sealing of active leaks in concrete tanks by means of specialist cementitious crystallising products.....Unit: ℓ / kg**

The unit of measurement shall be the litre or kilogram of product applied to seal/waterproof defects. The rate shall include all preparation and products specified by the Supplier.

The tendered rate shall include full compensation for all labour, materials, equipment, required for the defect preparation and sealing/waterproofing of defects with a suitable cementitious crystallising product (Xypex Patch and Plug, or Penetron Slurry/Penecrete, or Kryton Plug/Repair Grout, or equivalent approved) to all Supplier's requirements.

**PZ 08.16    Installation of joint-bridging flexible bandages.....Unit: m**

The unit of measurement shall be the linear meter of product installed.

The tendered rate shall include full compensation for all labour, materials, equipment, required for sealing of the joint with suitable joint-bridging flexible bandage with a minimum width of 200mm (Sikadur Combiflex SG-20 P, or ABE Durajoint Flexband, or Schomburg ASO-Tape, or equivalent approved), including all necessary preparation and required proprietary products, including but not limited to required anchoring adhesive.

**PZ 08.17    Perform holiday testing to protective linings.....Unit: m<sup>2</sup>**

The unit of measurement shall be the square metres of lining tested.

The tendered rate shall include full compensation for all labour, materials, equipment, required for holiday testing of protective linings.

**PZ 08.18    Perform pull-out testing to epoxied reinforcing dowels.....Unit: No.**

The unit of measurement shall be the number of dowels tested (up to 20mm diameter).

The tendered rate shall include full compensation for all labour, materials, equipment, required for the testing.

**PZ 08.19    Cut out of existing walls.....Unit: m**

The unit of measurement shall be the length to be removed with thickness of the wall stated:

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The tendered rate shall include full compensation for neatly cutting away existing walls and removing concrete and structural steel reinforcement and disposing off site by contractor. The tendered rate shall include full compensation for all labour, materials, equipment, required for the cut outs.

**PZ 08.20    Block existing pipes inlet and outlet pipes and provide a water tight seal.....Unit: No**

The unit of measurement shall be the number of pipes to be blocked:

The tendered rate shall include full compensation for blocking off existing pipes and providing a water tight seal in the structure. The tendered rate shall include full compensation for all labour, materials, equipment, required for the blocking off of pipes.

**END OF SECTION**

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**C3.8: MECHANICAL SPECIFICATIONS****C3.8.1 PROJECT SPECIFICATIONS****PSM 1 SCOPE**

An overall plan of the Site can be found in Drawing Number 60471/C/GW/003.

The Works consist of the design, supply, delivery, installation, testing, commissioning and upholding during the Trial Operation Period and the Defects Notification Period of mechanical equipment including, but not limited to, the following equipment and complying with the Specification:

**New Inlet Works**

- a) Trash Rack Screen
- b) Front Raked Screens
- c) Hand Raked Screens
- d) Water Launderers
- e) Washer Compactors
- f) Grit Removal Equipment
- g) Grit Classifiers
- h) Channel Mounted Sluice Gates
- i) Skip Dolly for Screenings and Grit
- j) Second Class Water System Reticulation at the inlet works (terminating at the various mechanical equipment as necessary)

**Biofilter Pump Station**

- a) Bio Filter Pumps
- b) Wall Mounted Sluice Gates

**Second Class Water System**

- a) Raw Water Pumps
- b) Booster Pumps
- c) Air Compressors
- d) Automatic self-cleaning Filters

**Sludge Stockpile Pump Station**

- a) Sludge Stockpile Pumps

**Other**

- a) Pipework and Valves
- b) Lifting Equipment
- c) Channel covers
- d) Operation and Control System
- e) Electrical Equipment

- f) Electronic and Control Instrumentation
- g) Airconditioning and Ventilation
- h) Site wide safety Signage and equipment tagging
- i) Spares
- j) Performance Accepting Testing
- k) Test on Completion
- l) Commissioning
- m) Trial Operation Period
- n) Training
- o) Rectification during Defects Notification Period
- p) Operating and Maintenance Manual



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**PSM 2      DESIGN****PSM 2.1      General**

Clause 19 of the Additional Conditions of Contract states that the Contractor shall be responsible for the design of the Works and that the design shall be prepared by engineers or other professionals.

**PSM 2.2      Safety – OHS Act**

In addition to safety requirements during the construction of the Works on Site, the Contractor is responsible for ensuring that all the equipment supplied, and the complete installation comply with the Occupational Health and Safety Act, Act 85 of 1993 and the regulations promulgated thereunder.

**PSM 2.3      Safety- General**

Safety shall be an all-important and overriding consideration and proper attention shall be paid to this aspect at the design stage. Installations which do not comply with the OHS Act or are not of a standard of safety to the satisfaction of the Engineer, shall be corrected by the Contractor at no cost to the Employer.

Equipment which is potentially dangerous shall be designed in accordance with a relevant South African or international Standard.

Hazards must be avoided or guarded to the satisfaction of the Engineer. Nip points shall be guarded. Sharp corners shall be rounded off. Items such as operating handles, supports and protrusions shall be kept clear of access ways or marked accordingly.

The Contractor shall be responsible for covering all unsafe gaps and openings left in structures after installation.

Each motor driven device shall be provided with an emergency stop station in an appropriate position.

Trip wires shall be provided along the accessible side/s of moving conveyor belts, conveyor screws, chains, etc. irrespective of operating speed and in addition to any guards provided. These shall stop the driving motor when pulled.

**PSM 2.4      Design Principles**

Mechanical engineering design shall ensure safety, robust construction, reliability, durability, prevention of avoidable corrosion, neatness as well as ease of maintenance and operation.

Design shall, as applicable, be based on:

- a) The full range of duties which can be reasonably anticipated;
- b) The maximum pressure or vacuum which can be produced by pumps, blowers and compressors under all conditions including blocked or closed inlet and outlet circuits;
- c) Conservative service and safety factors based on approved standards, laid down in the printed specifications of reputable and approved manufacturers or good engineering practice;
- d) Twenty-four hours per day operation (unless specified otherwise);

- e) A minimum life of 100 000 hours for large items of equipment before repair or major part replacement;
- f) Prevention of serious damage from normal operational problems such as blockages, blinding, jamming, seizure, malfunction and, as far as is practical, mal operation (assuming that these occurrences cannot be avoided by good design);
- g) The power and torque transmitted by the driver system under full load and stalled conditions;
- h) Machines with non-overloading characteristics shall be selected wherever possible; e.g., motors shall be sized so that they cannot be overloaded by the driven machine.

## **PSM 2.5 Fail Safe Operation and Protections**

Where damage can occur from normal operational or other foreseeable problems, plant, equipment and systems must be designed to be fail safe; i.e. must have built in redundant elements, or be fail-to-safe; i.e. must return to a safe condition where no further damage can be done in the event of a failure, malfunction, mal-operation, overload and, as far as practical, misuse. All reasonable and economically justifiable protections to prevent or limit damage to plant and equipment, particularly in high-risk situations, must be incorporated.

Protections shall:

- a) Be directed at the source of the problem, limit forces to safe levels and act quickly enough to prevent damage (electrical thermal type overloads are inadequate);
- b) Stop or prevent from starting all equipment at risk;
- c) Activate an alarm with a labelled indicator on the control panel whenever a protection operates;
- d) Operate reliably after long inactive periods exposed to corrosive and dirty conditions.

Contractors shall highlight equipment limitations which can be exceeded during operation and cannot be guarded against.

## **PSM 2.6 Moving Parts**

The following general requirements apply not only to machines but to all equipment with moving parts such as headstocks, extension spindles, swiveling davits, heavy duty hinges, pivots and the like:

- a) All rotating or swiveling shafts, pins and the like, shall be adequately supported, guided and restrained by lubricated or self-lubricating bearings, collars and/or bushes.
- b) Swiveling joints on linkages and the like shall be of the "universal" or fork and rod type with bearings or bushes fitted to the eyes or forks.
- c) Abrasion resistant materials and slow speed operation shall be used for abrasive applications. Raw sewage and sludge shall be regarded as abrasive.
- d) All applications associated with wastewater shall be regarded as corrosive and materials of construction shall be selected to suit.

- e) Susceptibility to fatigue failure shall be minimized by proper design and manufacturing procedures. Sharp changes in section and welding shall be avoided in components subject to fluctuating stress.
- f) The locking of nuts and pins in position shall be done to the approval of the Engineer.
- g) Wearing parts shall be designed for ease of removal and replacement

#### **PSM 2.7 Arrangement and Mounting**

The arrangement and general design shall take the following requirements into consideration:

- a) Lifting eyes, lugs, hooks, etc., shall be provided on heavy or large items to facilitate handling.
- b) Castings or fabrications shall have machined pads for seating and be mounted on either soleplates or baseplates as appropriate.
- c) Where accurate alignment is required, positioning pins and/or jacking screws shall be provided.
- d) The needs of operation and maintenance including neatness, access, working space, safety, cleaning, adjustment, handling, assembly, alignment, disassembly, removal, etc.
- e) With plant and equipment to be mounted on or against concrete or brick structures built by others, provision shall be made for adjustment in the mechanical design. Any special accuracy requirements must be specified on the Contractor's Documents.

#### **PSM 2.8 Prevention of Corrosion**

The Contractor shall review all designs from a corrosion protection point of view. Any details which might have a negative effect on the corrosion protection, and the future application of coatings, are to be brought to the Engineer's attention for a ruling prior to commencement of work.

All items shall be designed to minimise corrosion in the environment in which they will be exposed. Particular emphasis shall be placed on accessibility for surface preparation and the application of coatings. The detailed requirements for corrosion protection are dealt with elsewhere in this document.

Mastics, sealants, insertion rubber or suitable gasket material shall be used to seal unavoidable crevices such as bolted connections; e.g., under guardrail feet.

The design of articles shall ensure that surfaces of corrodible materials, such as carbon steel, shall be accessible for initial coating and for maintenance. The use of back-to-back angles, partially open box sections or inaccessible stiffeners shall be avoided. Fabrication openings shall be of sufficient size to enable fettling, blast cleaning, painting, pickling and passivation and particular attention shall be paid to the fabrication and inspection requirements for internal weld surfaces in pipework.

#### **PSM 2.9 Valves**

All valves shall comply with the following requirements:

- a) Valves shall be clockwise closing.

- b) Valves shall make use of rising spindles.
- c) Valves shall be class 10 or as specified in the relevant specification.
- d) Valves shall comply with the requirements of SABS 664/1974.

**PSM 3      PROCESS DESCRIPTION AND CONTROL PHILOSOPHY****PSM 3.1      Process Description**

Raw sewage enters the Isipingo Wastewater Treatment Works via two DN700 sewer pipelines. The flow is received at a single inlet channel, upstream of the new inlet works. The inlet channel is equipped with a single coarse mechanical trash rack screen to capture large, non-organic objects in the raw sewage. The inorganics capture by the trash screens are discarded onto a concrete slab for offsite disposal.

The raw sewage gravitates to the inlet works channels for further screening and grit removal. The inlet works is divided into 4 channels. Two main screen channels are each equipped with a single fine mechanical screen and the two passive bypass channels each equipped with a single hand raked screen. The captured screenings are conveyed by water launders using second class (or wash water) to transport them to one of two washer compactors for washing, dewatering, compacting and disposal offsite.

The screened sewage is distributed between 2 vortex type grit chambers, downstream of the screen channels. Grit and other inorganic solids are settled to the bottom of the vortex chamber for removal. Each vortex type grit chamber is equipped with a self-priming pump which pumps the captured grit and inorganic matter into one of two grit classifiers. The grit classifiers dewater the grit and inorganic matter before it is discharged into waste skips for offsite disposal.

Wash water is pumped from the second class water pump station to the inlet works for screening conveyance at the water launders, screenings washing at the washer compactors and grit sparging at the vortex grit chambers, respectively. The dirty wash water from the washer compactors and grit classifiers (overflow) is returned to the inlet works, into the common channel, via gravity.

The screened and degritted wastewater flows past the existing inlet works (to be decommissioned) under gravity and is measured at a flume upstream of the PSTs.

Humus sludge, sludge drying bed supernatant return and secondary digester supernatant return flows re-enter the main flow and is mixed with the screened sewage at the PST distribution chamber.

The screened sewage (and return flows) is distributed between 6 existing Primary Sedimentation Tanks (PSTs). The primary sludge (or underflow from the PSTs) gravitates to the Primary and Secondary Digesters for digestion and stabilization before it is solar dried at the Sludge Drying Beds. The dried sludge is stockpiled from where it is disposed offsite and the supernatant is returned to the main flow upstream of the PST distribution chamber.

Settled sewage (or primary effluent) from the PSTs collects at the Biofilter Feed Sump. The Biofilter Feed Sump and the new Settled Sewage Sumps are directly connected to the Biofilter Pump station. Four new pumps are provided at the Biofilter Pump Station and transfers the settled sewage to the Biofilter Distribution Chamber for equal distribute between 6 biofilters. Effluent from the biofilters gravitates to the 6 Humus Tanks.

Secondary effluent from the Humus Tanks gravitates to the maturation pond for final disinfection using gaseous chlorine. The settled secondary sludge (or humus sludge) is recycled to the Humus Sludge Sump to re-enter the main process flow at the PST distribution chamber. A portion of the humus tank effluent is recycled to the Biofilter Feed Sump. The disinfected final effluent gravitates from the Maturation Pond to the Isipingo River adjacent to the Works.

Emergency overflows located upstream of the new trash rack screen and upstream of the old grit channels, allows sewage to bypass the works directly to the maturation pond in the event

of an emergency. The overflow chamber is equipped with a single hand raked screen to remove screenings in the event of an emergency overflow.

### **PSM 3.2 Control Philosophy**

This control philosophy provides a basic overview of the control requirements for the process units included within the Scope for this Contract. This section describes the Engineer's intention as to how the process shall be operated.

This control philosophy shall be read in conjunction with the Piping and Instrumentation Diagrams (P&IDs) developed by the Engineer. The P&IDs provided is an indication of the equipment required and is by no means a comprehensive design showing all equipment and instruments required.

The Contractor shall be responsible for developing a detailed control philosophy and piping & instrumentation diagram (P&ID) for the Works based on the requirements stated below and from the outcome of the HAZOP study. The Contractor shall also be responsible for the supply, installation, and commissioning of additional components or equipment that would reasonably be required for the Works and have been implied by the intent of this control narrative/philosophy, but that have not been specifically identified on the drawings and Specifications. The Contractor's control philosophy shall make specific reference to each equipment tag number including valves and instrumentation and shall clearly state the start-up, normal operation and stopping sequence for all equipment as well as all process and safety interlocks.

The control philosophy shall be submitted to the Engineer for approval. Once approved by the Engineer, the Contractor shall include this control philosophy in the development of the final control system Functional Design Specification (FDS) before programming.

#### **Inlet Works**

##### **Trash Rack Screen**

A single mechanical trash rack screen shall be provided at the inlet channel, upstream of the inlet works. The trash screen shall always be duty, and a screening cycle shall be activated based on a timer.

The trash rack screen shall discharge directly onto a concrete slab located behind the trash screen.

An over-torque switch shall be provided on the trash rack screen drive unit to trip the screen on high torque. On over-torque, the screen shall move in the reverse direction for a preset duration before attempting a forward motion. If after three attempts, the over-torque persists, the screen shall trip and go offline. An audible alarm shall sound, and a strobe light shall illuminate to indicate a tripped trash screen, in addition to the control system alarms.

An emergency stop (e-stop) station with a forward and reverse start buttons shall be provided next to the trash rack screen. The reverse start shall be non-latching.

A new bypass equipped with a single hand raked screen and located upstream of the trash rack screen, shall divert the incoming raw sewage and screen it before conveyance to the maturation pond. This will occur when the trash screen is not available, and the inflow rises above the weir invert level. The hand raked screen shall be cleaned manually by plant personnel and screenings disposed on a concrete slab.

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### Mechanical Screens

The main screen channels shall be arranged in a duty/duty configuration, i.e. both screen channels and associated screens shall be duty under normal operating conditions. However, each mechanical screen and associated channel shall be designed to handle the full hydraulic capacity of the inlet works and shall take over as the sole duty screen, if required. A screening cycle shall be initiated based on time lapsed or based on level differential across the screens. The common channels upstream and downstream of the screen channels shall each be fitted with ultrasonic level sensors to monitor the level differential across the screen channels.

Each mechanical screen shall be fitted a torque switch to protect the screen against over-torque. Upon an over-torque event, the screen shall stop and run in reverse for a preset time. The forward motion shall resume once the run-in-reverse timer has lapsed. If the over-torque even persists, the screen shall repeat this sequence two more times before tripping on over-torque. The screen shall become "unavailable" until the over-torque is cleared by a process controller. The over-torque trip shall remain until the screen is reset by a process controller.

Each mechanical screen shall be provided with a local control station, each with an emergency stop (e-stop) button, forward running start button and a reverse run button. The reverse run button shall be non-latching, only operating when the button is pressed and stopping the screen when the button is not pressed.

All safety protections in automatic mode shall be active manual operation.

The upstream and downstream sluice gates shall be manually operated.

### Hand Raked Screen

The bypass channel at the inlet works shall be passive. The hand raked screen shall be cleaned manually by plant personnel.

### Sludge Stockpile Pumps

Supernatant from the sludge stockpile will drain into a sump with one duty and one standby submersible pump. The pump duty shall be rotated over a configurable time period. The pumps shall be controlled by the level in the sump that will be measured by an ultrasonic level sensor.

### Second Class Water System (Wash water)

The Second class water system shall be programmed to operate in conjunction with the mechanical screens, washer compactors and vortex grit chambers, respectively.

Second class water shall be sent to the water launder when a screening cycle is triggered. The solenoid valve upstream of the water launder shall automatically open to supply the required second class water. The solenoid valve (and thus second class water feed) shall remain open for the duration of the screening cycle and shall close after a set timer has lapsed after the screening cycle has stopped. The diverter valve (VLV-009) shall direct the screenings and second class water to the duty washer compactor. The diverter valve shall automatically switch between the washer compactors based on:

- i) second class water level in the duty washer compactor, or
- ii) the availability of the standby washer compactors.

Each vortex degritter chamber shall be fitted with sparge pipes for grit fluidization. The sparge pipes shall have solenoid valves to automatically control the flow of fluidizing water based on a timer. The sparging system shall be interlocked to work in conjunction with the pumps, fluidizing the grit before the pumps start to transport the settled grit to the grit classifiers.

Manual bypass pipework, with manual isolation valves, shall be provided across each solenoid valve installation. The manual valves shall be normally closed, except when bypassing the solenoid valves.

#### Washer Compactors

The washer compactors shall be configured in a duty / assist arrangement and shall take turns receiving screenings from the water launder. After every screening removal the feed trough of the Wash Press is filled with wash water up to level measured by a level sensor. The wash water solenoid valve is opened until a certain level is exceeded. The level signal is damped for a programmable time, i.e. the values must constantly and for a programmable time have exceeded or fallen below the limit values.

Once the screenings have reached a preset minimum volume in the washer compactor, the diverter valve (VLV-009) shall automatically switch over to the assist washer compactor. The duty washer compactor shall initiate screenings wash cycle and the washer impeller (or agitator) shall start automatically. The duty washer compactor shall continue to receive second class water via their respective solenoid valve (VLV 006 and VLV 015 for washer compactor 1 and washer compactor 2, respectively) until the wash water in the hopper reaches a high-water level. The wash impeller shall continue to run until a preset run time has lapsed. The wash impeller shall stop, and the drain valve shall open automatically. The screenings discharge conveyor shall start automatically and shall run for a preset time to discard the washed screenings. Once the entire wash cycle is complete, the washer compactor shall become standby, waiting to be duty.

The discharge screw and wash impeller of each washer compactor shall be equipped with a torque switch which shall trip the screw upon an over-torque event. The over-torque trip shall remain until the screen is reset by a process controller.

The washer compactors shall be interlocked to work in unison. When one compactor is not available, the remaining washer compactor shall remain duty and the diverter valve (VLV-009) shall maintain its position, until the other washer compactor can resume duty. Each of the washer impeller, discharge screw conveyor and drain valve shall be provided with means for manual operation. A single emergency stop (e-stop) button shall be provided at the same local control station as the manual start buttons for the washer impeller and the discharge screw conveyor and shall stop all functions of the washer compactor when activated. An e-stop shall remain active until reset by the process controller.

#### Grit Removal

Each vortex type degritter shall be equipped with a single self-priming pump to extract and transfer grit and other inorganic matter from the grit collection chamber to the grit classifiers. The pump shall always be duty for its dedicated vortex-type degritter and shall operate based on a timer, starting when a preset time has lapsed and stopping after a preset run time has expired.

A flow switch shall be installed on the discharge line of each pump to trip the pump under no flow conditions. Additionally, each pump shall be furnished with a discharge pressure gauge.

The pumps shall discharge into a common manifold to allow for duty / assist operation of the grit classifiers.

A manual start station with an emergency stop (e-stop) shall be provided next to each pump. The pump shall operate continuously in manual mode until stopped at the e-stop or due to a no flow trip.

#### Grit Classifiers



The grit classifiers shall be arranged in a 1 duty / 1 assist configuration and shall alternate in receiving grit from the grit pumps.

Electrically actuated gate valves (VLV-028 and VLV-029) shall be provided upstream of each grit classifier for flow isolation. The gate valves shall remain closed except when the grit classifier is called to duty, upon which the upstream gate valve shall open, only closing (automatically) when the grit classifier is no longer selected for duty.

The screw conveyor of each grit classifier shall operate intermittently to transport grit up the discharge chute, stopping intermittently to allow the grit to dewater, before moving it up the chute again. This action shall be repeated until the grit is dislodged at the outlet of the screw conveyor. The run time and time to pause shall be adjustable on the control system. The screw conveyors shall be equipped with torque sensors to protect the screw conveyors from over-torque. Upon experiencing an over-torque event, the screw shall run in reverse for a preset time and then shall attempt to run forward. If the over-torque persists, the over-torque procedure shall be repeated two more times before the grit classifier fails on over-torque. The grit classifier shall be prevented from running, even in manual mode, until the over-torque has been cleared by the process controller. Additionally, the discharge screw conveyor shall be prevented from operating when the water and grit level in the grit classifier is below a set minimum water level.

Each grit classifier shall be provided with a local control station fitted with a start button for the discharge screw. A single emergency stop (e-stop) button shall be fitted at the local control station to stop all grit classifier functions. The e-stop shall remain active until reset at the control system by the process controller.

All safety protections shall remain active during manual operation.

#### Skip Dollies

Collected grit and the screenings collected, washed and dewatered at the inlet works will be collected at 2 skip dollies, one for the screenings and the other for grit collection skips, respectively. Each dolly shall house two skips, and each dolly shall be provided with a local control station. The local control stations will have a forward, reverse and e-stop button. The forward and reverse buttons shall be non-latching and shall result in dolly movement so long as they are pressed and letting go of the button will immediately cut power to the dolly.

#### Biofilter Pump Station

The existing Biofilter Pump Station will be equipped with four new immersible type centrifugal pumps to pump settled effluent from the PSTs and Hummus Tanks to the Biofilter Distribution Chamber. The pumps shall be configured in a 3 duty / 1 standby arrangement with variable speed drives for flow control. The duty shall be rotated periodically. The duty rotation period shall be adjustable on the control system.

The pumps shall start and stop automatically in response to settled effluent level in the Settled Effluent Sump, starting on high settled effluent level and stopping on low settled effluent level, respectively. The sump shall be provided with level sensors to measure the settled effluent level in the sump.

The system shall be provided with pressure sensors and pressure gauges to trip the pumps on system over pressure, temperature sensors on each pump to trip the pump on stator winding overheating, flow sensors on pump discharge lines to trip the associated pump on no flow, and moisture sensors in the separation chamber of each pump to detect water ingress in the pump motor and stop the associated pump, respectively.

Manual operation of the pumps shall be provided at the MCC and at the local control stations. Each pump shall be provided with a dedicated emergency stop (e-stop) station.

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All pump and system protections shall be active during manual operation.

### **Second Class Water System**

#### **Raw Water Pump Station**

Two new Raw Water Pumps shall be provided to abstract second class water (disinfected final effluent) from the last channel of the Maturation Ponds, pumping it through a set of filters and it into the second-class water reservoir.

The pumps shall be configured in a 1 duty / 1 standby configuration. The pumps shall alternate being duty. The duty pump shall start based on water level inside the second-class water reservoir and shall stop once a present water level inside the reservoir has been reached.

Each pump shall be fitted with a flow switch to protect the duty pump from running dry by cutting off power to the motor when no flow is detected on the duty pump after a present time has lapsed. A pressure gauge shall be installed on the common suction manifold and the discharge line of each pump.

An ultrasonic level sensor shall be installed on the second-class water reservoir for pump control and to protect the reservoir from overflow. A high-level float switch shall be provided as a back-up to the ultrasonic level sensor. The float switch shall cut off all duty pumps.

A two-stage filtration system shall be installed between the pumps and the reservoir to filter the second-class water to less than 150 microns. Two 500 microns filters shall be installed at the first stage and two 150 microns filters shall be installed at the second stage. Each filter shall be an automatic self-cleaning filter with automatic backwash. The backwash shall start automatically based on differential pressure across the respective filters. Backwash water shall be returned to the maturation pond, downstream of the abstraction point.

The filters are to be operated in a standby/duty configuration, with a set of the 500 micron and 150 micron filters in use at a time. During the backwashing procedure, an electrically actuated butterfly valve will be used to isolate the flow to the 2<sup>nd</sup> class water system reservoir, ensuring that all of the available flow is used for the backwashing process. The actuated valve is to reopen upon completion of the backwashing.

The backwash shall start automatically based on differential pressure across the respective filters. Backwash water shall be returned to the maturation pond, downstream of the abstraction point. As a backup to the water supply from the raw water pumps. A potable water connection to the reservoir will be provided. A manual ball valve will be provided to fill the reservoir using potable water. A high level float switch will be used to cut off the flow from potable water connection once the reservoir reaches its full supply level. A mechanical (turbine) flow meter will be provided to record the use of potable water.

A compressed air system shall be provided for pneumatic control of the backwash system. Two air compressors shall be provided and shall be configured in a 1 duty / 1 standby arrangement.

#### **Booster Pump Station**

A booster pump station shall be provided downstream of the second-class water reservoir to deliver second class water to the various onsite users, e.g., motive water at the inlet works for screenings conveyance, washer compactor top-up, etc.

The booster pump system is to be configured with input from suppliers, such that the required minimum and maximum flow rate can be supplied at the required pressure. Each pump type used within the booster pump system is to have a standby pump. The pumps shall be VSD controlled and shall ramp up and down in response to demand.

Each pump shall be fitted with a temperature sensor to monitor the windings temperature. The pumps shall trip on overtemperature. Similarly, a no flow switch shall be fitted on each pump discharge to protect the pump against operating with no flow.

The booster pumps shall be primarily and directly controlled with the main PLC and main PLC program and if required may have the OEM control system as a backup to this.

An accumulator (pressure vessel) shall be supplied with the booster pump system, it should be sized to ensure that the booster pumps will not exceed their allowable number of starts per hour. The flow into the second-class water network shall be measured by a magnetic flow meter at the Booster Pump Station.

**PSM 4 TRASH RACK SCREEN****PSM 4.1 Specification**

As specified below.

**PSM 4.2 Amendments, Additions and Detailed Requirements****(i) Scope of Works**

One (1) new trash rack screen shall be provided at the inlet works. The trash rack screen shall be supplied complete with, but not limited to, mounting brackets, drive motor and gearbox, and discharge chute, etc.

Furthermore, safety closure plates shall be provided in front of the trash rack screen.

**(ii) Performance Requirements**General

The trash rack screen shall be installed upstream of the new inlet works. The trash rack shall discharge the captured screenings directly onto the concrete slab located behind the trash rack screen.

The trash rack shall be designed for motorised removal of large and bulky solids that enter the treatment works. The trash rack screen shall withstand the force of water against a blocked screen field without damage when the channel is full upstream and empty downstream. Operation shall be jerk free.

The trash rack screen shall be capable of operating across the full range of flows in the channel, which shall range from a minimum flow of 5.4 Ml/day to a peak flow of 54 Ml/day.

The trash rack screen rake comb shall engage the screen field freely and shall travel smoothly up to the discharge point. Objects with an effective diameter of less than 600 mm but larger than 100 mm shall be successfully removed by the trash rack screen without falling back into the channel.

There shall be no long-term accumulation of solid matter within the screen body or the discharge chute. It shall not be necessary for the operator to clear the unit.

Loading on the screens

The total solids loading of wastewater is random. While the exact composition of solids into the wastewater treatment works cannot be reliably predicted, the trash rack screen shall be capable of handling large items such as tree branches, car tyres, bricks, rocks, logs, bicycles, shopping trolleys, and similar types of solids typical to domestic sewage works in South Africa without damage to the screen. Notwithstanding, the trash rack screen shall meet the following performance requirements:

Parameter	Specification
Maximum head loss (mm) @ 40% blinded	20
Removal efficiency (%) [SCR]	60

**(iii) Operation and Control**

The trash rack screen shall always be duty.

The screening cycle for the trash rack screen shall be activated automatically based on a timer.

Ultrasonic level flow meters shall be installed upstream and downstream of the trash rack screen as a safety measure to initiate a screening cycle in the unlikely event of level build up upstream of the trash rack screen before the timer has lapsed or upon failure to initiate a screening cycle upon lapsing of the timer.

An over torque cut out device shall be installed on drive unit of the trash rack screen and shall cut off electric power to the trash rack screen motor when an over torque event is detected. An alarm shall be raised on the SCADA / control system.

The trash rack screen shall be provided with a local stop station with an emergency stop (e-stop) button to stop the trash rack screen in the event of an emergency.

All trash rack screen trips shall only be resettable at the field local control station.

It shall be possible to start the trash rack screen from the SCADA / control system, on condition that all trips have been reset on the field.

All protections shall be active in manual mode.

**(iv) Construction and Design**

General

The installation shall be as shown on related drawings.

The trash rack screen shall have a bar spacing of 100 mm. The bars forming the screen field shall be robust and accurately aligned. The screen bar thickness shall not be less than 8 mm, and the screen bar depth shall not be less than 60 mm.

Flow velocity, with reference to the nominal cross-sectional area of the full screen field, shall not exceed 0.9 m/s at the maximum specified flow.

The screen field shall be inclined to the direction of flow. The field shall be removable and replaceable without removing or dismantling the frame. The screen frame shall be robust, rigid and durable. It shall be self-supporting, and the screen unit shall be designed to be hoisted using slings when in fully assembled condition.

The support brackets which secure the screen's frame at the top of the channel shall be of stainless steel with a wall thickness of not less than 4.5 mm and with at least four (4) anchor fasteners per bracket.

The flow being screened shall contain grit. The design shall ensure reliability and shall provide adequate resistance to wear. Sliding contact between similar metals is not acceptable except for the replaceable items such as the screen field and rake comb.

The screen shall incorporate both a back-raked and a front-raked mechanism. The lower portion of the screen field shall be back-raked while the upper portion of the screen shall be front-raked. A linked chain mechanism shall be responsible for moving the rake over the screen field. The rake shall be attached to the chain mechanism on both ends of the rake. The rake shall be fabricated from at least 12 mm thick plate and shall have a depth of at least 375 mm such that large objects are able to rest on the rake and be removed from the flow. The screen field shall span the channel and shall extend to at least 200 mm above the maximum water level height.

Rolling element bearings shall be rated with an L-10 life of at least 100 000 hours and shall be mounted in sealed bearing housings. Greased bearings shall be provided with easily accessible greasing points with one stainless steel grease nipple per bearing. The external surface of bearing housings shall be provided with a tropical rated corrosion protection system.

Polymer and ceramic bearings shall be replaceable.

Machine components such as motors, gearboxes and bearings shall have ingress protection which is suitable for washing by hose.

The screen shall be mounted firm and level.

Screen frames which are mounted within the flat surfaces of channel walls and floor shall either be directly anchored to the concrete or shall be provided with cradle brackets which securely position the screen.

The spaces between the frame and the and the vertical concrete channel walls shall be provided with a sealing arrangement which prevents flow through any clearance.

Equipment which does not have local (South Africa) support shall not be acceptable unless specifically called for in the specifications or unless the Engineer agrees in writing.

**(v) Materials and Coatings**

The frame, screen field, rake mechanism, rake comb, chains, sprockets, chutes and covers shall be of EN Grade 1.4401 (316 stainless steel).

Low carbon equivalents shall be used for austenitic components which shall be welded.

The wiper blade shall be of a suitable polymer or elastomer.

Cradle brackets shall be of duplex or of EN Grade 1.4401 (316) stainless steel with anchor fasteners of EN Grade 1.4401 (316).

**(vi) Spares**

The Contractor shall provide the following spares. Quantities are specified in the BOQ:

- a) Set (2 off) full length chains for rake mechanism suitable for the screen supplied.
- b) Set (2 off) sprocket wheels.

**(vii) Inspections**

Shall comply with section **PSM 20** of this Document.

The screens shall be inspected by the Client and the Engineer prior to being released for delivery to Site. All fabrication aspects shall be inspected before delivery to site.

**(viii) Testing Requirements**

The correct operation of the equipment and achievement of the specified performance requirements shall be demonstrated to the Engineer prior to the commissioning of the Works. All safety measures (e.g. over-torque cut-out) shall also be successfully tested prior to acceptance and commissioning.

**PSM 5 MECHANICAL FRONT RAKE SCREEN****PSM 5.1 Specification**

The inlet mechanical front raked screens shall comply with Zut 4001.

**PSM 5.2 Amendments, Additions and Detailed Requirements****(i) Scope of Works**

The installation shall be designed to fit the structures as shown on the drawings.

Two (2) mechanical front raked screens shall be provided. The screens shall be positioned in parallel channels and shall discharge the collected screenings into a water launder that is common to both screens.

**(ii) Performance Requirements**

The screens shall be designed to remove a wide variety of solids that are typically found in wastewater. The screens shall cope with all such solid materials.

Each mechanical front raked screen, and associated channel, shall be designed to handle the full hydraulic capacity of the inlet works. The average dry weather flow and peak wet weather flow through the Inlet Works mechanical screen channels is 18 Ml/day (208.33 l/s) and 54 Ml/day (625 l/s) respectively. The peak flow rate per screen is 625 l/s. The screens shall be designed for these flow rates and the maximum head loss allowed is 110 mm at the peak flow rate when the screens are 40 % blocked.

The screenings removed by the screens shall be deposited into the water launder without hang up.

The volume and mass of screenings is not quantifiable, but the screen shall remove all screenings collected on the bars before the allowable head loss across the screen is exceeded.

**(iii) Operation and Control**

One (1) mechanical front rake screen shall be installed per screen channel. The screen channels shall be arranged in a duty/duty configuration (i.e., both screen channels and associated screens shall be duty under normal operating conditions).

The mechanical front raked screens shall operate automatically based on level differential across the screens or based on a timer, whichever occurs first after the last screening cycle.

Under normal operating conditions, i.e. when both screens are available and are duty, they shall be interlocked to operate simultaneously (i.e. both screens shall initiate a rake cycle upon a level differential or timer lapse).

Upon failure of one of the duty screens, the remaining screen shall take over as the only duty screen and shall continue to operate on differential level and timer. An alarm shall be raised on the SCADA / control system to notify personnel of the screen failure.

Local control stations with a start, reverse and emergency stop (e-stop) button shall be provided close to each screen. The reverse button shall initiate a screen reversal only while the button is physically actuated (i.e. shall be non-latching).

It shall be possible to start the screens (forward motion only) from the SCADA / MCC and local control station. However, reverse operation shall only be possible from the local control panel.

All screen protections shall be active in manual operation.

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**(iv) Construction and Design**

The screens shall have bar spacing of 8 mm and shall be constructed of screen fields of bar thickness of at least 6 mm and bar depth of at least 40 mm.

The Contractor is to take cognizance of the water levels and ensure their screens can accommodate the minimum and maximum water levels under all conditions. These minimum and maximum water levels that the screens can accommodate shall be submitted to the Engineer for approval.

The screen discharge chutes shall be constructed with an integral flap that can be used to bypass the launder. The pivot points shall be designed so that the chute which is formed discharges the screenings past the launder into a temporary collection tray placed adjacent to the screen. Hinged access doors that can be opened to inspect and maintain the screens shall be provided with stainless steel latches which can be used to keep the doors open / closed as required.

The screen frame shall not be grouted into recesses in the channel walls but shall, rather, be mounted against the flat walls.

The screens shall use a stationary turnabout system as the bottom chain support. Designs that make use of sprockets shall not be acceptable.

**(v) Materials and Coatings**

The materials and coatings for mechanical front raked screens shall comply with Zut 4001.

The drive shaft shall be fabricated from 316 stainless steel.

**(vi) Spares**

The Contractor shall provide the following spares. Quantities are specified in the BOQ:

- a) Set of full length chains (2 per screen) for rake mechanism suitable for the screens supplied.
- b) Set of bottom chain bearings (2 per screen).
- c) Set of screen rakes (2 per screen).
- d) Replaceable wiper blade for clearing screenings off rakes (1 per screen).

**(vii) Inspections**

Shall comply with Zut 4001 and section **PSM 20** of this Document.

**(viii) Testing Requirements**

Shall comply with Zut 4001.



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**PSM 6 HAND RAKED SCREEN****PSM 6.1 Specification**

The hand raked screens shall comply with Zut 4009.

**PSM 6.2 Amendments, Additions and Detailed Requirements****(i) Scope of Works**

Two (2) hand raked screens shall be supplied and installed in each of the two (2) passive bypass channels of the new inlet works. A third hand raked screen shall also be supplied and installed in the overflow chamber of the new inlet works.

**(ii) Performance Requirements**

The maximum head loss allowed is 230 mm at the peak flow rate when the screens are 40 % blocked.

**(iii) Operation and Control**

The hand raked screens shall be cleaned manually by plant personnel as required.

**(iv) Construction and Design**

The hand raked screens shall be manufactured with a bar spacing of 20 mm. The screening field shall span the full width of the channel and shall be secured in place with 316 stainless steel anchors. Screenings shall be placed on the trough.

For the passive bypass channels, the channel width is 1300 mm and the channel depth is 1345 mm. For the overflow chamber, the channel width is 1500 mm and the channel depth is 1600 mm.

**(v) Materials and Coatings**

The hand raked screens shall be constructed from grade 304L stainless steel.

**(vi) Spares**

Spares shall NOT be required for the hand raked screens under this Contract.

**(vii) Inspections**

Shall comply with Zut 4009 and section **PSM 20** of this Document.

**(viii) Testing Requirements**

Shall comply with Zut 4009.

**PSM 7 WATER LAUNDER****PSM 7.1 Specification**

As specified below.

**PSM 7.2 Amendments, Additions and Detailed Requirements****(i) Scope of Works**

The installation shall be designed to fit the structures as shown on the drawings.

The water launder system shall transport screenings from the mechanical front rake screens and screenings removed from the hand raked screens to the washer compactors for washing, dewatering, compacting and disposal offsite.

Water supplied by the Second Class Water System shall be used to transport the screenings in the launder system and the flow of water shall be regulated by motorised valves at each launder connection.

**(ii) Performance Requirements**

The amount of water used to clear the screenings shall not exceed the amount of water required to initiate a wash cycle. It is preferred that the launder is cleared several times before a wash cycle is started.

No screened material shall remain in the launder after a launder flush cycle has been completed.

The design of the diverter / valve chute at the washer compactors shall ensure that it is not possible for screenings to build up or to get caught on any part of the equipment supplied.

**(iii) Operation and Control**

The period for which the second class water valves are open shall be long enough for all screenings to be deposited into the awaiting screenings washer compactors so that the conveyor is empty and ready for the next load of screenings.

A launder flush shall take place when the screens are operational.

**(iv) Construction and Design**

The launder shall be constructed of U-trough sections that are at least 300 mm deep and 300 mm wide. Each U – section shall have stiffening lips at both ends and shall be sealed with U-shaped gaskets in-between adjoining sections. Hinged covers shall be provided along the full length of the launder except where the screen chutes are connected. Provision shall be made for depositing hand raked screenings into the launder. The launder shall not have any small radius bends, restrictions or joints that hinder the conveyance of screenings.

The discharge chute shall be square or rectangular and shall be the same width as the launders. The chute shall connect to the launders with flanges and shall be adequately supported independently of the launders. The flange connection and chutes shall be watertight.

The launder shall be designed to ensure that no wash water splashes out of or leaks from the trough during operation. All launders, chutes, covers and supports shall be fabricated from 316 stainless steel. The launders and chute shall be fabricated from at least 3 mm thick plate and at least 8 mm end plates / flanges. The covers shall be fabricated from at least 2 mm thick plate and fitted with handles that cannot be removed. Each cover shall have at least two hinges fitted along one edge and shall not exceed 750 mm in length. Supports shall be fabricated from 4.5 mm or thicker profiled plate and shall comply with Zut 7024.

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Water for the launder system shall be piped to the launders with 316 stainless steel piping and valves of at least 40mm in diameter. The flushing points shall consist of motorised valves (designed for use with final effluent) with manual bypass valve and an isolation valve upstream of the actuated valve. The bypass valve shall be connected to the launder so that it can be used to flush the launder, and this connection should be independent of the actuated valve connection. A pressure reducing valve shall be provided to limit the second class water (i.e., wash water) pressure supplied to the launders. The second class water supply pipework and supply valves are specified elsewhere.

**(v) Spares**

The contractor shall provide the following spares:

- a) Actuated valve for launder second class water complete.

**(vi) Inspections**

Shall comply with section **PSM 20** of this Document.

**(vii) Testing Requirements**

The correct operation of the equipment and achievement of the specified performance requirements shall be demonstrated to the Engineer prior to the commissioning of the Works.

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**PSM 8 WASHER COMPACTOR****PSM 8.1 Specification**

The washer compactors shall comply with Zut 4016.

**PSM 8.2 Amendments, Additions and Detailed Requirements****(i) Scope of Works**

The installation shall be designed to fit the structures as shown on the drawings.

Two (2) washer compactors shall be provided at the inlet works. The washer compactors shall be supplied complete with the required washer compactor drainage valves, level sensors and respective pipework.

**(ii) Performance Requirements**

The washer compactors shall remove fecal matter and excess moisture from the screenings.

Compaction shall ensure that the dry substance contents of the washed and pressed screenings are no less than 50%.

The organic content of the washed screenings shall be minimal and shall have a grey / white colour. Brown unwashed screenings shall not be acceptable.

The washer compactors shall be designed such that should one unit be out of service, the remaining washer compactor shall be able to handle the flow of screenings and dirty wash water from two duty screens.

**(iii) Operation and Control**

The washer compactors shall be fully automatic and shall receive screenings from the new Inlet Works mechanical front raked screens under gravitational flow via a water launder (specified elsewhere).

The washer compactors shall be configured in a duty / assist arrangement and shall take turns receiving the screenings.

Once sufficient water and screenings have been deposited into the duty washer compactor (as indicated by the level sensor), a wash cycle shall be initiated.

The washer compactors shall wash and compact the screenings in batches. If a batch has not been completed and the launder is to be flushed, the assist washer compactor shall receive the new screenings while the other washer compactor completes its washing cycle.

After each wash cycle has been completed, the washer compactor should be allowed to fill partially with second class water prior to receiving screenings. The second class water shall be controlled automatically by a solenoid valve. In addition, a manually operated bypass valve for manual addition of second-class water into the washer compactors, if necessary. The water supply valves are specified elsewhere.

Should one washer compactor become unavailable, the washing sequence of the active washer compactor shall be programmed to continuously accept new screenings, wash and discharge the screenings without causing blockages in the water launder.

A local control station shall be provided near each washer compactor. The control station shall consist of an independent start button for the washer compactor discharge screw and the washer impeller, respectively. A single emergency stop (e-stop) button shall be provided. The e-stop button shall cut out the power to the discharge conveyor and washer impeller simultaneously when actuated.

Over torque protection shall be provided for the washer impeller and discharge conveyor of each washer compactor. Current based (or non-physical devices) are permitted for over torque protections.

Manual operation of the washer compactors shall be provided at the MCC buckets and the local control stations.

All protections shall be active in manual mode.

**(iv) Construction and Design**

Each washer compactor shall be equipped with a screw conveyor driven by a geared motor and a washing unit consisting of a hopper and washer impeller. The screw conveyor shall also be equipped with easily replaceable brushes used for clearing the perforated drainage portion of the trough.

The hopper shall be designed with an access hatch for viewing and inspecting the internal components and for clearing any obstructions. This hatch shall be hinged and sealed when not in use by using latches (wing nuts will not be acceptable). This hatch shall be in addition to any hatch provided on the side of the hopper.

The washer impeller shall be designed so that screenings do not accumulate on or behind the impeller.

The water level in the washer compactor shall be measured by a pressure (or level) sensor mounted on the hopper.

An actuated diverter (or similar) shall be provided to direct water and screenings to the duty washer compactor. Water used for conveying the screenings and make-up second class water shall be used for washing of the screenings. The washed and compacted screenings shall be deposited into the centre of a standard 8 m<sup>3</sup> skip that shall be positioned on a skip dolly alongside the washer compactors. The skip dolly is specified elsewhere.

Water, drainage and any screenings from the washer compactor overflow shall flow under gravity to the common channel upstream of the Mechanical Front Raked Screens.

Access

Where the installation is such that the access hatches of the washer compactors are not accessible from the ground or are at least higher than 1.2 m above the ground, a fixed access platform or two separate platforms with steps shall be provided alongside the washer compactors.

The access platform(s) shall be at least 500 mm high and no lower than 1 m from the top of the hopper. The platform(s) shall be designed for operations personnel to inspect the washer compactor internals and for accessing the diverter gate for maintenance.

**(v) Spares**

The Contractor shall provide the following spares:

- a) Full length brushes for the discharge screw (1 per washer compactor).
- b) Discharge screw wear sleeve (1 per washer compactor).
- c) Discharge screw guide bars (1 complete set per washer compactor).

**(vi) Inspections**

Shall comply with Zut 4016 and section **PSM 20** of this Document.

**(vii) Testing Requirements**

Shall comply with Zut 4016.

**PSM 9 DEGRITTING SYSTEM****PSM 9.1 Specification**

The grit extraction pumps shall be self-priming centrifugal pumps and shall comply with Zut 5013.

The valves for the degritting system shall comply with Zut 7010.

**PSM 9.2 Amendments, Additions and Detailed Requirements****(i) Scope of Works**

Two (2) vortex type grit traps (or vortex degritters) shall be constructed from reinforced concrete equipment under this contract.

The degritters shall be furnished with mechanical equipment which aid with grit settling as well as equipment for grit extraction. The Contractor shall provide all the mechanical equipment and ancillaries that form part of the degritting system, which shall include, but not be limited to, the following:

- a) A centrally mounted paddle stirrer.
- b) Grit extraction pumps, complete with all pipework and valves.
- c) Grit sparging (or fluidising) pipework and valves.
- d) Baffle plates on the degritter exits to prevent flow short-circuiting.
- e) Manually operated upstream channel mounted sluice gate, as specified elsewhere.
- f) Manually operated downstream channel mounted sluice gate, as specified elsewhere.

The installation shall be designed to fit the structures generally as shown on drawings but the internal details of the degritting structures shall be provided by the equipment supplier.

**(ii) Performance Requirements**General:

The grit separation units are designed settle grit with grain sizes of 0.2 mm diameter or coarser and a specific gravity of 2.65 from flows varying from 0 l/s to a peak flow of 54 Ml/d (i.e., 625 l/s). The grit shall be collected in a grit trap or sump at the bottom of the separation unit.

Grit Extraction Pumps:

The grit extraction pumps shall be designed to remove and transport 100% of this grit from the grit trap hopper.

The grit extraction pumps provided and installed shall be capable of the duty below. The Contractor shall however finalise the duty point during detailed design to suit the degritting equipment offered. The proposal shall be presented to the Engineer for review and acceptance.

- Flow: 60 l/s
- Head: 3.5 m (up to 4 m)

Grit Sparging:

The grit sparging system shall be effective in injecting second-class water to loosen and fluidise the grit that settles inside the degritter collection chamber before it is pumped away by the grit extraction pumps.

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**(iii) Operation and Control**

The vortex type degritters shall be operated as duty / duty. However, when one degritter is offline, the remaining degritter shall handle the full hydraulic load of the plant for all design flow conditions.

**Grit Paddle:**

The grit paddle assembly shall be geared motor driven and shall operate continuously to induce a vortex flow pattern in the respective degritter.

The grit paddle shall be manually started at the MCC or at the local control station. The local control station shall also include an emergency stop (e-stop) button to stop the paddle in the event of an emergency.

**Grit Sparging System:**

The grit sparging system shall operate automatically to fluidise the grit in the collection chamber of each vortex degritter prior to and during the grit extraction cycle.

The system shall operate on a timer, admitting pressurised water into the vortex chamber after a pre-determined time has lapsed and shutting off the water supply once the predetermined sparging time has lapsed.

**Grit Extraction Pumps:**

The grit extraction pumps shall extract grit from each degritter one at a time and in sequence.

The pumps shall be controlled by a timer. The duty pump shall automatically start when a preset time has lapsed and shall run for a preset time before stopping to wait for the next grit extraction cycle. The frequency and duration of grit extraction shall be adjustable on the SCADA and provision shall be made for varying the frequency of degritting for periods of high and low flow to the works.

The electrically actuated discharge isolation valves shall be interlocked to open and close based on the downstream grit classifier duty status.

Each pump shall be provided with a local control station with a start, for manual starting of the pump, and emergency stop (e-stop) button. The pumps shall also be manually started at the MCC.

All pump protections shall be active in manual mode.

**(iv) Construction and Design**

The internal shape of the concrete structure of the vortex degritters shall be built to the requirements shown on the relevant drawings.

The mechanical equipment shall be designed and built such that rags and other such contaminants that may have passed thorough the New Inlet Works screens do not collect on the drive tube or shafts.

**General:**

The mechanical equipment shall be designed to suit the vortex degritters on the Engineer's civil and structural drawings. The design shall ensure that the velocity in the degritter is maintained to achieve optimal grit settling and organic particle separation as specified.

**Grit Sparging:**

Each vortex degritter shall be provided with a grit sparging system.



The grit sparging system shall consist of a single manifold, per vortex degritter, with at least 4 equally spaced high-pressure nozzles. Mist pattern nozzles shall not be accepted.

Additionally, the system shall consist of isolation ball valves, electrically actuated solenoid valves and pipework. The pipework shall be fabricated of steel pipes of minimum diameter DN25.

#### Grit Extraction Pumps:

The grit extraction pumps shall be designed to handle unscreened wastewater as well as settled wastewater grit.

The pumps shall be belt driven and the pump and motor shall be mounted on a single baseplate, installed on top of the vortex degritter cover slab.

The impellers of the grit extraction pumps shall be of the recessed type to minimise the amount of wear on the impeller.

#### Grit Extraction Pipework:

The delivery pipework for grit conveyance shall be installed above the ground and shall be routed on the shortest practical route between the vortex degritters and the grit classifiers.

The grit extraction pipework shall be at least DN100 unless agreed to by the Engineer.

The delivery pipes shall be straight and unnecessary bends and fittings shall be avoided to prevent grit from settling in the pipes. Elbows shall be long radius elbows and tees shall be swept tees.

The design and layout of the pipework shall be such that grit from either vortex degritter can be discharge in one of the two grit classifiers.

Electrically actuated valves shall be installed upstream of each grit classifier. One manually operated isolation valve shall be installed upstream of the actuated valve for isolation during maintenance and repairs.

Flanges shall comply with SANS 1123 and shall have a minimum pressure rating of PN10.

#### Grit Line Flushing Valves:

Flushing points, each fitted with manually operated ball valves and quick couplings, shall be provided on the grit extraction pipework wherever it may be necessary, especially on bends and low flow areas, to ensure that the grit extraction line can be unblocked if this becomes necessary.

Second-class water shall be used for flushing the pipelines.

### **(v) Materials and Coatings**

The pump impellers and wear plates shall be manufactured of austempered ductile iron.

All pipe work shall be manufactured from 316 stainless steel.

Pipe supports shall be manufactured from carbon steel and shall be hot dip galvanized for corrosion protection.

The grit paddles and drive shaft shall be manufactured from 304 stainless steel or better.

Ball valves used for flushing shall be from grade 316 stainless steel.

### **(vi) Motors**

#### Grit Extraction Pumps:

Electric motors for the grit extraction pumps shall comply with Zut 5013.

Grit Paddles:

The continuous rated output of motors shall exceed the driven unit's shaft power required at maximum duty and the worst operating conditions by not less than 15%.

Motors shall have ingress protection to at least IP 55.

**(vii) Gearboxes**Grit Extraction Pumps:

Grit extraction pumps shall be belt driven.

Grit Paddles:

The gearboxes of the grit paddles shall be motor driven and shall comply with the requirements set in Zut 0001.

Gearboxes shall have ingress protection to at least IP 55.

**(viii) Spares**

One (1) Grit extraction pump (complete with baseplate, couplings, coupling guards, etc.).

**(ix) Inspections**

Shall comply with Zut 5013, Zut 7010, and section **PSM 19** of this Document.

**(x) Testing Requirements**

Shall comply with Zut 5013 and Zut 7010.

**PSM 10 GRIT CLASSIFIER****PSM 10.1 Specification**

The grit classifiers shall comply with Zut 4026.

The terms grit washer and grit classifier can sometimes be used interchangeably. However, for the purposes of this project, the term grit classifier shall be used.

**PSM 10.2 Amendments, Additions and Detailed Requirements****(i) Scope of Works**

The installation shall be designed to fit the structures as shown on drawings.

Two (2) grit classifiers shall be provided under this Contract to dewater grit and inorganic matter from the vortex degritter before it is discharged into waste skips for offsite disposal. The grit classifiers shall be supplied complete with all the necessary components and ancillaries to meet the functional requirements set herein.

**(ii) Performance Requirements**

Each grit classifier shall be designed to receive and process the hydraulic load (grit and water) from two (2) grit extraction pumps with continuous grit extraction or 75 m<sup>3</sup>/h, whichever is greater.

The minimum grit handling capacity per grit classifier shall be 1.5 m<sup>3</sup>/h.

The grit classifier shall meet the grit discharge requirements set out in Zut 4026.

**(iii) Operation and Control**

Two (2) grit classifiers are required to operate in a 1 duty / 1 assist configuration and shall alternate in receiving grit from the grit extraction pumps.

The grit classifiers shall run for a preset period after each grit extraction cycle has been completed.

The screw conveyor of each grit classifier shall operate intermittently to transport grit up the discharge chute, stopping intermittently to allow the grit to dewater, before moving it up the chute again. This action shall be repeated until the grit is dislodged at the outlet of the screw conveyor.

A local control station with a start button and emergency stop (e-stop) button shall be provided for each grit classifier.

The discharge screw of the grit classifiers shall operate continuously in manual mode.

**(iv) Construction and Design**

The grit classifiers shall be offered without grit stirrers, mixers or agitators (i.e., no equipment provided that enables grit *washing* shall be provided).

The classifiers and pipe work to the classifiers shall be located and designed to ensure that grit and water enter the classifier without the possibility of blockages.

Water flow and overflow from the classifiers shall gravitate back to the common channel upstream of the degritters.

**(v) Materials and Coatings**

All pipework, nozzles and pipe anchors indicated as stainless steel in the general specification, Zut 4026, shall be 316 stainless steel.

**(vi) Spares**

The Contractor shall provide a complete set of wearing / replaceable parts including, but not limited to, the following:

- a) Wear protection ring,
- b) Lower screw bearing,
- c) Screw trough liner,

**(vii) Inspections**

Shall comply with Zut 4026 and section **PSM 19** of this Document.

**(viii) Testing Requirements**

Shall comply with Zut 4026.

**PSM 11 SKIP DOLLY****PSM 11.1 Specification**

As specified below.

**PSM 11.2 Amendments, Additions and Detailed Requirements****(i) Scope of Works**

The installation shall be as shown on the drawings.

Two (2) skip dollies shall be provided at the inlet works complete with rails and motor – one (1) for the screenings and one (1) for the grit.

**(ii) Performance Requirements**

Each skip dolly shall be capable of carrying 2 x 8 m<sup>3</sup> skips.

The dollies shall be able to travel without losing traction under the full range of loads ranging from no skips to two (2) full skips.

The dolly travel speed shall be approximately 6 m/min, irrespective of the loading.

**(iii) Operation and Control**

A local push button station shall be provided at each dolly for moving the dolly forward or in reverse. The push buttons shall be non-latching and marked with directional arrows.

It shall not be possible to operate the skips remotely.

**(iv) Construction and Design**

The dolly system shall be of rigid construction and shall be designed for not less than 10 000 operational hours before major repairs are required. The unit shall operate quietly and smoothly.

Grease points which are not easily accessible shall be piped individually to accessible positions for manual greasing.

Removable guards shall be provided to ensure that it is not possible for a hand to come into contact with the wheels.

The dolly system shall be of hot dip galvanized steel.

The rails and cable system shall be long enough to ensure that any of the skips can be placed or removed from the dolly without double handling of skips.

The rails shall be firmly anchored into the concrete, by means of chemical anchors and suitable standard rail cleats. The rails shall be level and aligned and shall be grouted in to ensure the minimum rail surface area is exposed to the atmosphere. The Contractor shall provide the details of all fixing arrangements including anchoring and grouting techniques and materials. Anchors shall be stainless steel.

The dollies shall be provided with locating lugs to ensure that the skips are properly positioned and cannot slide off the rails. The lugs shall not impede the easy removal or placement of the skips on the dolly.

Rails shall be at least of 22 kg/m size and shall have end stops to prevent the dolly from travelling off the rail ends.

Ingress protection shall be to IP 55 or higher for electrical motors and gearboxes and shall be suitable for washing by hose.

Bearings shall comply with the clause "Bearings" in Zut 0001.

The installation shall not impede access to the inlet works or to the skips by the collecting vehicles.

The motors shall comply with the requirements of the electrical specifications.

The motors shall be located on the dolly system and power be supplied via a cable drum system, with suitable protective insulation and corrosion protection for the application and Site environment.

Drive shafts shall be machined with a step so that the sections exposed to atmosphere can be painted.

An anti-seize compound shall be applied to all shafts before assembly.

The motor gearbox shall be protected from spillages and foreign material like stones that may be found on the concrete slab in the path of travel. The underneath of the gearbox shall be at least 25 mm above the finished floor level. A scraper shall be provided on both sides of the gearbox to ensure it is protected, should this be applicable to the design.

**(v) Spares**

Spares shall NOT be required for skip dollies under this Contract.

**(vi) Inspections**

Shall comply with section **PSM 19** of this Document.

The dollies shall be inspected during fabrication as per the requirements for items that are hot dip galvanised.

**(vii) Testing Requirements**

The dollies shall be tested for compliance with the specification.

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**PSM 12 RAW WATER PUMP STATION (SECOND CLASS WATER SYSTEM)****PSM 12.1 General**

The position for the raw water pumps shall be as shown on the drawings.

The contractor shall provide the equipment for the raw water pump station, which shall include, but not be limited to, the following:

- a) Raw water pumps
- b) Raw water pump station valves
- c) Pipework and pipe supports
- d) Water filters
- e) Etc.

**PSM 12.2 Raw Water Pumps****PSM 12.2.1 Specification**

The raw water pumps shall be self-priming centrifugal pumps and shall comply with Zut 5013.

**PSM 12.2.2 Amendments, Additions and Detailed Requirements****i) Scope of Works**

Two (2) raw water pumps shall be provided to abstract second class water (or disinfected final effluent) from the maturation ponds and pump it into a second-class water reservoir.

The pumps shall be supplied complete with all electric motors, pump, belt drives, couplings, air relief valves, etc.

**ii) Performance Requirements**

The raw water pumps shall be capable of the duty below:

- Flow: 10 l/s
- Head: 21.35 m

The Contractor shall however finalise the duty point during detailed design to match the pressure and flow requirements to suit the equipment offered. The proposal shall be presented to the Engineer for review and acceptance.

The pumps shall be installed after chlorine disinfection. Pump components and materials of construction for ancillary systems shall be designed to withstand residual chlorine in the second-class water.

**iii) Operation and Control**

The raw water pumps shall be configured in a 1 duty / 1 standby configuration and the pumps shall alternate being duty.

The duty pump shall start automatically in response to a "low water level" in the second-class water reservoir. The pump shall pump continuously and shall stop once a preset "high water level" has been reached inside the reservoir.

Each pump shall be fitted with a flow switch to protect the duty pump from running dry. The flow switch shall cut off power to the motor upon detecting a no flow condition.

An ultrasonic level sensor shall be installed on the second-class water reservoir for pump control and to protect the reservoir from overflow. A high-level float switch shall be provided

as a back-up to the ultrasonic level sensor. The float switch shall cut off all duty pumps when an overflow event occurs.

Each pump shall be provided with a local control station complete with a manual start button and an emergency stop (e-stop) button.

It shall be possible to start the pumps manually at the MCC and from the local control panel.

#### **iv) Construction and Design**

##### Pumps:

The raw water pumps shall be electric motor driven with V-belt couplings.

The raw water pumps shall be internally coated with a chlorine resistant epoxy.

##### Pipework, valves and pipe supports:

Each pump shall have a separate suction line. The discharge side of each pump shall be equipped with a swing check non-return valve and shut-off valve. All valves are specified elsewhere.

The delivery line for each pump shall have at least two flange adaptors installed to take up misalignment of the pipework. The flange adaptors shall be restrained where required such that all the loads on the pumps and pipework are properly dealt with. Flange adaptors and couplings shall be PN10 rated and shall comply with Zut 7023.

All piping shall be PN10 rated or higher.

Pipework shall be fabricated from mild steel and hot dip galvanized

Only long-radius and medium-radius bends shall be allowed on pipework. Pipework shall comply with Zut 7001.

Pressure gauges shall comply with Zut 0001.

Pipe supports shall also be installed at sufficiently located intervals to support the pipes and take load off joints.

The span between pipe supports shall at no stage be more than 2.5 m and shall comply with the requirements as detailed in Specification Zut 7024.

#### **v) Spares**

The Contractor shall provide the following spares:

- a) Oil for the first oil change of each pump.
- b) One set of v-belts per pump.

#### **vi) Inspections**

Shall comply with Zut 5013 and section **PSM 19** of this Document.

### **PSM 12.3 Raw Water Pump Station Shut-Off Valves**

#### **PSM 12.3.1 Specification**

The shut-off valves shall comply with Zut 7016.

#### **PSM 12.3.2 Amendments, Additions and Detailed Requirements**

##### **i) Scope of Works**



The Contractor shall supply shut-off valves for the discharge side of each pump, and upstream and downstream of each filter.

**ii) Performance Requirements**

All valves provided and installed shall be suitable for the full design flow of the Raw Water Pumps.

**iii) Construction and Design**

Valves shall be PN10 rated.

**PSM 12.4 Raw Water Pump Station Check Valves**

**PSM 12.4.1 Specification**

The check valves shall comply with Zut 7017 for wastewater applications.

**PSM 12.4.2 Amendments, Additions and Detailed Requirements**

**i) Scope of Works**

The Contractor shall supply check valves for the discharge side of each pump.

**ii) Performance Requirements**

All check valves provided and installed shall be suitable for the full design flow of the Raw Water Pumps.

**iii) Construction and Design**

Check valves shall be of the swing check type, PN10 rated.

**PSM 12.5 Automatic Self-cleaning Filters**

**PSM 12.5.1 Specification**

The automatic self-cleaning filters shall comply with the requirements set herein.

**PSM 12.5.1 Amendments, Additions and Detailed Requirements**

**(i) Scope of Works**

The Contractor shall supply at least four (4) automatic self-cleaning filters to filter the raw water before it is stored in the Second-Class Water Reservoir.

The filters shall be provided complete with a single control unit and shall control them as a single system. All associated actuating mechanism shall be included in the supply, including compressors for pneumatic actuation.

**(ii) Performance Requirements**

Each filter shall be capable of handling at minimum flow of 10 l/s at a minimum head of 21.35 m.

The head loss across a clean filter shall not exceed 20 kPa and the pressure differential required to initiate a backwash sequence shall not exceed 50 kPa.

**(iii) Operation and Control**

The filters shall backwash automatically based on a timer or a preset differential pressure across the filters, whichever occurs first. The time interval between backwash cycles shall be adjustable. During backwashing, an actuated valve on the discharge line of the filters shall close, ensuring that all the flow from the raw water pumps is used for the backwashing process. The valve shall reopen once the operation is complete.

The filters shall backwash one screen element per filter at a time.

The two (2) filter trains shall operate in a duty/standby configuration.

**(iv) Construction and Design**

The filters shall be arranged in a two-stage filtration configuration.

The first filtration stage filters the second-class water to less than 500 microns, with the next stage filtering it further to less than 150 microns.

Each filter shall be well supported by pipe supports on the inlet and outlet pipe to the filters.

**(v) Materials and Coatings**

The filter elements shall be manufactured from SS316 wedge wire screens.

**(vi) Spares**

The Contractor shall provide the following spares:

- a) One screen element per filter.
- b) A full set of O-ring seals and gaskets per filter.

**PSM 12.6 Compressed Air System**

**PSM12.6.1 Specification**

The compressed air system shall comply with the requirements set herein.

**PSM12.6.2 Amendments, Additions and Detailed Requirements**

**(i) Scope of Works**

A compressed air system shall be provided for pneumatic control of the backwash system at the raw water pump station. The compressed air system shall be supplied complete with, but not limited to, filters (pre- or inlet filters and inline filters in delivery air pipe), delivery pipework, pipe supports, valves and instrumentation, controller with HMI, and all required electrical cables terminating at the power source.

**(ii) Performance Requirements**

The compressed air system shall be designed to remove water, oil and solid particles from the inlet air and discharge air for the design air flow to levels acceptable to the downstream equipment. The final air quality required shall be verified at detail design in collaboration with the original equipment manufacturers of the air users (i.e., pneumatic instruments).

The free air delivery (FAD) rate shall be determined by the Contractor based on the pneumatic valve demand.

**(iii) Operation and Control**

The air compressors shall be configured in a 1 duty / 1 standby arrangement, taking turns to supply the required instrument air. The duty shall be periodically, and the period shall be adjustable on the control system. The duty compressor shall be based on run hours (i.e., the compressor with least run hours shall be duty at the next change over).

**PSM 12.7 Storage Reservoir**

**PSM12.7.1 Specification**

The mechanical component of the second class water system shall comply with the requirements set herein.

**PSM12.7.2 Amendments, Additions and Detailed Requirements**

**(i) Scope of Works**

A potable water connection shall be provided to the 2nd class water system storage reservoir. This connection shall serve as a backup to the booster pump system. This will comprise of a flagged connection to the above ground potable water line, an isolation valve, a mechanical (turbine) flow meter and a float valve.

Pipework, valves and fittings shall be provided for the overflow protection and scouring of the reservoir. An isolation valve shall be fitted on the reservoir scour pipe. The overflow and scour pipes are to tie into a common pipe.

**(ii) Performance Requirements**

The peak inflow from the raw water pumps shall govern the level and sizing of the overflow pipe.

**(iii) Operation and Control**

If the water supply from the raw water pumps is unavailable, the isolation valve on the potable water line must be manually opened to fill the reservoir with potable water. A float valve shall be fitted on the discharge into the reservoir, where it will immediately shut the inflow once the fully supply level in the reservoir is reached.

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**PSM 13 BOOSTER PUMP STATION (SECOND CLASS WATER SYSTEM)****PSM 13.1 General**

The contractor shall provide the equipment for the booster pump station, which shall include, but not be limited to, the following:

- a) Booster pumps
- b) Booster pump station valves
- c) Second class water supply pipework (outside of pump station)
- d) Second class water supply valves (outside of pump station)

**PSM 13.2 Booster Pumps****PSM 13.2.1 Specification**

The booster pumps shall comply with Zut 5030.

**PSM 13.2.2 Amendments, Additions and Detailed Requirements****i) Scope of Works**

A booster pump station shall be provided downstream of the second-class water reservoir to deliver second class water to the various onsite users.

The contractor shall provide all items for the booster pump vendor package including, but not be limited to, the following:

- a) Vertical in-line multistage booster pumps. A standby pump shall be provided for each pump type used,
- b) Pump motors and coupling and guards,
- c) Local control panel,
- d) Baseframe,
- e) Inputs into the plinth design,
- f) Plinth,
- g) Check valves,
- h) Accumulator (pressure vessel),
- i) Skid-mounted suction manifold, pump suction and discharge legs and discharge manifold,
- j) Suction and discharge pipework, pipe support and valves,
- k) Delivery pressure gauges,
- l) All associated electronic instrumentation,
- m) Fasteners and anchors,
- n) Etc.

**ii) Performance Requirements**

The pumps shall be capable of the meeting the duty below:

- Estimated maximum instantaneous water requirement: 23 l/s
- Head: 75 m

Besides the maximum second class water requirements, the pump station also shall be designed to meet low water demands, when few end users require water. It is estimated that the minimum second class water requirements shall be approximately 2 l/s.

The Contractor shall, however, finalise the duty point(s) during detailed design as the pressure and flow requirements shall be resized to match the second class water requirements of the equipment offered during the Tendering period. The Contractor shall present the Booster Pump Station design to the Engineer for review and acceptance.

The accumulator (pressure vessel) shall be sized to ensure that the booster pumps will not exceed their allowable number of starts per hour as per the selected manufacturer's requirements.

### iii) Operation and Control

The number of pumps operating at a given period shall be based on instantaneous second class water demand. The pumps shall be VSD controlled and shall ramp up and down in response to the demand.

Each pump shall be fitted with a temperature sensor to monitor the windings temperature. The pumps shall trip on overtemperature.

A no-flow switch shall be fitted on each pump discharge to protect the pump against operating with no flow.

The accumulator (pressure vessel) shall be used to maintain pressure in the second-class water reticulation network and supply small intermittent demands.

Each pump drive unit shall be fitted with a pressure transmitter. The pumps shall start on low pressure and shut down on either high pressure or low flow. The operational parameters of the pumping system shall be confirmed with both the manufacturer and plant operator.

The flow rate into the second-class water network shall be measured by a magnetic flow meter at the Booster Pump Station.

The selected booster pump system shall allow for its controls to be configured on the Second Class Water MCC H

I by the plant operator.

### iv) Construction and Design

#### Pumps:

Shall comply with Zut 5030.

#### Pipework, valves and pipe supports:

Each pump shall have a separate suction line. The discharge side of each pump shall be equipped with a swing check non-return valve and shut-off valve. All valves are specified elsewhere.

The delivery line for each pump shall have at least two flange adaptors installed to take up misalignment of the pipework. The flange adaptors shall be restrained where required such that all the loads on the pumps and pipework are properly dealt with. Flange adaptors and couplings shall be PN10 rated and shall comply with Zut 7023.

All piping shall be PN10 rated or higher.

Pipework shall be fabricated from mild steel and hot dip galvanized

Only long-radius and medium-radius bends shall be allowed on pipework. Pipework shall comply with Zut 7001.

Pressure gauges shall comply with Zut 0001.

Pipe supports shall also be installed at sufficiently located intervals to support the pipes and take load off joints.

The span between pipe supports shall at no stage be more than 2.5 m and shall comply with the requirements as detailed in Specification Zut 7024.

**v) Spares**

The Contractor shall provide the following spares:

- a) Supplier recommended set of critical spares.

**vi) Inspections**

Shall comply with Zut 5030 and section **PSM 19** of this Document.

**vii) Testing Requirements**

Shall comply with Zut 5030.

**PSM 13.3 Second Class Water Supply Pipework**

**PSM 13.3.1 Specification**

The second class water supply pipework shall be in accordance with Zut 7001.

**PSM 13.3.2 Amendments, Additions and Detailed Requirements**

**i) Scope of Works**

The Contractor shall provide all second class water supply pipework. The Contractor shall route and install all second class water pipework to the required delivery points as listed below:

Inlet Works

- a) Water launder,
- b) Washer compactors,
- c) Vortex degritters.

In addition to the above, the Contractor shall route and install all second class water pipework to all standpipes on the plant. The location of all standpipes is indicated on 60471-C-GW-011.

**ii) Construction and Design**

All pipework shall be 304 stainless steel.

The pipework shall have a minimum pressure rating of PN10. Piping shall be at least 40 mm in diameter.

**PSM 13.4 Second Class Water Supply Valves**

**PSM 13.4.1 Specification**

As specified below.

**PSM 13.4.2 Amendments, Additions and Detailed Requirements**

**i) Scope of Works**

The Mechanical Contractor shall provide all second class water valves, which shall include, but not be limited to, the following:

- a) Manual, electrically actuated and solenoid valves, as necessary, for flushing the water launder,
- b) Manual, electrically actuated and solenoid valves, as necessary, to supply water to the washer compactors,
- c) Manual, electrically actuated and solenoid valves, as necessary, to enable grit sparging at the vortex degritter.

**ii) Construction and Design**

Manual and electrically actuated valves shall be of the ball valve type valve. Ball valves installed shall either be manually or electrically actuated as indicated on the relevant drawing. Ball valves shall be from grade 316 stainless steel and shall have a minimum pressure rating of PN10.

**PSM 13.5 Second Class Water Supply Pressure Reducing Valves**

**PSM 13.5.1 Specification**

The pressure reducing valves shall comply with Zut 7025.

**PSM 13.5.2 Amendments, Additions and Detailed Requirements**

**i) Scope of Works**

Pressure reducing valves shall be provided along the second class water supply pipework as determined by the Contractor.

**ii) Performance Requirements**

The pressure reducing valves shall be capable of limiting the second class water pressure supplied to the launders, washer compactors and vortex degritters.

**iii) Construction and Design**

The pressure reducing valves shall be PN10 rated.

**PSM 14 BIOFILTER PUMPSTATION****PSM 14.1 Specification**

Shall comply with Zut 5020.

**PSM 14.2 Amendments, Additions and Detailed Requirements****(i) Scope of Works**

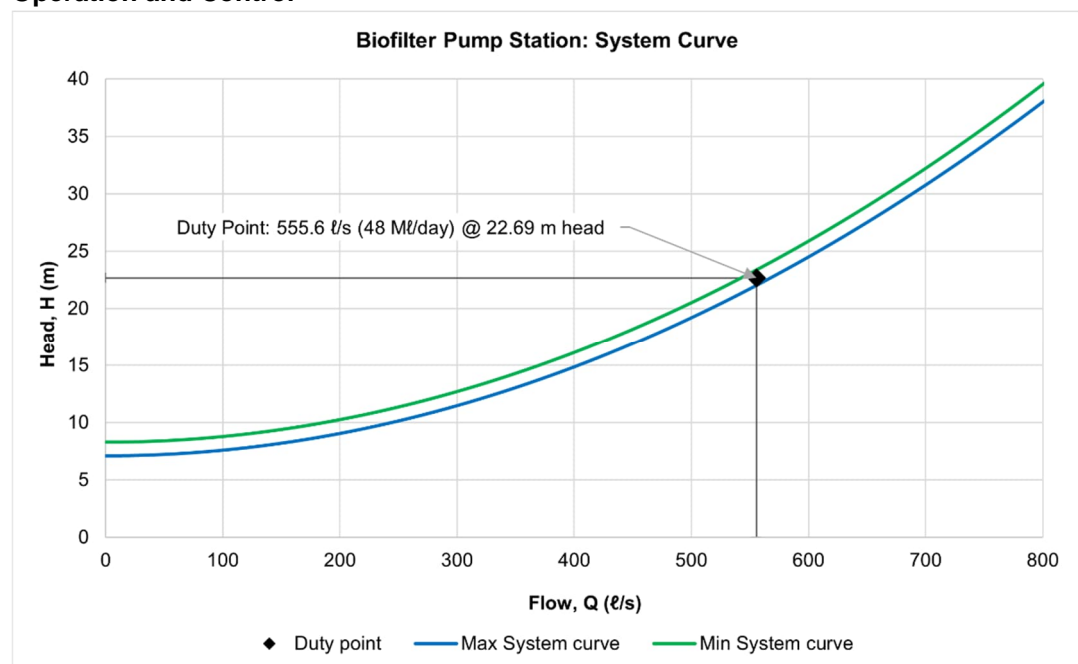
The Contractor shall provide four (4) immersible type centrifugal pumps to pump settled effluent from the PSTs and Hummus Tanks to the Biofilter Distribution Chamber. The pumpsets shall be supplied complete with, but not limited to, the following:

- a) Pump,
- b) Motor (including integral power and instrumentation cable),
- c) Base plate,
- d) Mounting brackets,
- e) Suction elbow (with inspection/cleaning porthole),
- f) Instrumentation (flow meters, pressure gauges, no flow switches, pressure transmitters, etc.) as necessary,
- g) Suction and discharge pipework, pipe supports and associated pipe accessories,
- h) Couplings,
- i) Pump station isolation valves,
- j) Pump station check valves,
- k) Etc.

**(ii) Performance Requirements**

The proposed installation layout for the pumps is shown on the drawings.

The Biofilter Pump Station shall be designed to deliver 555.6 l/s (48 Ml/day) at 22.7 m head.

**(iii) Operation and Control**



The pumps shall be configured in a 3 duty / 1 standby arrangement with variable speed drives for flow control. The duty shall be rotated periodically. The duty rotation period shall be adjustable on the control system.

The pumps shall start and stop automatically in response to settled effluent level in the Settled Effluent Sump, starting on high settled effluent level and stopping on low settled effluent level, respectively. The sump shall be provided with level sensors to measure the settled effluent level in the sump.

The system shall be provided with pressure sensors and pressure gauges to trip the pumps on system over pressure, temperature sensors on each pump to trip the pump on stator winding overheating, flow sensors on pump discharge lines to trip the associated pump on no flow, and moisture sensors in the separation chamber of each pump to detect water ingress in the pump motor and stop the associated pump, respectively.

Manual operation of the pumps shall be provided at the MCC and at the local control stations.

Each pump shall be provided with a dedicated emergency stop (e-stop) button at its respective local control station.

All pump and system protections shall be active during manual operation.

**(iv) Construction and Design**

Pumps:

Shall comply with Zut 5020.

Pipework, valves and pipe supports:

Each pump shall have a separate suction line. The discharge side of each pump shall be equipped with a swing check non-return valve and shut-off valve. All valves are specified elsewhere.

The delivery line for each pump shall have at least two flange adaptors installed to take up misalignment of the pipework. The flange adaptors shall be restrained where required such that all the loads on the pumps and pipework are properly dealt with. Flange adaptors and couplings shall be PN10 rated and shall comply with Zut 7023.

All piping shall be PN10 rated or higher.

Pipework shall be fabricated from mild steel and hot dip galvanized

Only long-radius and medium-radius bends shall be allowed on pipework. Pipework shall comply with Zut 7001.

Pressure gauges shall comply with Zut 0001.

Pipe supports shall also be installed at sufficiently located intervals to support the pipes and take load off joints.

The span between pipe supports shall at no stage be more than 2.5 m and shall comply with the requirements as detailed in Specification Zut 7024.

**(v) Spares**

The Contractor shall provide the following spares:

- a) Supplier recommended set of critical spares.

**(vi) Inspections**

Shall comply with Zut 5020 and section **PSM 19** of this Document.

**(vii) Testing Requirements**

Shall comply with Zut 5020.

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**PSM 15 LIFTING EQUIPMENT****PSM 15.1 Specification**

The lifting equipment shall comply with Zut 1003.

**PSM 15.2 Amendments, Additions and Detailed Requirements****(i) Scope of Works**

Lifting equipment for maintaining equipment items shall be provided at various locations as detailed below.

Lifting equipment shall include, but not be limited to:

- a) Steel gantries or crawl beams, hoist trolleys, hoist trolley gearboxes, manual or electrical hoists, etc. for manual lifting equipment.
- b) Etc.

The locations and layouts shall be as shown on the drawings.

**(ii) General requirements****Trach Rack Screen:**

One (1) steel gantry incorporating a crawl beam with a manual crawl and a manual hoist shall be provided for installation and maintenance of the trash rack screen located at the Inlet Works. The crawl beam and associated equipment shall be designed to lift and move the completely assembled screen.

**Mechanical Front Raked Screens:**

One (1) crawl beam with a manual crawl and a manual hoist shall be provided for installation and maintenance of the mechanical front raked screens located at the Inlet Works. The crawl beam and associated equipment shall be designed to lift and move the completely assembled screens.

**Biofilter Pumps:**

One (1) crawl beam with a manual crawl and a manual hoist shall be provided for installation and maintenance of the Biofilter Pumps. The crawl beam and associated equipment shall be designed to lift a complete pump assembly (i.e., fully assembled complete with pump, motor, couplings, base frame, etc).

**Raw Water Pumps:**

One (1) crawl beam with a manual crawl and a manual hoist shall be provided for installation and maintenance of the raw water pumps at the second class water pump station. The crawl beam and associated equipment shall be designed to lift a complete pump assembly (i.e., fully assembled complete with pump, motor, couplings, base frame, etc).

**Booster Pumps:**

One (1) crawl beam with a manual crawl and a manual hoist shall be provided for installation and maintenance of the booster pumps. The crawl beam and associated equipment shall be designed to lift a complete pump assembly (i.e., fully assembled complete with pump, motor, couplings, base frame, etc).

**Sludge Stockpile Pumps:**

One (1) overhead gantry incorporating a crawl beam with a removable manual crawl and a manual hoist shall be provided for installation and maintenance of the Sludge Stockpile pumps.

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The crawl beam and associated equipment shall be designed to lift a complete pump assembly (i.e., fully assembled complete with pump, motor, couplings, base frame, etc).

**(iii) Performance Requirements**

Shall comply with the performance requirements of Zut 1003.

**(iv) Operation and Control**

All lifting equipment shall be manually operated.

**(v) Construction and Design**

Steel Gantries

Shall comply with the steel gantry requirements set in Zut 1003.

Hoists

Shall comply with the hoist requirements set in Zut 1003.

Manual Hoist trolleys

In addition to the manual hoist trolley requirements set in Zut 1003, crawl beams shall comply with the requirements set here.

All hoist trolleys for manual lifting equipment shall be geared manually operated type.

Each hoist trolley shall be operated by chain wrapped around a pulley directly connected to the hoist trolley gears.

The chains shall be sufficient length to ensure that the chains are reachable to the operators without needing to climb on a platform. The chain shall hang no higher than 1 000 mm (1.0 m) above the operator's floor level.

Crawl Beams

In addition to the crawl beam requirements set in Zut 1003, crawl beams shall comply with the requirements set here.

The crawl beams provided for manual lifting equipment shall be I-beam sections.

The design of the I-beams shall be suitable for geared manually operated (pushed) hoist trolleys.

Davits

Shall comply with the davit requirements set in Zut 1003.

Hand Cranked Winches

Shall comply with the hand cranked winch requirements set in Zut 1003.

**(vi) Spares**

Spares shall NOT be required for lifting equipment under this Contract.

**(vii) Inspections**

Shall comply with the testing and certification requirements set in Zut 1003 and section **PSM 19** of this Document.

**(viii) Testing Requirements**

Shall comply with the performance requirements of Zut 1003.

**PSM 16 VENTILATION****PSM 16.1 Specification**

The ventilation equipment shall comply with Zut 10 015.

**PSM 16.2 Amendments, Additions and Detailed Requirements****(i) Scope of Works**

Ventilation systems for the following are required:

- a) Admin Building
- b) Inlet Works MCC Room
- c) Biofilter Pump Station MCC Room
- d) Second Class Booster Pump Station
- e) Raw Water Pump Station

The Work to be performed under this contract includes the supply, procurement, delivery, erection, testing, commissioning and handing over of a complete air conditioning and ventilation installation for the various pump stations, MCC rooms and Admin building, fully operational to the Employer and the guarantee and comprehensive maintenance thereof for a further period of 12 months.

The installation includes the following:

- a) Supply and installation of new midwall and cassette split units complete with outdoor units, piping, ducting and associated equipment and plant required as per manufacturer's requirements.
- b) Supply and installation of ventilation portion, including fresh air fan and extraction.
- c) Testing and Commissioning
- d) 12 months service and maintenance

The purpose of the ventilation systems is to ensure that the areas are kept well-ventilated and that moisture build up and odorous air is extracted from the working spaces. The contractor shall also base the design on site conditions (maximum ambient air temperature, dust, etc).

**(ii) Performance Requirements**Admin Building

The admin building shall utilise mid wall split units each consisting of an indoor unit and outdoor condenser unit. Each room shall have its own individual unit with some spaces requiring two (2) units based on the fresh air requirements.

The server room will have a run and standby mid wall split unit while the board room will have two (2) mid wall units to meet the minimum air changes of the room.

The entrance foyer will utilize a round flow cassette unit to provide ventilation in this area.

The number of units required are summarized in the table below.

Indoor and Outdoor Units			
Area	Fresh Air	Air Changes	Quantity
Server Room	2	4	2
Senior Operator	2	4	1
Supervisors Works Assistant	2	4	1

Indoor and Outdoor Units			
Area	Fresh Air	Air Changes	Quantity
Works Manager	2	4	1
Laboratory	2	4	1
Superintendent	2	4	1
Entrance Foyer	2	4	1
Reception	2	4	1
Board Room	2	4	2
Technicians	2	4	1

The manner in which fresh air shall be provided shall be the utilization of ducted fresh air systems, which is uninsulated. Each room shall have an individual disc valve for the supply of fresh air.

A two ducted system shall be utilized, one system serving the left wing of the building and likewise the second system serving the right wing of the building. The use of disc valves in the admin building provides efficient air distribution and improved control over the air flow, providing an energy efficient environment.

Each room shall have one disc valve whereas the canteen/kitchen as well as the boardroom shall have two (2) disc valves to meet the fresh air change requirements.

Disc Valves	
Area	Required Fresh Air
Canteen / Kitchen	As per fresh air changes
Senior Operator	As per fresh air changes
Supervisors Works Assistant	As per fresh air changes
Works Manager	As per fresh air changes
Laboratory	As per fresh air changes
Superintendent	As per fresh air changes
Entrance Foyer	As per fresh air changes
Reception	As per fresh air changes
Board Room	As per fresh air changes
Technicians	As per fresh air changes
Admin Store	As per fresh air changes

Fresh air fans shall be the summation of the fresh air required for each space for the appropriate wings. There shall be two fans, one placed on each end of the building along with a heater bank to supply the left and right wing of the building, please see Ventilation Drawings.

The kitchen shall have an extract fan to remove excess heat, smoke and odours from the area. A single wall mounted fan shall be utilized that is capable of providing the required air changes.

Extract and Fresh Air Fans		
Area	Type of Fan	Required Flow (l/s)
Left Wing	Fresh Air	As per fresh air changes, summation
Right Wing	Fresh Air	As per fresh air changes, summation
Kitchen/Canteen	Extraction	As per fresh air changes

The ventilation system shall be protected by the use of weather louvres on the end of the ducted systems. There shall be two wall mounted weather louvres utilized, one for the left-wing ducted system and one for the right-wing ducted system. These are to be sized appropriately and placed high-level running within the ceiling.

Weather Louvres	
Area	Type
Left Wing	As per the fresh air fans above
Right Wing	As per the fresh air fans above

#### Inlet Works MCC Room

The Inlet Works MCC Room shall utilise two (2) extraction fans (duty / standby) for the purposes of heat extraction for the VSD's within the room. These shall be placed centrally within the room and the door shall be either louvred or an external louvre shall be fitted for the purposes of cross ventilation. These louvres shall be sized to be no less than the matching air flow being extracted and checked with the engineer to ensure correct sizing.

The fans selected shall be flameproof with separate switches for manual control.

Air flow rate to be calculated using the internal heat load as well as the internal and external temperatures 40°C and 36°C, respectively.

Area	Type of Fan	Extraction Rate	Qty
Inlet Works MCC Room	Extraction	Minimum 20 ACH	2

#### Biofilter Pump Station MCC Room

The biofilter pump station mcc room shall utilise two (2) extraction fans (duty / standby) for the purposes of heat extraction for the VSD's within the room. These shall be placed centrally within the room and the door shall be either louvred or an external louvre shall be fitted for the purposes of cross ventilation. These louvres shall be sized to be no less than the matching air flow being extracted and checked with the engineer to ensure correct sizing.

The fans selected shall be flameproof with separate switches for manual control.

Air flow rate to be calculated using the internal heat load as well as the internal and external temperatures 40°C and 36°C, respectively.

Area	Type of Fan	Extraction Rate	Qty
Biofilter Pump Station MCC Room	Extraction	Minimum 20 ACH	2

#### Second Class Booster Pump Station

The second-class booster pump station shall utilise a duty and standby (2x) extraction fan for the purposes of heat extraction for the VSD's within the room. These shall be placed centrally within the room and the door shall be either louvred or an external louvre shall be fitted for the purposes of cross ventilation. These louvres shall be sized to be no less than the matching air flow being extracted and checked with the engineer to ensure correct sizing.

The fans selected must be flameproof with separate switches for manual control.

Air flow rate to be calculated using the internal heat load as well as the internal and external temperatures 40°C and 36°C, respectively.

Area	Type of Fan	Extraction Rate	Qty
Second Class Booster Pump Station	Extraction	Minimum 20 ACH	2

Raw Water Pump Station

The raw water pump station shall utilise a duty and standby (2x) extraction fan for the purposes of heat extraction for the VSD's within the room. These shall be placed centrally within the room and the door shall be either louvred or an external louvre shall be fitted for the purposes of cross ventilation. These louvres shall be sized to be no less than the matching air flow being extracted and checked with the engineer to ensure correct sizing.

The fans selected shall be flameproof with separate switches for manual control.

Air flow rate to be calculated using the internal heat load as well as the internal and external temperatures 40°C and 36°C, respectively.

Area	Type of Fan	Extraction Rate	Qty
Raw Water Pump Station	Extraction	Minimum 20 ACH	2

**(iii) Operation and Control**Admin Building

The mid wall split units and cassette shall be individual splits on a hard-wired controller independently controlled.

Fresh air fan shall run on an occupancy sensor within each room, either the whole system is switched on or switched off. Disc valves supplying the fresh air shall be set and tested to the required flow per room as per design.

Ensure fan is placed on a motor curve breaker for slow start.

Inlet Works MCC Room

The Inlet Works MCC Room system includes two fans, a primary "duty" fan and a secondary "standby" fan. The run fan will operate under normal conditions whereby it will be activated by the "start" button when ventilation is required, such as when heat or fumes buildup due to the VSD's within the room. The fan is able to be stopped in the same way as started, through the use of the "stop" button.

If the duty fails, then the standby is able to take over to maintain airflow and ensure continuous ventilation. Both fans will be of the same type and will operate in the same manner with a "start" and "stop" button. It will be visually and audibly visible when the fans are in operation as well as indicators to show their operational status.

Biofilter Pump Station MCC Room

The Biofilter Pump Station MCC Room system includes two fans, a primary "duty" fan and a secondary "standby" fan. The duty fan will operate under normal conditions whereby it will be activated by the "start" button when ventilation is required, such as when heat or fumes buildup due to the VSD's within the room. The fan is able to be stopped in the same way as started, through the use of the "stop" button.

If the duty fails, then the standby is able to take over to maintain airflow and ensure continuous ventilation. Both fans will be of the same type and will operate in the same manner with a "start" and "stop" button. It will be visually and audibly visible when the fans are in operation as well as indicators to show their operational status.

Second Class Booster Pump Station

The Second Class Booster Pump Station system includes two fans, a primary "duty" fan and a secondary "standby" fan. The duty fan will operate under normal conditions whereby it will be



activated by the “start” button when ventilation is required, such as when heat or fumes buildup due to the VSD’s within the room. The fan is able to be stopped in the same way as started, through the use of the “stop” button.

If the duty fails, then the standby is able to take over to maintain airflow and ensure continuous ventilation. Both fans will be of the same type and will operate in the same manner with a “start” and “stop” button. It will be visually and audibly visible when the fans are in operation as well as indicators to show their operational status.

#### Raw Water Pump Station

The raw water pump station system includes two fans, a primary “duty” fan and a secondary “standby” fan. The duty fan will operate under normal conditions whereby it will be activated by the “start” button when ventilation is required, such as when heat or fumes buildup due to the VSD’s within the room. The fan is able to be stopped in the same way as started, through the use of the “stop” button.

If the duty fails, then the standby is able to take over to maintain airflow and ensure continuous ventilation. Both fans will be of the same type and will operate in the same manner with a “start” and “stop” button. It will be visually and audibly visible when the fans are in operation as well as indicators to show their operational status.

### **(iv) Construction and Design**

#### Admin Building

As per drawing layout 60471/M/GW/028.

#### Inlet Works MCC Room

As per drawing layout 60471/M/LI/030.

#### Biofilter Pump Station MCC Room

As per drawing layout 60471/M/LS/031.

#### Second Class Booster Pump Station

As per drawing layout 60471/M/GW/036.

#### Raw Water Pump Station

As per drawing layout 60471/M/GW/037.

### **(v) Spares**

Spares shall NOT be required for ventilation under this Contract.

### **(vi) Inspections**

Shall comply with section **PSM 20** of this Document.

On completion of the entire installation the contractor shall complete a Certificate of Compliance and any other form or forms as required by the SANS and the Engineer.

### **(vii) Testing Requirements**

The contractor shall supply all required maintenance tools required for the system.

The Contractor shall inspect, test and commission the entire installation in conjunction with and to the satisfaction of the Engineer and in the presence of the Engineer in accordance with the SANS, NBR and applicable manufacturer’s commissioning requirements.

The Contractor shall make all arrangements for testing and inspection, the costs thereof being included in the tender price.

The Engineer reserves the right to witness all tests.

The Contractor shall advise the Engineer in writing of all results and furnish copies of all certificates.

The Contractor shall provide all the necessary instruments for the proper testing of the complete installation. If there is reason to doubt the accuracy of such instruments, the Contractor shall take the necessary action to prove their accuracy.

The Contractor shall ensure that the installation is complete in every respect and that there are no major defects prior to notifying the Engineer (in writing) of a first delivery inspection.

Should there be any minor defects upon final inspection, the Engineer will terminate that inspection and request that an additional final inspection be arranged by the Contractor.

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**PSM 17 SLUICE GATES****PSM 17.1 Specification**

The sluice gates shall comply with Zut 7007.

**PSM 17.2 Amendments, Additions and Detailed Requirements****(i) Scope of Works**

The locations of the sluice gates are shown on the drawings and the requirements are summarised in the tables below.

**(ii) Construction and Design**

Shall comply with Zut 7007.

The height of the handwheels and actuators above platform level shall be 1000 mm. Access platforms shall be provided if the handwheels are higher than 1200 mm above the platform.

The diameter of the handwheels shall be at least 300 mm.

Sluice gates and wall mounted gates are to be fabricated from 316 stainless steel.

All sluice gates shall make use of rising spindles. Spindle covers shall be provided for protection. The covers shall be of clear polycarbonate so that the height of the spindle is visible.

**(iii) Spares**

Spares shall NOT be required for sluice gates under this Contract.

**(iv) Inspections**

Shall comply with Zut 7007 and section **PSM 20** of this Document.

**(v) Testing Requirements**

Shall comply with Zut 7007.

The table below summarises the **channel mounted** sluice gate requirements:

Item	Location	Qty	Direction of Opening	Actuation	Tag	Width x Depth of Channel (m x m)	Water Level (m) from Floor Level
1	Upstream Mechanical Front Rake Screens	2	Upwards	No	PSK-001 PSK-002	1.300 x 0.812	0.812
2	Downstream Mechanical Front Rake Screens	2	Upwards	No	PSK-003 PSK-004	1.300 x 0.812	0.741
3	Upstream Vortex Degritters	2	Upwards	No	PSK-005 PSK-006	1.220 x 0.790	0.741
4	Downstream Vortex Degritters	2	Upwards	No	PSK-007 PSK-008	1.220 x 0.895	0.299

The table below summarises the **wall mounted** sluice gate requirements:

Item	Location	Qty	Direction of Opening	Actuation	Tag	Depth of Channel (m)	Dimensions of Opening (mm)	Maximum Differential Pressure (m)	Soffit Level from Invert Level (mm)
1	Isolation Gate Upstream New Settled Effluent Sump	1	Upwards	No	PSK-001	3.420	870	1.315	1.100
2	Isolation Gate Upstream Existing Settled Effluent Sump	1	Upwards	No	PSK-002	3.420	914	1.240	1.144
3	Isolation Gates between new common sump and individual sumps	4	Upwards	No	PSK-003, PSK-004, PSK-005, PSK-006	3.618	600	1.818	0.600
4	Downstream New Settled Effluent Sump	1	Upwards	No	PSK-007	4.888	738	1.705	2.051

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**PSM 18 CHANNEL COVERS****PSM 18.1 Inlet Works Channel Covers****PSM 18.1.1 Specification**

As specified below.

**PSM 18.1.2 Amendments, Additions and Detailed Requirements****(i) Scope of Works**

Glass Reinforced Plastic (GRP) open grid flooring is to be install over the open channels at the following locations:

- a) Inlet Works

**(ii) Performance Requirements**

The channels are to be covered with removable GRP open grid flooring panels. The panels shall be flush with the top of concrete and no parts of the panels shall present a tripping hazard. The panels are to be designed to accommodate personnel traffic (walk on) and shall be suitably stiffened for this purpose.

The grating shall be designed to meet the minimum design loads as follows:

- b) Uniformly distribute load = 5 kN/m<sup>2</sup>
- c) Concentrated load over 200 mm x 200 mm area = 1.5 kN

Care should be taken to ensure that the more onerous design load (UDL or Concentrated Load) is determined for each panel. The positions of the concentrated loads shall be those that produce the maximum deflection.

Flooring panels with a span of 1 000 mm shall not deflect by more than 20 mm when subject to a central load of 500 kg. Flooring panels with a span of 500 mm shall not deflect by more than 10 mm when subject to a central load of 500 kg. The allowable deflection for intermediate panel widths shall be calculated on a pro rata basis. For pedestrian use, the deflection limits recommended for calculation or test are those considered to be not only safe within the stress limits for the materials being used but at levels where the user is considered to feel safe.

The difference in level between a loaded and a neighbouring unloaded flooring panel shall not exceed 4 mm.

The flooring shall not show any deleterious effects after five years of external weathering in full sun exposure.

**(iii) Design and Construction**

Fibre prominence is not acceptable and components displaying visible fibres will be rejected.

The resin used for all GRP components of grid flooring shall contain a UV stabiliser. The design shall ensure the prevention of fibre prominence for a period of at least ten years. External GRP components and all internal components subject to direct sunlight shall, in addition to the UV stabiliser in the resin, be provided with a polyurethane based UV protective coating/veil to a thickness of at least 25 microns. A suitably stabilised flow coat will also be acceptable. The coat shall be provided over the full surface.

Proof of design life expectation shall be submitted to the Engineer.

Only Vinyl-Ester resin shall be used for all GRP components. Metal components related to the channel covers such as hinges, handles, washers and fasteners shall be 316 stainless steel. Seal material around and between panels shall be rigid rubber. This material shall not be damaged or degraded by sunlight or extremes of temperature which may be reasonably anticipated on site. The upper surface of the covers shall be non-slip.

Each cover panel shall be supported from below by means of 316 stainless steel sections/angles.

These sections shall be fastened to the concrete structure with chemical anchors and 316 stainless steel bolts with washers. No load on the panel may be transferred to the GRP extension mentioned above nor to a neighbouring panel.

Handles shall be 316 stainless steel. These handles shall drop into holes in the top surface of the cover. When not in use the handle shall be as flush with the top of the panel as necessary to prevent tripping hazard. The holes shall be no bigger than necessary and shall be placed in the gaps between the grid elements below. 316 stainless steel plates or disks shall be fixed to the ends of the bar in order to transfer the lifting force from the handle to the lowest surface of the grating. Minimum diameter/width of this plate shall be 50 mm.

All panels shall be removable by hand. No panel shall have a mass greater than 40 kg. Panels with a mass greater than 20 kg shall have 4 handles, and panels with a mass less than 20 kg shall have two (2) handles. Handles shall be positioned symmetrically to allow balanced lifting of the panel and spaced so that each handle can be accessed by a separate operator. Hinged covers below 10 kg shall have one handle, hinged covers above 10 kg shall have two (2) handles. Hinges shall be of the 'piano hinge' type and shall be a minimum of 200 mm long.

Every panel shall overlap its support structure by no less than 30 mm in order to prevent the panel falling through. This requirement shall apply at the extreme sideways movement of the panel within the support structure.

Where instruments are required in the channels, access and maintenance hatches shall be provided so that the covers do not have to be removed in the event that instruments need to be accessed.

The depth of a panel's structural members shall be 40 mm or greater.

Cut surfaces shall be provided with a layer of ultraviolet resistant flow coat. Application by dipping is preferred but other methods will be acceptable.

**(iv) Installation**

Grid flooring shall be mounted firm and level and shall be of neat and workmanlike appearance, solidly and evenly supported, true to line, level, plumb and in proper working order.

Panels shall be set level and fixed to frames to prevent rocking. No perceptible movement will be acceptable.

All fasteners and fixtures through GRP must have penny washers to prevent damage due to load concentrations.

**(v) Spares**

Spares shall NOT be required for the GRP open grid flooring under this Contract.

**(vi) Inspections**

Shall comply with section **PSM 20** of this Document.

## PSM 18.2 EFFLUENT SUMP COVERS

### PSM 18.2.1 Specification

As specified below.

### PSM 18.2.2 Amendments, Additions and Detailed Requirements

#### (i) Scope of Works

Glass Reinforced Plastic (GRP) covers are to be installed to cover the open channels at the following locations:

- d) Effluent Sump (Biofilter pump station)

#### (ii) Performance Requirements

The channels are to be covered with removable GRP panel covers. Covers shall be flush with the top of concrete and no parts of the covers shall present a tripping hazard. The covers are to be designed to accommodate personnel traffic (walk on) and shall be suitably stiffened for this purpose.

The grating shall be designed to meet the minimum design loads as follows:

- e) Uniformly distribute load = 5 kN/m<sup>2</sup>
- f) Concentrated load over 200 mm x 200 mm area = 1.5 kN

Care should be taken to ensure that the more onerous design load (UDL or Concentrated Load) is determined for each panel. The positions of the concentrated loads shall be those that produce the maximum deflection.

The deflection of a floor panel under the load indicated above should not exceed 10mm or 1/200th of the span, whichever is the lesser. For pedestrian use, the deflection limits recommended for calculation or test are those considered to be not only safe within the stress limits for the materials being used but at levels where the user is considered to feel safe.

The difference in level between a loaded and a neighbouring unloaded flooring panel shall not exceed 4 mm.

The flooring shall not show any deleterious effects after five years of external weathering in full sun exposure.

Fibre prominence is not acceptable and components displaying visible fibres will be rejected.

#### (iii) Design and Construction

The resin used for all GRP components of grid flooring shall contain a UV stabiliser. The design shall ensure the prevention of fibre prominence for a period of at least ten years. External GRP components and all internal components subject to direct sunlight shall, in addition to the UV stabiliser in the resin, be provided with a polyurethane based UV protective coating/veil to a thickness of at least 25 microns. A suitably stabilised flow coat will also be acceptable. The coat shall be provided over the full surface.

Proof of design life expectation shall be submitted to the Engineer.

Only Vinyl-Ester resin shall be used for all GRP components. Metal components related to the channel covers such as hinges, handles, washers and fasteners shall be 316 stainless steel. Seal material around and between panels shall be rigid rubber. This material shall not be damaged or degraded by sunlight or extremes of temperature which may be reasonably anticipated on site. The upper surface of the covers shall be non-slip.

If the channel cover is constructed from an open grate and flat board, a strong and continuous bond must be created over the entire contact surface between the two components. Continuously moulded covers are preferred.



The continuous upper layer of the cover (such as the board mentioned above) shall extend past the lower grid structure where the cover sits alongside a chamfered concrete wall. The purpose of this extension is to reduce the gap between the top of concrete surface and the cover surface. This extension may have to vary in length depending on the nature of the concrete structure but shall not exceed 25 mm.

Each cover panel shall be supported from below by means of 316 stainless steel sections/angles.

These sections shall be fastened to the concrete structure with chemical anchors and 316 stainless steel bolts with washers. No load on the panel may be transferred to the GRP extension mentioned above nor to a neighbouring panel.

The sealing material shall run around the entire border of the panel. The seal may be attached to either the supports below or the cover itself. The seal shall be fixed to a continuous and rigid surface so that it does not sag or deform. The sealing surface shall also be rigid, smooth and continuous around the entire border of the panel.

Handles shall be 316 stainless steel. These handles shall drop into holes in the top surface of the cover. When not in use the handle shall be as flush with the top of the panel as necessary to prevent tripping hazard. The holes shall be no bigger than necessary and shall be placed in the gaps between the grid elements below. 316 stainless steel plates or disks shall be fixed to the ends of the bar in order to transfer the lifting force from the handle to the lowest surface of the grating. Minimum diameter/width of this plate shall be 50 mm.

All panels shall be removable by hand. No panel shall have a mass greater than 40 kg. Covers with a mass greater than 20 kg shall have 4 handles, covers with a mass less than 20 kg shall have two (2) handles. Handles shall be positioned symmetrically to allow balanced lifting of the panel and spaced so that each handle can be accessed by a separate operator. Hinged covers below 10 kg shall have one handle, hinged covers above 10 kg shall have two (2) handles. Hinges shall be of the 'piano hinge' type and shall be a minimum of 200 mm long.

Every panel shall overlap its support structure by not less than 30 mm in order to prevent the panel falling through. This requirement shall apply at the extreme sideways movement of the panel within the support structure.

Areas that cannot be permanently closed such as sluice gates shall be provided with neoprene rubber seals that allow the gates to open. The rubbers shall be well supported and sufficiently thick so that they form a seal and do not sag under their own weight.

Hinged covers shall be provided at each of the two hand raked screens. The covers shall be constructed in such a way that one person can easily lift it. The cover shall also be supported in the open position and restrained from closing accidentally.

Covers shall be provided with inspection hatches for viewing as listed below. The hatches shall be at least 300 mm x 300 mm and shall be hinged on one side to prevent loss.

Where instruments are required in the channels, access and maintenance hatches similar to the inspection hatches mentioned previously shall be provided so that the covers do not have to be removed in the event that instruments need to be accessed.

#### **(iv) Installation**

Grid flooring shall be mounted firm and level and shall be of neat and workmanlike appearance, solidly and evenly supported, true to line, level, plumb and in proper working order.

Panels shall be set level and fixed to frames to prevent rocking. No perceptible movement will be acceptable.

All fasteners and fixtures through GRP must have penny washers to prevent damage due to load concentrations.

**(v) Spares**

Spares shall NOT be required for Channel Covers under this Contract.

**(vi) Inspections**

Shall comply with section **PSM 20** of this Document.

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**PSM 19 SLUDGE STOCKPILE PUMP STATION****PSM 19.2 Specification**

The Sludge Stockpile pumps shall comply with Zut 5020.

**PSM 19.2.2 Amendments, Additions and Detailed Requirements****i) Scope of Works**

The Contractor shall provide two (2) submersible type centrifugal pumps to pump supernatant from the sludge stockpile area to the new inlet works. The pumpsets shall be supplied complete with, but not limited to, the following:

- a) Pump with internal motor
- b) Guide rails
- c) Lifting chain
- d) Duckfoot bend or pedestal
- e) Electric cable
- f) Discharge pipework with pipe supports and associated pipe accessories
- g) Pump Station Check valves
- h) Pump Station isolation valves
- i) Instrumentation
- j) etc

**ii) Performance Requirements**

The pumps shall be capable of the meeting the duty below:

- Estimated maximum instantaneous water requirement: 16 l/s
- Head: 8 m

Besides the maximum second class water requirements, the pump station also shall be designed to meet low water demands, when few end users require water. It is estimated that the minimum second class water requirements shall be approximately 2 l/s.

The Contractor shall, however, finalize the duty point(s) during detailed design as the pressure and flow requirements shall be resized to match the second class water requirements of the equipment offered during the Tendering period. The Contractor shall present the Booster Pump Station design to the Engineer for review and acceptance.

The accumulator (pressure vessel) shall be sized to ensure that the booster pumps will not exceed their allowable number of starts per hour as per the selected manufacturer's requirements.

**iii) Operation and Control**

In addition to the requirements of Zut 5020, the operation and control of the submersible centrifugal pumps shall comply with the requirements set herein.

The pump station shall consist of two (2) submersible centrifugal pumps.

The pumps shall operate as 1 duty / 1 standby configuration and shall take turns being the duty pump. Duty rotation shall be daily, and the duty pump shall be selected based on run hours.

The pump station shall be equipped with at least one (1) radar level sensor and one (1) float switch which shall automatically stop the duty pumps when the sludge level drops below a set minimum level.

The duty pump shall start automatically when the liquid level in the sumps reaches the pump start point.

#### **iv) Construction and Design**

##### Pumps:

In addition to the requirements of Zut 5020, the design and construction of the submersible centrifugal pump station and pumps shall comply with the requirements set herein.

The submersible centrifugal pumps shall be installed inside concrete wet wells enclosed with concrete slabs. Access manholes shall be provided for installation and removing the pumps. Valves and all inline instrumentation will be installed in the dry well section (or valve chambers) of the pump station, located closer to final ground level

The pumps shall be installed in a vertical orientation, sitting flush on the duckfoot bend / pedestal. The connection between the pump and duckfoot bend shall be self-sealing due to the weight of the pump.

Immersible or air-cooled pumps shall not be accepted.

#### **v) Motors**

The motors shall comply with Zut 5020 and the motor requirements set herein.

Each pump shall be supplied complete with its own power (or electrical) cable.

The motor cable shall be factory terminated at the motor terminals and shall be of sufficient length to reach the electrical termination point but shall not be less than 25 m in length and shall be at least 1.5 m above top of concrete of the chamber in which the pumps are installed.

The full required cable length shall be priced for in the bill of quantities (BOQ).

The cable provided with the pumps shall be suitable for permanent immersion in water and municipal wastewater sludge.

#### **vi) Spares**

Spares shall NOT be required for Sludge Stockpile Pump Station under this Contract.

#### **vii) Inspections**

Shall comply with Zut 5020 and section **PSM 20** of this Document.

#### **viii) Testing Requirements**

Shall comply with Zut 5020.

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**PSM 20      INSPECTIONS****PSM 20.1    Workshop and/or Factory Inspections**Local Inspections

The Contractor shall arrange for Engineer to inspect fabrications, including fabricated pipework, in the fabrication workshop prior to corrosion protection.

Local inspection shall cover all inspection at fabrication workshops in eThekewni and surrounding areas easily accessible by vehicle and less than 150 km from the Isipingo WWTW, one way.

Other Inspections

The Contractor shall make all arrangements and carry all costs for the Engineer (2 pax) and Employer (1 pax), or an Engineer approved inspection authority, to inspect equipment for acceptance prior to dispatch to Site. The Contractor's representative and OEM Commissioning Engineer shall also attend these tests. Travel and accommodation costs for all persons shall be included in the tender pricing.

Where an inspection authority has been nominated to perform the inspections, the Contractor shall submit the report by the inspection authority to the Engineer for acceptance. The equipment shall not be acceptable unless this report confirms compliance with the specifications. The Engineer will, nevertheless, inspect this equipment for compliance once it has arrived on Site or at the Contractor's storage area. "Other inspections" shall cover all inspections at fabrication workshops outside eThekewni and surrounding areas greater than 150 km of travel from the Isipingo WWTW, one way.

**PSM 20.2    Site Inspections**

The Contractor shall make arrangements for the Engineer to inspect the completed installation on Site prior to commissioning.

**PSM 20.3    Inspection During Trial Operation Period**

The Contractor shall check the operation of the Works during the Trial Operation Period and shall provide a weekly performance report on all equipment to the Engineer. The Contractor shall carry out all necessary servicing of equipment and any adjustments required.

A single consolidate report shall be compiled and submitted to the Engineer at the end of Trial Operation Period, before the start of the Defects Notification Period.

**PSM 20.4    Inspection During Defects Notification Period**

The Contractor shall check the operation of the Works three (3), six (6) and twelve (12) months after the start of the Defects Notification Period and shall provide a comprehensive condition report on all equipment to the Engineer, after each visit.

### C3.8.2 ZUTARI SPECIFICATIONS

SPECIFICATION NUMBER	NAME OF SPECIFICATION
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#### General

ZUT 0001	General Mechanical Requirements
ZUT 0002	Operating and Maintenance Manual
ZUT 0003	General Corrosion Protection

#### Miscellaneous

Zut 1001	Permanent Ladders
Zut 1003	Lifting Equipment
Zut 1013	Air Receiver

#### Solids and Sludge

Zut 4001	Front Raked Screen
Zut 4009	Hand Raked Screen
Zut 4016	Washer Compactor
Zut 4026	Grit Washer

#### Pumps, Mixers, Blowers and Compressors

Zut 5013	Self-Priming Pumps
Zut 5016	Rotary Screw Air Compressor
Zut 5020	Submersible and Immersible Centrifugal Pumps
Zut 5030	Multi-Stage Pump (In-Line, Vertical Shaft)

#### Transmission, Drives and Power

Zut 6004	Actuators for Valves and Sluice Gates
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#### Pipework, Valves and Sluice Gates

Zut 7001	Design and Manufacture of medium-pressure steel specials
Zut 7002	Manufacture of medium-pressure steel pipelines
Zut 7003	Laying and jointing of medium-pressure steel pipes and specials
Zut 7007	Sluice Gates
Zut 7010	Knife Gate Valves
Zut 7016	Resilient Seal Gate Valve
Zut 7017	Single Door Check Valve
Zut 7023	Pipe Couplings
Zut 7024	Pipework Anchors

#### Systems

Zut 10 007	Compressed Air System
Zut 10 014	Ventilation for Plant Rooms
Zut 10 015	HVAC Specification

## **SPECIFICATION: ZUT 0001**

### **GENERAL MECHANICAL REQUIREMENTS**

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## 1. SCOPE

Zut 0001 specifies general technical requirements for contracts in which the Contractor is responsible for the detailed design.

## 2. NORMATIVE REFERENCES

The following form part of the Contract Document:

- Amendments, Additions and Detailed Requirements (Zut 0001).
  
- Zut 0003: General Corrosion Protection for Pipelines, Water and Waste Water Works.
- Zut 7001: Design and Manufacture of Medium Pressure Steel Specials.
- Zut 7023: Pipe Couplings and Flange Adaptors.
- Zut 7024: Pipe Anchors.
  
- SANS 200
- SANS 719
- SANS 936/7
- SANS 989/992
- SANS 1034
- SANS 1062
- SANS 1123
- SANS 1186
- SANS 1200H
- SANS 1465
- SANS 1700
- SANS 3834
- SANS 4427
- SANS 9606
- SANS 10104
- SANS 10160
- SANS 10167
- SANS 10108
- SANS 10268
- SANS 12944
- SANS 15614
- SANS 15609
- SANS 15874
- SANS 50025
- SANS 60034
- SANS 61241
- SANS/ISO 4427

- BS 1400
- BS 1452
- BS 1490
- BS 2035
- BS 2789
- BS 3100
- BS 3790
- BS 4515
- BS 4872
- BS 7854
- BS EN 681
- BS EN 1092
- BS EN 1591
- BS EN ISO 23936
  
- DIN 17 445
  
- ISO 4184
- ISO 10816

Equipment, materials and operational methods shall comply with the latest edition of relevant national and/or international standards.

## 3. MATERIALS

### 3.1 GENERALLY

All materials used in the manufacture and construction of plant and equipment shall be new and unused. The Contractor shall ensure that the materials are selected in accordance with the best engineering practice to suit the working conditions and corrosive environments.

### 3.2 STEEL

Structural steel shall comply with the requirements of SANS 50025 for grade S 355 JR or for grade S 355 JO.

### 3.3 STAINLESS STEEL

#### 3.3.1 General

The grade of stainless steel to be used shall be as specified. Rolled material shall be supplied with a matt, annealed and pickled or otherwise de-scaled surface finish.

Where grades EN Grade 1.4401 (316) and EN Grade 1.4301 (304) are specified, these shall be taken synonymously with the low carbon grades for welding.

If stainless steel is to be coated, it shall be suitably abrasive blasted to ensure adherence of the prime coat.

### 3.3.2 Certification

The Contractor shall provide spectroscopic analyses of stainless steel materials. The analysis shall be undertaken by a local materials laboratory and shall be submitted to the Engineer.

Stainless steel supplied shall be clearly and permanently marked with the grade of stainless steel and cross referenced to the applicable test certificate.

### 3.4 3CR12

This is the titanium stabilised, 12 % chrome steel. It shall be supplied with an annealed and pickled finish.

If 3CR12 is to be coated, it shall be suitably abrasive blasted to ensure adherence of the prime coat.

### 3.5 PLASTICS

Thermoplastics and fibre reinforced polymers shall be UV resistant, have adequate tensile strength and high impact strength and generally suit the application.

PVC is regarded as too brittle and shall not be used unless called for in this Specification or accepted in writing by the Engineer before supply.

### 3.6 ELASTOMERS

The Contractor shall select elastomeric materials to be used for common duties as follows:

- Nitrile (NBR) shall be used if oil is present. PTFE or silicone shall be used if the working temperature is above 80 degrees Centigrade.
- EPDM may be used if oil is not present. PTFE or silicone shall be used if the working temperature is above 110 degrees Centigrade.

## 4. CASTINGS

Castings shall comply with the relevant South African or international standard for the material used, including the following:

Grey Cast Iron	SANS 1034; BS 1452
S. G. Iron	SANS 936/7; BS 2789
Steel (General Purpose)	SANS 1465; BS 3100
Aluminium	SANS 989/992; BS 1490
Stainless Steel	DIN 17 445
Copper and Copper Alloy	SANS 200; BS 1400

Castings shall be clean and sound and shall be neatly fettled and dressed. Surfaces shall be smooth and irregularities caused by mould washaways, and the presence of porosity, inclusions and sharp edges will not be tolerated. Areas under bolt heads, nuts and washers, shall be machined or spot faced to ensure a flat and smooth pressure bearing area, and sufficient space shall be provided for the use of ring or socket spanners.

All pressure retaining castings shall be hydrostatically tested to not less than 1,5 times the maximum working pressure after machining and shall be pressure tight.

No repairs shall be undertaken to castings without the written permission of the Engineer. Cast iron castings shall not be welded.

Castings shall be heat treated to provide optimum corrosion resistance and toughness combined with reasonable machinability. In particular stainless steel castings shall be heat treated so as to ensure that all carbides are in solution, to ensure optimum grain size, and to provide maximum corrosion resistance.

The Contractor shall provide a test certificate for each casting or batch of castings, except for those made of grey cast iron, giving details of the material analysis, the heat treatment and any mechanical tests carried out.

## **5. FABRICATION OF CARBON STEEL & STAINLESS STEEL**

### **5.1 GENERAL**

Steelwork shall generally be constructed, fabricated and erected in accordance with the applicable requirements of SANS 1200 H.

Welding shall comply with the clause "Welding".

Sharp edges, pits, inclusions, weld spatter, undercuts, indentations or other surface defects are not acceptable.

Edges shall be rounded to a radius of at least 2 mm.

Designs shall avoid inaccessible pockets and hollows.

Sharp edges on items fabricated from thin sheets will not be acceptable and sharp edges shall preferably be avoided by good design.

Inspection of fabrications shall generally be done after fabrication is complete.

### **5.2 CARBON STEELS**

Structural steelwork shall be of grade S 355 JR or of grade S 355 JO in accordance with SANS 50025.

The requirements of the Hot Dip Galvaniser's Association of South Africa shall be complied with if the item is to be hot-dip galvanised. Designs shall provide proper access for safe and complete entry of the molten zinc into open spaces so that subsequent drilling at the galvaniser's yard is avoided.

Surfaces to be coated shall be accessible by blast and spray equipment. Inaccessible pockets, such as bad weld profile as well as hollow structures, are unacceptable and the angle of impact of blast material and sprayed coatings shall not be less than 45 degrees. Edges shall be rounded for safety reasons and also to be suitable for the coating system to be applied.

### **5.3 AUSTENITIC STAINLESS STEELS**

Fabrication of austenitic stainless steels shall comply with the recommendations in the "Pocket Guide" issued by Columbus Stainless. Compliance with publications from equivalent authorities will be acceptable.

Stainless steel fabricators shall use permanently dedicated storage and fabrication areas and shall use machines, tools and handling equipment which are suited and permanently dedicated to this type of material.

Fabrications shall be pickled and passivated over their full surface to achieve an even colour. If grinding is required before pickling, the final grinding shall be done with a fine disc in order to remove coarse grinding marks.

#### **5.4 3CR12**

Fabrication of 3CR12 shall comply with the requirements for austenitic stainless steels except that the recommendations for Utility Ferritics in the "Pocket Guide" issued by Columbus Stainless shall be used. Compliance with publications from equivalent authorities will be acceptable.

#### **5.5 HIGHLY ALLOYED STAINLESS STEELS**

Fabrication of duplex, super austenitic and other highly alloyed stainless steels shall follow the metal producer's own guidelines.

Welding of duplex stainless steel pipework shall be in accordance with BS 4515 Part 2 or equivalent.

### **6. WELDING**

#### **6.1 STANDARDS**

Welding shall be in accordance with SANS 15614-1 or with other equivalent standards acceptable to the SAIW.

Welders shall be experienced artisans approved in accordance with BS 4872 or equivalent.

The Contractor shall ensure that all structural welding, including all welding of pipework, is done in accordance with a welding procedure specification (WPS). The welding supervisor shall ensure compliance with the WPS. The document shall be available for scrutiny at all times.

#### **6.2 PREPARATION**

Wire brush and de-grease both surfaces to at least 30 mm from the weld.

Cleaning of stainless steel shall utilise non-chlorinated fluids only.

#### **6.3 CONTINUOUS WELDING AND ELIMINATION OF CREVICES**

Welding shall be continuous on all sides of any joint. Designs which do not allow this shall be re-designed.

Crevice, including those arising from welding on one side only, shall be eliminated. This requirement applies to the welding of all metals and welding procedure shall be designed to prevent unacceptable deformation.

Welds which are only accessible from one side shall be prepared so that the root run provides an acceptable profile and prevents the formation of crevice. Pipework shall be designed so that such welds can be inspected and, where applicable, pickled and passivated.

In special cases only, non-continuous welding might be accepted in writing by the Engineer. The resulting crevice shall be sealed with a two part solvent free epoxy which can be applied at thicknesses of up to 600 µm and above such as Sigmaline 523 or Corrocoat Zip E or Sigmacover 1000 or equivalent.



#### **6.4 WELD APPEARANCE**

Welding shall be free of blowholes, projections, pinholes, splatter and undercuts and all welding flux, weld spatter and other sharp imperfections shall be removed. Weld beads with a surface irregularity exceeding 3 mm or with sharp crests having a radius under 2 mm shall be ground.

#### **6.5 SITE WELDING**

Site welding shall be kept to a minimum and shall only be undertaken with the acceptance of the Engineer.

#### **6.6 WELDING OF STAINLESS STEEL AND 3CR12 – ADDITIONAL REQUIREMENTS**

Fabrication of austenitic stainless steels and 3CR12 shall comply with good practice and as described in the recommendations in the publications issued by Columbus Stainless. Compliance with publications from equivalent authorities will be acceptable.

Stainless steels to be welded shall be of the low carbon grade; e.g. 1.4306 rather than 1.4301 and 1.4404 rather than 1.4401.

The welding rods used shall be the most suitable for the metal and purpose.

Only welders experienced with welding stainless materials shall be used.

Welds which are accessible from only one side shall be executed in a manner to prevent heat tint or shall be post-weld treated in order to remove all traces of heat tint.

Type 309 stainless steel welding rods shall be used for welding 3CR12 unless otherwise accepted in writing. 3CR12 shall be welded as recommended by Columbus Stainless.

All possible steps shall be taken to ensure maximum corrosion resistance and strength of the welds and welded material. Special care shall be taken to avoid prolonged heating. Welds shall be passivated. Discolouration and steel contamination must be removed by pickling or electro cleaning as accepted by the Engineer but should rather be avoided by taking the appropriate measures.

#### **6.7 INSPECTIONS**

The Contractor shall arrange for all fabrications to be inspected by the Engineer prior to transport from the fabrication workshop.

### **7. CORROSION PROTECTION**

#### **7.1 GENERAL**

Unless stated otherwise in the contract document, corrosion protection shall be suitable for the high corrosivity category (C4 of SANS 12944-2).

Corrosion protection shall comply with Zut 0003.

Corrosion protection systems used shall be suitable for an expected item life of at least 30 years in the environment for which they are designed. Corrosion protection for items which are buried or cast into concrete shall be designed for a life of 70 years.

#### **7.2 SYSTEMS**

The Contractor shall propose corrosion protection systems to the Engineer for review.

The preferred system for structural steelwork and gantries is hot-dip galvanised carbon steel.

The preferred system for cranes is hot metal zinc spray and seal.

The preferred system for pipework internals is a solids containing barrier coating with a dry film thickness of not less than 800 microns.

The preferred system for guard rails, grid flooring, trench covers, stairways and ladders is hot-dip galvanised carbon steel (unless stainless steel is called for in the project specifications).

The preferred system for clarifier bridges and other carbon steel structures above water bodies is epoxy coated 3CR12 or hot-dip galvanised and painted carbon steel or hot metal zinc sprayed and sealed carbon steel.

Hot-dip galvanised surfaces to be painted shall be sweep blasted with air pressure less than 2,5 bar and a nozzle distance of at least 500 mm.

### **7.3 STAINLESS STEEL**

Where specified, stainless steel pipework which is in contact with pipework or valves of other materials shall be provided with an internal coat to provide an electrical barrier between the stainless steel and the fluid. Stainless steel valves, strainers and other items of equipment shall be similarly coated if specified.

The surface shall be blasted in order to achieve an acceptable profile for the coating material.

A coating such as 70 microns of Sigmacover 280 or equivalent is acceptable. The coat shall extend over flange faces.

## **8. INSTALLATION**

### **8.1 GENERAL**

The Works shall comply with the following:

- a) When erected and installed, the plant and equipment shall be of neat and workmanlike appearance, solidly and evenly supported, true to line, level, plumb and in proper working order.
- b) There shall be no visible movement of static components.
- c) The Contractor shall provide all anchor bolts, supports, hangers, brackets, etc. required for the support and fixing of equipment.
- d) The Contractor is responsible for grouting work associated with the equipment and pipework to be provided in terms of the Contract.
- e) No more than three shims at each position shall be used in the alignment of equipment. Machined spacers shall be prepared where necessary. Shims and spacers shall be of a corrosion resistant material such as stainless steel.
- f) Corrosion protection requirements shall be carefully attended to and the requirements of Zut 0003 must be noted. All mating faces must be coated before and sealed after assembly.
- g) A small amount of a nickel based, anti-seize compound shall be applied along the full length of fastener threads before the nut is threaded on.
- h) Crevices which are formed by bolting between two metal surfaces shall, prior to final fastening, be filled with a suitable formable packing, Denso tape or equivalent, or with a suitable mastic or sealant.

## **8.2 ALIGNMENT OF SHAFTS**

Shafts for drives with an output above 150 kW shall be aligned to the driven shaft as follows:

- a) Final alignment shall be done after installation and before commissioning and shall be checked in the presence of and to the approval of the Engineer. Alignment shall be sufficiently accurate to ensure that no pre-load is placed on the shaft coupling.
- b) Each motor shall be aligned to its pump by alignment specialists using laser aligning equipment with real time computer display. This shall be done after the pipework is bolted to the pump.

# **9. CIVIL AND BUILDING WORKS**

## **9.1 GENERAL DUTIES**

The Contractor shall be responsible for grouting pipework required to pass through walls, for all equipment grouting work, anchoring of equipment and closing of apertures associated with equipment to be provided in terms of this Contract.

The Contractor's Documents shall indicate the civil and building details required to accommodate the equipment installation; subject to and in accordance with any details shown on the drawings provided by the Employer. These details shall include plinths, foundation blocks, rebates, pockets, sleeve ducts, holes, thrust blocks, anchor fasteners and openings/box-outs for pipework passing through walls.

The Contractor shall inspect and check the related structures constructed by others for accuracy and suitability of construction and for conformance with the Contractor's documents before commencing installation and construction. No payments shall be allowed for additional costs to the Contractor resulting from a failure to check such works timeously or a failure to provide the related information in Contractor's Documents timeously.

## **9.2 CIVIL CONTRACTOR'S WORK**

The main civil and building works will be completed by others and will be mostly completed when the Contractor is granted access to the Site.

## **9.3 PUDDLE PIPES**

The Contractor shall install the puddle pipes required by the design into concrete structures. For this purpose, the Contractor shall provide the details of box-outs required in the structure to the Engineer. Puddle flanges shall be of the same dimensions as standard flanges and the box-out shall be designed accordingly and with allowance for civil tolerances of  $\pm 40$  mm.

Concrete structures will generally be constructed by others and, if required, it will be tested for water tightness by the Engineer before handover to the Contractor by temporary closure of the box-outs.

Upon receiving access to the Site, the Contractor shall install the pipework and shall grout the puddle pipes into the structure using a suitable non-shrink grout to the approval of the Engineer. The Contractor shall provide a water tight installation and shall be responsible for rectifying any leakage at the puddle pipe.

**9.4 BASEFRAMES, PIPE ANCHORS, ETC.**

The design requirements for baseframes and pipework anchors are specified elsewhere in Zut 0001.

The Contractor shall be responsible for grouting of baseframes, pipe anchors, plinths, etc. required for installation of the equipment and this includes any metallic structure which is mounted onto a concrete surface.

The method proposed for anchoring baseframes and for securing pipe anchors, etc., to concrete shall be submitted to the Engineer for approval and shall incorporate the details of the grout proposed. The material used for the primary grouting of the anchors shall be a non-shrink, cementitious grout such as ABE DuragROUT 1000, or equivalent. ABE Epidermix 324, or equivalent, is acceptable if an epoxy grout is required.

The secondary grout shall be applied only after each anchor fastener has been tested for integrity. The design and grouting shall eliminate collection points for water or dirt.

If called for by the Engineer, the initial grouting shall be overseen by the grout supplier's technical representative.

**10. PUMP SUCTION & DISCHARGE PIPEWORK****10.1 PUMP SUCTION PIPEWORK**

Pump suction pipework shall comply with good hydraulic design so that the flow at each pump inlet has a steady, uniform pattern.

Suction side pipework shall have a pressure rating which is greater than the operating pressure of the pumping system.

Air leaks shall be prevented.

Two mechanical couplings shall be provided on each pump's suction pipework. A single rubber tyre type coupling is acceptable for pump inlets of DN 100 and smaller.

The pipe connected to the pump inlet shall be a straight pipe of the same diameter as the pump inlet and shall have a length of at least five times its diameter. The remainder of the pipework shall preferably be sized so that the flow speed is no higher than 1,5 m/s.

The configuration of the suction manifold shall ensure equal flow to each pump, regardless of the number of pumps operating. The speed of flow in the suction manifold and into each pump branch shall be as low as feasible. Suction manifold tee offs shall be of swept tee formation if the nominal speed of flow in the pump's branch pipe is 0,7 metres per second or higher. The suction manifold tee offs may be a normal tee formation for lower flow speeds.

Pipework shall be level or shall slope upwards toward the pump. High points shall be avoided where the flow speed is below one metre per second.

The Contractor shall provide bell mouths for pump suction pipework drawing water from open sumps. The bell mouth shall be flanged on one end and shall be of glass reinforced plastic, EN Grade 1.4401 (316) stainless steel or of cast iron. Bell mouth openings shall be mounted between 0,3D and 0,5D above the sump floor ("D" is the pipe diameter). All bell mouths in a single sump shall be mounted at the same height. The flow speed through the pipe shall be approximately 1,7 metres per second.

An access hatch shall be provided upstream of each screen and/or flow straightener. The hatch shall incorporate an inner surface which is streamlined to match the pipe curvature.

## **10.2 PUMP DISCHARGE PIPEWORK**

Two mechanical couplings or one rubber tyre type coupling shall be provided on each pump's discharge pipework.

## **11. PIPEWORK FOR FLOW METER CHAMBER**

One flange adaptor shall be provided upstream of the flow meter and one flange adaptor shall be provided downstream of the meter.

The pipework shall also make allowance for one isolation valve upstream of the flow meter.

## **12. STEEL PIPEWORK**

### **12.1 INTRODUCTION**

This clause specifies requirements for carbon steel and stainless steel pipework.

### **12.2 INSPECTION AND TESTING**

Prior to the start of welding, the Contractor shall perform the following:

- a) Obtain acceptance of quality control documentation from the Employer's Representative.
- b) Provide certification of the chemical composition of the pipe steel; including heat treatment.
- c) Confirm that the welder(s) has passed the qualification tests as specified in Clauses 6.1 to 6.7 of API Standard 1104. An equivalent standard, such as SANS 9606, is acceptable.
- d) Provide the welding procedure specification (WPS); which shall comply with SANS 15609.

Quality of welding shall comply with SANS 3834. Where dispute arises regarding acceptance of welds, the requirements of SANS 10167 shall be used. All failures shall be reported to the Engineer who shall determine the rectification procedure.

The Contractor shall perform the following:

- a) Visually inspect pipework.
- b) 100 % dye penetrant testing of all welds.
- c) X-Ray test the first five butt welds by any individual welder.
- d) X-Ray 10 % of welds. This percentage might be reduced by the Engineer if welds are found to be in order during initial testing. On discovery of defective welds, however, the Engineer may call for X-Ray examination of all welds until it is shown that the necessary standard is being maintained. Repairs of welded joints will be permitted and the repair procedure and performance of repairs shall be in accordance with Section 10 of API Specification 5L.
- e) Arrange for the Engineer to inspect the pipework after fabrication but before any corrosion protection.
- f) Measure paint thickness.
- g) Pressure test pipelines.
- h) Provide inspection and test reports

## **12.3 CONSTRUCTION, MATERIALS AND CONFIGURATION**

### **12.3.1 Overall Configuration**

Steel pipework shall be joined using bolted flanges. Steel pipework smaller than DN 150 may be of threaded rather than of flanged construction.

Pipework shall be anchored to withstand forces. It shall be supported above floor level on pipe anchors or shall be wall mounted and shall not be installed at the floor level.

Gravity lines shall have a minimum downward slope in the direction of flow of one percent.

Pipework shall be configured and shall be provided with couplings and/or bends to allow easy dismantling and disassembly without damage to the pipework or pipe anchors.

The Contractor's design shall accommodate thermal and structural movement and shall isolate structures from vibration.

Provision shall be made for draining all sections of pipework and for venting high points. Stainless steel ball valves shall be provided at each point.

Bends shall preferably be of the long radius type. 90 degree "lobster back bends" shall have a minimum of five segments and the pipe welded to each flange shall be perpendicular to its flange.

Convergences shall preferably be of swept tee configuration.

The full internal surface of welds shall be accessible for inspection and this might require that bends, tees and bifurcations are short.

Pipework shall be sized so that the speed of flow of fluids containing solids which could settle does not drop below 0,8 metres per second during operation.

### **12.3.2 Pipe**

Carbon steel pipework shall be fabricated from welded carbon steel pipes complying with SANS 719.

Austenitic stainless steel and 3CR12 pipes shall be to ASTM A312, ANSI B36.19 or ANSI B36.10 or equivalent. Duplex stainless steel pipes shall be fabricated in an automated production pipe facility using mechanised welding procedures; i.e. they shall not be fabricated by the Contractor from plate.

### **12.3.3 Flanges**

Flanges shall comply with SANS 1123 or BS EN 1092. Flange sizes and pressure ranges greater than provided in these standards shall be designed in accordance with an equivalent flange in ASME B16.47 and shall meet the jointing requirements of BS EN 1591. Flanges which are required to match existing flanges may deviate from these requirements.

Pipework of PN 25 and above shall have raised face flanges.

Flange drilling shall be "off centre" unless required to match an existing flange which is drilled otherwise.

The jointing material used on flange joints shall be of a suitable rubber or compressed mineral fibre at least 3 mm thick complying with BS EN 681 or BS EN ISO 23936, as applicable. Gaskets shall be full face. Properly designed O-ring seals are also acceptable.

Carbon steel flanges shall be chamfered on their outside edges, on their inside edges and on both sides of each bolt hole in order to provide a suitable surface for the corrosion protection coating to be applied. Stainless steel flanges shall be chamfered on their outside edges.

#### **12.3.4 Manufacture**

The manufacture of pipe specials shall comply with Zut 7001.

Welding shall be in accordance with SANS 15614-1. Welding shall achieve full penetration. Crevices are not acceptable. Both internal and external weld surfaces shall have a neat profile.

Fabrication shall comply with the quality requirements for fabrications specified elsewhere in Zut 0001.

#### **12.3.5 Corrosion Protection**

Corrosion protection shall comply with Zut 0003.

#### **12.3.6 Pipe Couplings, Alignment & Flexibility**

Pipe couplings shall be provided where misalignment or dismantling must be allowed for and also for possible pipe movement from settlement or other cause. The coupling shall have the same or higher pressure rating than the pipework in which it is installed.

Thrust restraints on couplings shall only be provided where these are essential.

Pipe couplings shall comply with Zut 7023.

#### **12.3.7 Reducers**

Reducers shall have a maximum total angle of divergence of 10 degrees.

The tapered pipe shall not be welded directly to the flanges; i.e. a short, perpendicular, cylindrical length of pipe shall be provided between the tapered pipe and each flange.

#### **12.3.8 Nozzles/Sockets**

Nozzles shall be provided for the installation of gauges, transmitters, drain pipes, cooling water take-offs, air release valves, etc.

In carbon steel pipework, nozzles shall be designed so that the pipework corrosion prevention system can be correctly applied. A nozzle shall consist of a flanged, welded tee-off of at least 100 mm diameter, coated internally and provided with a non-corrosive blank flange, e.g. EN Grade 1.4401 (316) stainless steel. The blank flange shall be provided with tapped holes, or similar, suitable for the installation.

Stainless steel pipework shall be provided with stainless steel sockets which are welded into the pipework with no crevices either externally or internally.

Nozzles on the suction side of pumps shall be designed and positioned to cause minimum interference to the flow.

Nozzles for pressure gauges and sensors shall be positioned for steady, uniform flow.

### 12.3.9 Flow Velocity

Air flow speeds in pipework smaller than DN 150 shall be approximately 10 m/s and shall not exceed 20 m/s. Air flow speeds in larger pipework shall be approximately 20 m/s and shall not exceed 25 m/s.

Where the pipe diameter is not specified elsewhere, the design flow velocities for water shall be as follows:

DESIGN FLOW VELOCITY [m/s]				
	<i>flow = 0 - 2,5 l/s</i>	<i>flow = 2,5 - 15 l/s</i>	<i>flow = 15 - 100 l/s</i>	<i>flow = 100 - 500 l/s</i>
grit free	< 0,75	< 1,25	< 1,5	< 2
solids containing	0,8 – 1,5	0,8 – 1,5	1 – 1,75	1 – 2

### 12.3.10 Site Work

Pipework shall be neatly installed, straight to line and level and adequately supported.

The Contractor shall make allowance for the misalignment of pipework to which the Contractor's pipework is to be connected.

### 12.3.11 Sludge Pipework

Sludge pipework shall be provided with a rodding eye, or similar, at bends to provide access for cleaning.

Sludge discharge pipework shall have a minimum slope of one percent downwards in the direction of flow.

### 12.3.12 Puddle Pipework

Puddle pipes to be cast into concrete shall be of EN Grade 1.4401 (316) stainless steel or shall be of a grade of stainless steel with a higher Pitting Resistance Equivalence Number than EN Grade 1.4401 (316).

Puddle pipes shall be a straight length, flanged both ends and with a puddle flange. Puddle pipe length shall be as short as feasible but adequate clearance shall be provided for inserting flange bolts and for valve handwheels and/or actuators.

The puddle flange shall be of the same diameter as a normal flange and shall be positioned in the central plane of the concrete. It shall be of the same material as the puddle pipe. Puddle flanges shall have a plate thickness of at least half the thickness of the standard flange but with a minimum of 10 mm. They shall be fully welded on both sides.

External surfaces which are not encased in concrete shall receive the full corrosion protection system. The coating shall extend about 50 mm into the concrete but the area in contact with the concrete shall otherwise be uncoated. This uncoated area shall be abrasive blasted to promote bonding with the concrete.

The Contractor shall submit a method statement for the grouting process and shall not cast the puddle pipe into the concrete structure until the Engineer has accepted this statement.



**12.3.13 Marine Pipework**

Pipework containing sea water or brine shall comply with the following:

- a) Shall be of EN Grade 1.4410 (2507) super duplex stainless steel.
- b) One bolted hatch shall be provided upstream of each valve. The hatch shall be DN 150 or larger.

**13. PLASTIC PIPEWORK**

Polyethylene or Polypropylene pipes shall comply with SANS/ISO 4427 and SANS 15874 respectively and shall carry the SABS mark.

PVC pipework is not acceptable for applications involving vibration or shock, including hydraulic shock.

An operating life of 50 years shall be designed for and appropriate de-rating factors shall be applied to suit the application. The class of pipe selected shall be suitable for at least 1,5 times the actual maximum operating pressure.

Plastic pipework installed externally shall be provided with protection against ultraviolet light.

Tappings, for example for gauges, shall be provided with welded, external doubler plates. The plates shall have a thickness at least equal to the wall thickness of the pipe.

Welding of thermoplastic pipework shall comply with SANS 10268.

**14. CAST IRON PIPEWORK**

Cast iron pipes and fittings shall comply with BS 2035 (Class D) and shall be pressure tested in accordance with Clause 12 of that Standard. The requirements of the Standard's Clause 6 regarding freedom from defects and casting appearance and Clauses 8, 9 and 10 regarding casting accuracy will be strictly applied.

Cast iron pipework shall comply with the requirements of the clause "Castings".

**15. PIPEWORK ANCHORS**

Anchors for steel pipework and for plastic pipework shall comply with Zut 7024.

**16. ELECTRIC MOTORS SMALLER THAN 30 KW**

**16.1 PREAMBLE**

Induction motors smaller than 30 kW shall comply with this clause.

**16.2 GENERAL REQUIREMENTS**

Motors shall be rated for operation on a 3-phase, 4-wire, 400/230 Volt, 50 Hz, AC supply.

Motors shall be squirrel cage motors in accordance with SANS 60034. Cooling shall be IC 0141 (similar to "tefc") and the motors shall be suitable for a damp environment. Ingress protection shall be IP 55 or higher.

Motors shall be suitable for both "continuous running duty", Duty Class S1, and "intermittent periodic duty", Duty Class S3. Windings shall be insulated with Class F material (100 °C rise capability) with a designed Class B temperature rise (80 °C). The motors shall be suitable for 6 starts per hour, two of which shall be consecutive.

A stainless steel rating plate shall be secured to the frame with stainless steel fasteners. This shall include the motor's lubrication details. If the manufacturer's nameplate does not comply with these requirements, the Contractor shall provide additional nameplates.

Motors above 30 kg shall be provided with lifting eyes or lugs.

### **16.3 PERFORMANCE REQUIREMENTS**

Motors shall perform in accordance with the requirements of the specified mechanical equipment but the rated power of the motor shall, nevertheless, not be less than 20 % in excess of the designed power requirement of the driven equipment (the Engineer might waive this latter requirement if the motor forms part of a factory packaged unit).

Motors shall be designed to provide their rated power output at an ambient temperature of up to 40 °C and at an altitude of at least 1 500 masl.

### **16.4 OPERATION AND CONTROL**

Protection against both starting overload and running overload shall be provided.

### **16.5 VFC DRIVEN MOTORS**

The Contractor shall submit correspondence from the motor manufacturer/designer which confirms that the motor is designed for supply from the particular make and model of variable frequency converter to be provided in the application without shortening of the motor's lifespan.

Unless of the submersible or immersible type, VFC driven motors shall be cooled by a separate, constant speed fan (this requirement will be waived if the Contractor provides documentation confirming that the drive and motor design can operate in the application, with shaft-mounted fan, without exceeding its designed temperature rise).

Motors shall incorporate protection against damage to the bearings from induced currents.

### **16.6 BEARINGS**

Bearings shall be of the rolling element type (i.e. ball or roller) and may be either oil or grease lubricated.

Grease lubricated bearings shall be re-greasable during motor operation. They shall be provided with stainless steel grease nipples and shall be suited for external applications. A port for relief against over-greasing shall be provided. Greasing points shall be provided with stainless steel extension tubes where access is restricted.

L-10 design life shall not be less than 100 000 hours.

Bearings shall comply with the clause "Bearings" in Zut 0001.

### **16.7 CORROSION PROTECTION**

Motors shall be provided with a corrosion protection system which is suitable for the high corrosivity category, C4, of SANS 12944-2.

The fan cowl shall preferably be of cast iron or of stainless steel. For internal applications, plastic fan cowls are acceptable. Carbon steel cowls are acceptable if hot-dip galvanised. Painted carbon steel cowls are not acceptable.

#### **16.8 HAZARDOUS LOCATIONS**

If the specification calls for a motor to suit a hazardous location in terms of SANS 10108, then suitable motors complying with SANS 60034-5 or SANS 61241, as appropriate, shall be supplied.

The relevant SANS certificates, clearly indicating the location classification in which the machine may be operated, shall be submitted to the Engineer before delivery of the motors.

Each motor shall be clearly and permanently marked with the applicable certificate number.

#### **16.9 SAFETY**

Rotating parts shall be guarded as required by legislation.

### **17. ELECTRIC MOTORS OF 30 KW AND LARGER**

#### **17.1 PREAMBLE**

Cage and slipring induction motors of 30 kW and above, with the exception of 3,3 kV, 6,6 kV, 11 kV and 15 kV motors, shall comply with this clause.

3,3 kV, 6,6 kV, 11 kV and 15 kV motors shall comply with the specification for MV motors.

#### **17.2 GENERAL REQUIREMENTS**

Motors shall be in accordance with SANS 60034.

The type of motor and starter to be provided by the Contractor shall be determined by the requirements of the application specified and by any starting limitations specified. In the absence of such specifications, a squirrel cage motor shall be provided. If a special motor is required to obtain special starting characteristics and/or variable speed, this shall be to a standard at least equal to this specification and shall incorporate all aspects of electrical protection.

Motors with a rating below 1 000 kW shall be squirrel cage motors with cooling to IC 0141 (similar to "tefc"). Ingress protection shall be IP 55 or higher.

Motors with a rating above 1 000 kW shall be squirrel cage motors of CACA configuration with an ingress protection rating of at least IP 55 and shall be provided with oil lubricated sleeve bearings.

Motors shall be suitable for both "continuous running duty", Duty Class S1, and "intermittent periodic duty", Duty Class S3. Windings shall be insulated with Class F material (100 °C rise capability) with a designed Class B temperature rise (80 °C). The motors shall be suitable for 6 starts per hour, two of which shall be consecutive.

Wound rotor motors shall have a separate enclosure for the slip-ring assembly to ensure that dust from the slip ring followers does not enter the motor. The enclosure shall have the same ingress protection as the main motor enclosure but shall have covers for direct access. The rings shall preferably be of stainless steel.

Motors shall be structurally suitable for DOL starting regardless of the specified starting system.

The frame and end covers shall locate on a spigotted register to ensure concentricity and parallelism.

Motors shall be provided with lifting eyes or lugs.

An earth terminal shall be provided on the frame.

Access shall be provided to the winding neutral point.

All monitored motor parameters; e.g. bearing temperature, winding temperature, current, etc.; shall be appropriately indicated.

Motors shall be of the reduced noise level type.

At least one internal cooling circuit fan shall be provided for frame sizes 355 and larger.

Motors of size 75 kW and above shall be fitted with "pocket" heaters. These shall be arranged to switch on when the motor stops operating and switch off when the motor starts operating.

A stainless steel rating plate shall be secured to the frame with stainless steel fasteners. This shall include the machine's lubrication details. If the manufacturer's nameplate does not comply with these requirements, the Contractor shall provide additional nameplates.

Measured vibration severity at the bearings shall meet the requirements of Zone A or Zone B of ISO 10816.

When motors are transported, care shall be taken to prevent damage to bearings.

### **17.3 PERFORMANCE REQUIREMENTS**

Motors shall perform in accordance with the requirements of the specified mechanical equipment but the rated power of the motor shall, nevertheless, not be less than 15 % in excess of the designed power requirement of the driven equipment.

Motors shall be designed to provide this rated power output at an ambient temperature of up to 40 °C and at an altitude of at least 1 500 masl.

Motors shall reach full operating speed within 5 seconds unless driven by electronic soft start or variable speed drive.

Protection against both starting and running overload shall be provided.

### **17.4 400 VOLT MOTORS**

400 Volt motors shall be designed to operate on a 3-phase, 4-wire, 400/230 volt, 50 Hz, AC supply.

### **17.5 TEFC MOTORS**

The fan cowl shall preferably be of cast iron or of stainless steel. For internal applications, plastic fan cowls are acceptable. Carbon steel cowls are acceptable if hot-dip galvanised. Painted carbon steel cowls are not acceptable.

If it is specified that the motor shall produce low sound output, the fan cowl shall be provided with internal damping.

### **17.6 CACA MOTORS**

The heat exchanger shall be provided with lifting eyes or lugs.

Silencers shall be provided for cooling air inlets and outlets.

Rotors shall be dynamically balanced.

Ports shall be provided for air gap measurement at the drive end and at the non-drive end.

Vertical jacking shall be provided at each holding down point.

## **17.7 VFC DRIVEN MOTORS**

Motors fed by frequency converters shall comply with the following:

- Motors shall be rated to allow for additional harmonic losses in accordance with SANS 60034-17. The voltage stress withstand capability of the motor shall be checked against the converter supplier's specification. The stress due to converter operation shall be lower than the repetitive voltage stress withstand capability of the motor winding insulation system.
- Motors shall incorporate an insulated bearing and an earthing brush (or other approved protection against damage to the bearings from induced currents).
- Motors, unless submersible or immersible, shall be cooled by auxiliary constant speed motor driven fans.

The Contractor shall submit the following to the Engineer.

- Confirmation that the motors comply with the requirements of SANS 60034-25 for the application.
- Motor manufacturer's written confirmation that the motor is suitable for drive by the VFC make and model to be provided, including confirmation that the motor's voltage withstand capability is sufficient for the voltage stresses that will occur at the motor terminals.
- Guaranteed VFC harmonic performance including sample output wave forms with harmonic distortion levels at 40, 45 and 50 Hz for the VFC for the load.
- Guaranteed VFC dip ride through capability curve.
- Copy of VFC type test certificate (this is required if type tests have been carried out on the model).

## **17.8 BEARINGS**

Bearings shall comply with the clause "Bearings" in Zut 0001.

Grease lubricated rolling element bearings shall be re-greasable during motor operation. They shall be provided with stainless steel grease nipples and shall be suitable for external applications. A port for relief against over-greasing shall be provided. Greasing points shall be provided with stainless steel extension tubes where access is restricted.

Bearings for motors of 250 kW and above shall be provided with temperature measurement, indication and alarm.

Bearings for motors in belt drive applications shall be of the rolling element type; i.e. shall not be slide bearings.

## **17.9 INSTRUMENTATION**

Motors of 30 kW and up to (but not including) 150 kW shall be provided with thermistors embedded in the windings of each phase. The thermistor tails shall be "brought out" to separate terminals mounted near the motor winding terminal block.

Motors rated at 150 kW and above shall be provided with PT 100 type RTDs. Two RTDs shall be provided per phase winding. All six shall be incorporated into the control system; three to provide monitoring and three to provide high temperature trip functions.

## **17.10 CORROSION PROTECTION**

Motors shall be provided with a corrosion protection system which is suitable for the high corrosivity category, C4, of SANS 12944-2.

#### **17.11 HAZARDOUS LOCATIONS**

If the specification calls for a motor to suit a hazardous location in terms of SANS 10108, then suitable motors complying with SANS 60034-5 or SANS 61241, as appropriate, shall be supplied.

The relevant SANS certificates, clearly indicating the location classification in which the machine may be operated, shall be submitted to the Engineer before delivery of the motors.

Each motor shall be clearly and permanently marked with the applicable certificate number.

#### **17.12 SAFETY**

Rotating parts shall be guarded as required by legislation.

### **18. PLINTHS & BASEFRAMES - PERMANENTLY MOUNTED EQUIPMENT**

#### **18.1 GENERAL**

Permanently mounted rotating equipment shall be mounted on a metal baseframe and shall not be mounted directly onto concrete plinths.

The Contractor shall provide the baseframe, anchor fasteners, grouting, chemical anchor, etc. and is responsible for all installation work, including anchoring of the baseframe to the plinth.

The concrete plinth shall be designed by the Contractor for the application.

Equipment up to 1 000 kW shall be mounted on common baseframes. Separate baseframes may be provided for equipment above 1 000 kW and such base frames shall be grouted within (encapsulated in) their concrete plinths.

Equipment shall be secured to baseframes with both flat washers and spring washers (or another locking mechanism) of adequate size. Through bolts shall be used; i.e. a nut shall be used to secure the bolt.

The Contractor shall submit the baseframe workshop drawings to the Engineer for acceptance.

#### **18.2 PLINTHS**

The Contractor shall take into account all dynamic and static forces in the design of the reinforced concrete plinth and shall submit the design calculations and drawings to the Engineer for acceptance. The calculations shall confirm that the equipment's enforcing vibration will cause no resonant condition. If the plinth rests directly on soil, the calculations shall demonstrate that the design is suitable for the ground conditions. The design shall ensure that all forces, including the motor breakdown torque (or equivalent force if the driver is not a motor) and the torque experienced at power failure, will be properly withstood.

Plinths shall comply with all of the following:

- Plinth shall be of reinforced concrete.
- Plinth mass shall be greater than 4,5 times the sum of the masses of the driver and the driven equipment.
- Width of plinth shall be greater than the height between the shaft centreline and the bottom of the plinth.
- Height of plinth shall be greater than one fifth of the width.
- Height of plinth shall be greater than one tenth of the length.

- Plinths for rotating equipment above 130 kW shall be isolated from the surrounding floor and other machinery plinths (this requirement does not apply to machinery which is isolated from the floor by proprietary anti-vibration mounts).

### 18.3 SOLEPLATES

Sole plates; i.e. plate supports for equipment feet which are individually anchored into the concrete plinth; are acceptable as baseframes for equipment above 1 000 kW. They shall be grouted within (encapsulated in) their concrete plinths.

The soleplates to a depth of 50 mm within the concrete plinth/grout shall be of EN Grade 1.4401 (316) stainless steel or better for corrosion resistance. Carbon steel is acceptable for portions of the soleplates with concrete cover of 50 mm or more.

The soleplate's structure shall be designed so that air will not be captured under it during grouting.

### 18.4 BASEFRAMES

#### 18.4.1 Dimensions

Baseframes shall have dimensions which comply with the larger of the following:

- The main frame members shall have a height of at least 0,095 times the length of the baseframe.
- The main frame members shall have a height of at least 0,18 times the width of the baseframe.

Baseframes fabricated from members which are cold formed from plate shall also comply with the following:

- The plate thickness shall have a thickness greater than 0.0037 times the length of the baseframe (but with a minimum of 4,5 mm).

#### 18.4.2 Materials

Baseframes shall be fabricated from carbon steels complying with SANS 50025 for grade S 355 JR or S 355 JO or from 3CR12 or from EN Grade 1.4162 (LDX 2101) stainless steel.

#### 18.4.3 Mounting Pads

The baseframe shall incorporate machined mounting pads for each equipment foot. The thickness of the mounting pads before machining shall be at least 1,25 times the diameter of the holding down bolts. The pads shall be drilled for inserting through-bolts (i.e. not machine screws in threaded holes) and access to the underside shall be provided.

Machining of the top surfaces of mounting pads shall be done after fabrication, stress relieving and hot-dip galvanizing, if applicable, are complete. In the period between machining and installation of the equipment, the machined surface shall be protected against corrosion by a removable coating. After installation, a non-hardening compound, Valvoline Tectyl Multipurpose 506 or equivalent, shall be liberally applied to exposed machined surfaces and to the crevices formed at the foot of the equipment.

#### 18.4.4 Jacking Points

Baseframes shall be provided with robust jacking points for alignment of the motor to the driven equipment.

Jacking screws shall be hot dip galvanised.



#### 18.4.5 Fabrication

Fabrication and welding shall comply with the requirements elsewhere in Zut 0001.

The Contractor shall arrange for the Engineer to inspect the fabrication of the baseframe before corrosion protection.

#### 18.4.6 Corrosion Protection

##### 18.4.6.1 General

The design of the baseplate shall take into account all practical aspects of the corrosion protection system; for example:

- accessibility for surface preparation and coating.
- hidden surfaces are not acceptable.
- inaccessible pockets and hollow spaces which cannot be accessed by blast and spray equipment shall be avoided or shall be welded closed;.
- structures to be hot dip galvanised shall provide proper access for safe and complete entry and exit of the molten zinc.

Baseframe designs shall prevent pooling of water. They shall be grout filled and/or shall be provided with large drain holes in all side members (before corrosion protection).

Holes in the baseframe and welded lugs for mounting of conduits, etc. are acceptable on condition that these are provided prior to galvanising or prior to pickling and passivation, whichever is applicable. They shall preferably be positioned near the neutral axis of steel sections.

##### 18.4.6.2 Carbon Steel Baseframes

Carbon steel baseframes shall be hot-dip galvanized in accordance with Zut 0003.

Baseframes which are drilled, welded or ground after galvanising will be rejected. Machine milling of mounting pads, with subsequent protection against corrosion as specified, is acceptable.

##### 18.4.6.3 Stainless Steel and 3CR12 Baseframes

3CR12 shall be coated with a suitable system complying with Zut 0003.

EN Grade 1.4162 (LDX 2101) stainless steel and other stainless steels need not be coated.

#### 18.4.7 Anchor Fasteners

##### 18.4.7.1 Requirements for All Baseframes

Baseframe anchor fasteners shall be of EN Grade 1.4401 (316), or better.

Fasteners shall comply with the requirements for fasteners elsewhere in this specification.

The baseframe and plinth shall form a structural unit (i.e. the baseframe and plinth shall vibrate as a unit) and, to achieve this, the baseframe anchors must transfer force into the concrete (i.e. it is not acceptable to provide a levelling nut below the baseframe as the anchor will not be properly pre-stressed into the plinth).

Anchor fasteners shall be provided with both a lock washer and a flat washer of adequate size.

##### 18.4.7.2 Additional Requirements for Pump Baseframes

Baseframe anchor fastener size for pump installations shall be in accordance with the table below.



Pump Inlet Size	Minimum Fastener Size
DN 50	M10
DN 100	M12
DN 200	M12
DN 300	M16
DN 400	M20
DN 500	M24
DN 600 and larger	M30

The number of baseframe anchors for pump installations shall be in accordance with the table below.

Pump Inlet Size	Minimum Fasteners (No.)
DN 50	6
DN 50 to DN 150	8
Above DN 150	10, or more.

#### 18.4.8 Installation

Not more than three shims may be used at any point and these shall be of a corrosion resistant material.

Concrete surfaces under baseframes shall be scabbled before the baseframe is placed and shall be clean. Dust shall be removed from the surface by compressed air immediately before grouting.

Baseframes shall be grouted in a manner which will eliminate collection points for water or dirt.

The material used for grouting shall be a non-shrink, cementitious grout (ABE Duragrout 1000, or equivalent).

Final equipment alignment shall be done after grouting has been completed.

## 19. SKID MOUNTED EQUIPMENT

Skid baseframes shall comply with the design requirements for anchored baseframes. They shall be single fabricated units.

The baseframe shall be provided with four jacking points and four lifting points.

Equipment shall be secured to the baseframe on anti-vibration mounts.

Skid baseframes shall be placed on anti-vibration rubber mats, "Tico pad" or equivalent. These shall provide a gap between the skid and the concrete in order to prevent pooling of liquids (in addition to vibration isolation). The elastomeric materials shall be resistant to oil.

## **20. MACHINE GUARDS**

Guards shall comply in all respects with the Occupational Health and Safety Act of 1993 as amended.

Guards are required to cover all moving or revolving components of machinery and shall prevent a person from touching any moving protrusion. Guards which do not adequately cover moving protrusions such as keys, lock nuts, lock washers, setscrews, etc., or irregularities such as keyways, will under no circumstances be accepted.

Guards shall be neatly and rigidly constructed and fixed and shall not vibrate or cause noise during operation.

Where expanded metal or similar mesh is used, the mesh opening shall not permit a circular object 10 mm or larger to penetrate. Mesh shall not be used for chain guards but on belt drives the side of the guard most conveniently sited for inspection shall be constructed of expanded metal or similar. Mesh should similarly be used in other situations where inspection or ventilation is required.

Allowance must be made for adjustment where adjustment will be required such as on belt guards.

It shall be possible to remove guards easily for maintenance purposes.

Guards shall preferably be fabricated of EN Grade 1.4401 (316) stainless steel (uncoated) but may also be hot-dip galvanized, hot metal zinc-sprayed or hot metal aluminium-sprayed carbon steel, coated to Specification in all these cases. Fasteners shall be M10 or larger and shall be of EN Grade 1.4401 (316) stainless steel.

## **21. SHAFT COUPLINGS**

Shaft couplings shall be selected to reduce transmission of misalignment forces and of torsional oscillations between the driving and the driven machine. The service factor for electric motor drives shall be at least 1,5; for electric motors on variable frequency converter drives shall be at least 2 and for internal combustion engine drives shall be at least 2,5.

Couplings shall preferably be of the rubber tyre or rubber compression type, keyed to the shafts. Elastomeric elements shall be urethane based.

The design shall respect the requirements of the machine bearings in order to counter thrust forces and limit axial movement.

Flexible metallic elements shall be of stainless steel. Couplings shall not require lubrication.

Spacer couplings shall be used where required for disassembly of the equipment. It shall be possible to dismantle the coupling without having to move either the driver or the driven equipment.

Coupling guards shall comply with the requirements of the OHS Act and shall be to the approval of the Engineer.

After installation, shaft alignment shall be checked by the Contractor in the presence of the Engineer or a person delegated by him. Alignment shall be accurate and to the approval of the Engineer.

## **22. BELT DRIVES**

Belt drives shall be designed to suit the power rating of the motor using service factors appropriate to the driving and driven machinery. Drives shall be designed, manufactured and installed in accordance with BS 3790 and ISO 4184 or equivalent, utilizing taperlock pulleys with taperlocks keyed to the shaft.

Where alternative pulley diameters can be selected, preference must be given to the larger pulley diameters to minimize the belt loading on bearings.

The bearing arrangements of driving and driven machinery shall be designed to cope with the loads imposed by belt drives. Rolling element bearings shall be designed for an L-10 life exceeding 100 000 hours.

Belt drives shall incorporate lay shafts where necessary. Lay shafts shall be supported by bearings mounted in bearing housings which are adequately sealed and fitted with grease nipples. Bearing units incorporating open, shielded bearings are not acceptable.

Belt driven machinery shall be equipped with rolling element bearings; i.e. shall not be equipped with slide bearings.

## **23. DRIVEN GEARBOXES**

### **23.1 GENERAL**

Driven gearboxes shall be supplied with environmental protection to IP 55 or higher.

The gearbox ratings shall be provided for an ambient temperature of 40 degrees Centigrade.

Gearboxes shall have an efficiency of not less than 96 % on two stage reduction and 95 % on three stage reduction.

### **23.2 SERVICE FACTOR**

#### **23.2.1 Motor Driven Gearboxes**

The service factor to be used for the design of gearboxes in uniform load duty shall be at least 1,25 for electric motor driven applications. A minimum service factor of 1,5 shall be used for moderate shock applications and a minimum service factor of 2 shall be used for heavy shock applications.

#### **23.2.2 Engine driven gearboxes**

The service factor to be used for engine driven gearboxes shall not be less than 2.

### **23.3 DESIGN REQUIREMENTS**

Gears shall be case hardened, profile ground and lapped, helical and spiral bevel gears.

The gearbox housing shall be of rigid cast construction preferably split in the horizontal plane.

Unless close coupled, each gearbox shall be mounted on machined sole plates fitted with jacking screws to assist with alignment.

Rolling element bearings shall be designed for an L-10 life in excess of 100 000 hours.

A breather designed to prevent moisture from entering shall be fitted.

#### **23.4 LUBRICATION**

Oil-bath gearboxes shall have suitable oil level indicators or dipsticks which indicate the allowable levels. Inaccessible oil drain points shall be provided with extensions so that the oil can be easily drained. The drain line shall be of EN Grade 1.4401 (316) stainless steel and shall be fitted with a ball valve and square head plug.

Grease lubrication points shall be easily accessible. Grease nipples shall be of stainless steel.

#### **23.5 OIL CHANGE**

The Contractor shall drain and replace oil in all gearboxes during the Defects Notification Period.

#### **23.6 CORROSION PROTECTION**

Gearbox external surfaces shall be provided with a coating suitable for the high corrosivity category (C4 of SANS 12944-2) and the dry film thickness shall not be less than 200 micron.

### **24. MANUAL GEARBOXES**

An over-torque limiting device shall be incorporated.

Grease lubrication points shall be easily accessible. Grease nipples shall be of stainless steel.

A breather designed to prevent moisture from entering shall be fitted.

### **25. BEARINGS**

#### **25.1 BEARING CHOICE**

Bearing design shall suit the requirements of the equipment and the installation.

Greased lubricated bearings are acceptable for units with power ratings up to 100 kW but oil lubricated bearings are preferred for larger machines.

Units with power ratings above 1 000 kW shall be provided with slide bearings (oil film type). Slide bearings are also preferred for units with high speed shafts and for high temperature applications.

#### **25.2 OPERATIONAL REQUIREMENTS**

Bearing designs shall ensure safe shut down without damage following electrical supply failure.

Bearing designs for variable speed drive applications shall be suitable for the full expected speed range.

#### **25.3 SEALS**

Bearings shall be provided with seals to prevent the ingress of water and solids.

#### **25.4 ROLLING ELEMENT BEARINGS**

For shaft sizes above 50 mm, the bearing shall be selected for an L-10 bearing life of at least 100 000 hours. This may be reduced if the equipment is expected to operate for less than 3 000 hours in a normal year.

Grease lubricated rolling element bearings shall be provided with relief against over greasing.

Oil lubricated rolling element bearings shall be provided with an oil ring.

#### **25.5 SLIDE BEARINGS**

Slide bearings (“plain bearings”, “oil-film bearings” or “sleeve bearings”) which are oil lubricated shall have lubrication by oil ring, by rotating dish or by pumped feed or by a combination of these.

Lubrication shall be active during normal run down and during power failure and the design shall ensure that the bearing is not damaged.

Loss of pressure in pumped lubrication systems shall lead to shut down of the machinery.

Small diameter bushes shall preferably be self-lubricated sintered metal or of engineering polymer with suitable lubrication.

#### **25.6 MOTOR BEARINGS**

Motor bearings shall be provided with protection against stray currents which cause damage to the bearing.

#### **25.7 THERMAL ALARMS**

Thermal alarms on bearing systems shall be set in accordance with the equipment manufacturer’s instructions.

Alarm settings done on Site shall be set after at least 24 hours of operation have occurred.

If high temperature protection is specified for a bearing, the Contractor shall note the equilibrium temperature reached after 30 minutes of normal operation and shall also note the ambient temperature. The high level trip temperature shall then be calculated as follows:

$$T_{\text{trip}} = T_{\text{equilibrium}} + (40^{\circ}\text{C} - T_{\text{ambient}}) + 10^{\circ}\text{C}.$$

(This assumes that the bearing is operating correctly.)

#### **25.8 BELT DRIVEN EQUIPMENT**

Belt driven machinery and belt drive motors shall be equipped with rolling element bearings; i.e. shall not be equipped with slide bearings.

### **26. LUBRICATION**

#### **26.1 TYPE**

Grease lubrication is generally acceptable where design parameters are not severe. Oil lubrication shall be provided where the design parameters are more severe.

Lubrication systems shall be designed to exclude dirt and moisture. Air vents on the oil reservoir shall incorporate filters. Drain facilities shall always be provided.

#### **26.2 GREASE LUBRICATION**

Where a grease point is not easily accessible, a grease line shall be piped to an easily accessible position for manual greasing. Each grease point shall be provided with its own grease point and pipework.

A distributor shall be provided where motorised lubrication is provided to more than one destination. The distributor shall be a positive displacement device which ensures equal, successive lubrication to all destinations. Only one distributor shall be used for each lubrication pump; i.e. distributors shall not be cascaded.

Pipework for grease distribution shall be of stainless steel.

### **26.3 OIL LUBRICATION**

Where oil lubrication is provided, the Contractor is responsible for the initial oil fill and the first oil change, including flushing, draining and filling, after an initial run in period not exceeding 3 months

Oil level indicators shall be provided for visual checking. Drain valves, including EN Grade 1.4401 (316) fittings where necessary to permit convenient draining, and plugged at the end, shall be provided for oil reservoirs exceeding 1,5 litre capacity. Drains shall be from the lowest point and syphon type drains are unacceptable.

### **26.4 SUBMERGED BEARING HOUSINGS**

Submerged bearing housings shall be grease lubricated by motorised lubrication. The seals shall be arranged to avoid overgreasing of the bearing. These requirements apply to the bottom bearings of equipment such as Archimedes screw pumps but do not apply to equipment such as submersible pumps in which the bearing housing is contained within the pumpset housing.

## **27. GAUGES**

### **27.1 CONSTRUCTION**

Gauges shall be of industrial construction. The case and bezel shall be of stainless steel unless this material is unsuitable for the application.

Pressure, vacuum or compound gauges shall comply with SANS 1062 and shall bear the Standards mark. Gauges shall be of Accuracy class 1.6 and Durability grade A.

The gauge reading shall indicate gauge pressure unless absolute pressure measurement has been called for.

Gauges shall have a scale diameter of not less than 100 mm.

Calibration shall be in mWC (metres Water Column). The units of measurement shall be clearly marked on the dial.

The scale shall be chosen so that the operating pressure is not less than half full scale reading. In addition, the full scale reading for a gauge on the discharge of a centrifugal pump shall be higher than the pump's shut-off head.

Wherever applicable, gauges shall be clearly strip marked in green to indicate the normal operating range and in red to indicate the non-permissible range of values.

Gauges shall be suitable for continuous operation and shall be glycerine filled on all pump applications and where fluctuations in pressure may cause damage.

Scale markings shall be radial, plain, straight, black lines on a white background and shall be spaced so that one scale division represents approximately 1,5 % of the maximum scale value in values of 1, 2 or 5 multiplied by any power of 10 to suit the maximum operating rating. On circular gauges the scale shall be concentric and the maximum and minimum scale values shall be near the bottom of the gauge, with the scale symmetrically disposed about the vertical centre line of

the gauge. The tip of the pointer shall be of the knife edge type extending across the scale divisions and shall be as close as practical to the dial.

## **27.2 INSTALLATION**

Gauges shall not be mounted directly on equipment subject to vibration.

Gauges for pipework larger than DN 250 shall be remotely mounted and isolating valves shall be provided at each end of the connecting pipework.

Gauges shall be mounted vertically and in such a position that they can be easily read from floor level.

Nozzles/sockets for gauges shall be provided in accordance with the clause "Steel Pipework; DN 150 and Larger".

Pressure gauges shall be fitted with an isolating and an air bleed valve. Valves shall be stainless steel ball valves with stainless steel operating levers.

Gauges for sludges and other liquids which contain solids shall have their nozzles on the side of the parent pipe. The configuration shall allow easy cleaning of the passageways.

Gauges used on wastewater, sludge, chemical, solids conveying or other applications where blockage or corrosion of the gauge is possible shall be fitted with a diaphragm type chemical seal, both being liquid filled. The portion of the seal in contact with the process liquid shall be of a suitable non-corroding material.

When used on steam lines a siphon shall be fitted between the steam line and the gauge which shall be filled with water before it is put into service.

## **27.3 CALIBRATION**

The Contractor shall calibrate all instrumentation prior to commissioning and shall submit the calibration certificates to the Engineer.

# **28. ELECTRONIC INSTRUMENTATION**

Environmental protection of electronic instrumentation shall be as follows:

- a) Instrumentation and associated displays and transmitters which are either located inside or located outside and above ground level shall have IP 55, or higher, rating.
- b) Instrumentation and associated displays and transmitters which are located in underground chambers shall have IP 68 environmental protection. The instrument shall be mounted in an enclosure which shall provide physical protection and shall be self-draining.
- c) Instruments and associated displays and transmitters which are located outside buildings shall be mounted in enclosures. Enclosures shall be of polycarbonate construction with transparent front, Fibox EK or equivalent. The complete enclosure installation shall have an IP 55 rating or higher. The enclosure size shall be chosen to provide a clearance of at least 100 mm all around the instrument.

Instruments and their cabling shall be protected so that electromagnetic interference does not affect their operation and signal transmission.

Instruments shall have permanently affixed nameplates.

The Contractor shall calibrate all instrumentation prior to commissioning and shall submit the calibration certificates to the Engineer. Calibration certificates shall be included in the Manual.

## **29. GUARD RAILS**

### **29.1 GENERAL**

Legislated requirements call for guard railing to be provided in positions where the vertical change in level is 1 000 mm or greater.

Guard railing shall comply with SANS 10104 and shall be designed for access for maintenance purposes.

### **29.2 OPERATIONAL REQUIREMENTS**

Guard railing shall be designed to resist, without any damage and without excessive deflection, the loadings in Category E in Table 7 in Clause 9.4 of SANS 10160 2:2011, Edition 1.1, namely:

- a) a force of 1 000 Newtons in any direction (concentrated over a length of 100 mm).
- b) a distributed horizontal force of 1 000 Newtons per metre applied along the top rail.

### **29.3 DESIGN REQUIREMENTS**

Guard railing shall be designed to resist the loadings set out in SANS 10160.

Hand and knee rails shall have an outside diameter of not less than 33 mm and a wall thickness of not less than 2,5 mm and a maximum span of 1 500 mm (greater spans will be acceptable if heavier tube dimensions are used).

Tubular stanchions shall have a wall thickness of at least 3,0 mm.

On platforms, walkways, landings or around dangerous areas the vertical height, measured from the top of the hand rail to the floor or surface, shall be at least 1 000 mm.

On stairways and fixed ladders the rails shall be parallel to the strings, and the vertical height, measured from the top of the hand rail to the nosing of the tread, shall be at least 900 mm.

No opening between rails shall allow the passage of a ball of diameter 600 mm.

Stanchions and rails shall be smoothly finished and free from sharp corners, edges and projections which may injure persons or damage clothing. Stanchion bases shall have the corners rounded or sheared off.

Welded guard rail installations are preferred. Installations which incorporate bolted sections shall be secure and tight under loading. "Pop" rivetted installations will not be acceptable. Joints shall be smoothly finished, without shoulders.

Railings shall be ended off with positively fixed closure bends. At corners, short radius bends with stanchions on both ends shall be employed or, alternatively, stanchions specifically designed for such a position shall be employed. No sharp ends will be permitted.

Stanchions shall generally be base-mounted to suit the arrangement requirements and shall be of solid or welded construction.

Stanchions which are hollow shall be self-draining.

Stanchion feet which are attached to metallic surfaces shall have minimum dimensions of 150 mm X 60 mm X 8 mm. Two fasteners, of minimum size M16, shall be used to secure each



foot. Neatly fitting packing, Denso tape or equivalent, shall be fitted under stanchion feet to prevent the formation of crevices.

Stanchion feet which are attached to non-metallic surfaces shall have minimum dimensions of 150 mm X 150 mm X 10 mm. In instances where the horizontal surface to which the foot is to be fastened is less than 150 mm wide, the foot shall be designed to be seated on at least two surfaces. Four fasteners, of minimum size M16, shall be used to anchor the foot. Non-shrink, cementitious grout shall be applied under the foot prior to final tightening of nuts.

Toe plates shall be provided. These shall extend to 150 mm above the walkway level.

#### **29.4 ADDITIONAL DESIGN REQUIREMENTS FOR GUARD RAILING IN PUBLIC PLACES**

The requirements for guard railing at equipment installations shall also apply for guard railing for public places. The following specific requirements shall also be complied with:

- a) The structural design shall be done in accordance with the requirements of SANS 10104.
- b) No opening in guard railing installed in public places shall allow the passage of a ball of 100 mm diameter.

#### **29.5 CARBON STEEL GUARD RAILS**

Fabrication and welding shall comply with the clauses "Fabrication of Carbon Steel and Stainless Steel" and "Welding".

The guard rails shall be hot-dip galvanised. Designs shall provide proper access for safe and complete entry of the zinc into open spaces so that subsequent drilling at the galvaniser's yard is avoided.

If the guard rails are welded or cut after hot-dip galvanising, they shall be returned to the galvaniser for re-galvanising.

#### **29.6 STAINLESS STEEL AND 3CR12 GUARD RAILS**

Fabrication and welding shall comply with the clauses "Fabrication of Carbon Steel and Stainless Steel" and "Welding".

#### **29.7 FASTENERS**

All anchor fasteners, including nuts and washers shall be of EN Grade 1.4401 (316) stainless steel.

Fastener diameter shall not be less than M12.

### **30. GRID FLOORING**

The depth of bearer bars in metal grid flooring shall not be less than 30 mm with a bearer bar pitch of not greater than 40 mm.

The bearer bars shall be across the shorter span.

Panels shall be set level and fixed to angle frames to prevent rocking.

Cut-outs in grid flooring for pipes, valve spindles, etc. are to be fully banded. The edges of removable grid access covers must also be fully banded. Corrosion protection shall only be done after welding of banding has been completed.

Unless another material such as stainless steel is specified, grid flooring and frames shall be of carbon steel, hot-dip galvanized after fabrication. If hot-dip galvanising is not suitable, a glass flake resin, such as Power Blast's Vitaglass or equivalent which is applied by dipping the flooring in catalysed resin, is acceptable. Painted coatings are not acceptable as corrosion protection.

Where grid flooring rests on painted surfaces, strips of rubber insertion material shall be secured under the grid to protect the paint.

The fixing clip set (saddle clamp and locking plate) shall be of hot-dip galvanised steel or stainless steel. Fasteners shall be of EN Grade 1.4401 (316), or better.

GRP grid flooring is not acceptable.

## **31. FASTENERS**

### **31.1 STANDARDS**

Bolts and nuts shall be hexagon head type complying with SANS 1700 with threads of the coarse pitch series.

### **31.2 LOADING/STRESS**

Fasteners shall be loaded in accordance with their design and shall not be loaded as columns and/or in bending. In particular, anchor fasteners shall only be loaded in tension and sideways forces shall be transferred to the concrete structure in which they are anchored.

### **31.3 MATERIALS**

M12 fasteners and smaller shall be of EN Grade 1.4401 (316) or better.

Fasteners in corrosive areas shall be of EN Grade 1.4401 (316) or better. Corrosive areas shall be taken to include any moist or wet area such as in and above settling tanks, in or in the vicinity of open channels, where a continuous spray can be expected and all areas in the vicinity of a wastewater treatment works or wastewater sump.

Fasteners larger than M12 which are in non-corrosive areas shall, except when specified otherwise, be hot-dip galvanized.

Plated fasteners are not acceptable.

### **31.4 HIGH TENSILE BOLTS**

Where high tensile bolts are required by the design, they shall be hot-dip galvanized and painted. The bolt holes and crevices shall be filled and sealed prior to painting.

### **31.5 ANCHOR FASTENERS**

Anchor fasteners shall be of EN Grade 1.4401 (316), or better.

Anchor fasteners for water retaining structures and for brickwork shall be of the chemical anchor fastening type. Other anchors may be of the expanding type or chemical anchor type.

Where hook bolts are used, these shall be supplied and grouted by the Contractor into pockets which will be provided in the concrete structure in accordance with the information to be supplied by the Contractor. The grouting products shall be used strictly in accordance with the manufacturer's instructions.

Where machinery is anchored by studs or bolts which extend through the supporting structure and is therefore fastened down with the use of nuts from both sides, the studs or bolts, together with associated washers and brackets, shall also be of EN Grade 1.4401 (316), or better.

Anchors shall be tensioned when their nuts are tightened; i.e. it is not acceptable to use a second nut below the baseplate to position it; and the holding down force shall be loaded into the concrete structure rather than the baseplate being held between two nuts.

Submerged anchors shall be secured with chemical anchor designed for submersion.

## **31.6 MATERIAL COMPATIBILITY**

Fastener material shall always be of equal or better corrosion resistance than the items being fastened, e.g. EN Grade 1.4401 (316) bolts must be used to fasten together EN Grade 1.4401 stainless steel flanges and fabrications.

## **31.7 WASHERS**

Flat washers shall be provided under nuts and setscrew heads.

Flat washers shall be provided under bolt heads on painted surfaces.

Flat washers shall be provided under bolt heads where the bolt is positioned in a slot.

Spring washers shall be used on fasteners subject to vibration (other approved locking arrangements will also be acceptable on proprietary equipment).

Anchor bolts for machinery shall each be provided with a flat washer and a spring washer (other locking arrangements are not acceptable).

Washers shall be of the same material as the fasteners.

Flat washers exhibiting visual deformation shall be replaced by thicker washers.

## **31.8 ANTI-SEIZE COMPOUND**

Before assembly, stainless steel threads shall be treated with a nickel-based, anti-seize/corrosion protection compound such as Chesterton 725 : Nickel Anti-Seize Compound, or equivalent. Copper based compounds are not acceptable.

A small amount of the compound shall be applied along the full length of the exposed thread before fastening. Excessive compound visible on the thread after the nut has been applied is unacceptable and indicates that the compound has not been used correctly.

## **31.9 THREAD PROJECTION**

Bolt threads shall project no less than 1 thread and no more than 8 threads from the head of the nuts when fixed. Longer projections will only be allowed if the Contractor can show that bolts of a more suitable length are not manufactured.

## **31.10 CORROSION PROTECTION**

After installation, the exposed surfaces of fasteners not of stainless steel shall be coated as for the items being fastened.

"Self-tapping" fasteners are not acceptable.

If the use of Allen head or similar fasteners has been accepted by the Engineer, the recessed heads shall be filled with a suitable non-hardening sealing compound.

## **32. MACHINE VIBRATION**

The mechanical vibration of machines measured at all important points such as bearings shall be lower than that specified as "good" for that class of machine in BS 7854 (ISO 10816).

Reciprocating machines shall be designed and installed so that the machine vibrations are isolated from the floor structure. Vibration isolation mountings which will eliminate not less than 90 % of the vibrations transmitted by the equipment shall be provided between the baseframe and the concrete plinth. When mounted on the vibration isolators, distortion of the baseframe shall be negligible in comparison with the permissible and acceptable misalignment of the equipment mounted thereon.

Shafts shall be designed so that the critical speed is outside the operating speed range.

## **33. NOISE CONTROL**

### **33.1 GENERAL**

Noise emitted by equipment shall be kept to a minimum and shall not exceed the noise levels specified in these documents.

### **33.2 NOISE LEVELS**

The sound power of any equipment shall not exceed 89 dB(A) (referred to  $10^{-12}$  Watts) unless specifically accepted by the Engineer. This is approximately equivalent to a sound pressure level of 81 dB(A) at a radius of one metre from the acoustical centre assuming uniform hemispherical propagation in a free field on a hard floor. In certain instances, a lower noise level may be called for.

Where the Contractor is unable to restrict the noise level of the machines to the maximum specified by the appropriate selection of suitable equipment; e.g. by selecting slow speed or silent type machines, quiet type cooling fans, suitable silencers, etc.; the Contractor shall inform the Engineer so that appropriate steps can be taken to counteract the effects of noise.

### **33.3 ACOUSTIC TREATMENT**

Standard acoustic enclosures shall be provided where called for.

Acoustic treatment of high noise sources shall be provided where this can be done without greatly interfering with operation or maintenance.

If acoustic lagging of pipework or ducting is specified, this shall consist of pre-formed rockwool encapsulated in stainless steel sheet metal. Alternatively, a 100 mm thick layer of rockwool having a density of  $60 \text{ kg/m}^3$ , suitably fixed in place and reinforced to prevent collapse, and covered with 25 mm thick asbestos free plaster having a density of  $1\,000 \text{ kg/m}^3$  (I.P. Insultex AF720, or equivalent). The outer surface shall be finished off with scrim cloth before being painted.

It is not normally necessary to lag flow meters and cast iron valves on acoustically lagged pipelines.

Components which can move, such as those associated with expansion bellows or mechanical couplings, shall be enclosed by an effective acoustic enclosure designed to prevent sound transmission but able to cope with movement without damage.

#### **33.4 MEASUREMENT**

Noise levels will be verified by taking impulse weighted Leq readings in dBA over ten minutes at the specified positions. Readings so achieved shall not exceed the specified level by more than 2 dBA. Should the noise exceed the specified level or should the level be in dispute, the Contractor will be responsible for obtaining certified sound pressure levels across the full octave band mid-frequency range in order to establish the precise A weighted level.

#### **34. THERMAL LAGGING**

Thermal insulation shall only be carried out after successful pressure testing of the equipment.

The efficiency of the insulation system shall exceed 90 % and the insulation cold face temperature shall not exceed 40 °C.

Pipe insulation shall consist of pre formed insulation material having a thermal conductivity of approximately 0,040 W/m °K at 60 °C. The insulation material shall not have any corrosive effect on the pipework and, in particular, it must be noted that fibreglass may not be used on stainless steel.

Inside buildings, or in other protected areas, pipe insulation shall be supplied with a canvas covering having a 50 mm lap at one end and along the longitudinal seam. The laps shall be sealed using a suitable lagging adhesive. On bends the insulation material shall be neatly mitred and covered with canvas. At all flanges the insulation shall be closed off. Flanges, couplings, tees and valves shall be insulated using a removable canvas blanket or jacket fastened in place with brass hooks and eyes.

All insulation shall be coated with a suitable sealer and then painted in accordance with the colour code. The manufacturer shall advise regarding the paint types and system to be used.

Outside buildings or in other exposed areas pipe insulation shall be fixed in position using three bands per section or a suitable adhesive and then clad with aluminium. All longitudinal and circumferential joints shall incorporate a 50 mm lap with each edge grooved. The longitudinal joints shall be positioned in the "twenty past" position with the lap and groove downwards. All ends next to couplings or flanges shall be closed off and sealed before fitting muff type insulation and cladding over the couplings and flanges. All bends, tees and other fittings shall also be insulated and clad but valves need not be insulated. All joints shall be primed and sealed using a silicone or other appropriate sealer and the contractor shall generally ensure that the lagging is weatherproof with particular attention being paid to all joints and pipework anchor points.

With large exposed items such as vessels mounted outside, a suitable system incorporating a 20 mm thick, smooth layer of weatherproof, reinforced plaster covered with a scrim cloth and overcoated with at least two coats of fibre reinforced resin sealer shall be acceptable.

#### **35. SPARES**

Spares which are specified as part of the Works shall be packed individually in wooden boxes with the lids unattached. Each box shall be labelled with the Contract number, manufacturer, contents, relevant part/model numbers and the supplier's address. The boxes shall be brought to Site and the lids shall be secured to the boxes immediately after the Engineer has accepted the spares and the packaging.

## **36. SIGNAGE**

### **36.1 GENERAL**

All signs as specified below shall be installed prior to commissioning.

### **36.2 OPERATING INSTRUCTIONS**

Operating instructions shall be framed and shall be attached to the wall in the control room using brass screws. The frame shall be of wood or aluminium with a glass front and hardboard backing. They shall include the following:

- a) Start up, Shut down and Operating instructions shall be comprehensive and shall indicate actions to be taken in the case of all alarm conditions. These shall be written from the point of view of the plant operator.
- b) A layout drawing of the equipment installation.
- c) A process flow diagram.
- d) A P&ID.

### **36.3 SAFETY**

Safety signs shall be suitably framed or encapsulated. Symbolic signs shall comply with SANS 1186. The wording of the signs shall be accepted by the Engineer prior to final printing. They shall be provided by the Contractor in appropriate places on the walls of the plant room and shall include the following:

- a) All statutory and special safety warning instructions.
- b) Course of action during/after electrical shock.
- c) Any operating restrictions for equipment.
- d) Operating instructions in cases of plant trip and electrical supply failure.
- e) Spares list.

# **SPECIFICATION: ZUT 0002**

## **OPERATING AND MAINTENANCE MANUAL**

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## 1. INTRODUCTION

Zut 0002 specifies the requirements for the Operating and Maintenance Manual to be provided by the Contractor.

## 2. SUBMISSION OF MANUAL

The Contractor shall submit the Manual to the Engineer for acceptance. If the Manual does not comply with this specification and/or is incorrect, the Contractor shall correct it and re-submit it for acceptance until the Engineer accepts it. At each submission, the Contractor shall provide a duplicate copy for the Employer.

Six copies of the final version of the Manual, as accepted by the Engineer, shall be provided prior to the issue of the Taking Over Certificate by the Engineer and the start of the Defects Notification Period.

## 3. GENERAL REQUIREMENTS

The Manual shall be for the complete Works.

The Manual shall be in English and shall be practically and neatly presented.

One Manual shall contain original documents and this set shall be marked "Original". The other 5 Manuals shall contain all the information in the original and shall be marked "Copy 2" to "Copy 6".

Binders shall have hard, plastic protected covers utilising four-ring, spring-clip holders. Each binder shall not be more than two-thirds full. A title label shall be affixed to the spine of each binder. This shall indicate the Employer, the Contract number, title, Contractor's name, Site/Plant name and volume number.

Sections and sub-sections shall be titled, uniquely numbered and provided with separator sheets.

Manufacturer's printed matter shall be marked to identify the model provided.

Drawings shall be to a scale which makes details clear. Large drawings shall be held in plastic envelopes in the Manual. A4 and A3 drawings may be bound as normal pages. Drawings shall also be provided on electronic data storage in Autocad, or equivalent, format.

Cross-referencing within the Manual is acceptable if this will avoid duplication.

Three copies of the complete Manual shall be provided in pdf format, on flash drives.

## 4. FORMAT AND CONTENTS

The Manual shall comply with the following format:



NO	HEADING	CONTENT
<b>1</b>	<b>General</b>	
1.1	Contents List	Contents list for complete Manual.
1.2	Description of the Works	Description of the equipment installation with reference to layout drawings and process flow diagrams. Process description and performance parameters for the Works.
1.3	Equipment List	Single list of the make, model, operating range and hazardous zoning of every item of mechanical, electrical, instrumentation and control equipment.
1.4	Drawing List	List of the Contractor's drawings.
<b>2</b>	<b>Operation</b>	
2.1	Training Manual	Basic operating instructions (5 page maximum plus Contents List, Layout drawing and Process flow diagram). Include Start-up, adjustment, operating and shut-down procedures for manual and automatic operation - Emergency operating procedures - Process verification - Settings, setpoints, protection, alarms and trips. A paper copy of this document shall be provided to each trainee.
2.2	Commissioning	Trainee attendance registers & Commissioning results.
<b>3</b>	<b>Maintenance Schedule</b>	
		Schedule of routine maintenance for all <b>mechanical, electrical, instrumentation and control</b> equipment, broken down into daily, weekly, monthly and annual periods. The schedule shall be all-inclusive but may refer to manufacturer's standard manuals in other parts of the Manual. The schedule shall include <b>all</b> lubrication periods, lubricants and capacities.
<b>4</b>	<b>Mechanical Equipment</b>	
4.1	Equipment item 1 (e.g. pumps)	<ul style="list-style-type: none"> <li>- The make, model, serial number, description, size, design range, performance data, motor and drive details and supplier's details of the item.</li> <li>- Dimensioned drawing.</li> <li>- A photograph of the nameplate.</li> <li>- Manufacturer's operating and maintenance manual.</li> <li>- Operating curves, test results, etc.</li> <li>- Specified certification; e.g. lifting and pressure equipment inspection and testing.</li> </ul>
4.2	Equipment item 2 (e.g. mixers)	ditto
4.3	etc.	ditto
<b>5</b>	<b>Electrical Equipment</b>	
5.1	Equipment item 1 (e.g. transformer)	As for 4.1 above; <b>PLUS:</b> Control and electrical details, including logic sequence, circuit diagrams and software, as applicable - Electrical reticulation drawings - Equipment overall dimensions - Wiring diagrams - Switchboard layout drawings - SLDs.
5.2	Equip. item 2 (e.g. VFCs)	ditto
5.3	etc.	ditto
<b>6</b>	<b>Instrumentation Equipment</b>	
6.1	Instrumentation Equip. Item 1 (e.g. Magflo)	As for 4.1 above; <b>PLUS:</b> Circuit diagrams of instrumentation systems and of individual instruments - Installation arrangement - Normal operating range – Pressure relief valve certificates - Calibration certificates.
6.2	Equip. Item 2 (e.g. level)	ditto
<b>7</b>	<b>Control</b>	
7.1	Identifying Information	Make and model of PLCs, transmitters, HMIs, computers, etc.; copied from the Equipment List.
7.2	I/O List	Cross-referenced listing of all I/Os used.
7.3	SCADA	Colour prints of SCADA mimic screens, control faceplates, sequences and trend screens. Schedule of alarm messages and TAG lists. File structures, lists and naming conventions.
7.4	Program	An annotated program listing. CDs containing all software. Loop and logic diagrams for each PLC. System control diagram and logic sequence chart.
7.5	Documents	Schedule of cable terminals. Copy of SCADA hardware diagnostic mimic.
<b>8</b>	<b>Documents</b>	
8.1	Drawings	As-built drawings, including GAs, MFDs, P&IDs, electrical panel construction drawings, etc. These shall also be provided electronically.
8.2	Cable Schedule	Cable schedule for power, data, control and instrumentation cables. This shall include the cable construction, conductor material, insulation, protection, voltage rating, start and finish points, route length, duty, load, voltage drop, core area, no. of cores, no. of cores used and gland size. For cable voltages above 400 Volts, the schedule shall also include the purchase details, specification and date of manufacture.
8.3	Other	Certificate of electrical compliance - Corrosion protection systems used - Coating supplier's data sheets and coating repair procedures - Protection relay settings and test certificates - List of spares provided – Pressure relief valve test certificates.

# **SPECIFICATION: ZUT 0003**

(Version: August 2014)

## **General Corrosion Protection for Pipelines, Water and Waste Water Works**

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## 1 SCOPE

This Specification covers the painting and corrosion protection of plant, equipment in pump stations and water and wastewater treatment works and pipelines exposed to environments with variable corrosive tendencies.

Interpretations and variations of this Specification are set out in the Amendments of this Specification.

## 2 NORMATIVE REFERENCES

### 2.1 SUPPORTING SPECIFICATIONS

Where this Specification is required for a project, the following specifications shall, inter alia, form part of the Contract Document:

- a) Amendments to this Specification;

Equipment, materials and operational methods shall comply with the latest edition of the relevant SANS, ISO, AS, BS, DIN or equivalent American Standard as shown in Annexure A.

## 3 DEFINITIONS AND ABBREVIATIONS

### 3.1 DEFINITIONS

In this Specification the following shall have the meaning given:

- a) **Coat:** A single uniform film of corrosion protection material applied to a substrate for corrosion protection purposes.
- b) **Layer:** A uniform protective film of corrosion protection material applied to plant, equipment and piping in a specified manner consisting out of multiple coats.
- c) **System:** A corrosion protection coating or lining consisting of multiple coats and/or layers, the type of coat, the number of coats and their thickness, the method of application and the requirements of the complete system.
- d) **Coating:** A system on the outside of plant, equipment and pipework. However, certain international specifications referred to in this specification (e.g. AWWA specifications) use the term 'coating' to refer also to internal pipe protection and where these specifications are being referred to their terminology is used.
- e) **Lining:** A system on the inside of plant, equipment and piping.
- f) **Dis-bonded area:** An area of coating or lining that initially did adhere to the steel substrate after application, but which subsequently became loose from the substrate as a result of mechanical, chemical or other action.
- g) **Un-bonded area:** An area of coating or lining which at no stage adhered to the steel substrate.
- h) **Water path:** The shortest distance along the surface of an object embedded in concrete but exposed to water measured along the concrete interface.
- i) **Holiday:** A discontinuity in a coating or lining which exhibits electrical conductivity when exposed to a specific voltage.
- j) **Abrasive blast cleaning:** The process of projecting a stream of abrasive particles at high velocity towards a surface for the purpose of removing contaminants from that surface and to produce a textured surface which will increase the surface area and thus increase adhesion of the coating.
- k) **Dry film thickness (DFT):** The thickness of a coating or lining after it is hard dry.

- 
- l) **Electrical insulation defect (EID):** Defects in a coating or lining that impair the protective properties of the coating or lining and that are detected instrumentally by either:
- i) a low-voltage, wet-sponge detector, or
  - ii) a high-voltage, sparking detector,
- operated in each case within the parameters specified.
- Note:** EID's include such defects as steel projections from the substrate, conductive particles embedded in the coatings or linings, voids and those defects commonly known as pinholes and holidays.
- m) **Fusion bonded epoxy (FBE):** A thermoset epoxy powder coat. (The powder is normally applied by electrostatic spray to a preheated surface. The powder normally melts, fuses and cures at a temperature of 220°C to 250°C.)
- n) **Inspector:** A person authorised by the Engineer to act as his representative in examining the work and materials and drawing such samples and carrying out such tests as may be necessary to ensure compliance with the specification.
- o) **Lot:** A number of similar or related items submitted for inspection at one time by the Contractor and of such size that the inspector can reasonably be expected to examine adequately in not more than one working day.
- p) **Paint:** A liquid material that, when applied as a thin film to a suitably prepared surface by an appropriate method, undergoes a physical or chemical change (or both) that converts it to a solid coating or lining bonded to the surface to which it is applied.
- q) **Pinhole:** An electric insulation defect detected by the use of a wet sponge detector (see EID).
- r) **Pot life:** The period, after the contents of the packs of a two-pack paint have been mixed together, during which the paint remains suitable for use without the addition of further solvent.
- s) **Powder coat:** A material in the form of a dry, free flowing powder that, when applied to a suitably prepared steel surface by an appropriate method, can be fused by application of heat and subsequent cooling to form a continuous coating or lining that is bonded to the surface. A powder coat is classified as thermoplastic when the applied coat may be re-melted by heating, or as thermoset when it cannot be re-melted by heat. Low or medium density polyethylene powder is thermoplastic whilst FBE is a thermoset material.
- t) **Significant surface:** The part of the article covered or to be covered by the coating or lining and for which the coating or lining is essential for serviceability and/or appearance.
- u) **Steel:** This term embraces carbon steels, 3CR12 and all grades of stainless steels.
- v) **Water break free:** A surface which, when wetted all over with plain potable water, maintains a continuously wet surface and the water does not break up into islands surrounded by unwetted surfaces.
- w) **Wet film thickness (WFT):** The thickness of a coating or lining immediately after application and before any volatile matter has evaporated.
- x) **Quality control:** The operational techniques and activities that are employed by the Contractor to sustain the required quality of a product, process or service.
- y) **SAHDGA:** South African Hot Dip Galvanisers Association.
- z) **Sa:** Followed by a number refers to a photographic illustration of the standard of blast cleaning required, as shown in ISO 8501-1
- aa) **St:** Followed by a number refers to a photographic illustration of the standard of mechanical cleaning required, as shown in ISO 8501-1.



### 3.2 ABBREVIATIONS

The following abbreviations shall have the meaning assigned to them:

µm	:	Micrometre
3CR12	:	A 12% chromium-containing corrosion resistant steel
3LPE	:	Three layer high density polyethylene
ABS	:	Acrylonitrile-butadiene-styrene
Al	:	Aluminium
CI	:	Cast iron
CS	:	Cast steel
DCA	:	Die cast aluminium
DFT	:	Dry film thickness
EID	:	Electrical insulation defect
FBE	:	Fusion-bonded Epoxy
FBP	:	Fusion-bonded Polyester
FBPE	:	Fusion-bonded Polyethylene
GRP	:	Glass fibre reinforced Polyester
HDG	:	Hot-dip galvanized
HDPE	:	High Density Polyethylene
MIO	:	Micaceous Iron Oxide
MS	:	Mild steel
PC	:	Polycarbonate
PVC	:	Polyvinylchloride
QCP	:	Quality Control Plan
SG	:	Spheroidal graphite cast iron
SS	:	Stainless steel – grades 304, 304L, 316 and 316L
UV	:	Ultra Violet
WFT	:	Wet film thickness

## 4 REQUIREMENTS

### 4.1 CONTRACTOR'S OBLIGATION

The requirements, material, surface preparation and corrosion protection systems prescribed in this Specification is regarded as a minimum requirement for the specific application. No deviation from this Specification shall be allowed without the written approval of the Engineer.

The Contractor is responsible for the design of the corrosion protection system and shall submit to the Engineer details of the material selection, surface preparation method and corrosion protection system he

intends using as part of his design, including the Manufacturer's Instructions for each product and shall only proceed with the purchase of the corrosion protection materials/paints upon receipt of conformation from the Engineer.

The Contractor shall obtain a written evidence from the chosen material manufacturer/supplier that the proposed materials, surface preparation method and corrosion protection system comply with the specified requirements and are suitable for the intended purposes under the specified Environmental Conditions (refer to Clause 4.3). The Contractor shall also obtain the Manufacturer's Instructions (refer to Clause 4.2). The written evidence and Manufacturer's Instructions shall be submitted to the Engineer for comment before commencement of the work.

In the event that no corrosion protection is specified for any Plant, equipment or pipes within the Specifications or Drawings, this Specification shall be used as a basis to agree on a corrosion protection system for the specific application.

## **4.2 MANUFACTURER'S INSTRUCTIONS**

The manufacturer's instructions shall be regarded as the recommendations supplied by the manufacturer in the form of the latest edition of printed data sheets, or given in writing on the manufacturer's letterhead.

The following details shall be made available to the Engineer and the applicator:

- Brand and type of corrosion protection material;
- Mixing and thinning instructions;
- Recommended type and quantity of solvent required for thinning during application;
- Pot life of mixed product;
- Minimum and maximum recommended dry film thickness per coat;
- Minimum and maximum recommended dry film thickness per layer;
- Recommended time intervals between coats;
- Recommended minimum and maximum steel surface temperatures during application;
- Time for complete drying and curing on applicable surfaces;
- Substrate surface preparation requirements;
- Recommended primers for substrate;
- Recommended method of coating and lining application;
- Repair procedures for damaged coatings and/or linings and field joints on pipelines;
- Toxicity if in contact with water, and
- All relevant information the Supplier wishes to submit on his product.

Verbal instructions by the manufacturer's representative will not be accepted unless confirmed in writing by the Contractor.

## **4.3 ENVIRONMENTAL CONDITIONS**

Environmental conditions shall be classified according to SANS 10120-3 HC. The corrosion protection system design and applied by the Contractor shall be suitable for the Environmental Conditions specified.

Unless otherwise specified in the Amendment of this Specification the Environmental Conditions shall be classified as follows:

- Mildly-corrosive: Dry, indoor/internal, above ground and ventilated conditions, not within 5km from the coastline or polluted industrial area. Relative humidity below 70%.
- Severely corrosive: Submerged, splash-zone, underground, very moist conditions, or within 5km from coastline or polluted industrial area, or in waste water works, or close to electrical power lines. Relative humidity above 85%.

- Medium Corrosive: All other conditions not included in the abovementioned definitions.

Notwithstanding the abovementioned information the Contractor shall satisfy himself of the environmental conditions on Site and design the final corrosion protection systems accordingly.

#### **4.4 WORKMANSHIP**

A high standard of workmanship is required. Only experienced personnel shall be used to carry out corrosion protection work. All work shall be carried out under the constant supervision of a qualified supervisor.

Similarly all repair work at Site shall be done by competent personnel under the supervision of a qualified supervisor.

#### **4.5 COMPATIBILITY OF MATERIALS**

##### **4.5.1 Design Precautions**

All equipment shall be designed to suppress corrosion in an exposed environment with special reference to galvanic corrosion.

The Contractor shall ensure that dissimilar metals or alloys alongside each other are compatible or are adequately protected if, in the galvanic series, there is more than a 0,3 volt difference in the galvanic potential.

##### **4.5.2 Galvanic Corrosion Prevention**

The Contractor shall ensure that the following steps are taken to minimise corrosion:

- (1) If dissimilar metals are used: Coat all surfaces of the whole assembly including the more noble member of the galvanic series.
- (2) If the noble member of the assembly cannot be entirely covered:
  - (a) Keep the anode/cathode ratio as large as possible in the particular component.
  - (b) Use electrical insulators between two metals. Insulation must be complete, a bolt requires a sleeve as well as washers of an insulating material.
- (3) Joints and crevices between metals shall be sealed.
- (4) Where fastening is unavoidable, the fasteners shall be more noble (cathodic) than the base material. Fasteners shall be coated where possible and/or adequately electrically insulated between fasteners and the base material.

#### **4.6 HANDLING OF CLEAN ITEMS**

After cleaning, surface shall not be contaminated in any way. Operators shall wear clean gloves and all surfaces shall be clean and free from oil, grease, grit, dirt and other contamination.

#### **4.7 MACHINED AND MATCHING SURFACES**

Mating surfaces of joints shall be coated with primer (where specified) or first coat only. The coating or lining shall be uniform in thickness and shall not interfere with the mechanical tolerances. After assembly the outside surface of the joints shall be fully coated.

#### **4.8 SPECIAL AREAS**

Areas that are inaccessible after assembly shall be prepared and fully coated with the specified system to the specified requirements before assembly. The coats shall be fully cured before assembly.

Steel edges to be welded after coating shall not be coated for a distance of 50 mm from the welding edge. The unlined strip of grit blasted surface shall be temporarily protected with a coat of (red or a different colour to the lining/coating) weldable primer between coating and/or lining application and installation.

Friction grip areas shall be left un-coated unless otherwise specified.

#### **4.9 SUPPORTS**

During coating and/or lining application, the items shall be so supported to prevent damage to the wet coatings or linings until the coatings or linings have hardened adequately. Items shall remain supported during curing, storing and handling.

#### **4.10 WATER RETENTION AREAS**

Pockets, recesses and crevices in which water and dirt may collect shall be avoided. Water retention areas shall be properly drained by holes as large as possible.

Surfaces of corrodible metals, such as the insides of tanks or hollow Specifications that cannot be protected by any method (e.g. painting or dipping), shall be avoided, or where not possible, be fully sealed against ingress of air and moisture.

#### **4.11 STRIPE COATS AND CREVICES**

All complex surfaces including metal edges, up stands, welds, bolts and nuts shall be adequately coated to ensure complete corrosion protection. Additional stripe coats shall be applied after initial priming, if required or ordered by the Engineer.

Special attention shall be given to crevices and edges to ensure complete coverage and uniform paint thickness.

#### **4.12 REPAIR OF DAMAGED COATS**

Repair procedures shall be approved by the Engineer and repairs will be subject to inspections as set out in Clause 11.2. Where the damage is extensive the particular remedial procedures for each such instance shall be agreed with the Engineer in writing.

All repairs shall comply with the requirements of the repair-product Manufacturer's Instructions. The Engineer may at his discretion request that repaired areas undergo adhesion tests.

Any damage occurring during transit from the Contractor's premises to the Site shall be the responsibility of the Contractor. The Contractor shall repair any damage occurring on Site during handling, assembly, storage, transport and erection.

A repaired area shall be tested in accordance with Sub-Clauses 5.4 and 5.9 of SANS 1217 for compliance with the relevant requirements for thickness and electrical insulation defects respectively.

Any item showing electrical insulation defects exceeding an average of five per square metre (a cluster of pinholes within a radius of 25 mm being regarded as a single defective area), or flaking or other signs of loss of adhesion, shall not be repaired. The item shall be blast cleaned and re-coated in accordance with the relevant requirements of this Specification.

Paint surfaces which become streaky because paint has run, will be rejected.

Touching up of damage to the final paint coat will NOT be permitted. If final paint coat is damaged the item shall completely repainted with the finishing coat in accordance with the specifications.

##### **4.12.1 Repair Methods for Minor Defects**

The repair of areas showing electrical insulation defects or low film thickness shall, if approved by the Engineer, be carried out as follows:

- Degrease in accordance with Clause 7.4.1.
- Thoroughly abrade the area, including an adjacent surrounding area of at least 25 mm wide, with a medium grade 220 abrasive paper.

- Vacuum-clean the surface to remove dust and debris in accordance with Clause 7.2 to achieve a dust quantity rating 1 and a dust size class 0 in terms of ISO 8502-3.
- Wipe the abraded paint surface with methyl ethyl ketone and allow to dry.
- Apply as many coats of repair material as necessary to achieve the specified electrical insulation thickness and finish as to conform to the adjoining corrosion protection system's requirements.
- Apply a final top coat over the repaired area to achieve a pleasing, uniform finish of the item.

#### **4.12.2 Repair Methods for Major Defects**

The repair of areas showing damage down to the steel surface shall, if approved by the Engineer, be carried out as follows:

- Degrease in accordance with Clause 7.4.1.
- Blast-clean area to Sa 3 (ISO 8501-1).
- Feather the surrounding paint for a distance of 25 mm beyond the damaged areas with a medium grade 220 abrasive paper.
- Vacuum-clean the surface to remove dust and debris in accordance with Clause to achieve a dust quantity rating 1 and a dust size class 0 in terms of ISO 8502-3.
- Wipe only the abraded paint surface with methyl ethyl ketone and allow to dry.
- Apply as many coats of repair material as necessary to conform to the specified adjoining corrosion protection system's requirements.
- Apply a final top coat over the repaired area to achieve a pleasing, uniform finish of the item.

#### **4.13 QUALITY CONTROL**

This clause and its sub-clauses shall be read in conjunction with Specification AUR 0005 - Quality Control.

##### **4.13.1 Submission for approval**

The Contractor shall submit the following to the Engineer, including data sheets where applicable, for approval:

###### **4.13.1.1 Corrosion Protection**

- A programme;
- The Quality Control Plan (QCP) for corrosion protection indicating hold points;
- Process Method Statement;
- Blast material;
- Proposed corrosion protection systems; and
- Proposed pickling and passivating products.

###### **4.13.1.2 Manufacture and Corrosion Protection Programmes**

The manufacture and corrosion protection programmes shall state the time and place when the following will be conducted:

- Inspection of material;
- Hydrostatic testing of uncoated castings, pipes and fittings;
- Manufacture of components;
- Fettling or dressing;
- Degreasing;

- Water soluble salts test;
- Blast cleaning and application of the first coat;
- Application of intermediate and final coats; and
- The commencement of Site repairs.

#### 4.14 HEALTH & SAFETY REQUIREMENTS

##### 4.14.1 Control of Major Classes of Risk

- (1) Health risks, these include:
  - (a) Gases/vapours;
  - (b) Volatile liquids in the paint; and
  - (c) Powders/dust.
- (2) Fire or explosion risks, these include:
  - (a) Fire risk during storage/transport; and
  - (b) Explosion hazard during application.

##### 4.14.2 General Aspects of Explosion Hazards

The essential precaution to be taken is, inter alia that sufficient ventilation air shall be provided to maintain the ratio of vapour/air to no more than 10% of the lower explosive limit.

##### 4.14.3 General Aspects of Toxic Hazard

Measures shall be taken by the Contractor to ensure that the following are prevented:

- Inhalation of dust/fumes;
- Skin contact with paint;
- Ingestion of paint; and
- Eye contact/penetration of paint.

Operators shall be provided with the necessary Personal Protective Equipment (PPE), such as masks/hoods, barrier creams and protective clothing to minimize the chances of the above occurring.

Emergency procedure shall be in place and First Aid kit provided to deal adequately with any of the above occurrences.

The Contractor shall ensure that in terms of Clause 6(2) of the Construction Regulations of the OH&S Act 85 of 1993, an assistant construction supervisor is specifically appointed for the application or repairs of linings inside enclosed or semi-enclosed areas e.g. pipe linings, prior to the execution of any such work.

#### 4.15 SPECIFIC REQUIREMENTS FOR PIPES AND SPECIALS

##### 4.15.1 Cut Back of Coated Pipes

The blast cleaned surface shall be stopped off or cut back by suitable masking which shall not contaminate the cleaned surface. Cut-backs shall comply with the requirements as set out in Table 4.1 below:

*Table 4.1: Cut-back of Coatings*

PIPE END	CUT-BACK (mm)	COMMENT
----------	------------------	---------

<b>Pipe ends prepared for field butt welding</b>	100	All coatings to be mitred or feathered to prevent air entrapment in the joint coating system
<b>Pipe ends prepared for flexible joint couplings</b>	Various	The coating shall be cut back a sufficient distance to accommodate a standard coupling for the particular diameter of pipe
<b>“Bell and spigot” pipe ends prepared for first welding</b>	100	The cut back shall be measured from either side of the (field) external fillet weld position when the spigot is fully inserted into the “bell”

#### 4.15.1.1 Protection of Pipe Ends on Pipes with Cut-Back

Before delivery cut backs of each pipe for field welds shall be coated with an approved rust inhibitor. This inhibitor shall provide corrosion protection for up to 6 months and shall enable good cutting and welding properties (Sigmaweld 120, Plascon etching primer or equivalent approved). Plain ended pipes (to be joined by flexible couplings) are to be coated with an approved rust inhibitor for a distance of 100mm from the pipe ends on the inside and the outside of each pipe. Careful attention must be paid to ensuring the pipe ends are also completely covered. The inhibitor used must be compatible with both the lining and the coating.

#### 4.15.2 Pipe Ends

##### 4.15.2.1 Extension of Lining

For flanged pipes or specials and pipes or specials intended for joining with flexible couplings or for Site welding by means of double sleeve weld-on couplings, the lining shall extend to the ends of pipes and specials including edges and shall overlap by at least 300 mm on the outside of the pipe. Coatings shall overlap surfaces on the outside by at least 25 mm.

##### 4.15.2.2 Butt Weld Edges

For pipes and specials intended for Site butt-welding, lining and coating shall extend up to a distance of 50 mm from pipe ends. The unlined circumferential strip of grit blasted surface shall be temporarily protected between the Works and Site with a coat of weldable primer (of a different colour to the lining/coating).

#### 4.15.3 Field Joints

No welding whatsoever shall be performed on any pipe or special on which the lining or coating has been completed, unless otherwise approved by the Engineer in writing.

The materials used for the repairs to field joints, linings and coatings shall be the same as that used for the pipes, unless otherwise approved by the Engineer in writing.

The linings and coatings of butt welded steel pipes or continuously welded steel cylinder type prestressed concrete pipes, shall be made continuous over joints as soon as possible after approval and acceptance by the Engineer of the welded joint. At no time shall field joints, lining and coating repairs/remedial work lag more than 250 metres behind the last pipe laid.

Flexible couplings shall be provided with external protection as soon as the pipeline has been hydrostatically tested and electrically bonded, where applicable.

#### 4.15.4 Supports

When pipes are installed or mounted on concrete supports, rubber insertion shall be used to insulate the pipe from the support. The thickness of the rubber insertion shall not be less than 10 mm and protrude not less than 20 mm all round.

#### **4.15.5 Sealing**

Pipes that enter or exit concrete shall be sealed on their circumference with a continuous polyurethane or polysulphide flexible sealer, in a 25 mm square recess.

#### **4.15.6 Spare Pipes**

Corrosion protection of spare pipes shall where applicable be supplied with a top coat of Re-coatable Polyurethane to a DFT of 30 – 50 µm, colour white or silver, for storage and above ground installation.



## 5 MATERIALS

The material requirements for each corrosion protection system is specified in the relevant clauses of Clause 10 and shall be read in conjunction with this clause.

### 5.1 GENERAL

All materials in a corrosion protection system shall be purchased from the same manufacturer unless approved by the Engineer.

Materials offered and subsequently approved shall not be changed without written approval of the Engineer.

All corrosion protection materials shall be delivered in the manufacturer's original containers clearly marked with the following:

- Manufacturer's name;
- Product Brand and Reference Number;
- Batch Number which may incorporate the date of manufacture;
- Abbreviated instructions for storage and use of material, which shall include mixing ratios of the components of multi-component materials, minimum and maximum temperature of application and the method of application; and
- The SANS mark where applicable.

Any conflict between the manufacturer's data sheet and the specification shall be referred to the Engineer for adjudication.

### 5.2 TOXICITY OF LINING MATERIAL

Materials used for the lining of equipment that will be in contact with water shall be non-toxic and shall not impart any odour, taste, or colour to the water.

### 5.3 STORAGE

All corrosion protection materials shall be kept in an approved dry and enclosed store. The temperature shall not drop below 0°C nor exceed 40°C.

Usage of materials shall be on a first in, first out basis and no materials shall be used that have exceeded the shelf life recommended by the manufacturer.

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## **6 CONTRACTOR'S EQUIPMENT**

### **6.1 HANDLING AND TRANSPORTATION**

The plant and equipment used by the Contractor for handling of pipes, valves, pumps and other equipment, for the purpose of corrosion protection shall be such that no pipe shell, valve or pump casing or any other piece of equipment is over stressed during any operations covered by this Specification.

### **6.2 SURFACE PREPARATION EQUIPMENT**

The Contractor shall provide all the equipment required for abrasive blast cleaning, preparation and cleaning of all surfaces to be coated.

### **6.3 COMPRESSOR**

Compressors used for abrasive blast cleaning shall be fitted with an after cooler and oil and water traps such that the air delivered at the nozzle is completely free from oil and water. The volume displacement of the compressors shall be adequate for the number and bore of blast nozzles, the spray equipment and flame spray equipment that may be necessary to carry out the specified coating operations.

### **6.4 APPLICATION EQUIPMENT**

The Contractor shall provide all the equipment required for airless spray painting, two component hot airless spray painting, electrostatic powder coating, fluidised bed powder coating, or any other approved method of applying the corrosion protection system in the shop or required for site application and repairs to coats. All equipment shall be thoroughly cleaned on completion of each day's work and maintained in clean working order.

### **6.5 INSPECTION OF EQUIPMENT**

All facilities and equipment shall be subject to inspection by the Engineer or the independent inspectorate and defects in the equipment shall be rectified when so required.

### **6.6 INSPECTION EQUIPMENT**

The Contractor shall supply all facilities and equipment for inspecting and testing the specified preparation and corrosion protection of all items supplied under the Contract. Recent calibration certificates shall be available for all equipment requiring calibration. This equipment shall be made available to the Engineer or his independent inspectorate for the purpose of testing the specified corrosion protection systems and verifying the accuracy of the test equipment.

## 7 PREPARATION OF SURFACES TO BE COATED

The surfaces of all items to be coated and/or lined, irrespective of the corrosion protection system used, shall be prepared in accordance with the relevant following requirements.

### 7.1 STANDARDS

Reference is made to the latest issues of the following Standards:

<b>SANS 1344</b>	Medium duty solvent detergent.
<b>SANS 10064</b>	The preparation of steel surfaces for coating.
<b>ISO 8501-1</b>	Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of un-coated steel substrates and of steel substrates after overall removal of previous coatings.
<b>ISO 8502-3</b>	Preparation of steel substrates before application of paint and related products - Tests for the assessment of surface cleanliness Part 3: Assessment of dust on steel surfaces prepared for painting (pressure-sensitive tape method)
<b>ISO 8504-2</b>	Preparation of steel substrates before application of paints and related products – Surface preparation methods – Part 2: Abrasive blast cleaning.
<b>SANS 5770</b>	Cleanliness of blast-cleaned steel surfaces for painting (freedom of soluble salts).
<b>SANS 5772</b>	Profile of blast-cleaned steel surfaces for painting (profile gauge).
<b>ISO 11125</b>	Preparation of steel substrates before application of paints – Metallic blast-cleaning abrasives.
<b>ISO 11127</b>	Preparation of steel substrates before application of paints – Non-metallic blast-cleaning abrasives.

### 7.2 SURFACE CONDITION

Before surface preparation all items to receive a coating or lining shall be in rust condition A to C of ISO 8501-1. Items in rust condition D will be rejected.

Prepared surfaces shall conform to Table 7.1 below. If only surface cleanliness to ISO 8501-1 is specified in the Specifications then the corresponding values of Table 7.1 for degreasing, surface profile and soluble salts shall apply.

Table 7.1: Surface Condition

Cleanliness to ISO 8501-1 (min)	Sa 3	Sa 2½	St 2
Residual dust quantity rating and size class (ISO 8502-3)	1 / 0	1 / 1	1 / 1
Oil, grease and perspiration	Nil	Nil	Nil
Surface Profile(min)	30 µm	30 µm	n/a
Layers up to 200 µm (max)	50 µm	50 µm	
Surface Profile (min)	50 µm	50 µm	n/a

Cleanliness to ISO 8501-1 (min)	Sa 3	Sa 2½	St 2
Layers > 200 and up to 300 µm (max)	80 µm	80 µm	
Surface Profile (min)	60 µm	60 µm	n/a
Layers > 300 and up to 500 µm (max)	100 µm	100 µm	

**Water soluble salts:**

Maximum at any point.	100 mg/m <sup>2</sup>	400 mg/m <sup>2</sup>	500 mg/m <sup>2</sup>
Average of any 250 cm of Pipe length.	100 mg/m <sup>2</sup>	100 mg/m <sup>2</sup>	100 mg/m <sup>2</sup>

*Note: The maximum surface profile shall be less than 1/3 of the coat thickness.*

Unless otherwise specified in the Amendments to this Specifications the surface condition shall conform to the following requirements:

- Sa 3 for the environmental condition classified as severely corrosive,
- St 2 for Tape Wrapping, and
- for all other environmental conditions the surface condition shall be Sa 2½.

### 7.3 PREPARATION OF ITEMS

Prior to the application of any coat, each item shall comply with the following:

- Weld splatter shall have been removed by chipping or grinding to a smooth surface flush with the surrounding steel.
- Weld seams shall have a smooth contour, free from sharp edges, protrusions and undercuts.
- Sharp edges and protrusions shall have been removed by grinding to a smooth radius. The radius shall be a minimum of 3 mm for steel of thickness 6 mm or greater, or a minimum of 50% of the steel thickness for steel of thickness less than 6 mm.
- Laminations, scabs or occluded scale shall be ground out. If such grinding penetrates deeper than 3.5% of the metal thickness, the area shall be repaired by welding or the metal shall be rejected at the discretion of the Engineer.
- Articles for hot-dip galvanizing shall not have any overlapping joints. Closed sections shall be suitably vented.

### 7.4 CLEANING OF ITEMS

#### 7.4.1 Degreasing

All surfaces to be coated shall be tested for oil and grease contamination by the water break free test.

In the event that degreasing is required, items shall be degreased by the use of a water based solvent degreaser such as that complying with SANS 1344 or, for use in enclosed systems, with SANS 1365.

Items shall be thoroughly washed with clean potable water to remove all residues. The items shall then be allowed to dry. The washed surfaces shall be tested after degreasing to show that no oil, grease and chemical contamination are present.

Care shall be taken to avoid entrapment of cleaning agents in recesses or other retention areas.

#### **7.4.2 Blast Cleaning**

Blast-cleaning shall be done in accordance with the code of practice SANS 10064. Any abrasive used for blast cleaning shall be composed of clean, non-recycled, sound hard particles free from foreign substances such as dirt, oil, grease, toxic substances, organic matter, water soluble salts and foreign metals.

The surface of the items to be coated or lined shall be blast cleaned by centrifugal or air blast cleaning methods, then vacuum cleaned or blown off to achieve the following requirements:

- The surface condition shall be in accordance with ISO 8501-1 as stipulated in Clause 4.2 and specified in the Amendments and Additions of the Specification, when tested in accordance with SANS 5772.
- Any laminations revealed by blast cleaning shall be ground out and re-blast cleaned to meet the above requirements. If grinding penetrates the steel to a depth greater than 3.5% of the nominal wall thickness, the item will be rejected.
- The time interval between abrasive blast cleaning and paint application shall not exceed those given in Clause 9.2.6.2.

#### **7.4.3 Mechanical Surface Preparation**

Cleaning by hand or by means of power tools (e.g. wire brushing) shall be carried out in accordance with the methods described in SANS 10064 to the standards specified in the Amendments of this Specifications and as shown in ISO 8501-1 and Clause 7.2.

### **7.5 PICKLING AND PASSIVATION**

Where specified the following areas shall be pickled and passivated:

- All un-coated areas;
- Ground and sheared edges; and
- Heat affected zones caused by welding or cutting.

Where possible, pickling and passivation shall be done by the dipping process.

Proprietary pickling and passivation chemicals (as supplied by approved suppliers) shall only be used in accordance with the manufacturer's recommendations. Pickling formulations made up of 15 to 20% nitric acid (HNO<sub>3</sub>) and 1 to 2% hydrofluoric acid (HF) by volume with potable water are considered suitable. Care shall be taken not to exceed the maximum contact time recommended.

After pickling and passivation, surfaces shall be very thoroughly washed with clean potable water to remove all traces of acid. Repeat the process, if necessary to remove all discolouration. Surfaces shall be allowed to dry, then polished where necessary, using polishing compounds recommended by the stainless steel manufacturer.

## **8 SURFACE PREPARATION METHODS**

The requirements as specified below shall be read in conjunction with the requirements of Clause 7: Preparation of Surfaces to be Coated. Each preparation method specified below shall also conform to the relevant requirements of Clause 7 and its sub-clauses. Where in conflict with Clause 7 and its sub-clauses the requirements hereunder shall take precedence.

Unless otherwise specified in the Amendments of this Specifications and subject to the approval of the Engineer, the surfaces of all items to be coated and/or lined shall be prepared in accordance with one or more of the following methods.

### **8.1 MILD STEEL**

Components manufactured from mild steel shall be degreased and blast clean before the corrosion protection system is applied. Oil and grease contamination, when present, shall be removed to a water break free surface by degreasing (Refer to Clause 7.4.1) before blast cleaning (refer to Clause 7.4.2).

Steel items less than 2 mm thick may distort when blast cleaned. Sheet steel items less than 2 mm in thickness shall be degreased, acid pickled and phosphated with an approved proprietary 7 or 9 stage process to produce a fine grain zinc phosphate surface complying with SANS 10064 Table 1 Lightweight or by a proprietary process approved by the Engineer for the standard of cleaning specified.

All surfaces of steel 2 mm or more in thickness shall be abrasive blast cleaned in accordance with SANS 10064 Section 5.3 and cleaned to achieve the requirements given in Table 4.1 for the standard of abrasive blast cleaning specified.

### **8.2 CAST IRON AND CAST ALLOYS**

Cast iron shall be abrasive blast cleaned until all sand particles, residual burnt-on sand and casting skin have been completely removed. Cast iron surfaces shall be abrasive blast cleaned in accordance with SANS 10064 Section 5.3 to achieve the requirements given in Clause 7.2 for the standard of abrasive blast cleaning specified.

Blowholes and omegas in cast surfaces shall be opened up where necessary and filled with a two component solvent free epoxy filler. When the filler has set hard, the surface shall be abraded to be flush with the surrounding metal.

### **8.3 STAINLESS AND CORROSION-RESISTANT STEEL**

Components manufactured from stainless or corrosion-resistant steel shall be supplied in the fully passivated condition. Sheared edges, welds or surfaces subjected to any form of heat treatment or contamination with iron or mild steel, shall be pickled and passivated in terms of Clause 7.5.

Surfaces shall thereafter be thoroughly degreased in terms of Clause 7.4.1, then rinsed with potable water to obtain a water-break-free surface.

When it is required to paint stainless steel exceeding 2 mm thickness, the surface shall be blast cleaned in accordance with the parameters given in Clause 7.2, using non-metallic abrasives such as iron slag, copper slag or platinum slag. The use of steel shot, steel grit or cast-iron grit is strictly prohibited. Any contamination with iron or mild steel is prohibited.

Where blasting is impractical, the surface shall be cleaned with detergent solution and roughened manually by the use of non-metallic abrasive pads, followed by washing with clean potable water to a water-break-free surface. If a water-break-free surface is not obtained, detergent cleaning shall be repeated until the surface is water-break-free. Allow the surface to dry before coating.

## **8.4 ALUMINIUM**

Generally, aluminium surfaces will be anodized or powder coated and will require no further treatment. Where painting is required, the aluminium surface shall be thoroughly degreased then rinsed with clean potable water. If the surface is not water break free, repeat the degreasing process until a water-break-free surface is obtained. Allow to dry completely, then apply a thin coat (8 to 13 micrometres dry film thickness) of wash primer, mixed and applied in accordance with the manufacturer's instructions. Note that the "wash primer" is an adhesion promoter and does not replace the primer specified in the paint system.

## **8.5 HOT-DIP GALVANIZED SURFACES**

Hot-dip galvanized surfaces shall be thoroughly degreased by scrubbing with water rinsable solvent degreaser, followed by thorough washing with clean, potable water. If the water breaks up into islands of non-wetted surface, the degreasing shall be repeated until a water break free surface is obtained. Small areas may be abraded with a non-metallic abrasive paper prior to painting. Large surfaces may be sweep blast cleaned, using ultra-fine abrasive (particle size 0,2 to 0,8 mm) and a nozzle pressure not exceeding 300 kPa. A uniform matt surface shall be obtained. Loss of zinc thickness shall not exceed 10 µm. Cracking and flaking of the galvanized layer is indicative of excessive blast cleaning by using too coarse abrasive or too high blast pressure. Such surfaces will be rejected. The article shall then be stripped and re-galvanized.

## **8.6 PAINTED SURFACES**

### **8.6.1 Primer Only**

Where the surface has been contaminated it shall be washed and dried to remove dust and deposits before overcoating.

The succeeding coats shall be compatible with the primer. Where the type of primer is unknown, a test patch shall be applied. There shall be not loss of adhesion or other defects of the primer or between primer and undercoat. If defects or adhesion loss occur, the primer shall be completely removed, feather blasted and replaced by a primer which is compatible with the specified system.

### **8.6.2 Recoatable Materials**

Surfaces painted with recoatable paints shall be abraded with abrasive paper grade 220 to a uniform matt finish, washed and dried to remove dust and deposits before overcoating.

### **8.6.3 Fully Cured Non-Recoatable Materials**

Surfaces painted with fully cured non-recoatable paints that have exceeded their overcoating time shall be thoroughly abraded with abrasive paper grade 220 to a uniform matt finish, washed and dried before overcoating. The edges of any damage shall be smoothly feathered into the sound paint. Repairs to damaged areas shall extend 25 mm beyond the damage.

### **8.6.4 Two Component Paints within their Overcoating Time**

Surfaces painted with two component paints where the paint is still within the overcoating time specified by the manufacturer shall be recoated without special surface preparation. Where the surface has become contaminated, it shall be cleaned.

## **8.7 PLASTIC SURFACES SUCH AS PVC AND GRP**

Where the surface has been contaminated it shall be washed and dried to remove dust and deposits before overcoating.



## 8.8 CONCRETE AND PLASTER SURFACES

Concrete and plaster surfaces to be painted shall be clean, dry and free from laitance, dust or similar friable surface layers and from mould oil or similar contaminants that will interfere with the adhesion of the coating or lining.

Mould oil shall be removed by the use of a water-based detergent followed by high pressure water washing. When all contaminants have been removed, the surface shall be allowed to dry either to a damp condition or to a completely dry condition, depending on the coating or lining to be applied.

For immersion or other heavy duty applications, laitance shall be totally removed by water blast cleaning, with abrasive injection, or by mechanical scabbling of the surface, or by acid pickling, followed by very thorough washing with potable water.

Off shutter concrete usually shows surface blowholes or omegas. Omegas shall be drilled or chipped open to the full hole diameter. Blowholes and opened omegas shall be filled with a suitable filler such as acrylic or solvent-free epoxy. The use of gypsum or cellulose-based fillers is not permitted for underwater or humid conditions. Shutter kicks and similar projections shall be removed by grinding to a smooth surface.

For coatings or linings of low water permeability, such as solvent-borne epoxies, vinyls and chlorinated rubber, the moisture content of the concrete or plaster shall be not more than an indicated 5% when tested with an approved electrical conductivity meter, designed for use on concrete or plaster (such as the Delmhorst meter). The pins of the meter shall penetrate the concrete or plaster to a depth of not less than 5 mm.

The first coat of the coating or lining system may require thinning with the manufacturer's recommended solvent to assist in penetration of the substrate.

## 9 APPLICATION OF CORROSION PROTECTION SYSTEM

All coatings and/or linings, irrespective of the surface preparation method or corrosion protection system used, shall be applied in accordance with the relevant following requirements.

### 9.1 CONDITIONS DURING APPLICATION

If in the opinion of the Engineer adverse weather conditions are such as to interfere with the successful application of an efficient corrosion protective system, he shall order a stoppage of work. The Contractor will be deemed to have accepted this risk and made provision for it in his rates.

#### 9.1.1 Dusty Conditions

Coats shall not be applied in dusty or contaminated conditions.

#### 9.1.2 Surface Temperature

Coats shall not be applied if the surface temperature of the base metal is less than 3°C above dew point or outside the range 5 - 40°C, unless otherwise recommended in the manufacturer's instructions.

#### 9.1.3 Ambient Temperature

Coats shall not be applied when the ambient temperature is less than the minimum or greater than the maximum recommended by the manufacturer's instructions of the corrosion protection material.



#### 9.1.4 Relative Humidity and Time Interval

The time interval between abrasive blast cleaning and paint application shall not exceed those given in Table 9.1

Table 9.1 - Maximum time interval - Between blast cleaning and coating

Ambient Relative Humidity	Maximum Time (hours)
Below 50%	6
50% - 70%	4
70% - 85%	2
Over 85%	Coating not permitted - Reblast and coat when rel. humidity below 85%

Should immediate lining/coating not be possible, or should any atmospheric oxidation take place between the completion of blast cleaning and commencement of lining/coating, such oxidation shall be removed by flash blasting to restore the specified surface finish.

## 9.2 PAINTS

### 9.2.1 Application method

The recommendations of the paint manufacturer as per the manufacturer's instruction (refer to Clause 4.2) as shown on his data sheets or given in writing shall be followed.

Apart from touch up, all liquid paints applied in the shop shall be applied by means of airless spray machines. Before use all paints shall be thoroughly stirred so as to be completely homogeneous. Two component paints shall be thoroughly mixed in the correct proportions as specified in the manufacturer's data sheet.

Painting on site shall be carried out to the Engineer's written approval. Significant surfaces to be painted on site shall be those specified in the Specification or shown on the drawings. Site application methods shall comply with the paint manufacturer's recommendations.

### 9.2.2 Colour

Successive coats shall have distinctively different shades to facilitate coverage of each coat. Unless otherwise specified in the Amendments to this Specification, or directed by the Engineer, the final paint colour shall be that given in Appendix B of this specification and shall be a commercial match to the appropriate colour in SANS 1091 - National Colour Standards for Paint.

### 9.2.3 Wet film thickness

The Contractor shall regularly and frequently monitor wet film thickness and shall calculate the dry film thickness from the volume solids of the paint.

### 9.2.4 Mixing

All paint components, particularly two- or multi-component materials, shall be thoroughly mixed until a homogeneous mixture is achieved.

### 9.2.5 Degree of Cure

The degree of cure of paint will vary with time, temperature and ventilation and shall be assessed by solvent wiping in accordance with the method given in SANS 1217 (Methyl Ethyl Ketone Resistance Test).

## **9.2.6 Overcoating**

### **9.2.6.1 Compatibility of Coats**

All primer, intermediate, finishing coats and layers shall be mutually compatible and recoatable paints shall be used where applicable. There shall be not loss of adhesion between the consecutive coats or other defects.

### **9.2.6.2 Overcoating intervals**

The minimum and maximum overcoating intervals provided in the manufacturer's data instructions shall be strictly observed. Times and dates of application shall be recorded for each separate item and coat in the quality control records.

Since overcoating times are frequently quoted at 20 °C or 25 °C, longer overcoating times shall be allowed at lower temperatures. As a rough guide, increase time by 50% for a 5° decrease (or by 100% for a 10° decrease) in the ambient temperature below the temperature quoted in the data sheet.

### **9.2.6.3 Thickness of Consecutive Coats**

Generally a corrosion protection system will be build-up with multiple coats. The thickness of all coats, primer, intermediate or finish coats shall be strictly according to the manufacturer's instructions. For solvent-base paints it is imperative that the applicator does not exceed the maximum film thickness per coat applied in order to prevent entrapment of the solvent and the formation of pinholes.

## **9.3 DUPLEX OR MULTI-LAYER SYSTEMS**

Duplex or Multi-layer systems consist of more than one corrosion protection system applied consecutively e.g. a Hot-Dip Galvanizing and Polyurethane system

The specifications for each of the corrosion protection systems shall be strictly followed. Special attention shall be given to adhesion between the systems.

## **9.4 FINISHING ON SITE**

Repairs, finish painting and cleaning on the site are regarded as inherent parts of the installation. On completion of erection, all pipework, control gear and indicating gear shall be thoroughly cleaned.

After erection, paint work shall be washed down, using nylon brushes and detergent to remove all adhering contamination. It shall then be washed with clean water to remove all traces of detergent and allowed to dry. The finishing coat shall then be applied as specified in the Amendments to this Specification.

All surfaces which cannot be painted after erection shall be painted as specified before erection. The painting system so applied shall be allowed to become fully hard dry (for at least two weeks for epoxy type paints) before erection.

For coatings such as epoxies, having a limited overcoating interval as specified in the manufacturer's data sheets, the surface shall be washed and thoroughly abraded to a matt finish before application of the finishing coats in accordance with the manufacturer's instructions.

## **9.5 TOLERANCES**

### **9.5.1 Individual Coats Film Thickness**

At least 90% of all thicknesses measured shall comply with the minimum thickness of the system specification. Up to 10% of all readings may be below the specific minimum thickness, but no reading shall be less than 70% of the specified minimum thickness.

#### **9.5.2 Total Dry Film Thickness**

Not more than 10% of readings shall be less than the minimum specified and no reading shall be less than 90% of the specified minimum. For severely corrosive conditions no reading shall exceed the specified thickness by greater than 60% of the minimum.

## 10 CORROSION PROTECTION SYSTEMS

The requirements as specified below shall be read in conjunction with the requirements of Clause 9: Application of Corrosion Protection Systems. Each system specified below shall also conform to the relevant requirements of Clause 9 and its sub-clauses. Where the requirements of this clause is in conflict with Clause 9 and its sub-clauses the requirements hereunder shall take precedence.

### 10.1 RECOMMENDED CORROSION PROTECTION SYSTEM

Unless otherwise specified in the Amendments to this Specification and subject to the approval by the Engineer, Plant, equipment and pipework in pump stations and water and wastewater treatment works and pipelines shall be corrosion protected with one or more of the corrosion protection systems described in the following paragraphs of this Specification.

### 10.2 SYSTEM 1: ALKYD RESIN BASED

Alkyd systems are intended for use in environments of low corrosivity, where a good decorative finish is required. Materials shall therefore be applied with due cognisance of appearance and protection. Defects such as runs, sags, curtaining, shrivelling or wrinkling will not be permitted.

#### 10.2.1 Standards

Reference is made to the latest issues of the following Standard Specifications:

SANS 630:	Decorative high gloss enamel paints.
SANS 681:	Undercoats for paints
SANS 1319:	Zinc phosphate primer for steel

#### 10.2.2 Material

Alkyd zinc phosphate primer for steel shall comply with the requirements of SANS 1319.

General purpose alkyd undercoat shall comply with the requirements of SANS 681 Type 2.

Alkyd enamel shall comply with the requirements of SANS 630.

#### 10.2.3 Surface Preparation

The substrate surface preparation shall conform to the Manufacturer's Instructions or as specified in the Amendments of this Specification as approved by the Engineer. In the event of it being omitted the surface preparation shall conform to the requirements Sa 2½ (ISO 8501-1) and the corresponding requirements as specified in Table 7.1 and the applicable Method as specified in Clause 8.

#### 10.2.4 Application

Coating thicknesses shall be at least 250 µm unless otherwise specified in the Amendments of this Specification.

#### 10.2.5 Repair of Damaged Coats

Repair procedures shall be approved by the Engineer and in Clause 4.12.

#### 10.2.6 Testing

Testing shall conform to the requirements of Clause 11 and SANS 1217.

### **10.3 SYSTEM 2: VINYL RESIN BASED**

Vinyl copolymer (PVC) paints are a single component vinyl resin-based paints have excellent resistance to water, chemicals, dilute acids and hypochlorites. Their resistance to heat is poor and they must never be used on surfaces continually subjected to a temperature of 70 °C or higher. They are not resistant to solvents and should not be used where there may be contact with oils, grease, kerosene, petrol etc.

The main advantage of vinyls is their easy maintainability. Whereas epoxies are difficult to recoat after about one month's exposure, vinyls may be recoated after any period of time.

Vinyls are recommended for use above water and for interior and exterior use where and could be subject to chemical fumes, as in chlorination rooms.

#### **10.3.1 Material**

Vinyl copolymer (PVC) paints shall have a solids content of 50% by mass and 32% by volume with a viscosity of 4,5 poise +\_ 0,5 poise. The paint shall be stabilised against UV radiation.

#### **10.3.2 Surface Preparation**

The substrate surface preparation shall conform to the Manufacturer's Instructions or as specified in the Amendments of this Specification as approved by the Engineer. In the event of it being omitted the surface preparation shall conform to the requirements Sa 2½ (ISO 8501-1) and the corresponding requirements as specified in Table 7.1.

#### **10.3.3 Application**

Coating thicknesses shall be at least 250 µm unless otherwise specified in the Amendments of this Specification.

#### **10.3.4 Repair of Damaged Coats**

Repair procedures shall be approved by the Engineer and in Clause 4.5.

#### **10.3.5 Testing**

Testing shall conform to the requirements of Clause 11 and SANS 1217.

### **10.4 SYSTEM 3: THERMAL SPRAY METAL**

Thermally sprayed metal coatings shall consist of the metal spray plus the application of a suitable sealant and a suitable coating.

#### **10.4.1 Standards**

Reference is made to the latest issues of the following Standard Specifications:

SANS 2063: Thermal spraying - Metallic and other inorganic coatings - Zinc, aluminium and their alloys

#### **10.4.2 Surface Preparation**

The substrate surface preparation shall conform to the Manufacturer's Instructions or as specified in the Amendments of this Specification as approved by the Engineer. In the event of it being omitted the surface preparation shall conform to the requirements Sa 2½ (ISO 8501-1) and the corresponding requirements as specified in Table 7.1.

#### **10.4.3 Application**

Thermally sprayed metal coatings shall consist of the metal spray plus the application of a suitable sealant and a suitable coating.

The minimum coating thickness for both aluminium and zinc shall be 150 µm. Greater thicknesses may be specified for particular applications.

Thermal spray metal paints shall be continuously agitated in a pressure pot to ensure dispersion of the zinc particles in the liquid components.

The time between surface preparation and coating shall be shortened from 4 hours to 2 hours at any application area closer than 10 km from the coast.

#### **10.4.4 Repair of Damaged Coats**

The requirements of Clause 10 shall apply.

#### **10.4.5 Testing**

The thickness shall be checked on every surface plane at points not more than 300 mm apart for small articles and 500 mm for large articles. Angles shall be checked along all 4 surfaces, channels along all 6 surfaces, pipes in 4 planes. The minus tolerance on thickness in isolated areas shall also not exceed -10 % and such low areas shall not be larger than 50 mm in diameter.

### **10.5 SYSTEM 4: POWDER COATS**

#### **10.5.1 Standards**

Reference is made to the latest issues of the following Standards:

BS 5493: Protective coating of iron and steel structures against corrosion.

#### **10.5.2 Material**

Material used shall conform to SANS 1217, Type 2, powder coating.

#### **10.5.3 Surface Preparation**

The substrate surface preparation shall conform to the Manufacturer's Instructions or as specified in the Amendments of this Specification as approved by the Engineer. In the event of it being omitted the surface preparation shall conform to the requirements Sa 2½ (ISO 8501-1) and the corresponding requirements as specified in Clause 7.2 and Table 4.1.

#### **10.5.4 Application**

##### **10.5.4.1 Coating Thicknesses**

Coating thicknesses shall be at least 250 µm unless otherwise specified in the Amendments of this Specification

##### **10.5.4.2 Coating Application**

Powder shall be applied in the shop by electrostatic spray or by fluidised bed as applicable. Items for powder coating shall after surface preparation, be pre heated to the required temperature, usually in the range 200 to 250°C, coated by electrostatic spray or by fluidised bed, then post cured if necessary to obtain complete fusion and cure. For surfaces to be immersed the applied coating shall be tested for defects by high voltage spark testing. No defects will be permitted. Thermoset materials such as FBE shall be fully cured.

#### **10.5.5 Repair of Damaged Coats**

No repairs of damaged coatings will be accepted.

#### **10.5.6 Testing**

Testing shall conform to the requirements of Clause 11 and SANS 1217.

### **10.6 SYSTEM 5: TWO PACK EPOXY**

This corrosion protection system is suitable for large steel items subject to medium corrosive and severely corrosive environmental conditions such as valves, pipes, etc.

#### **10.6.1 Standards**

Reference is made to the latest issues of the following Standard Specifications:

- SANS 1217: Internal and external organic coating protection for buried steel pipelines.  
ISO 2808: Paints and varnishes - Determination of film thickness.  
BS 5493: Protective coating of iron and steel structures against corrosion.

#### **10.6.2 Material**

The material used for two component (two pack) high build polyamide epoxies shall be based on epoxy-polyamide resins and shall comply with the requirements of SABS 1217. Epoxies shall be of the high build, modified aluminium epoxy mastic type, containing at least 90% solids.

Solvent free epoxies in accordance with SANS 1217 Type 1B is preferred. Type 1A (solvent-borne chemically cured paint material) will only be approved by the Engineer for specific application conditions.

The epoxies shall be non toxic and non tainting when it will be in contact with potable water.

#### **10.6.3 Surface Preparation**

Unless otherwise specified in the Amendments of this Specification the surface preparation shall confirm to the requirements Clause 7.2.

#### **10.6.4 Application**

##### **10.6.4.1 Dry Film Thicknesses**

Dry film thicknesses shall be at least 250 µm unless otherwise specified in the Amendments of this Specification.

##### **10.6.4.2 Mixing**

In the case of two-pack materials, each component containing pigments shall be thoroughly mixed.

The two components shall then be mixed together in the proportions supplied by the manufacturer until the mixture is completely homogeneous. For two pack materials, the use of part of the contents (split packs) is strictly forbidden.

In the case of solvent based Epoxy materials, it is recommended that the mixed material be allowed to stand for an induction period, as recommended by the manufacturer, before use.

During application, paint materials shall be agitated regularly to keep the solids in suspension.

The preparation time, induction time and pot life of these materials shall be closely adhered to.

#### 10.6.4.3 Curing

Adequate ventilation (and heating if required), shall be provided for the proper curing of the epoxy coating or lining in all circumstances with special reference remedial work, repairs and to field joints of pipelines.

#### 10.6.5 Repair of Damaged Coats

Repair procedures shall be approved by the Engineer and in terms of Clause 4.12.

#### 10.6.6 Testing

Testing shall conform to the requirements of Clause 11 and SANS 1217.

#### 10.6.7 Pipe Field Joints for Epoxy Linings

The internal corrosion protection System of welded field joints, for pipes with epoxy linings, shall be the same as that used for the adjacent pipes.

The surface preparation of the field joint area shall be the same as for the repair of major defects as specified in Clause 4.12.2.

### 10.7 SYSTEM 6: FUSION BONDED EPOXY (HEAVY DUTY)

This corrosion protection system is suitable for large steel items subject to medium corrosive and severely corrosive environmental conditions such as valves, pipes, etc.

#### 10.7.1 Standards

Reference is made to the latest issues of the following Standards:

SANS 1217: Internal and external organic coating protection for buried steel pipelines.

ISO 12944: Paints and varnishes – Corrosion protection of steel structures by protective paint systems.

#### 10.7.2 Material

Material used shall conform to SANS 1217, Type 2, powder coating.

#### 10.7.3 Surface Preparation

Unless otherwise specified in the Amendments of this Specification the surface preparation shall confirm to the requirements Clause 7.2.

#### 10.7.4 Application

##### 10.7.4.1 Dry Film Thicknesses

Dry film thicknesses shall be at least 250 µm unless otherwise specified in the Amendments of this Specification

##### 10.7.4.2 Coat Application

Items shall be heated to a temperature of 200°C (only applicable to heavy items) and coated with Fusion-bonded Epoxy by means of an electrostatic powder gun.

The normal procedures pertaining to powder application shall apply.



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On completion of the coating or lining, items shall be cured for 60 minutes at 200°C (mean temperature).

#### **10.7.5 Repair of Damaged Coats**

Repair procedures shall be approved by the Engineer and conform to the requirements of Clause 4.12. with an approved repair kit.

#### **10.7.6 Testing**

Testing shall conform to the requirements of Clause 11 and SANS 1217.

### **10.8 SYSTEM 7: HOT-DIP GALVANIZING (HEAVY DUTY)**

This corrosion protection system is suitable for steel items subject to mildly corrosive and medium corrosive environmental conditions such as handrails, covers, small diameter pipework, etc.

#### **10.8.1 Standards**

Reference is made to the latest issues of the following Standards:

SANS 32:	See EN 10240.
SANS 121:	Hot-dip galvanized coatings on fabricated iron and steel articles.
SANS 1344:	Medium duty solvent detergent.
SANS 2063:	Thermal spraying - Metallic and other inorganic coatings - Zinc, aluminium and their alloys.
SANS 5772:	Profile of blast-cleaned steel surfaces for painting.
ISO 752:	Zinc ingots.
ISO 2808:	Paints and varnishes - Determination of film thickness.
ISO 14713:	Protection against corrosion of iron and steel in structures - Zinc and aluminium coatings - Guidelines.
EN 1179:	Zinc and zinc alloys – primary zinc.
EN 10240:	Internal and/or external protective coatings for steel tubes - Specification for hot dip galvanized coatings applied in automatic Plants

#### **10.8.2 Material**

Impurities in the molten zinc, as defined in ISO 752 and EN 1179, shall not exceed a total of 1.5%.

Steel to be hot-dip galvanized shall be as listed below. In both cases material certification shall be supplied:

- For aesthetic appearance:
  - Aluminium killed steel, or
  - Silicon-killed steel with a Silicon content not exceeding 0.04% and a Phosphorus content not exceeding 0.02%.
- For general corrosion protection:
  - Aluminium killed steel, or
  - Silicon killed steel with a Silicon content not exceeding 0.25% and a Phosphorus content not exceeding 0.02%.

The condition of articles to be hot-dip galvanized shall comply with Clause 7.3 of SANS 121.

The condition of tubes to be hot-dip galvanized on a continuous line shall comply with “Annexure A” of EN 10240.

### 10.8.3 Surface Preparation

Unless otherwise specified in the Amendments of this Specification the surface preparation shall confirm to the requirements Clause 7.2.

### 10.8.4 Application

Galvanizing shall only be done by members of the Hot Dip Galvanizers Association of Southern Africa (HDGASA) in accordance with SANS 121 and EN 10240.

The coating of lining thickness shall comply with the values specified for General Applications or Heavy Duty Applications as specified in this Specification.

Galvanized surfaces which are to be painted shall NOT be passivated by the galvanizer.

### 10.8.5 Special Requirements

#### 10.8.5.1 Steel Specials

##### (1) Surface

Surfaces shall be free from nodules, blisters, roughness and sharp points. Un-coated areas, flux residues, lumps and zinc ash will not be permitted.

Notwithstanding Clause 6.1 of SANS 121, in the case of handrails etc. a high quality surface finish is required and a bright smooth surface shall be achieved. Double dipping shall not be allowed.

##### (2) Thickness

The thickness of hot-dip galvanizing shall comply with the requirements of the Table 10.1 below.

*Table 10.1: System 7 - Minimum Coat Thickness on Items that are not Centrifuged*

ARTICLES AND ITS THICKNESS	HEAVY DUTY	LIGHT DUTY	
	Thickness μm (min)	Local Thickness μm (min)	Mean Thickness μm (min)
Steel ≥ 6 mm	105	70	85
3.0 mm ≤ Steel < 6.0 mm	80	55	70
1.5 mm ≤ Steel < 3.0 mm	65	45	55
Steel < 1.5 mm	55	35	45
Castings ≥ 6.0 mm	105	70	80
Castings < 6.0 mm	-	60	70

Heavy duty coats are required except in the following cases:

- Where a high surface finish is required; and
- Where otherwise specified in the Amendments of this Specification.

#### 10.8.5.2 Steel Tubes

Steel tubes shall be in accordance with Clause 7 of EN 10240.

##### (3) Surface

The surface of the coat shall be continuous, smooth and free from flux residues.

(4) Thickness

The thickness shall comply with the requirements of the coat quality A1, in accordance with Clause 8, Table 1 of EN 10240, as specified below.

*Table 10.2: System 7 - Minimum Local Coat Thickness Requirements for Coat Quality A1*

REQUIREMENTS	QUALITY A1
Minimum local coat thickness on the inside surface except at the weld bead	55 µm
Minimum local coat thickness on the inside surface at the weld bead	28 µm
Minimum local coat thickness on the outside surface	55 µm

(5) Adhesion

The coat shall show no evidence of flaking or cracking when tested in accordance with Clause 11.4 of EN 10240.

(6) Qualities

Coat qualities shall be A1 for water installations – see Sub-Clause 8.2 of EN 10240.

The surface of the coat on the inside shall be as smooth as can be achieved by steam blowing.

### 10.8.6 Testing

This clause and its sub-clauses shall be read in conjunction with Clause 4.13 and Clause 11.1 of this Specification.

#### 10.8.6.1 Steel Items

(7) Visual Examination

Where a superior aesthetic appearance of hot-dip galvanizing is requested, a bright mirror surface finish shall be achieved by the galvanizer.

(8) Thickness

Thicknesses shall be in accordance with Clause 10.8.5 and shall be tested in accordance with Sub-Clause 6.2 of SANS 121.

#### 10.8.6.2 Steel Tubes

(9) Visual Examination

Where a superior aesthetic appearance of hot-dip galvanizing is requested, a bright mirror surface finish shall be achieved by the galvanizer.

(10) Thickness

Shall be tested in accordance with Sub-Clause 11.3 of EN 10240 (SANS 32).

(11) Adhesion

Shall be tested in accordance with Sub-Clause 11.4 of EN 10240 (SANS 32).

#### 10.8.6.3 Chemical Analysis

Items shall be tested in accordance with Sub-Clause 11.5 of EN 10240 (SANS 32).

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### 10.8.7 Repair of Damaged Coats

#### 10.8.7.1 General

Repairs to damaged galvanizing shall be carried out in accordance with the procedures specified in SANS 121 by hot metallic zinc spraying unless the use of an appropriate solder is approved. Conventional solder shall NOT be used. Solder composition shall have been approved in writing by the SANS (Metallurgy Division) or by the SAHDGA.

#### 10.8.7.2 Steel Items

The total un-coated areas for renovation by the galvanizer shall not exceed 0.5% of the total surface area of a component. Each un-coated area for renovation shall not exceed 400 mm<sup>2</sup>. If un-coated areas are larger, the item containing such areas shall be re-galvanized.

The repair method shall be approved by the Engineer before repairs are initiated.

Repairs shall be by zinc thermal spray in accordance with SANS 2063 or three component zinc solvent free Epoxy repair system. The repair shall include removal of any scale, cleaning and any necessary pre-treatment to ensure adhesion – refer to Clause 7

The coat thickness on the renovated areas shall be a minimum of 30 µm more than the local coat thickness specified in Clause 10.8.5 for the relevant hot-dip galvanized coat unless otherwise specified by the Engineer. The coat on the renovated areas shall be capable of giving sacrificial protection to the steel to which it is applied.

#### 10.8.7.3 Steel Tubes

Repairs shall not be allowed on internal surfaces of tubes. Where repairs are required, tubes shall be re-galvanized. Repairs on external surfaces shall be in accordance with Clause 10.8.7.1.

### 10.9 SYSTEM 8: ELASTOPLASTIC POLYURETHANE

This part of the Specification applies to two component solvent free elastoplastic polyurethane. This system shall only be used in limited approved applications.

#### 10.9.1 Standards

Reference is made to the latest issues of the following Standards:

SANS1217: Internal and external organic coating protection for buried steel pipelines.

#### 10.9.2 Material

The paint material shall be a solvent free two-component polyurethane hybrid based on a polyester type polyol and aromatic isocyanate. The cured paint shall comply with the following requirements:

- Tensile strength at 3 mm thickness - ASTM D638 - not less than 15 MPa.
- Adhesion to primed steel - SANS Method 776 - not less than 10 MPa.
- Impact resistance (direct) - ASTM G14 - not less than 9 Joules.
- Dielectric Strength - not less than 10 kV/mm.
- Elongation at break - not less than 25%.
- Compressibility - not less than 25 MPa.
- Surface hardness of 5 mm thick sample - not less than 60 nor greater than 80 Shore 'D'.
- Water Vapour Permeability - not greater than 0.5 g/24 h/m<sup>2</sup>/mm<sup>2</sup>.

- Cathodic disbonding - when tested in accordance with ASTM G8 Method A, for 60 days, the dis-bonded area shall not exceed 500 mm<sup>2</sup>.

#### 10.9.2.1 Adhesive

Adhesive shall be a two component polyurethane adhesive designed to maximise adhesion between used polyurethane and freshly mixed polyurethane.

### 10.9.3 Application

#### 10.9.3.1 Dry Film Thicknesses

Dry film thicknesses shall be at least as follows unless otherwise specified in the Amendments of this Specification

- Overcoating as duplex system
  - The dry film thickness shall be 40 µm minimum.
- For corrosive/abrasive environmental conditions:
  - The dry film thickness shall be 1.0 mm minimum.
- For highly corrosive/abrasive environmental conditions:
  - The dry film thickness shall be 3.0 mm minimum.

### 10.9.4 Repair of Damaged Coats

Repair procedures shall be approved by the Engineer and conform to the requirements of Clause 4.12.

### 10.9.5 Testing

Testing shall conform to the requirements of Clause 11 and SANS 1217.

## 10.10 SYSTEM 9: TAPE WRAPPING

The tape wrapping system is intended to be used in areas where special protection is required due to handling of items e.g. pipelines at road crossings etc. or where it is highly likely that the paint system can be damaged e.g. at specials and addition precaution is required to protect the pipeline. It is also often used to repair field joints of pipelines. It is suitable for severely corrosive environments.

### 10.10.1 Standards

Reference is made to the latest issues of the following Standards:

SANS 1117: Plastic wrappings for the protection of steel pipelines.

SANS 10129: Plastics tape wrapping of steel pipelines.

### 10.10.2 Material

Polyethylene pressure-sensitive tape or polyethylene laminated to an elastomeric layer of butyl rubber tapes shall conform to SANS 1117, types A, B or C.

### 10.10.3 Application

#### 10.10.3.1 General

Steel pipes, fittings and specials, protected by means of tapes, shall be wrapped in accordance with SANS 10129 as amended and supplemented by this Specification. All pipes shall be wrapped outside the trench in accordance with acceptable factory applications. Tape wrapping may be carried out in an "over the trench" operation for pipe diameters up to 450 mm.

#### 10.10.3.2 Surface Preparation

Steel pipe surface preparation shall conform to Clause 3.2 of SANS 10129.

#### 10.10.3.3 Priming

Immediately after surface preparation but not later than 4 hours after cleaning, provided the pipe surfaces are kept dry and free from dust, a primer shall be applied according to Clause 4.2.1 of SANS 10129.

#### 10.10.3.4 Normal Wrapping

Tape wrapping shall be applied with sufficient pre-tensioning immediately after priming, in accordance with Clause 4.2.2 of SANS 10129, and shall ensure a smooth wrap free from wrinkles, blisters, frayed or torn edges, cracks or other defects at temperatures up to 65°C.

For normal wrapping, tape shall be applied in two layers with a minimum overlap of 50 mm on both the inner and outer wraps.

Tape joints and repairs shall be done in accordance with Clause 4.2.3 of SANS 10129.

Hand wrapping shall only be allowed for short lengths that are inaccessible to a wrapping machine, specials, joints, small diameter pipes and small repairs – refer Clause 10.10.6

#### 10.10.3.5 Armouring

Where armour wrapping is specified, two layers of tape wrapping shall first be applied with sufficient pre-tensioning immediately after priming, in accordance with Clause 4.2.2 of SANS 10129, and shall ensure a smooth wrap free from wrinkles, blisters, frayed or torn edges, cracks or other defects even at temperatures up to 65°C.

The first layer of wrap shall overlap by half the tape width plus 25 mm and the second wrap shall overlap by not less than 50 mm.

The above-mentioned layers of tape shall be armoured by the application of a third layer of pressure-sensitive polyethylene tape with a carrier thickness of 750 micrometres and a minimum overlap of 50%.

Armoured wrappings shall generally be applied at the following positions:

- All road crossings through sleeves and culverts;
- All railway crossings through sleeves or culverts; and
- Wherever the Engineer may consider that special conditions warrant such measures.

#### 10.10.3.6 Wrapping of Specials

In the case of specials or pipe lengths where length and/or shape preclude the application of a protective wrapping system by any means, the protection shall be carried out either by bitumen-fibre glass or epoxy corrosion protection system in accordance with the requirements of the applicable corrosion protection system. In the case of access, scour, air valve and farmers off-take tees the special shall be deemed to incorporate at least two (2) diameter lengths either side of the main tee barrel.

#### 10.10.3.7 Armour Wrapping of Coated Pipes

Where armour wrapping of coated pipes is specified, a single layer of pressure-sensitive polyethylene tape with a carrier thickness of 750 micrometres and a minimum overlap of 50% shall be applied.

#### 10.10.4 Tolerances

##### 10.10.4.1 Pressure Sensitive Tape Wrapping

The minimum thickness of the inner low-density polyethylene tape carrier component shall be 300  $\mu\text{m}$  and the maximum thickness of the outer high-density tape carrier shall be 1000  $\mu\text{m}$ . Total minimum polyethylene thickness of 1450  $\mu\text{m}$ .

The adhesive part of the inner layer shall be a minimum thickness of 1.5 times the polyethylene tape carrier thickness. For the outer layer the adhesive layer shall be at least equal to the thickness of the polyethylene tape carrier thickness.

##### 10.10.4.2 Butyl Rubber Laminates

The minimum thickness of the completed wrapping shall be 750  $\mu\text{m}$ . The inner layer shall be a butyl rubber laminate of 450  $\mu\text{m}$  minimum thickness of which the butyl rubber film shall not be less than 200  $\mu\text{m}$  thick and the polyethylene film shall not be less than 200  $\mu\text{m}$  thick.

The outer layer shall be high density pressure tape of 300  $\mu\text{m}$  minimum thickness.

#### 10.10.5 Testing

This clause and its sub-clauses shall be read in conjunction with Clause 4.13 and Clause 11.1 of this Specification.

##### 10.10.5.1 Visual Inspection

The wrapping shall have a smooth appearance, free from wrinkles, blisters, bridging across weld beads, frayed edges, cracks, dis-bonding and any signs of physical damage.

##### 10.10.5.2 Non-Destructive Testing

###### (12) Electrical Insulation Defect (Holiday) Testing

The entire wrapping of the pipeline shall be tested to ASTM G62 with an approved Holiday Detector equipped with a rolling ring detector around the pipe by the Contractor to the Engineer's satisfaction. The ring shall be in close contact with the surface of the wrapping along the pipe circumference. The test shall be carried out immediately prior to lowering the pipe into the trench. The wrapping on specials or short pipe lengths shall be tested with an approved Holiday Detector fitted with a copper bristle brush detector of suitable form. The wrapping shall exhibit no Holidays when tested with an effective voltage of 12 kV at a nominal pulse frequency of not less than 30 Hz.

The Engineer may instruct any length of pipe or any number of specials to be re-tested using a Holiday Detector with a copper bristle brush detector.

###### (13) Insulation Test

The Engineer shall carry out a conductance test on the wrapping over any section of pipeline between valves when the pipeline has been wrapped and installed in the trench with padding and back filling completed. The test shall be conducted as per NACE TM0102 with the valves temporarily removed from the line, at the Contractor's expense, to ensure complete isolation of the pipeline section under test or between gaps left for tie-ins.



The length of the section of pipeline under test shall be carefully measured and the conductance over the section tested shall not exceed 180 micro-Siemens per square metre of pipe surface under all conditions of test. If the results of the test for the section of pipeline tested are not satisfactory, two sections immediately adjacent to the testing section will be tested. If the results on one or both of these sections tested are not satisfactory, all sections of wrapped pipeline shall be tested.

#### 10.10.5.3 Destructive Testing

The Engineer may from time to time collect samples of 10 m of each type of tape and one litre of primer for testing, for compliance with the Specification, by any independent laboratory appointed by the Engineer. The supply of samples shall be for the Contractor's account. The Engineer reserves the right to reject the whole batch of materials from which unsatisfactory samples were obtained.

#### 10.10.5.4 Repair of Damaged Coats

The Contractor shall be required to locate areas of faulty protection on all sections on which unsatisfactory results are obtained and to affect the necessary repairs. The cost of this work and all additional materials provided or supplied, including the reinstatement of the trench and the retest shall be for the Contractor's account.

### 10.10.6 Repair Methods

Where damage to the wrapping on a pipeline has occurred and where there are creases, wrinkles and folds in the wrapping, proceed as follows:

#### 10.10.6.1 Small Damaged Areas

If the width of the tape being used exceeds by at least 100 mm the length of the section affected, cut the area of damaged wrapping away to bare metal leaving no raised edges or protrusions.

Clean and prime the exposed area in accordance with Clauses 10.10.3.2 and 10.10.3.3 and apply a patch of tape, ensuring an overlap of not less than 50 mm on all sides onto the surrounding wrap.

Apply by hand-wrapping with a 55% overlap, a further layer of tape commencing two turns before and continuing for two turns beyond the patch.

#### 10.10.6.2 Large Damaged Areas

Where the extent of damaged or faulty wrapping is such that the tape cannot span the affected area and provide a 50 mm overlap on all sides it must be completely removed from the pipe over the affected section. The area shall be cleaned and primed in accordance with Clauses 10.10.3.2 and 10.10.3.3. The pipe must be re-wrapped with a 55% overlap, commencing two turns before and finishing two turns beyond the bared section.

#### 10.10.6.3 Damage on Double Wrap

Where damage or a defect has occurred in a section that has been double wrapped and in the case of small Holidays, the outer wrap shall be removed for a distance equal to three (3) times the width of the inner wrap tape on each side of the damaged area.

The appropriate procedure given in Clauses 10.10.6 shall be used to affect the repair of the inner wrap.

The outer wrap shall be re-instated in accordance with Clause 10.10.3.5.



#### 10.10.6.4 Outer Wrap Damage

Where damage extends through an outer wrap / rockshield (see Section 6 of SANS 10129), this shall be carefully removed for a distance equal to three (3) times the width of the inner wrap tape on each side of the damaged area without damaging the inner wrapping.

The repair shall be carried out by the appropriate method given in Clauses 10.10.6 and the outer wrap / rockshield re-instated in accordance with Clause 10.10.3.5.

### 10.11 SYSTEM 10: PETROLATUM WRAPPING

Profiling mastic and mastic blankets are used for corrosion protection of couplings and flanges in chambers with high humidity and buried in soil.

#### 10.11.1 Standards

Reference is made to the latest issues of the following Standards:

- ISO 8501-1: Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of un-coated steel substrates and of steel substrates after removal of previous coatings.
- SANS 10129: Plastics tape wrapping of steel pipelines.

#### 10.11.2 Surface Preparation

Mechanically clean and wire brush the joint to remove all loose rust, scale, old coating or lining and foreign matter to St 2 (ISO 8501-1).

Areas subjected to chemical attack, salt spray, fungus or bacteria shall be neutralized, rinsed with clean potable water and mechanically cleaned as specified above.

#### 10.11.3 Priming

Brush priming solution well over the entire joint area, leaving a thin film (at a nominal coverage rate of 0.8 m<sup>2</sup>/litre). Apply a liberal amount around the bolt threads, narrow cavities and crevices.

Paste shall be used where excessive surface corrosion has occurred and under high humidity or submerged conditions.

#### 10.11.4 Application

Use profiling mastic and/or strips to fill all voids, crevices and sharp or irregular contours.

Apply mastic tape circumferentially over the area to be coated with a 25 mm overlap on either side of the mastic with a 75 mm end overlap.

Pre-formed petrolatum mastic blanket system (10 mm thick), supported by a coated tape backing, is available to provide a quick and easy method to apply this system.

Eliminate all air pockets, wrinkles and creases.

#### 10.11.5 Top Coat

##### 10.11.5.1 Buried Conditions

Two complete turns of the polyethylene sheeting shall be applied circumferentially. The ends are secured to the pipe barrels with 48 mm wide bands of PVC adhesive tape, which is also applied to the outside diameter of the bolted joint.

#### 10.11.5.2 High Humidity Conditions

Overcoat with a synthetic coat mixed with a cementitious filler to give a tough, flexible coat. The base coat may be over-coated with water based Acrylics or Epoxies.

**NOTE:**

- Detail of application shall be in accordance with the manufacturer's data sheets and approved by the Engineer.

### 10.12 SYSTEM PC1: SOLVENT FREE POLYURETHANE COATING

This corrosion protection system covers the application of Solvent Free Polyurethane as a coating to steel pipes. Generally the coating is to be applied in accordance with ANSI/AWWA C222-99 'Polyurethane Coatings for the Interior and Exterior of Steel Water Pipe and Fittings'. Where in conflict with ANSI/AWWA C222-99, the amendments hereunder shall take precedence.

#### 10.12.1 Section Numbers of ANSI/AWWA C222-99

The section (clause) and sub-section numbers in this clause refer to the same numbered sections and subsections in ANSI/AWWA C222-99.

##### 10.12.1.1 ANSI Section 4.2 Test Requirements

Replace 'Table 1 Requirements' with the new Table 1 below.

New Table 1: Physical and Performance Requirements

Property	Polyurethane Coating Material	Test Method Sub-Section
<b>Adhesion</b> , MPa min (laboratory)	15 MPa	ASTM D 4541
<b>Impact resistance</b> Kg m, min	1.6 kg m	ASTM D 2794 Intrusion
<b>Water absorption</b> %, max	max 3%	ASTM D 570 long term
<b>Dielectric strength</b> kV/mm thick min	7.5 kV/mm thick min	SANS 1217 clause 5.9
<b>Resistance to abrasion</b> , mg max	max 100/1000 rev	ASTM D 4090 CS17 1 kg 1000 cycles
<b>Cathodic disbondment</b>	max 12 mm radius	ASTM G 95 at 23 deg C
<b>Durometer Hardness</b>	min 65 Shore D	ASTM D2240
<b>Chemical Resistance</b> 10% sulphuric acid 30% NaCl 30% NaOH Diesel fuel	max 5% in mass, length or width max 5% in mass, length or width max 5% in mass, length or width max 5% in mass, length or width	ASTM D543

##### 10.12.1.2 ANSI Section 4.3 Coating Thickness

###### ANSI Sub-Section 4.3.1

The minimum dry film thickness of coating is to be 2000 microns within a tolerance of -100 microns and +1000 microns.

#### 10.12.1.3 ANSI Section 4.4 Surface Preparation

The requirements of section 4.4 of ANSI/AWWA C222-99 will apply and will take precedence over Clause 3.2 above.

#### 10.12.1.4 ANSI Section 4.7 Welded Field Joints

##### ANSI Sub-Section 4.7

The hold backs (cut-backs) are to comply with Clause 4.15.1 of this Specification.

#### 10.12.1.5 ANSI Section 5.3 Coating Tests

##### ANSI Sub-Section 5.3.1

The basis of acceptance of proposed coating material shall be as per method (1).

#### 10.12.1.6 ANSI Section 5.5 Coated Pipe Inspection

##### ANSI Sub-Section 5.5.4

Electrical continuity inspection shall be conducted on all pipes as per Clause 5.9 'Dielectric strength' of SABS 1217.

#### 10.12.1.7 ANSI Sub-Section 5.5.3

The adhesion is to be tested in accordance with ANSI/ASTM D4541.

#### 10.12.1.8 ANSI Section 6.5 Affidavit of Compliance

The manufacturer is to submit with his/her first request for payment an affidavit that all material and work has been conducted in accordance with the requirements of this standard.

### **10.13 SYSTEM PC2: FUSION-BONDED MEDIUM DENSITY POLYETHYLENE**

This coating system shall comply with the Australian Standard Specification AS 4321-1955 entitled "Fusion bonded medium density polyethylene coating and lining for pipes and fittings" except as modified hereunder.

#### **10.13.1 Modifications to Specification AS 4321-1955**

##### 10.13.1.1 Preparation of Surface

Delete Clause 5.1 of AS 4321-1955 and replace with Section 3 "SURFACE PREPARATION FOR PIPES TO BE COATED AND LINED" of this specification.

##### 10.13.1.2 Repairs

Delete the last sentence of Clause 8.1 of AS4321-1995 and replace with "Damaged areas that pass the continuity test need not be repaired provided that the coating or lining thickness is equal to or greater than the thickness specified in Table 1 of AS 4321-1995. Generally no more than 3 repairs will be allowed per 9m length of pipe and the area of a single repair is not to exceed 0.01 square m. If the area of a single repair does exceed 0.01 square m the pipe will be rejected. Repairs may be undertaken in accordance with Clause 8 of AS 4321 for the following methods of repair:- Fusion bond; Heat shrink sleeve or Hot gas welding. A wrapping system may also be used if applied as detailed hereunder.

#### 10.13.1.2.1 Repairs with Tape

When repairs are permissible the repairs shall be made using a repair system comprising (1) a polymer bitumen primer (Denso Primer D or equivalent approved), (2) an inner seal of modified rubber bitumen sealing tape (Denso Mastic Sealing Tape or equivalent approved) and (3) an outer protective layer of acrylic coated/modified bitumen adhesive pipeline tape (Denso Acrylic Pipeline Tape or equivalent approved) is to be applied with a 50% overlap, ensuring that it is placed 50mm wider all round than the inner repair tape. The outer protective tape is to be wrapped around the entire pipe.

#### (14) Pinholes

At each pinhole detected by the electrical test, the surrounding area shall be abraded to at least a minimum area of 175mm by 175mm around the hole. The abrasion shall be carried out (with clean emery paper of 80 to 100 mesh) around the repair so as to provide a suitable rough surface profile without causing the removal or excessive amounts of coating material. The repair area is to be feathered into the surrounding sound coating. Debris and other deleterious matter are to be removed by means of a clean rag moistened with Cleaning Solvent. The primer is applied and once it has dried the prepared surface is covered with a patch of modified rubber bitumen sealing tape (Denso Mastic Sealing Tape or equivalent approved) of size 150mm by 150mm. The bond is to be free of air bubbles and smoothed out by hand or using an aluminium fluted roller. Finally, acrylic bitumen adhesive pipeline tape (Denso Acrylic Pipeline Tape or equivalent approved) is to be applied with a 50% overlap, ensuring that it is placed 50mm wider all round than the inner repair tape.

#### (15) Larger Damaged Areas

The edges of the damaged coating must be chamfered back to remove all potential void areas. The primer and modified bitumen rubber are applied as for pinholes but the modified bitumen rubber tape is pre-cut and applied with 55% overlap. Finally acrylic bitumen adhesive pipeline tape (Denso Acrylic Pipeline Tape or equivalent approved) is to be applied with a 50% overlap, ensuring that it is placed 50mm wider all round than the inner repair tape. Weld beads are repaired with suitable lengths of the above size tapes. When covering weld beads, the centre portion of the square must make contact first. Smooth the tape out with an outward direction to remove all entrapped air.

#### 10.13.1.3 Storage, Handling, Transport and Marking

Add to Clause 11 of AS 4321-1955, Clause 1.5 entitled "Plant and Rigging for the handling and delivery of Pipe and Specials" of this specification.

### 10.14 SYSTEM PC3: THREE LAYER SYSTEM

The three layer corrosion protection system consists of a powdered epoxy primer, a polymeric adhesive and a polyethylene outer sheath which shall be applied in accordance with Canadian Standards Association Specification (CSA) Z245.20-06 and Z245.21-06.

The application is to be in accordance with, inter alia, the following sections of the Canadian specifications listed below.

#### 10.14.1 Z245.20 External Fusion Bond Epoxy Coating for Steel Pipe

- a) General Requirements
- b) Materials

The following Fusion Bonded Epoxy primers are approved for use.

Akzo Nobel PCL 331

Jotun CORRO-COAT EP-F 1003HW

Should the Supplier wish to use any other make of primer, samples must be left with the Employer or his/her agent for testing. Delays in approval will not be accepted as a reason for late delivery.

- c) Coating Application

- d) Inspection and Testing
- e) Repair of Coated Pipes
- f) Markings
- g) Handling and Storage
- h) Test Reports and Certificates of Compliance
- i) Test Procedures

#### **10.14.2 Z245.21 External Polyethylene Coating for Pipe**

- a) General Requirements

The Polyethylene outer sheath is to comply with System B1

- b) Materials

The following adhesives are approved for use:-

Borealis Borcoat ME0420

Industrie Polieco M.P.B. SRL COESIVE L8.92.8

The following HDPE Outer Sheath materials are approved for use:-

Borealis Borcoat HE3450

Industrie Polieco M.P.B. SRL HDPE 2050

Should the Supplier wish to use any other make of adhesive or outer sheath materials, samples must be left with the Employer or his/her agent for testing. Delays in approval will not be accepted as a reason for late delivery.

- c) Coating Application
- d) Inspection and Testing
- e) Repair of Coated Pipes
- f) Markings
- g) Handling and Storage
- h) Test Reports and Certificates of Compliance
- i) Test Procedure

#### **10.15 SYSTEM PC4: BITUMEN FIBRE COATING**

##### **10.15.1 General**

Where bitumen fibre coating of steel pipes is specified, the method of coating is generally to comply with SABS 1178 'The production of lined and coated steel pipes using bitumen or coal tar enamel'. The lining is to consist of a hot-applied bitumen with a double wrap of glass fibre reinforcing material to a thickness of 5mm. There shall not be less than 1mm of bitumen between the pipe surface and the inner wrapping and also between the inner and outer wrappings. Where in conflict with SABS 1178, the amendments hereunder shall take precedence.

##### **10.15.2 Amendments to SABS 1178**

The following details are to be noted. The clause and sub-clause numbers hereunder refer to the same numbered clauses and sub-clauses in SABS 1178.

#### 10.15.2.1 SANS Sub-Clause 3.1.1 Primers

Before the application of external protections, pipes and specials shall be primed with primer type (a) a cold applied bitumen primer complying with SABS 1136 or a synthetic primer for bitumen, complying with SABS 1140.

#### 10.15.2.2 SANS Sub-Clause 3.1.2.1 Bitumen

The bitumen used is to conform to SABS 1137.

#### 10.15.2.3 SANS Sub-Clause 3.1.3 Reinforcement Wrappings

Glass fibre material is to be used as the reinforcement wrapping and is to conform to SANS 1130.

#### 10.15.2.4 SANS Sub-Clause 3.1.4 Reflective Finish

A non-stick, reflective covering shall be applied to the coating. This shall consist of a lime wash based on a dolomitic type lime suitable for non-porous surfaces mixed with water to a slurry and further mixed with boiled linseed oil to improve its water resistance.

#### 10.15.2.5 SANS Sub-Clause 3.2.2 Coating and Table 1

The coating type is to be CB6A as per Table 1. However, the inner wrap may conform to type 1 or type 3 of SABS 1130 and the outer wrap may conform to type 1, type 2 or type 3 glass fibre reinforcing material. The minimum coating thickness excluding the weld seam is to be 5mm. The thickness tolerance shall be +2mm, -0mm.

#### 10.15.2.6 SANS Sub-Clause 3.7.7 Disbonded Areas

Holidays are not to be repaired unless authority to do so is given by Umgeni Water's authorized Quality Inspector.

#### 10.15.2.7 SANS Sub-Clause 3.7.8 Holidays

The coating shall be free from holidays and tested in accordance with Clause 7.2.2 of SABS 1178 at 15Kv.

#### 10.15.2.8 SANS Clause 6 Markings

Refer to Clause 7 of Sub-Clause 2.2 of this specification.

#### 10.15.2.9 SANS Sub-Clause 7.1 Inspection

*Add the following sentence –*

Before leaving the shop the coating of every pipe and special shall be inspected visually for all defects including, but not restricted to:- tears, holes, mechanical damage and cracking.

#### 10.15.2.10 SANS Sub-Clause 7.2.2 Holiday Detection

A metallic brush or a jointed spiral ring type of scanning electrode is to be used on the variable voltage detector.

#### 10.15.2.11 SANS Sub-Clause 7.3 Destructive Tests

Sufficient coating material shall be removed from the ends of at least one pipe of each day's production for

the purpose of carrying out destructive tests as detailed under Clause 7.3 of SABS 1178.

#### **10.16 SYSTEM PC5: POLYMER MODIFIED BITUMEN COATING**

This corrosion protection system is suitable for large pipes items subject to medium corrosive and severely corrosive environmental conditions.

This specification relates to factory applied pipe coating operations based on hot applied polymer modified bitumen.

##### **10.16.1 Standards**

This standard makes reference to the documents listed below. Unless otherwise specified the latest editions of these documents, including all addenda and revisions, shall apply.

##### **British Standards**

BS 410	Specification for test sieves.
BS 1796	Methods using test sieves of woven wire cloth and perforated metal plate.
BS 2000	Methods of test for petroleum and its products.
BS 3900	Methods of test for paints: Part A 6 (replaced by EN 535) – Determination of flow time of paints. Part B 2 (replaced by ISO/DR 1515) – Determination of volatile matter and non-volatile matter.
BS 4147	Bitumen-based hot-applied coating materials for protecting iron and steel, including suitable primers where required.
BS 7079	(Replaced by ISO 8501-8504) – Preparation of steel substrates before application of paints and related products.

##### **Swedish Standard**

SIS OS 5900	Pictorial surface preparation standards for painting steel surfaces.
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##### **American Standard**

ASTM D 113-86	Ductility of bituminous materials.
ANSII AWWA C203-91	Coal-tar Protective Coatings and linings for steel water pipelines – enamel and tape-hot applied.

##### **South African Standard**

SANS Method 772	Blast profile.
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##### **10.16.2 Materials**

###### **10.16.2.1 Primer**

The primer shall be of synthetic composition, designed to be used with a specific polymer modified bitumen.

The drying rate of the primer shall be suited to the application conditions. The primer shall be supplied in new sealed steel drums.

The primer shall have the characteristics shown in Table 3. In addition, when stored in original sealed containers at ambient temperature, the primer shall retain the properties as set out in Table 3 for not less than 6 months from the date of delivery.

*Table 3: Characteristics of Primer*

CHARACTERISTIC	REQUIREMENTS	METHOD OF TEST
Viscosity at 23°C	35-60 seconds	Flow cup No 4
		BS3900: Part A6 = EN 535
Volatile matter	75	BS3900: Part B2 = ISO/DR
(max. % loss by mass)		1515 (105°C for 3 hours)

#### 10.16.2.2 Polymer Modified Bitumen

##### 10.16.2.2.1 Composition

The polymer modified bitumen shall consist of a uniform mixture of the following:

- A formulated blend of polymer modified bitumen, as specified in (c) and (d) below.
- A proportion of approved filler (limestone or asbestos shall not be used).
- Characteristics of the filler shall be as specified in (b) below.

##### 10.16.2.2.2 Filler Grading

Method of test to BS 1796 modified to use the metric sieves specified in BS 410.

Passing 90 microns – not less than 93%.

Passing 250 microns – not less than 99%.

##### 10.16.2.2.3 Characteristics of the Polymer Modified Bitumen

The material shall conform to the requirements given in Table 4 when tested in accordance with the methods specified.

##### 10.16.2.2.4 Performance Tests of the Polymer Modified Bitumen System

The polymer modified bitumen shall be of thermoplastic rubber/bitumen modification.



The polymer modified bitumen containing mineral filler with the characteristics detailed in 10.16.5.1.2 shall pass the performance test specified in Table 4.

*Table 4: Characteristics and Performance Test for Polymer Modified Bitumen*

PROPERTIES	METHOD	UNIT	REQUIREMENTS
Softening Point	ASTM D36	°C	115-130
Penetration @ 25°C	ASTM D5	1/10 mm	15-30
Density @ 25°C	BS 4147	g/cm <sup>3</sup>	1.1-1.4
Viscosity @ 170°C	Brookfield	Cp	7000-12000
Viscosity @ 190°C	Brookfield	Cp	3000-6000
Filler Content	BS 4147	%	20-30
Impact @ -10°C	BS 4147	mm <sup>2</sup>	Max. 6500
Peel Initial / Delayed	BS 4147	mm	Max:
Sag @ 25°C	BS 4147	mm	3,0/3,0
Sag @ 40°C	BS 4147	mm	3,0/3,0
Sag @ 50°C	BS 4147	mm	3,0/3,0
Sag @ 60°C	BS 4147	mm	3,0/3,0
Sag @ 80°C	BS 4147	mm	Max. 1.5
Aging Test @ 190°C	Phoenix	hours	Min. 72
Bend	BS 4147	mm	Min. 15

**NOTES:**

- The test plates shall be cleaned by abrasive blasting to grade Sa 2½ of SIS OS 5900 (BS 7079 and ISO 8501 – 8504) and with a profile of 50 – 75 microns (SANS Method 772). They shall be coated with primer at a rate of 100g per m<sup>2</sup>.
- For the impact test a plate 12.7 mm thick shall be used and a single impact made in each quarter of the plate. The average of the four areas disbanded shall not exceed the permitted

value shown in Table 4.

- The peel test at 25°C is equivalent to / replaces the preliminary adhesion test in the original Specification.

#### 10.16.2.3 Outerwrap

- The outerwrap consists of a combination of polyester and glass fibres to ensure the required strength and elasticity. This is combined with a glass fabric of uniform quality and amount to control the best application and the required amount of bleed through, in order for the outerwrap to provide maximum protection.
- The outerwrap shall be impregnated with the polymer modified bitumen compatible material to fulfil the characteristics shown in Table 5.
- The characteristics of the outerwrap shall comply with the requirements of Table 5 and shall be determined in accordance with the test procedure.

*Table 5: Characteristics of Outerwrap Saturant*

CHARACTERISTIC	REQUIREMENT	METHOD OF TEST
Softening Point	Min 100°C	BS 2000
Penetration @ 25°C	60-85 1/10 mm	BS 2000
Saturant	Polymer Modified Bitumen	

*Table 6: Physical Characteristics of Outerwrap*

CHARACTERISTIC	TYPE A	TYPE B	METHOD OF TEST
Minimum Thickness (mm)	0.6	0.6	AWWA C203-91
Weight (g) per m <sup>2</sup>	500 – 700	500 – 700	AWWA C203-91
Tensile strength (N/50 mm)			
Longitudinal	> 800	> 400	AWWA C203-91
Transverse	> 800	> 200	AWWA C203-91

### **10.16.3 Application**

#### **10.16.3.1 Care of Wrapping Materials**

All wrapping materials consigned to the coating yard or factory shall be properly stored to prevent damage or deterioration.

#### **10.16.3.2 Care of Pipe**

Throughout the wrapping process pipe and coating materials shall be kept clean and away from all foreign matter.

#### **10.16.3.3 Marking**

Any pipe manufacturer's identifying marks shall be removed before the start of the wrapping process and shall be permanently marked on the side of each pipe at both ends with a weatherproof paint. Metallic dye stamping shall only be permitted using approved stamps and only on the pipe bevel.

#### **10.16.3.4 Blast Cleaning**

In preparation for the application of primer all grease or heavy soil shall be removed without spreading over the surface with a volatile solvent, e.g. xylene (or approved equivalent) and thereafter the external surface of the pipes shall be cleaned by abrasive blasting to at least Sa 2½ grade SIS O5 009 (BS 7079 and ISO 8501-8504) SANS 772 and surface profile amplitude 75 µm. DWS 9900 C1 for detailed description of surface preparation process.

#### **10.16.3.5 Priming**

- d) Following blast cleaning and within 2 hours, the pipe exterior shall be coated with the primer applied at a controlled rate to the manufacturer's recommendations. Pipes shall be coated within 24 hours of being primed.
- e) The primer shall be applied to a dry, clean and dust free pipe and thereafter the primed pipe shall be kept free from moisture, dust or any other contaminant. The primed pipe shall be uniform and free from runs, drips, flooded or bare areas. Particular care shall be taken to ensure complete coverage of weld areas.
- f) The primer should be applied at a pipe temperature of 10°C (or above) or 3°C above the dew point. If the pipe temperature is lower than this level or if moisture is present on the pipe, heating of the pipe may be required.
- g) Deteriorated or contaminated primer shall not be applied to the pipe. Primer that has deteriorated or become contaminated after its application shall be removed to the satisfaction of the Employer or his representative, at the Contractor's expense. The cleaned area shall then be re-primed.

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#### 10.16.3.6 External Coating and Wrapping Application

- h) The pipe, after priming and when the primer is no longer tacky, shall be passed through coating facilities of a type approved by the Engineer. The machine shall coat the pipe weld (longitudinal or spiral) with a 50 mm wide strip of extruded polymer modified bitumen and thereafter the entire pipe with an extruded coating of polymer modified bitumen and shall simultaneously apply the outerwrap.
- i) All primed surfaces shall be clean and dust free immediately prior to coating.
- j) The coating shall have an average thickness of not less than 4 mm, with an absolute minimum thickness of 3 mm. The coating shall be reinforced by a spirally-wound layer of outerwrap pulled into the polymer modified bitumen with an overlap of 20 mm, such that the outerwrap is wetted by the polymer modified bitumen. Particular attention shall be paid to the location of the reinforcement and thickness of the wrapping over the weld. The average thickness shall be determined in the following manner: At least four thickness measurements at approximately the pipe quarter points per lineal metre of pipe length shall be taken. At least 25% of the measurements shall be taken at the weld bead. The average thickness shall be the arithmetic average of all measurements.
- k) The completed coating shall be well bonded to the pipe metal; uniform, smooth and free from Holidays, laminations, voids or other defects.
- l) The wrapping shall be carefully trimmed off 100 mm from the ends of each pipe and bevelled throughout its thickness over a minimum length of  $\pm 5$  mm, unless otherwise specified by the Employer or his representative.
- m) Solar protection paint shall be applied to the coated pipe while the coating is still warm. It shall be white in colour, water resistant, continuous and shall cover the wrapping sufficiently to form an effective barrier to solar radiation. The solar protection shall be terminated approximately 100 mm from each end of the wrapping (i.e. 200 mm from each end of the pipe).

#### 10.16.4 Inspection and Testing

The Contractor shall be responsible for, and shall bear the cost of a system of inspection and repair of the wrapped pipe approved by the Engineer. The system shall meet all relevant requirements in this Section and in addition the following requirements:

- n) Monitoring of grit size and the finish of blast cleaned pipe.
- o) Viscosity measurement (see Table 3) and control of film thickness of external primer at least once for every batch of primer, in addition to visual checks of the applied prime coating.
- p) Adequate temperature control the polymer modified bitumen at the application head. In order to ensure that the polymer modified bitumen applied to the pipe has the characteristics specified in Table 4, samples of the polymer modified bitumen shall then be taken from the application head and subjected to the following test and frequency of testing shown in Table 7.
- q) Visual checks on the outer wrap and the appearance of the final wrap.
- r) Holiday detection of 100% of the surface area of every wrapped pipe with approved equipment operating at a minimum 15 kV, maximum 25 kV with regular calibration of the equipment to the satisfaction of Quality Assurance.
- s) Test of bond strength and thickness of the wrapping including removal of samples of the wrapping for inspection.

- t) Adequate and proper repair of any defects to ensure compliance with this Section. A need to repair more than 1 defect per m<sup>2</sup> of pipe coating shall be sufficient grounds to reject the pipe and cause the Contractor to adjust his process to reduce the number of defects to an acceptable level.

Any necessary repairs of tested pipes shall be carried out by the Contractor at no additional cost to the Employer.

One pipe from every day's production shall be held back for examination on the following day. This examination shall include bond testing, thickness testing and examination for laminations, voids or any other defects.

If, in the opinion of the Engineer, there are a significant number of defects on the test pipe, then a back check procedure will be invoked. This will involve checking the ten pipes immediately preceding and the ten pipes immediately following the faulty test pipe (the pipe numbers shall be available from the final inspection). These twenty pipes shall be subjected to an examination similar to that carried out on the test pipe. Should the number of defects detected be, in the opinion of the Engineer, significant, then the entire production for that week shall be quarantined and jointly investigated by the Contractor and the Engineer.

Should tests in any production batch show a defect rate of more than 10%, the Engineer may reject the whole batch. In such cases the Contractor shall conduct an investigation to establish the cause of the defects.

*Table 7: 'In Plant Testing'*

TEST	FREQUENCY OF TESTING
1. Softening Point	Twice per working shift
2. Penetration at 25°C	Twice per working shift
3. Bond test for coated pipes	One pipe per working shift

These tests should be conducted at the coating Plant by the Contractor and monitored by the Approved Inspection Authority (AIA), who would be trained in the procedures by the coating material supplier.

At least once during the Contract or when the method of surface preparation is changed, a sample wrapped pipe shall be tested for resistance to cathodic disbonding.

When tested, the wrapping shall not be disbonded from the pre-damaged area by more than a 5 mm radius after exposure for 28 days at the specified potential, i.e. -1500 mV (BS 3900:F1 1).

The inspection activities shall be coordinated with the Contractor's operations so as to delay or interfere with the operations as little as possible. The Contractor's methods shall, nevertheless, always permit inspection to be made and allow adequate repair of imperfections.

Prior to dispatch from his Plant, the Contractor shall ensure that the wrapped pipe is correctly marked on the internal painted surface of the pipe at each end with approved paint, with sufficient information to enable subsequent identification of the pipe to be made. Documentation shall be supplied to the Engineer to enable the history of the processing of each pipe to be traced.

### **10.16.5 Methods of Testing**

#### **10.16.5.1 Testing of Wrap Characteristics**

##### **10.16.5.1.1 General**

The procedures given below are reference methods of test, which shall be used to establish conformity to the Specification in cases of dispute. Other similar methods, however, may be used by manufacturers for routine quality control purposes with the approval of the Engineer.

##### **10.16.5.1.2 Thickness**

The thickness shall be determined by means of a suitable instrument fitted with a micrometre dial gauge, a cylindrical brass block 57 mm in diameter and giving a nominal loading of 3.45kN/m<sup>2</sup> and a surface plate.

The thickness shall be measured by interposing the outer wrap between the cylinder and the surface plate. Measurements shall be made by marking 75 mm square across the effective width of the mat and making a measurement within each square. No single reading across the width of the mat shall be less than the specified minimum thickness.

##### **10.16.5.1.3 Weight per m<sup>2</sup>**

The weight per square metre shall be determined by cutting representative samples from the effective width of the outer wrap. The samples shall be of such a size, that the weight per square metre may be determined to an accuracy of  $\pm 2\%$ .

##### **10.16.5.1.4 Tensile Strength**

The tensile strength shall be measured with approved equipment. The size of the samples cut from the roll shall be 520 mm long and shall have the required width. (See Table 4 for the minimum tensile strength).

When mounted in the equipment, the distance between the jaws shall be 320 mm. The constant rate of separation of the jaws shall be in the range of 100 mm to 610 mm/minute and the tensile strength at breaking point shall be determined. For reference purposes the rate of separation of the jaws shall be 200 mm/minute. At least four samples shall be tested and an average figure obtained. The test may be carried out on narrower samples if required, provided that at least two of the reinforcing strands are included in the specimen. Sealing of the ends is recommended.

The value for tensile strength obtained from a narrower sample shall be extrapolated to 150 mm width.

#### **10.16.5.2 Bond Test for Coated Pipes**

- u) Measure the temperature of the coating with a surface thermometer.
- v) If the temperature of the coating is not between 10°C and 25°C, cool or warm the pipe in the test area to bring the temperature within this range.
- w) Using a knife, heated if necessary, make two parallel cuts, through the coating down to the pipe surface. The cuts shall be 100 mm long and 30 mm apart.
- x) With a stiff flat blade, loosen the coating the full width between the two cuts and lift the wrap upward in a direction at right angles to the pipe surface.
- y) The bond shall be considered satisfactory if the coating does not peel cleanly from the primer or the pipe surface but is removed with difficulty.
- z) This bond test should be carried out at the start of each shift or change in production and thereafter at a frequency approved by the Engineer.

#### **10.16.6 Handling**

At all times the pipe, unwrapped as well as wrapped, shall be handled with the aid of slings, lifting yokes and protected hooks to the approval of the Engineer.

At all times the coated pipe shall be handled and stacked in such a manner as to prevent damage to the coating. Particular care shall be taken immediately after coating to avoid damage while the enamel is above ambient temperature. No stacking or loading shall be undertaken until the coating has cooled sufficiently to avoid marking.

The coated pipe shall be stored at all times clear of the ground and in such a way that either water or mud cannot accumulate on the inside or outside of the pipe. Storage shall be effected by the use of wooden bearers, suitably covered, or mounds of gravel-free sand, covered with polyethylene sheets.

The pipe shall only be stacked to a height such that no flattening of the wrapping occurs.

The pipes shall be separated from each other with approved polyethylene covered pads.

#### **10.16.7 Repairs**

Although the polymer modified bitumen has excellent self-healing properties, damage caused by transportation or laying of the coated pipe may occur. This shall be quickly repaired using torch-on membrane.

Damage shall be repaired by removing the existing coating to at least 10 mm beyond the area of damage. The repair area shall then be cleaned of all deleterious matter to 100 mm beyond the proposed repair area. Exposed metal shall be re-primed in accordance with this Section. The repair patch, which shall lap at least 50 mm onto sound coating, shall be applied by gently heating with a gas torch and applying it to the pipe in a manner, which prevents the entrapment of air bubbles. All air bubbles shall be removed using a wooden roller or by other means and the perimeter of the repair patch shall be neatly finished off. The patched area shall then be Holiday tested in accordance with the Specification.

### **10.17 SYSTEM PL1: CEMENT MORTAR LINING**

This corrosion protection system covers the application of Cement Mortar as a steel pipe lining. The pipes will be used to convey potable water.

#### **10.17.1 Standards**

Reference is made to the latest issues of the following Standards:

AS 1281-2001: Cement mortar lining of steel pipes and fittings

#### **10.17.2 Material**

All materials for the cement mortar lining of pipes shall be in accordance with AS 1281-2001.

#### **10.17.3 Application**

##### **10.17.3.1 Mixing of mortar**

Components of the mix shall be accurately weighed. Each batch shall be identical. Mixing shall be carried out in a suitable mechanical mixer. Aggregate and cement shall be measured in correct proportions, then dry mixed in the mixer. When homogeneous, water shall be added from a measuring vessel to achieve the correct consistency but shall not exceed the amount stated previously. When correctly mixed, the material shall be used as soon as possible and not later than 1 hour after the first addition of water. Re tempering of the mix by further addition of water or other material shall not be permitted.



From a random batch of each days production prepare three 150 mm test cubes, in accordance with SANS 5863. After 28 days curing, the compressive strength shall not be less than 30 MPa.

#### 10.17.3.2 Placing of cement mortar

Cement mortar shall be placed to the specified thickness by spin casting (preferred method) or by mechanical drag trowel. In either case, sufficient centrifugal force shall be used to ensure optimum bonding to the pipe wall and optimum compaction of the cement mortar, with minimum segregation of different sizes of aggregate. The finished lining shall be smooth and uniform. Hand application is not permitted except on specials or by prior agreement of the Engineer.

#### 10.17.3.3 Curing of lining

After completion of placing, spinning, trowelling an end finish, the lining shall not be disturbed until set. The pipe ends shall be closed with waterproof end covers or caps and the pipe shall be left undisturbed for at least 40 hours. After 48 hours the lining shall be sprayed with a fine mist of water and the covers and caps replaced or shall be steam cured by an approved method. The lining shall be kept wet for not less than 7 days. Pipes shall not be transported within 21 days from the date of applying the lining.

During placing of the cement mortar and the whole of the curing period, the pipes shall be kept constantly in the shade or under cover. Pipes shall not be exposed to direct sunlight.

Some of the pipes are likely to be stored on site for periods in excess of 3 months before being laid.

#### 10.17.4 Testing

The Quality Control Plan and Procedure referred to in Clause 4.13 above will detail the means of demonstrating compliance with AS 1281-2001 and will be based on Appendix B of AS 1281-2001.

### 10.18 SYSTEM PL2: SOLVENT-FREE EPOXY LINING

This system is specific design to be used as a lining system for pipelines conveying potable water and raw water.

#### 10.18.1 General

This corrosion protection system covers the application of Solvent Free Liquid-epoxy as a steel pipe lining. Generally the lining is to be applied in accordance with AWWA C210-97 'Liquid-epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines'. Where in conflict with ANSI/AWWA C210-97, the amendments hereunder shall take precedence. The full cost of all the testing is to be included in the rates for coating unless it is itemised separately in the Schedule of Quantities.

#### 10.18.2 Amendments to AWWA C210-97

The section and sub-section numbers in this clause refer to the same section and sub-section numbers in AWWA C210-97.

##### 10.18.2.1 AWWA C210 SECTION 1.1 SCOPE

##### ANSI Sub-Section 1.1.2 Coating and Lining Systems

The lining system is to be type (3), a single coat of a two part, chemically cured epoxy coating. In the event of the thickness being less than the minimum specified the coating shall be removed and the pipe length shall be re-blasted and re-lined to comply with the specification.



#### 10.18.2.2 AWWA C210 SECTION 4.2 QUALITY AND SAFETY

Details of all quality related controls and tests are to be included in the QCP&P referred to in Clause 4.13 of the Employer's specification above.

##### AWWA C210 Sub-Section 4.2.2 Certification

Copies of the certification of the products used, as required by this section, are to be submitted with the tender documents.

#### 10.18.2.3 AWWA C210 SECTION 4.3 COATING SYSTEMS

##### AWWA C210 Sub-Section 4.3.1 Liquid-Epoxy Coatings.

*Add the following:-*

The following products have been approved by Umgeni Water: - Sigma Line 523, Carboline 891 and Denso ST100. Should the Manufacturer/ Supplier wish to offer an alternative product it will be necessary to get the approval of the client. Only solvent free epoxies which have been certified non-toxic and non-tainting and suitable for use with potable water will be permitted. Any delays in approval will not be accepted as a reason for late delivery.

##### AWWA C210 Sub-Section 4.3.2 Coating Thickness

The pipes shall be lined to a dry film thickness of a minimum of 406 and a maximum of 1000 microns, and shall be free from sags and runs.

##### AWWA C210 Sub-Section 4.3.4 Physical Requirements

*Replace Table 1 with the following new Table 1*

Tests 1 through 3 in the new TABLE 1 new shall be conducted on every pipe.

Tests 4 and 5(a) and 5(b) in the new TABLE 1 below shall be applied to at least one pipe selected at random from the first day's production or from each new batch of liquid epoxy, whichever is more frequent.

Tests 6, 7 and 8 in the new TABLE 1 below shall be applied to at least one pipe selected at random from the first day's production of each item.

Should the Manufacturer experience difficulties in achieving this specification, additional tests may be required by the Purchaser until the problem(s) has been identified and rectified. Such additional tests shall be to the Purchaser's account.

No	PROPERTY	REQUIREMENT	TEST METHOD
1	Visual	Smooth glossy or semi-glossy finish, free from excessive runs, sags, orange peel, occlusions or other visible defects	Use an experienced observer
2	Coating Thickness	Min 406 microns Max 600 microns	ISO 2808. Take a minimum of 2 readings per m <sup>2</sup> of surface up to 300 mm nominal bore, or 12 per m <sup>2</sup> over 300 mm
3	Electrical Insulation Defects	Nil defects at 90 Volts, 10 Mega-ohm	SABS 1217, Section 5.10
4	Impact Resistance	No defect at 1 Joules	SABS 1217, Section 5.6 but modified as given in Note 1

5a	Degree of cure: • Static Test	No softening or discolouration when fully cured	SABS 1217, Section 5.8. Cure time shall be in accordance with the manufacturer's data
5b	• Dynamic Test	No softening or discolouration when fully cured	50 Double rubs with cotton wool swab soaked in MEK. Cure time shall be in accordance with the manufacturer's data
6	Adhesion (Hot water soak)	Not more than 15 mm disbonding from point of V	Immerse in water at 75°C for 48 hrs. Make V cut at 30° angle. Test adhesion when panel has cooled to 25°C
7	Cathodic Disbonding	Total disbonded area not to exceed 40 mm diameter after 30 days. Current flow not to exceed 5mA	ASTM G8 Method B – Magnesium Anode - 20°C – 7 mm holiday
8	Cathodic Disbonding	Total disbonded area (including holiday) not to exceed 20 mm diameter	Impressed current -3, 5 volts potential at 75°C for 48 hours 3 mm artificial holiday

NOTE: Impact resistance shall be carried out on a sample of production pipe firmly clamped and choked (to be rebound free) to a rigid base. No electrical insulation defects shall be detected at the point of impact when tested at 1 Joule.

#### NEW TABLE 1

#### 10.18.2.4 AWWA C210 SECTION 4.4 COATING APPLICATION

##### AWWA C210 Sub-Section 4.4.1 General

Application by airless spray is required.

##### AWWA C210 Sub-Section 4.4.2 Pipe Preparation

The requirements of section 4.4.2 of AWWA C210-97 will apply and will take precedence over the Purchaser's Clause 3.2 above.

##### AWWA C210 Sub-Section 4.4.3.2 Hold-Back for Field Welds

The hold backs (cut backs) are to comply with the Clause 4.15.1 of this Specification.

##### AWWA C210 Sub-Section 4.4.3.4 Application Temperature

*Add the following:-*

The cure rate of liquid epoxy coating is very dependent upon temperature, with the rate of cure being very slow below 10°C and the reaction generally ceasing below 5°C. Manufacturer's tendering for this type of lining are therefore expected to have a heated shop or warm air blowers with suitable heat insulating tunnels to enable the temperature of the coating to be maintained at not less than 15°C from the time of application until full cure has taken place. Adverse weather conditions will not be accepted as a reason for delay in supply.

#### 10.18.2.5 ANSI SECTION 4.5 COATING REPAIR

##### AWWA C210 Sub-Section 4.5.1 Defective Coating

*Add the following at the beginning of the Clause:*

Repairs of electrical insulation defects may be carried out provided that the number of repairs necessary does not exceed 3 per pipe. A cluster of pinholes within a radius of 25mm shall be regarded as one defect. Any pipe needing repairs in excess of this number or where the lining shows any sign of flaking

or loss of adhesion shall not be repaired. The lining shall be removed and the pipe length shall be re-blasted, cleaned and re-coated to comply with the requirements of the specification.

AWWA C210 Sub-Section 4.5.1.1

*Delete this sub-section and replace with the following:-*

Repairs with Epoxy

When repairs with epoxy are permissible, the following method shall be used :-

- Abrade an area at least 25mm diameter around and beyond the defective area. The abrasive paper shall not be coarser than 220 mesh and shall be preferably 400 mesh. It shall be used preferably wet to avoid excessive removal of coating.  
The repair area shall be smoothly feathered into the surrounding sound area. The repair area shall be abraded to a matt finish, free from deep scratches and excessive removal of coating. After abrasion, the area shall be wiped clean with M.E.K. or other suitable approved clean solvent and allowed to dry.
- All repairs shall be undertaken using a repair product recommended by the material manufacturer.
- Repair material shall be mixed in the proportions supplied by the manufacturer. No splitting of packs shall be permitted unless the material is supplied in self metering packs.  
The mixed repair material shall be applied to the clean, dry, abraded repair area so as to cover the defect and extend to within 1 or 2mm of the edge of the abraded area. A "halo" of abraded area shall be visible around the repair material.
- After curing, the repair and at least 250mm surrounding area shall be tested for electrical insulation defects as specified in the contract. There shall be no electrical insulation defects.

## 11 COMPLIANCE WITH REQUIREMENTS

### 11.1 TESTING

Tests, instruments, methods and criteria shall be as specified below or in the Amendments of this Specification.

The requirements of Clauses 4.13 shall apply.

#### 11.1.1 Visual Inspection

All surfaces shall be inspected visually and shall be free from tears, runs, sags, wrinkles, blisters, change in colour or gloss, orange peel, dirt, visible pinholes, dust or fluff occlusions or any other visible defects.

#### 11.1.2 Holiday Inspection

100% of all coated surfaces shall be tested and there shall be no electrical insulation defects on any area inspected.

For films exceeding 500 µm thickness, a high voltage, electrical insulation defects detector shall be used in accordance with SABS 1217.

Except on system containing conductive pigment (Zn, Al), low-voltage wet sponge electrical insulation defects inspection shall be carried out in accordance with SANS 1217 for coatings and linings of thickness not exceeding 500 µm.

For systems exceeding 500 µm thickness, the high voltage, sparking electrical insulation defects detector shall be used in accordance with SANS 1217.

During the inspection procedure the Contractor shall ensure that sufficient moisture is present at all times on the surfaces to be tested.

#### 11.1.3 Dry Film Thickness

The dry film thickness (DFT) shall also conform to the requirements of Clause 9.5

- (a) Measurements shall be taken in accordance with ISO 2808.
- (b) 100% of all system thicknesses measured shall comply with the minimum requirements of this Specification.
- (c) Film thickness in excess of the prescribed maxima shall not necessarily constitute reason for rejection if the system is demonstrated to be sound in all respects.
- (d) The method used to measure film thickness, and the significance of the readings for each particular project, shall be agreed upon by all parties prior to commencement of the work.

#### 11.1.4 Degree of Cure of Fusion-Bonded Materials

The degree of cure of corrosion protection material shall be assessed by solvent wiping in accordance with the method given in SABS 1217 (methyl ethyl ketone resistance test)

#### 11.1.5 Free of Oil and Grease

##### 11.1.5.1 Wetting with Water

All surfaces cleaned of oil and grease shall be tested using the "water-break-free" method. The surface shall be wetted with water and the entire surface shall be covered by an unbroken film.

#### 11.1.5.2 Solvent-Wiping

Where water soluble lubricants may be present the surface shall be further tested by wiping with a clean cotton wool swab soaked in solvent. No stain shall be evident on the swab after solvent-wiping.

#### 11.1.6 Water Soluble Salt Contaminants

Substrate surfaces shall be tested for the presence of water soluble salt contaminants in accordance with SANS 5770 or by means of the Weber Reilly Test.

#### 11.1.7 Standard of Mechanical Surface Preparation

Mechanical surface preparation shall be visually compared to the standard shown in SABS ISO 8501-1.

#### 11.1.8 Blast Profile

The blast profile of the substrate surfaces shall be determined in accordance with SANS 5772.

#### 11.1.9 Residual Dust and Debris

Substrate surfaces shall be tested for the presence of residual dust and debris in accordance with ISO 8502-3.

#### 11.1.10 Blasting Material

All blasting-materials shall be approved by the Engineer.

##### 11.1.10.1 Metallic Abrasive

Abrasive shall be tested in accordance with ISO 11125 for particle size, hardness, density, foreign matter and moisture.

##### 11.1.10.2 Non-Metallic Abrasive

Abrasive shall be tested in accordance with ISO 11127 for particle size, hardness, density, moisture and water soluble contaminants.

### 11.2 PIPE AND SPECIALS SPECIFIC TESTING

#### 11.2.1 Dry Film Thickness (DFT)

Measurements shall be taken in accordance with ISO 2808.

100% of all system thicknesses measured shall comply with the minimum requirements of this Specification.

In the case of coats applied after the erection of steel work on Site, the frequency at which measurements of the DFT are taken shall be at the discretion of the Engineer, and may be dictated by accessibility.

DFT in excess of the prescribed maxima shall not necessarily constitute reason for rejection if the paint film is demonstrated to be sound in all respects.

DFT shall be tested within 7 days of application.

The method used to measure DFT, and the significance of the readings for each particular item, shall be agreed upon by all parties prior to commencement of the coating work.

#### 11.2.1.1 Automated Shop Applied Lining and Coating

The film thickness on the first pipe of a production run and thereafter on at least one pipe selected at random from every day's production, but not less than one pipe out of every ten pipes, shall be measured non-destructively by an approved eddy current instrument. At least four readings at equally spaced intervals around the circumference, approximately 300 mm from each end of the pipe, shall be taken. The first reading shall be over the weld bead. When practicable an additional four readings at equally spaced intervals around the circumference in the centre of the pipe shall be taken. The thickness shall not be less than the minimum specified over 100% of the area including weld beads. The Engineer may at his discretion supplement the above test by checking wet film thickness on any or all pipes during application of the coats.

#### 11.2.1.2 Hand and In-situ Applied Lining and Coating

All the hand applied lining and coating thicknesses shall be tested by means of an approved eddy current or magnetic instrument. At least four readings shall be taken at equally spaced intervals around the pipe circumference at any test point. The first reading shall be over the weld bead. The thickness shall not be less than the minimum specified over 100% of the area including weld beads.

## 12 MEASUREMENT AND PAYMENT

### 12.1 GENERAL

The rates tendered under this Specification shall not include for the general obligations, Contractor's Equipment and work deemed to be covered by the Items provided in Specification.

Payment for the requirements of this Specification will be included in the payment item for the particular item supplied including painting or corrosion protection. No separate payment shall be made for painting and corrosion protection unless specifically allowed for in the Bill of Quantities.

### 12.2 SCHEDULED ITEMS

#### 12.2.1 QCP and documentation

**Unit: lump sum (Sum)**

Separate Items are provided in the Bill of Quantities for the submission of the Quality Control Plan (QCP ) and all other pre-manufacture documentation.

The rate shall include full compensation for the preparation and submission of the QCP and the submission of all pre-manufacture documentation in compliance with the Specification.

Payment will only be made after the QCP and all documentation has been approved by the Engineer."

## ANNEXURE A: APPLICABLE STANDARDS

The following Standards and Codes of Practice are referred to in this Specification:

### Standards Australia

AS 1281-2001	Cement mortar lining of steel pipes and fittings
AS 4321-2001	Fusion-bonded medium-density polyethylene coating and lining for pipes and fittings

### American National Standards Institute

ANSI B31.3	Standards of pressure piping
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### American Petroleum Institute

API 5L	Specification for line pipe
API 1104	Standard for welding pipelines and related facilities

### American Society of Mechanical Engineers

ASME BPVC-IX	Boiler and Pressure Vessel Code – Section IX, Welding and Brazing Qualifications
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### American Society for Testing of Materials

ASTM A240	Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A312	Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipes
ASTM D543	Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents
ASTM D570	Standard Test Method for Water Absorption of Plastics
ASTM D638	Standard Test Method for Tensile Properties of Plastics
ASTM D2240	Standard Test Method for Rubber Property—Durometer Hardness
ASTM D2794	Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)



ASTM D4090

ASTM D4541      Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers

ASTM G8              Standard Test Methods for Cathodic Disbonding of Pipeline Coatings

ASTM G14           Standard Test Method for Impact Resistance of Pipeline Coatings (Falling Weight Test)

ASTM G62           Standard Test Methods for Holiday Detection in Pipeline Coatings

ASTM G95           Standard Test Method for Cathodic Disbondment Test of Pipeline Coatings (Attached Cell Method)

#### **American Water Works Association**

AWWA M11           Steel pipe – A guide for design and installation (3<sup>rd</sup> edition)

AWWA: C207      - Steel pipe flanges 4" through 144".  
1994

AWWA: C208      - Dimensions for fabricated steel water pipe fittings.  
1996

AWWA C210-97      Liquid epoxy coating systems for the interior and exterior of steel water pipelines

AWWA C222-99      Polyurethane coatings for the interior & exterior of steel water pipe & fittings

#### **British Standards Institution**

BS 970                Specification for wrought steels

BS 2494               Materials for elastomeric joint rings for pipe work and pipelines

BS 2633               Class I arc welding of ferritic steel pipe work for carrying fluids

#### **Canadian Standards Association**

CSA Z245.20        External Fusion Bond Epoxy Coating for Steel Pipe

CSA Z245.21        External Polyethylene Coating for Pipe

### European Standards

EN 1179	Zinc and zinc alloys – Primary zinc
EN 10240	Internal and/or external protective coatings for steel tubes - Specification for hot dip galvanized coatings applied in automatic Plants

### International Organization for Standards

ISO 544	Welding consumables - Technical delivery conditions for welding filler materials - Type of product, dimensions, tolerances and markings
ISO 752	Zinc ingots
ISO 2808	Paints and varnishes - Determination of film thickness
ISO 8501-1	Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of un-coated steel substrates and of steel substrates after overall removal of previous coatings.
ISO 8502-3	Preparation of steel substrates before application of paint and related products - Tests for the assessment of surface cleanliness Part 3: Assessment of dust on steel surfaces prepared for painting (pressure-sensitive tape method)
ISO 8504-2	Preparation of steel substrates before application of paints and related products – Surface preparation methods – Part 2: Abrasive blast cleaning.
ISO 11125	Preparation of steel substrates before application of paints – Metallic blast-cleaning abrasives.
ISO 11127	Preparation of steel substrates before application of paints – Non-metallic blast-cleaning abrasives.

### NACE International

NACE TM0102	Measurement of Protective Coating Electrical Conductance on Underground Pipelines
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### South African Bureau of Standards

SANS 32	See EN 10240
SANS 62-1	Steel pipes Part 1

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SANS 121 (ISO 1461)	Hot-dip galvanised coatings on fabricated iron and steel articles
SANS 630	Decorative high gloss enamel paints
SANS 681	Undercoats for paints
SANS 719	Electric welded low carbon steel pipes for aqueous fluids (large bore)
SANS 1091	National colour standard
SANS 1117	Plastics wrappings for the protection of steel pipelines
SANS 1130	Fibre reinforcing material for pipe wrapping
SANS 1178	The production of lined and coated steel pipes using bitumen or coal tar enamel
SANS 1200 L	Standardized specification for civil engineering construction Section L: Medium-pressure pipe lines
SANS 1217	Internal and external organic coating protection for buried steel pipelines
SANS 1274	Coatings applied by the powder-coating process
SANS 1319	Zinc phosphate primer for steel
SANS 1344	Medium duty solvent detergent
SANS 1365	Solvent degreasers that contain chlorinated hydrocarbons
SANS 1700	Fasteners
SANS 2063	Thermal spraying - Metallic and other inorganic coatings - Zinc, aluminium and their alloys
SANS 5770	Preparation of steel substrates before the application of paints and related products - Test for the assessment of cleanliness of blast-cleaned steel surfaces - Freedom from certain soluble salts
SANS 5772	Preparation of steel substrates before the application of paints and related products - Surface roughness characteristics of blast-cleaned steel surfaces - Profile of blast-cleaned surfaces determined by a micrometre profile gauge
SANS 10044	Welding
SANS 10064	The preparation of steel surfaces for coating
SANS 10120-3 HC	Code of practice for use with standardized specifications for civil engineering construction and contract documents Part 3: Guidance for design Section HC: Corrosion protection of structural steelwork

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SANS 10129	Plastics tape wrapping of steel pipelines
SANS ISO 14713	Protection against corrosion of iron and steel in structures - Zinc and aluminium coatings - Guidelines

## ANNEXURE B: PAINT COLOUR CODING

### MECHANICAL AND GENERAL

ITEMS	COLOUR	SANS 1091 CODE
Structural steel, Gates	Light grey	G29
Hydraulic power Pack	Strong blue	F11
Hydraulic oil	Salmon pink	A40
Hazardous objects/areas (restricted headroom, crane hook etc.)	Golden yellow with black chevron	B49*
Handwheels and levers	Golden yellow	B49
Handrails: vertical	Black	
- horizontal	Golden yellow	G49
Handrails on dam walls	Un-coated	
- Aluminium	Un-coated	
- Stainless steel	Light grey	G29
- Galvanized		
Floors:		E14
- safe and walking areas	Emerald green	B49*
- restricted areas	Golden yellow	
- open flooring (gratings) – MS galvanized	Un-coated	
3Cr12		
Stainless steel	Un-coated	
	Un-coated	
Fire protection Plant	Signal red	A11*
Control panels	Eau de nil	H43

### PUMP STATION

ITEMS	COLOUR	SANS 1091 CODE
Electric motors	Light beige	C57
Pumps/control valves: for raw water	Apple green	H29
for chem-treated water	Middle blue	F07
Fan and coupling guards	Signal red	A11*
Base plates	Black	
Overhead traveling cranes	Golden yellow	B49
Isolating valves: for raw water	Brilliant green	H10

ITEMS	COLOUR	SANS 1091 CODE
for chem-treated water	Arctic blue	F28

## ELECTRICAL

ITEMS	COLOUR	SANS 1091 CODE
Low voltage panels: Indoor	Light orange	B26*
Outdoor	Light orange	B26
Medium voltage panels: Indoor	Admiral grey	G12
Outdoor	Admiral grey	G12
Panel accessories (gland plates, back plates, interior)	White	
UPS Plant items	Light orange	B26
Transformers	Light stone	C37
LV distribution kiosks, mini subs	Light stone	C37
Standby electrical Plant items(Permanently powered)	Signal red	A11*
General outdoor	Light grey green	H40
All Plant– interior	White	

## WATER TREATMENT PLANT

ITEMS	COLOUR	SANS 1091 CODE
Plant	Same colour of respective pipe work	
Handwheels (remote valves)	Same colour of respective pipe work	
PIPE WORK		
Raw water	Brilliant green	H10
Chemical treated raw water	Verdigris green	E22
Clarified raw water	Eau de nil	H43
Filtered water	Pale blue	E39
Chlorinated filtered water	Arctic blue	F28
Backwash water	Cornflower blue	F29
Air saturated water	Turquoise blue	E18
Wash water recovery	Middle buff	B33

## SEWAGE PIPE WORK

ITEMS	COLOUR	SANS 1091 CODE
Raw sewage	Dark earth	B11
Settled sewage effluent	Brilliant green	H10
Biologically treated sewage effluent	Verdigris green	E22
Final/chlorinated effluent	Eau de nil	H43
Digested sewage sludge	Middle brown	B07
Raw sewage sludge	Dark brown	B03
Humus sludge	Golden brown	B13
Return activated sludge	Golden brown	B13
Waste activated sludge	Middle brown	B15
Supernatants/underflows returning to head of works	Middle buff	B33

## DOSING/CONTROL PIPE WORK

ITEMS	COLOUR	SANS 1091 CODE
Poly-electrolyte	Pinotage	A08
Alum/Ferric chloride	Jacaranda	F18
Chlorine solution	Primrose	C67
Chlorine gas	Lemon	C54
Chlorine liquid	Light orange	B26
Lime slurry	Biscuit	B64
Lime hydrated	Biscuit	B64
Lime saturated water	Biscuit	B64
Air/compressed air	White	
Steam	Pastel grey	G54

**NOTE:** Colours marked thus \* are restricted for specified Plant only.

# **SPECIFICATION: Zut 1001**

## **Permanent Ladders**

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## 1. INTRODUCTION

Zut 1001 specifies the standard requirements for permanent metal ladders to be provided by the Contractor.

Permanent ladders shall comply with the requirements of the OHS Act.

## 2. SCOPE OF WORKS

See project specification.

The installation shall be configured as shown on applicable drawings.

## 3. NORMATIVE REFERENCES

Where this specification is required for a project, the following documents shall, inter alia, form part of the Contract Document:

- Amendments. Amendments, Additions and Detailed Requirements (Zut 1001).
- Zut 0001: General Mechanical Requirements.
- Zut 0003: General Corrosion Protection for Pipelines, Water and Waste Water Works.
- The Occupational Health and Safety Act and Regulations.

Equipment, materials and operational methods shall comply with the latest edition of relevant national and/or international standards.

## 4. CONSTRUCTION & DESIGN

### 4.1 LADDER

The width between strings shall be between 400 mm and 500 mm.

The rise height shall be between 250 mm and 300 mm. All rises in a flight shall be uniform.

A minimum clear space of 230 mm shall be provided behind the rungs along the full height of the ladder.

The distance between anchoring supports shall not exceed 2 000 mm.

Strings, rungs and supports shall be of solid structural sections (e.g. flat bar, round bar, square bar, angles, etc.). Hollow sections are not acceptable for any part of the ladder.

Strings shall be formed from 65 mm X 10 mm flat bar; or larger section.

Rungs for stainless steel ladders shall be one of the following (in order of preference):

- 20 mm stainless steel rebar.

- 20 mm stainless steel round bar with knurled (or otherwise roughened) surface.
- 20 mm stainless steel surface roughened square bar (with sides horizontal and vertical; i.e. not diamond configuration).

Rungs for hot-dip galvanised carbon steel ladders shall be one of the following (in order of preference):

- 20 mm carbon steel rebar,
- 20 mm carbon steel round bar,
- 20 mm carbon steel square bar (with sides horizontal and vertical; i.e. not diamond configuration).

Rungs shall be welded to strings. It is not required that rungs penetrate strings.

The top rung shall be level with the upper landing. Additional rungs shall be provided in the same horizontal plane as the top rung in order to close the gap behind the ladder. These additional rungs shall have a spacing of approximately 75 mm.

## **4.2 TOP STRUCTURE**

The strings shall extend to at least 1 100 mm above the upper landing and shall complement any guard rails at this level.

The top structure shall be rigid and shall be designed so that the climber's hand slides along the gripped members without snagging.

Access to the head of ladders from platforms and walkways shall be protected by self-closing gates or by chains.

Ladder/guard rail connections between stainless steel and hot-dip galvanised steel shall be bolted.

Footings onto concrete shall have minimum dimensions of 150 mm X 150 mm X 10 mm plate thickness. If the horizontal surface to which the foot is to be fastened is less than 150 mm wide, the foot shall be designed to be seated securely on at least two surfaces. Four fasteners, of minimum size M16, shall be used to anchor the foot.

Footings onto steel structures shall have minimum dimensions of 150 mm X 60 mm X 8 mm plate thickness. Two fasteners, of minimum size M16, shall be used to secure each foot. Neatly fitting packing, Denso tape or equivalent, shall be fitted under the feet to completely seal the crevices between the two metallic surfaces.

## **4.3 CAGE**

If the ladder exceeds 5 000 mm in length, it shall be provided with a cage which extends from 2 300 mm above ground level to at least 1 100 mm above the upper landing served by the ladder. The cage shall comprise no fewer than five vertical elements in addition to the strings. The vertical distance between horizontal hoops shall not be greater than 1 000 mm.

The safety cage "shall afford firm support along its whole length for the back of the person climbing the ladder, and for which purpose no part of the cage shall be more than 700 mm away from the level of the rungs." (as per OHS General Safety Regulations). The preferred dimension is 650 mm.

Hoops and verticals shall be formed from 50 mm X 8 mm flat bar, or larger.

#### **4.4 PLATFORMS**

Platforms shall be provided in accordance with the requirements of the OHS Act.

Ladders with a height greater than 10 metres shall be provided with intermediate landings which are spaced apart by not more than 8 metres.

Platforms and landings shall be 850 mm X 850 mm or larger. They shall be provided with guard rails and kick plates complying with Zut 0001.

#### **4.5 MATERIALS AND CORROSION PROTECTION**

Ladders, cages, etc. shall either be of stainless steel or shall be of carbon steel as specified elsewhere.

Carbon steel ladders shall be hot-dip galvanised after all fabrication has been completed. The unit shall be blasted and re-galvanised if it is welded, drilled or ground or the zinc layer is damaged by any fabrication activity.

Stainless steel shall be correctly pickled and passivated. All stainless steel surfaces shall be completely clear of ferrous stain upon commissioning.

Corrosion Protection shall comply with Zut 0003.

#### **4.6 FABRICATION**

Fabrication and welding shall comply with Zut 0001.

#### **4.7 FASTENERS**

Anchor bolts in concrete and brickwork shall be of EN Grade 1.4401 (316), or better, and shall be no smaller than M16. Other bolts may be of hot-dip galvanised steel unless specified otherwise.

Fasteners shall comply with the clause "Fasteners" in Zut 0001.

### **5. INSTALLATION**

Installation work shall comply with Zut 0001.

Access for installation of permanent ladders is normally hazardous and, as for all of the Works, the Contractor shall ensure that all such work is executed in accordance with the requirements of the OHS Act and other applicable national regulations.

### **6. CIVILS AND BUILDING**

As required in terms of the General Conditions, the Contractor shall:

- provide the details of civil and building requirements to the Engineer for incorporation into the structure.
- at an appropriate point, measure on Site in order to check for correctness for the Works.

The Contractor shall ensure that the design can accommodate a tolerance of +/- 40 mm for civil and building items constructed by others (unless a tighter tolerance is called for by the Contractor in good time and approved by the Engineer).

## **7. INSPECTIONS**

The Contractor shall make arrangements for the Engineer to inspect the fabricated ladders for compliance prior to corrosion protection and prior to payment being made.

The Contractor shall arrange for the Engineer to inspect the completed installation before commissioning.

# **SPECIFICATION: ZUT 1003**

## **Lifting Equipment**

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## 1. PREAMBLE

Part A of Zut 1003 specifies general requirements for all lifting equipment to be provided by the Contractor.

Part B of Zut 1003 specifies additional specific requirements for the following types of lifting equipment;

- Steel gantries.
- Travelling cranes.
- Hoists.
- Manual hoist trolleys.
- Crawl beams.
- Davits.
- Hand cranked winches.

## **PART A:** **GENERAL REQUIREMENTS FOR ALL LIFTING EQUIPMENT**

## 2. SCOPE OF WORKS

The project specification defines the Contractor's responsibility for providing lifting equipment such as steel gantries, travelling cranes, hoists, hoist trolleys, crawl beams, davits and/or hand cranked winches.

The installation shall be configured as shown on applicable drawings.

## 3. NORMATIVE REFERENCES

The following form part of the Contract Document:

- a) Amendments, Additions and Detailed Requirements (Zut 1003).
- b) Zut 0001: General Mechanical Requirements.
- c) Zut 0003: General Corrosion Protection for Pipelines, Water and Waste Water Works.
- d) Zut 1001: Permanent Ladders.
- e) National Occupational Health and Safety Act and Regulations.
- f) SANS 50025: Hot Rolled Products of Structural Steels.
- g) SANS 2063: Metallic and other inorganic coatings – Thermal spraying – Zinc, aluminium and their alloys.
- h) SANS 4310: Cranes – Test Codes and Procedures.

- i) SANS 10108: The classification of hazardous locations and the selection of apparatus for use in such locations.
- j) BS 466: Specification for Power Driven Overhead Travelling Cranes, Semi-Goliath and Goliath Cranes for General Use.
- k) BS 2573: Rules for the Design of Cranes. Specification for Classification, Stress Calculations and Design Criteria for Structures.
- l) BS EN 1011: Welding. Recommendations for welding of metallic materials.
- m) BS 4872: Specification for approval testing of welders when welding procedure approval is not required.

Equipment, materials and operational methods shall comply with the latest edition of the relevant national and/or international standard.

## **4. EQUIPMENT ELIGIBILITY**

Lifting equipment components provided by the Contractor shall have a successful record of use in similar applications locally and shall also have had at least three years of technical support locally. Service and spares shall currently be available.

## **5. PERFORMANCE REQUIREMENTS**

The lifting equipment shall safely lift any load between zero and the test load, and shall be capable of traversing the full operating footprint whilst holding these loads.

All travel movements shall be free of snatching, shuddering and crabbing over their full travel distances.

## **6. TECHNICAL REQUIREMENTS**

### **6.1 GENERAL**

Lifting equipment shall be in accordance with the OHS Act and Regulations of RSA and, in particular, with Regulation 18 of the Driven Machinery Regulations.

The guidelines given in the Southern African Steel Construction Handbook may be used where applicable and where these do not conflict with the technical standard or with Zut 1003.

The safe working load of the lifting equipment ("SWL") shall exceed the heaviest operational load to be lifted by at least 30 % (greater margins are specified in Zut 1003 for certain types of lifting equipment).

The SWL shall be permanently marked on all components.

The lifting equipment will be used for maintenance purposes.

The lifting equipment, when erected and installed, shall be of neat and workmanlike appearance, solidly and evenly supported, true to line, level, plumb and in proper working order.

The operating chains of manually operated hoists shall fall to one metre above floor level.

The complete installation shall be designed to handle the test load.

## **6.2 TECHNICAL STANDARD**

In accordance with 18. (1) (a) of the Driven Machinery Regulations of the OHS Act of RSA, lifting equipment shall be designed and constructed in accordance with a generally accepted technical standard for lifting equipment.

The standard used shall be noted on all Contractor's drawings submitted for acceptance.

## **6.3 MANUFACTURER'S IDENTIFICATION PLATE**

In accordance with 18. (1) (c) of the Driven Machinery Regulations of the Occupational Health and Safety Act of RSA, the manufacturer's identification plate shall be fixed to the equipment and shall display the manufacturer, the design standard, the serial number and the country of origin.

## **6.4 FABRICATION, FASTENERS AND ANCHORING**

Fabrication and welding shall comply with Zut 0001.

Hollow sections are not acceptable as structural members unless the section is fully closed to the atmosphere.

Fasteners shall comply with Zut 0001. Steel foot-plates for securing steel structures to concrete shall have a minimum of four anchor bolts. Anchor fasteners shall have a diameter of not less than M16 and shall be of EN Grade 1.4401 (316), or better. Other fasteners, including high tensile fasteners, shall be of stainless steel or of hot-dip galvanised steel. Fasteners which form standard parts of proprietary equipment and do not comply with these requirements will require an additional anti-corrosion coating to suit the environment.

Chemical anchor shall not be used where the load is hung on the anchor fastener. Such anchors shall preferably be through-bolted. Mechanical anchors will also be acceptable on condition that application of the test load on the completed installation shall not cause the loading on the anchor to exceed 45 % of the anchor manufacturer's recommended loading at any position of the load.

## **6.5 CORROSION PROTECTION**

Components shall be designed for corrosion resistance to the high corrosivity category (C4) of SANS 12944-2.

Surface abrasive blasting to Sa 2,5 is a minimum requirement prior to the application of any corrosion protection coating (with the exception of hot dip galvanising).

Corrosion protection shall comply with Zut 0003.

Materials shall comply with Zut 0001.

Stainless steel shall be correctly pickled and passivated. Stainless steel surfaces shall be free of ferrous stain and heat tint at commissioning.

Metal plating of ferrous materials is not an acceptable corrosion protection system.

Steel and cast iron items which have been hot dip galvanised but which are then welded, cut, ground, drilled or have the base metal exposed by any other means shall be rejected.

## **6.6 MOTORS**

Motors shall comply with Zut 0001.



Motors shall have ingress protection to at least IP 55 and shall comply with the electrical specifications.

Electronic variable speed drives are acceptable for both hoisting and for travel but the control system shall prevent the motor from being overloaded under all load conditions.

## **6.7 WHEELS**

All wheels shall be provided with a fail to safe device ("drop stop") in case of wheel or axle breakage.

## **6.8 FACTORS OF SAFETY**

The factors of safety for cables, chains, webbing, fibre ropes etc. shall comply with the requirements of the Driven Machinery Regulations of the Occupational Health and Safety Act of RSA.

# **7. CIVILS AND BUILDING**

## **7.1 INTERFACES**

As required in terms of the General Conditions, the Contractor shall:

- provide the details of civil and building requirements to the Engineer.
- at an appropriate point, measure on Site.

The Contractor shall ensure that the design can accommodate a tolerance of +/- 40 mm for civil and building items constructed by others unless a tighter tolerance is called for by the Contractor in good time and accepted by the Engineer.

## **7.2 PROGRAMMING**

The installation of lifting equipment normally has to be programmed in conjunction with others and the Contractor shall consult with the Engineer timeously on this.

The Contractor shall submit a programme detailing all of the Works.

# **8. ELECTRICAL EQUIPMENT**

Electrical Equipment shall comply with the electrical specifications.

# **9. INSPECTIONS**

## **9.1 WORKSHOP/FACTORY**

### **9.1.1 Fabrications**

The Contractor shall arrange for the Engineer to inspect fabrications at the following stages:

- a) after fabrication. During this inspection and in the presence of the Engineer, the Contractor shall conduct dye penetrant testing of all fillet, butt and lap welds on structural

members. This shall include welding of peripheral items onto structural members (such as brackets for attachment of platform supports).

- b) after blasting.
- c) after the final coat (but before the items are transported from the coatings yard).

### **9.1.2 Equipment**

The Contractor shall make all arrangements and carry all costs for the Engineer to inspect the equipment for acceptance prior to despatch to Site and prior to payment being made.

## **9.2 SITE**

The Contractor shall make arrangements for the Engineer to inspect the completed installation on Site prior to commissioning.

## **9.3 INSPECTION DURING DEFECTS NOTIFICATION PERIOD**

The Contractor shall check the operation of the Works three months after the start of the Defects Notification Period and shall provide a condition report on all equipment to the Engineer.

# **10. TESTING, CERTIFICATION AND USE OF EQUIPMENT**

## **10.1 TESTING**

Lifting equipment and installations shall be tested after installation. The Contractor shall comply with all aspects of SANS 4310.

In accordance with SANS 4310, the test load shall be 1,25 times the SWL or greater if required by the design standard. This test load shall be traversed over the full range of operation in order to test the structure in every position.

The Contractor shall conduct the testing procedures, shall provide the test weights and shall arrange for the Engineer to witness this test.

The test certificates shall be submitted to the Engineer and shall be included in the Manual.

## **10.2 CONTRACTOR'S USE OF LIFTING EQUIPMENT**

The Contractor may use the lifting equipment for the installation of other parts of the Works if testing and certification for the complete lifting installation has been successfully completed.

## **10.3 EMPLOYER'S USE OF LIFTING EQUIPMENT**

The lifting equipment shall be available for the Employer's use after the commissioning has been done, after the taking over has occurred and after the Defects Notification Period has started. The Contractor shall provide the following:

- the required inspections [18.(6) of the Driven Machinery Regulations of the OHS Act of RSA] within the previous three months, and;
- the testing required by [18.(5) of the Driven Machinery Regulations of the OHS Act of RSA] within the previous six months,

so that the equipment can immediately be used by the Employer fitly and legally. The Contractor shall provide confirmatory documentation at commissioning.

**PART B:**  
**ADDITIONAL REQUIREMENTS FOR PARTICULAR TYPES OF**  
**LIFTING EQUIPMENT**

**11. STEEL GANTRIES**

A “gantry” is the structure which supports the lifting equipment. Steel gantries shall comply with *Zut 1003 Part A: General Requirements for All Lifting Equipment* and with the additional requirements of this sub-clause.

**11.1 GENERAL**

The same technical standard used for design of the crane or crawl beam shall be used for the steel gantry design.

Gantry columns shall be cross-braced and/or “triangulated” in more than one plane; i.e. columns shall not be cantilevered in any vertical plane.

The test load shall be permanently displayed.

**11.2 CORROSION PROTECTION**

Gantry steelwork shall be hot-dip galvanised.

If it is not feasible to hot dip galvanise the gantry steelwork, it shall be protected by a duplex system consisting of hot-metal zinc-spray, sealant and coating in accordance with the requirements for travelling cranes in Zut 1003.

**12. TRAVELLING CRANES**

“Travelling Cranes” refers to:

- Overhead travelling cranes.
- Goliath cranes.
- Semi-goliath cranes.

Travelling cranes shall comply with *Zut 1003 Part A: General Requirements for All Lifting Equipment* and with the additional requirements of this clause.

**12.1 REQUIREMENTS FOR ALL TRAVELLING CRANES**

**12.1.1 Certificate**

The Contractor shall submit a certificate from the crane manufacturer which certifies that the crane has been manufactured in accordance with the requirements of the Driven Machinery Regulations of the Occupational Health and Safety Act. It shall also refer to the technical standard used and shall state the SWL and the test load.

This certificate shall be provided to the Engineer prior to delivery of the crane to Site.

### **12.1.2 Configuration**

The long travel, cross travel and hook travel shall be electrically powered.

The lowest hook level shall be floor level of the area to be serviced.

Cranes shall be designed with suitable dimensions, wheel spacings and gusset plates or diagonal bracing to prevent slewing. The wheel base of end carriages shall be at least one seventh of the crane span.

End stops with rubber buffers shall be fitted to prevent the hoist from moving off the travelling beam. Stops and buffers are also required to limit the travel on the long travel rails.

### **12.1.3 Construction**

Construction shall be in accordance with BS 466 and BS 2573 (or BS EN 13 001), as applicable. Suitable equivalent standards are acceptable.

Welding of steelwork shall be carried out in accordance with BS EN 1011 by competent artisans meeting the requirements of BS 4872. Suitable equivalent standards are acceptable.

Materials shall be new and unused and suited to the application. Structural steel shall comply with the requirements of SANS 50025 for grade S 355 JR or for grade S 355 JO.

### **12.1.4 Operation**

All three directions of travel shall be driven by motors with a minimum of two speeds. Drive shall preferably be by electronic variable speed drives. Starting and stopping shall be smooth. Inching capability shall be provided for all three directions of travel. Both long and cross travel shall revert to low speed prior to contact with the end stops.

### **12.1.5 Long Travel Rails**

The long travel rails shall be standard rail sections to DIN 536, or equivalent. Square section steel bar is not acceptable.

Rail lengths shall be joined using fish-plates which shall provide the crane wheels with a smooth passage across the join. Each fish-plate shall have at least four fasteners.

Rails shall be secured with rail fastenings at a spacing not greater than one metre.

Every rail length shall be supported at both its ends.

### **12.1.6 Crane Hoists**

Hoists are specified elsewhere in Zut 1003.

### **12.1.7 Machined Components**

Gear wheels and other machined components shall be fully enclosed against dust and externally mounted components shall have ingress protection to at least IP 55.

Bearings shall be mounted in sealed, cast iron bearing housings and shall be provided with grease nipples.

### **12.1.8 Electric Cabling**

Electric cables for cranes with a distance of up to 30 metre long travel shall be of the insulated, festooned type. Winding drum cables shall be provided with protection for the full length of the

cable lay so that accidental damage is prevented; e.g. it shall not be possible to walk on the cable. Travelling brush contacts are not acceptable on wastewater treatment works and in other corrosive and hazardous environments.

Cabling shall be suitable for the applicable hazardous zone classification.

#### **12.1.9 Corrosion Protection**

Long travel rails shall be hot-dip galvanized.

The crane beam and end carriages shall be hot-metal zinc-sprayed and sealed and coated as follows:

- the thermal spray metal coating shall be in accordance with SANS 2063.
- the minimum zinc coating thickness shall be 150 µm.
- the sealant shall consist of the application of a two-part epoxy primer to a dry film thickness of 40 µm; (Carboline Rustbond Penetrating Sealer, Intergard 269, thinned Carboguard 545, or equivalent.
- the coating shall consist of at least two coats of a two-part polyurethane enamel to a minimum combined dry film thickness of 70 µm.

Small items, such as cable brackets and protective covers, shall be hot-dip galvanized.

The Contractor shall arrange for the fabrication of the crane to be inspected by the Engineer for acceptance at the fabricator's premises prior to corrosion protection.

Corrosion protection shall comply with Zut 0003.

#### **12.1.10 Installation**

The long travel rails shall be straight, over their entire length, to within the permissible deviations in BS 466.

Long travel rail anchor fasteners shall be M16 or larger and shall be of EN Grade 1.4401 (316) or better.

Crane rails which are mounted directly on concrete beams shall be grouted along the full length of the rails. Grouting shall be done using a non-shrink, cementitious grout, ABE Duragrout 1000 or equivalent, to the acceptance of the Engineer and in accordance with the manufacturer's instructions. A suitable gap between the rails and the beam shall be provided for application of the grout. The grout shall be applied to a clean, scabbled concrete surface strictly in accordance with the manufacturer's instructions. The grout shall be neatly finished with a 45° chamfer. The Engineer shall be notified prior to application of the grout.

Shims shall be fully grouted in to provide corrosion protection.

#### **12.1.11 Signage**

The test load shall be permanently displayed.

#### **12.1.12 Access for Installation**

The Contractor shall determine a suitable method of installation and shall timeously submit an installation method statement to the Engineer for acceptance.

### **12.2 OVERHEAD TRAVELLING CRANES – ADDITIONAL REQUIREMENTS**

Overhead travelling cranes shall comply with the Requirements for All Travelling Cranes and with the additional requirements of this sub-clause.

### 12.2.1 Hoist, Hoist Trolley, Crane Beam, End Carriage, Long Travel Rail, Rail Beam and Gantry

The **gantry** shall be founded on the ground.

The **crane rail beams** shall be supported on the gantry. These beams shall be of hot dip galvanised steel unless the drawings indicate that they are of reinforced concrete. If the beams are of reinforced concrete, they will be provided by others but the Contractor shall timeously submit the requirements for loading and for fixing and installation of the long travel rails and shall be responsible for performing this work.

The **long travel rails** shall be supported on the crane rail beams.

The **end carriages** at each end of the crane beam shall travel on the long travel rails.

The **crane beam** shall be a steel structure and may consist of more than a single beam. It shall be supported at each end on the end carriages.

The **hoist** and **hoist trolley** shall travel along the crane beam. On single girder cranes, the hoist trolley may travel on the section flange. On double girder cranes, the hoist and hoist trolley shall travel on rails mounted on top of the girders.

### 12.2.2 Rails

#### 12.2.2.1 Single Girder Crane

The long travel rails shall be supported on the crane rail beams.

The cross travel will not require rails.

#### 12.2.2.2 Double Girder Crane

The long travel rails shall be secured on the crane rail beams.

The cross travel wheels shall move on cross travel rails which are secured to the top of the girders.

### 12.2.3 Control

Electrical control pendants shall be arranged to move independently along the length of the crane beam and shall hang to one metre above operating floor level.

Independent radio control modules are also acceptable on condition that all operating functions are also provided on a suitably located wall mounted control panel. The control panel shall incorporate a switch to alternate between the two methods of operation.

### 12.2.4 Maintenance Platform and Ladder

Overhead travelling cranes which have a SWL above 3 000 kg shall be provided with a platform for maintenance. The platform shall span the full length of the crane beam and shall be designed for at least two people.

The crane beam structure shall incorporate welded brackets onto which the platform shall be bolted; i.e. the platform shall be removable and shall not be welded to the crane beam. The platform floor shall have a minimum width of 500 mm and shall comply with Zut 0001 for grid flooring. Guard rails with toe plates shall be provided on the platform and shall comply with Zut 0001. The complete platform and all guard-railing shall be hot-dip galvanised after fabrication.

A hot-dip galvanised, fixed steel ladder shall be provided at a suitable position within the building for accessing the platform on the crane. This shall comply with Zut 1001.

The design shall ensure that persons on the platform cannot be injured by crane movement.

### 12.3 GOLIATH AND SEMI-GOLIATH CRANES – ADDITIONAL REQUIREMENTS

Goliath and Semi-Goliath cranes shall comply with the Requirements for All Travelling Cranes and with the additional requirements of this sub-clause.

The requirements for Goliath and Semi-Goliath Cranes are as follows:

- Goliath and Semi-Goliath cranes shall be provided with an operator's cab which is mounted on the crane. All controls in the cab shall be of the "dead man's handle" type.
- A platform shall be provided to allow inspection of the hoist and cross travel.
- A ladder shall be provided on one of the legs in order to provide safe access to the cab and platform. The ladder shall comply with Zut 1001. A stairway is also acceptable in which case it and its guard rails shall comply with Zut 0001.
- The position of the cab, platform and ladder shall be decided in conjunction with the Engineer.
- A cow catcher shall be provided at each long travel wheel. These shall be designed to push a person's foot away and, thereby, prevent injury during movement of the crane. They shall incorporate a flat, horizontal top surface onto which a person can climb if required.
- The long travel rails shall be provided with a protective cage at each end so that vehicular access over them is blocked.
- During movement of the crane along the long travel rails, a warning buzzer shall sound. This buzzer shall be audible at all points of the installation.
- If counterweights are required to stabilise the crane under the test load at the limits of travel, then these shall be of solid material which is permanently attached to the structure; i.e. water ballast is not acceptable.

## 13. HOISTS

Hoists, including crane mounted hoists, shall comply with *Zut 1003 Part A: General Requirements for All Lifting Equipment* and with the additional requirement of this Clause.

### 13.1 GENERAL

Hoists shall be provided with an overload prevention device.

The lifting length shall be sufficient to service the intended equipment.

The bottom hook shall swivel on a ball or roller bearing through 360° and the bearing shall have a protective skirt. Bearing design shall be fail-to-safe ("drop stop"). The hook shall be fitted with a sprung safety latch.

Chain hoists shall be provided with chain boxes for holding unloaded lengths of load chain and these shall be provided with drain holes.

### 13.2 MANUAL HOISTS

The operating chain shall be as short as practical to prevent entanglement with the lifting chain.

The hoist shall hold the load stationary during both lifting and lowering operations if the operating chain is released.

### 13.3 POWERED HOISTS

Powered hoists shall comply with Driven Machinery Regulation 18 of the OHS Act of RSA.

Lifting chain is preferred for hoists of up to 5 tonnes but corrosion-protected steel wire rope is acceptable where appropriate.

Wire rope hoists shall comply with the following:

- a) Drum diameter shall be at least 25 times the wire rope diameter.
- b) Drums shall have no more than three layers of wire rope when fully wound up.
- c) Drums shall have no fewer than three full turns of wire rope remaining when the hook is at the lowest level.

Powered hoists shall hold the load stationary upon power failure.

## 14. MANUAL HOIST TROLLEYS

Manual Hoist Trolleys shall comply with Zut 1003 *Part A: General Requirements for All Lifting Equipment* and shall comply with the additional requirements of this clause.

The requirements for manual hoist trolleys are as follows:

- Manual hoist trolleys shall have chain/gear operated movement.
- The operating chain shall be as short as feasible in order to prevent entanglement.

## 15. CRAWL BEAMS

Crawl Beams shall comply with Zut 1003 *Part A: General Requirements for All Lifting Equipment* and shall comply with the additional requirements of this clause.

The requirements for Crawl Beams are as follows:

- Crawl beams shall be standard hot rolled I-Sections or standard hot rolled H-Sections.
- Crawl beams shall be hot-dip galvanised after all fabrication is complete. If the steel is exposed after galvanising by drilling or welding or any other activity, the complete beam shall have the zinc removed by abrasive blasting to bare steel and it shall be returned to the galvanisers for hot-dip galvanising. Patch repairs are not acceptable.
- Crawl beam anchors shall preferably be through bolted; i.e. through the concrete slab. Expanding bolts are acceptable on condition that the loading during testing does not exceed forty percent of the manufacturer's maximum recommended load. Chemical anchor is not acceptable if the load is in line with the anchor.
- Crawl beams fastened to steel support structures shall be secured using hot-dip galvanised fasteners.
- Fasteners shall be provided with spring washers in addition to the flat or fender washer.

## 16. DAVITS

Davits shall comply with Zut 1003 *Part A: General Requirements for All Lifting Equipment* and shall comply with the additional requirements of this Clause.



The requirements for davits are as follows:

- Davits shall be column mounted with swivelling booms.
- The foot of the column shall be securely anchored. The foot plate shall have a thickness of at least 16 mm and the column shall be provided with gussets between the column and the anchors. Anchors shall be proprietary units (threaded bar is not acceptable) and the drilling depth shall comply with the manufacturer's instructions. Anchors shall be of EN Grade 1.4401 (316) stainless steel or better and shall be of size M20 or larger. Each foot plate shall have a minimum of six anchors.
- The davit shall be designed for a SWL at least 100 % greater than the maximum load requirements.
- A platform shall be provided if required to allow safe use of the davit and, if applicable, its winch.
- The davit shall be manufactured of LDX 2101 or of EN Grade 1.4401 (316), or better, or of hot dip galvanised carbon steel. All fasteners, pins, shafts, shackles, hooks, etc., shall be of EN Grade 1.4401 (316), or better. Guide pulleys and shafts shall be made of EN Grade 1.4401 (316) or other accepted corrosion resistant material, and shall use self-lubricating bearings.
- The slewing arrangement shall be designed for easy operation, shall be accurately fitted and shall not be subject to corrosion. Bushes made of nylon, "Vesconite" or other suitable non-metallic material shall be used and any metallic mating face shall be of stainless steel. The distance between bushes shall be at least one third of the total height of the davit above its footing.
- A lever shall be provided to facilitate rotation of the davit.
- Operating levers, locking arrangements, fixing arrangements, etc., shall not present a hazard. If necessary, operating levers shall be hinged so that they can be swung out of the way when not in use.
- Guide pulleys shall be provided to suit the arrangement. The pulley effective diameter shall be not less than 25 times the wire rope diameter. These pulleys shall be machined with a groove having a radius 5 % to 7,5 % greater than the rope radius. The groove depth shall be twice the rope diameter or greater.
- Where specified, each davit shall be provided with a winch rigidly bolted to the davit. If hand cranked, the winch shall be provided at a convenient height and position for operation.

## **17. HAND CRANKED WINCHES**

Hand Cranked Winches shall comply with Zut 1003 *Part A: General Requirements for All Lifting Equipment* and shall comply with the additional requirements of this clause.

The requirements for hand cranked winches are as follows:

- Hand cranked winches shall be rated for a SWL of at least 100 % in excess of the maximum working load. All gears, clutches, etc., shall be enclosed in a robust cast iron, cast steel or fabricated stainless steel casing which shall be lubricated and sealed against ingress of dirt and moisture.
- The winch shall hold the load stationary when the hand crank is released during both raising and lowering. In addition, an operator controlled positive locking arrangement to lock the position of the load at any point shall be provided. A simple ratchet alone is not adequate.

- The force on the hand crank required to operate the winch when lifting its test load shall not exceed 110 Newtons.
- The wire rope shall be of stainless steel. The wire rope shall be long enough to reach the lowest required position and still have at least 3 turns remaining on the drum. The drum size shall neatly and easily accommodate the full rope length. The drum shall have a diameter of at least 25 times the diameter of the wire rope.
- Swaging of cables using crimped metal sleeves is preferred to clamping. Clamped cables shall be provided with at least three clamps. Cable ends shall be secured against fraying.
- The support brackets, all exposed fasteners, shafts, pins, etc., shall be of EN Grade 1.4401 (316) stainless steel, or better.

# SPECIFICATION: ZUT 1013

## Air Receivers

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## 1. INTRODUCTION

Zut 1013 specifies the requirements for air receivers to be provided by the Contractor.

## 2. SCOPE OF WORKS

See project specification.

The installation shall be configured as shown on applicable drawings.

## 3. NORMATIVE REFERENCES

The following form part of the Contract Document:

- a) Amendments, Additions and Detailed Requirements (Zut 1013).
- b) Zut 0001: General Mechanical Requirements.
- c) Zut 0003: General Corrosion Protection for Pipelines, Water and Wastewater Works.
- d) SANS 347: Categorization and conformity assessment criteria for all pressure equipment.
- e) SANS 1123: Pipe Flanges.
- f) SANS 12944-2: Paints and varnishes – Corrosion protection of steel structures by protective paint systems; Part 2: Classification of environments.
- g) Pressure Equipment Regulations of the Occupational Health and Safety Act 85 of 1993.

Equipment, materials and operational methods shall comply with the latest edition of relevant national and/or international standards.

## 4. APPROVED INSPECTION AUTHORITY

From Regulation 7 of the Pressure Equipment Regulations: *“Only an organisation holding an approved certificate from the chief inspector shall perform the duties of an approved inspection authority within the scope of accreditation.”*

## 5. EQUIPMENT ELIGIBILITY

The make and model of receiver provided shall have a successful record of use in similar applications locally and shall also have had at least three years of technical support locally.

Service and spares shall currently be available. Upgraded versions of a manufacturer's earlier designs which comply with these criteria are acceptable.

Equipment which does not satisfy these requirements is not acceptable unless called for in the specifications or unless the Engineer agrees in writing.

## **6. PERFORMANCE REQUIREMENTS**

Air receivers shall perform in accordance with the system requirements of the system.

The unit shall withstand the pressure testing.

The pressure relief valve shall blow off at the correct pressure.

## **7. DATA PLATE**

In accordance with sub-regulation 9 (2) of the Pressure Equipment Regulations of the Occupational Health and Safety Act, the air receiver shall have a permanently fixed nameplate which indicates:

- the manufacturer's name,
- the country of origin,
- the year of manufacture,
- the manufacturer's serial number,
- the design pressure in Pascals,
- the minimum and maximum design temperatures in degrees Celsius,
- the capacity in cubic metres,
- the unique mark of the approved inspection authority,
- the SANS 347 hazard category,
- the reference number, date and edition of the health and safety standard applicable to the design, construction and manufacture of receiver.

Receivers which are not provided with such a nameplate in the factory shall have the nameplate permanently affixed to a leg or other non-pressurised part of the structure.

The nameplate shall be designed to resist corrosion and to last the expected lifetime of the receiver.

## **8. DESIGN AND CONSTRUCTION**

### **8.1 CATEGORY**

The Contractor shall establish the SANS 347 hazard category and the conformity assessment module applicable to the receiver and shall submit this information to the Engineer.

## **8.2 RECEIVERS**

Air receivers shall be of welded construction. They shall be manufactured in accordance with the manufacturer's or importer's certificate of manufacture.

The design working pressure of the receiver shall be at least as high as the design working pressure of the compressed air system of which it forms a part.

The receiver shall incorporate two elliptical hand holes with oil resistant gaskets, one near each end of the cylindrical section. The hand holes shall be in addition to any screwed plugs.

The drain for condensate removal shall be at the lowest point of the receiver. The design, including the weld contour, shall ensure that condensate cannot collect in the receiver. The Contractor shall provide an automatic drain valve. The discharge shall be visible but shall not cause pooling near the receiver's feet.

Nozzles for inlet pipework, outlet pipework, pressure gauge, pressure relief valve, etc. shall be flanged (not threaded). The flanges shall comply with SANS 1123.

Isolating valves shall be provided upstream and downstream of the air receiver. These shall be rated for the test pressure.

The receiver shall preferably be mounted on three legs.

## **8.3 INTEGRAL RECEIVERS**

Air receivers which form an integral part of a mass produced unit (such as an oil separation device in a packaged rotary screw compressor unit) shall be provided with an importer's certificate of manufacture. Handholes will not be required if the diameter of the separator is too small to accommodate them physically.

The specified Site pressure testing and certification of such air receivers shall be done by the Contractor.

## **8.4 PRESSURE RELIEF VALVE**

A lockable pressure relief valve shall be provided and shall be directly mounted on a flanged nozzle on the air receiver. There shall be no intervening pipework or valve.

The valve shall be rated for the test pressure but shall be set at the correct blow off pressure.

A padlock, suitable for the corrosivity of the applicable environment, shall be provided.

## **8.5 PIPEWORK**

Pipework connections to the receiver shall be flanged.

## **8.6 FASTENERS**

Fasteners shall comply with Zut 0001.

## **8.7 PRESSURE GAUGE**

A suitably rated pressure gauge with isolating cock shall be mounted on the receiver. This shall have a diameter of not less than 100 mm, shall be calibrated in kPa and shall be permanently redline marked at the maximum safe working pressure of the air receiver.

The scale maximum shall exceed the hydraulic test pressure of the air receiver.

The gauge shall comply with Zut 0001.

## 9. MATERIALS AND COATINGS

Equipment shall comply with the table below. Components not specified in the table shall be designed to the very high - industrial category (C5-I) of SANS 12944-2.

ITEM	MATERIAL	COATING
Receiver	Manufacturer's standard	Internal Surface: Nil.
		External Surface: Inorganic zinc system or a micaceous oxide epoxy system. Top coat shall be a suitable gloss finish, colour coded and with UV resistance.
Flange fasteners	Carbon steel.	Hot dip galvanised.
Floor anchors	EN Grade 1.4401 (316)	N/A
Auxiliary metal components	EN Grade 1.4401 (316)	Pickled and passivated.
<b>NOTES</b> <ul style="list-style-type: none"> <li>- Stainless steel shall be correctly pickled and passivated. Stainless steel surfaces shall be free of ferrous stain and heat tint at commissioning.</li> <li>- Metal plating of ferrous materials is not acceptable as the corrosion protection system.</li> </ul>		

## 10. REQUIREMENTS FOR INSTALLATION

Installation of the receiver shall be in accordance with Zut 0001.

The installation shall comply with the applicable regulations of the Occupational Health and Safety Act and Regulations.

The receiver shall be installed on a concrete plinth with a minimum height of 70 mm.

Each foot shall be located by a floor anchor fastener, a penny washer and two nuts. The nuts shall be locked together but shall not bind the foot plate. The arrangement shall allow about 2 mm of movement in each horizontal direction. The fasteners shall be of EN Grade 1.4401 (316) stainless steel and shall be anchored with chemical anchor compound.

## 11. INSPECTIONS AND TESTING

The Contractor shall provide the following:

- The receiver installation, including all connected pipework, shall be inspected and accepted by the approved inspection authority before being commissioned.
- The installation shall be tested and certified by the approved inspection authority in accordance with sub-regulation 6. (2) (d) of the Pressure Equipment Regulation.
- The air receiver and its safety accessories shall, in accordance with sub-regulation 11(1)(a) of the Pressure Equipment Regulations, be subjected to a hydraulic pressure test by the approved inspection authority. The test shall be performed after installation and the test pressure shall be 1,25 times the design pressure of the receiver. This test shall be witnessed by the Engineer.

## 12. DOCUMENTS TO BE PROVIDED

The Contractor shall submit the following documents to the Engineer for acceptance:

- Confirmatory documentation for all inspection and testing activities specified.
- Confirmation of the SANS 347 hazard category.
- Calibration certificate for the pressure relief valve.
- Calibration certificate for pressure gauges.
- Manufacturer/Importer's certificate of manufacture in accordance with sub-regulation 4. (3) of the Pressure Equipment Regulations.
- Certificate for pressure test by the approved inspection authority.
- Certification by the approved inspection authority of the equipment installation in accordance with sub regulation 6. (2) (d) of the Pressure Equipment Regulation.
- Importer's certificate of manufacture for receivers which form an integral part of a mass produced unit (such as an oil separation device in a packaged screw compressor unit).

The Contractor shall provide copies of all documentation in the Manual.



# **SPECIFICATION: ZUT 4001**

## **Front Raked Screen**

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## **1. INTRODUCTION**

Zut 4001 specifies the requirements for channel mounted, chain driven, front-raked mechanical screens.

## **2. SCOPE OF WORKS**

See project specification. The project specification takes precedence over Zut 4001.

The installation shall be configured as shown on applicable drawings.

## **3. NORMATIVE REFERENCES**

Where this specification is required for a project, the following specifications shall, inter alia, form part of the Contract Document:

- a) Amendments, Additions and Detailed Requirements (Zut 4001).
- b) Zut 0001: General Mechanical Requirements.

Equipment, materials and operational methods shall comply with the latest edition of the relevant national and/or international standard.

## **4. EQUIPMENT ELIGIBILITY**

The make and model of screen provided shall have a successful record of use in similar applications locally and shall also have had at least three years of technical support locally. Service and spares shall currently be available. Upgraded versions of a manufacturer's earlier designs which comply with these criteria are also acceptable.

Screens which do not satisfy these requirements are not acceptable unless called for in the specifications or unless the Engineer agrees in writing.

## **5. PERFORMANCE REQUIREMENTS**

The screen shall be capable of operating correctly when subject to the specified range of flows in the channel.

The screen shall withstand the force of water against a blocked screen field without damage when the channel is full upstream and empty downstream and the raking shall operate successfully under this condition.

The rake comb shall engage the screen field freely and shall travel smoothly up to the discharge point. Objects with an effective diameter up to 250 mm shall be successfully removed without falling back into the channel.

The rake mechanism shall clear the full screen field and shall prevent accumulation of solids at the foot of the screen.

Solid matter shall not accumulate within the screen body or the discharge chute. It shall not be necessary for the operator to clear the unit.

Operation shall be jerk free.

The screen shall be designed to operate reliably when screening a wide range of types of solids because the exact composition of solids cannot be reliably predicted. The total solids loading of wastewater is random and variable but is normally about 0,3 kg/m<sup>3</sup>. A screen shall be capable of handling this loading at maximum flow and shall be capable of dealing with rags, hard solids, stringy solids, plastic and other solids which can be expected from a mixture of domestic and industrial wastewater.

## **6. OPERATION AND CONTROL**

### **6.1 GENERAL**

It shall be possible to start the operation of the rake mechanism of a screen by pushbutton. Protection systems shall function during manual starting and stopping.

It shall be possible to operate all the installed screens simultaneously.

Any process parameter which is monitored electronically shall be indicated on the SCADA and/or the HMI mimics (if these form part of the Contract).

Emergency stops shall be provided.

### **6.2 AUTOMATION**

The screen field shall be raked by the rake mechanism when the difference between the upstream level and the downstream level rises to a setpoint which indicates that the screen field has reached a certain degree of blockage. For this purpose, the level both upstream and downstream of the screen shall be measured by ultrasonic units.

Time based initiation of the rake cycle shall also be provided. The timer shall be initially set at 5 minutes. The setpoint shall be adjustable (with password protection) between 5 minutes and 30 minutes. One rake cycle shall consist of at least one complete rotation of the chain drive.

The unit's control system shall prevent damage to the screen field and the rake mechanism from obstructions by sensing an overload, stopping the rake movement and reversing the direction and then attempting to continue normally. This shall be attempted three times after which the raking action shall stop and an alarm shall be activated.

Over-torque protection shall be provided and shall be active in both forward and reverse directions of operation.

Operation of the screen shall be coordinated with the operation of downstream equipment and any other associated equipment necessary to convey the screenings to their final discharge point without blockage.

## **7. CONSTRUCTION AND DESIGN**

### **7.1 TYPE AND CONFIGURATION**

The screen shall be installed in a channel and shall be designed for motorised removal of solids from the flow in the channel. The screen field shall be cleared of screenings by a chain actuated rake which engages with the front of the screen field, collects the screenings in its upward movement and then deposits the screenings into a discharge chute.

### **7.2 SCREEN ELEMENT**

The screen field shall span the channel and shall extend to at least 200 mm above the maximum water level height.

The bars forming the screen field shall be robust and accurately aligned. Screen fields with a bar spacing of 6 mm or greater shall have a screen bar thickness of not less than 8 mm and a screen bar depth of not less than 40 mm. Bars shall have a rectangular cross section or shall have decreasing thickness in the direction of flow.

Flow velocity through the nominal (total) area of the screen field shall not exceed 0,9 m/s at the maximum specified flow.

The screen field shall be removable and replaceable without removing or dismantling the frame.

### **7.3 FRAME**

The screen frame shall be robust, rigid and durable. It shall be self-supporting and the screen unit shall be designed to be hoisted at lifting eyes when in fully assembled condition.

Screens which have side frames longer than four metres shall be provided with additional anchor supports in order to prevent flexing of the structure. Screens which protrude more than two metres above floor level shall be provided with additional support struts.

The cradle brackets which anchor the screen's frame at the top of the channel shall be of stainless steel with a wall thickness of not less than 4,5 mm. Each bracket shall be provided with at least 3 anchor fasteners per bracket. These anchors shall not be in a straight line.

### **7.4 GRIT**

The flow to be screened will contain grit. The design shall ensure reliability and shall provide adequate resistance to wear. Sliding contact between similar metals is not acceptable except for the screen field and rake comb.

### **7.5 RAKES**

Raking devices shall be provided on the chain drive every 1 900 mm (or closer).

The rake comb shall be replaceable.

### **7.6 WIPER**

The rake comb wiper shall have a non-metallic blade to wipe the screenings from the rake into the discharge chute. It shall be replaceable.

The wiper shall not be activated by metal on metal sliding contact. If the comb teeth are used to activate the wiper, the effective contact surface shall total at least 75 mm.

## **7.7 DISCHARGE CHUTE**

The discharge chute shall prevent screenings from hanging up.

## **7.8 ENCLOSURE**

The screen shall be enclosed above the top level of the channel for safety reasons.

Doors for inspection, cleaning and maintenance of the working parts shall be provided in front. A removable door shall also be provided at the rear in a position to allow inspection of the wiper mechanism.

The front doors at the operator's working level shall be provided with stainless steel hinges and shall open safely. Designs which place excess stress on the hinge when open are not acceptable. The doors shall be stable when both fully open and when fully closed. The height dimension of each door, in the direction of the chain drive, shall not be greater than 800 mm.

A duct with an area of at least 0,03 m<sup>2</sup> shall be provided at a high point for drawing off foul air.

## **7.9 BEARINGS**

### **7.9.1 General**

Rolling element bearings shall be rated with an L-10 life of at least 100 000 hours.

Above water bearings shall be mounted in sealed bearing housings with easily accessible greasing points and with one stainless steel grease nipple per bearing.

All bearings, including polymer and ceramic bearings, shall be replaceable.

### **7.9.2 Underwater Bearings**

Bearing housing design shall be such that rags and similar material cannot accumulate.

Bearings which are located below channel top water level shall be provided with continuous greasing by a pumped greasing unit in order to prevent ingress of grit. Ceramic bearings need not comply with this requirement. Seals shall be provided in order to exclude grit but to allow excess grease to escape.

The greasing system shall start and shall operate continuously whenever the raking mechanism operates and shall stop when the raking mechanism stops.

The grease container shall have a capacity of more than 1 kg and the grease level shall be indicated. The container shall be easy to refill without affecting the operation of the pump. The pump shall incorporate a device to release air trapped in the grease during filling.

A flow indicator shall be provided to allow visual confirmation of grease flow in the pipeline. This shall be provided as close to the bearing as is feasible for the application.

The grease shall be piped to the bearing through EN Grade 1.4401 (316) stainless steel pipe with stainless steel fittings. Pipework supports shall be of stainless steel and shall be spaced at distances not exceeding 500 mm. Snagging of solids and damage to the pipework shall be prevented. The pipe shall be protected by a shroud which is manufactured of 316 stainless steel,

securely bolted to the concrete with 316 anchors of minimum diameter 8 mm and contoured in order to prevent snagging.

#### **7.10 INGRESS PROTECTION**

The machine components of the screen above water level (such as motors, gearboxes and bearings) shall have ingress protection which is suitable for washing by hose.

### **8. DRIVE**

#### **8.1 INTRODUCTION**

Drive shall be by an integrated gearmotor with ingress protection rating of IP 55 or higher.

#### **8.2 MOTOR**

The motor shall comply with Zut 0001.

The rake motor installation shall have a nominal rating of at least 15 % above the maximum power requirement as installed and shall be suitable for at least 20 starts per hour.

#### **8.3 GEARBOX**

The gearbox for the rake mechanism shall have a service factor of 1,3 or higher and shall comply with Zut 0001.

#### **8.4 OVERTORQUE CUT-OUT**

An overtorque cut-out linkage shall be provided and this shall be arranged to interrupt the electrical supply to the motor when the rake assembly is snagged and cannot be cleared automatically.

#### **8.5 CHAIN**

All components of the chain shall be of stainless steel.

### **9. FABRICATION**

Fabrication and welding shall comply with Zut 0001.

### **10. FASTENERS**

Fasteners shall comply with Zut 0001.

## 11. MATERIALS AND COATINGS

Equipment shall comply with the table below. Components not specified in the table shall be designed to the very high – industrial category (C5-I) of SANS 12944-2.

ITEM	MATERIAL	COATING
Frame	EN Grade 1.4162 (LDX 2101); or EN Grade 1.4401 (316) stainless steel.	N/A
Screen Field	EN Grade 1.4162 (LDX 2101); or EN Grade 1.4401 (316) stainless steel.	N/A
Rake Mechanism	EN Grade 1.4162 (LDX 2101); or EN Grade 1.4401 (316) stainless steel.	N/A
Rake Comb	EN Grade 1.4162 (LDX 2101); or EN Grade 1.4401 (316) stainless steel.	N/A
	Engineering polymer.	N/A
Chain pins, bushes, retainers and all other joining pieces	EN Grade 1.4462 (2025 duplex) stainless steel or super duplex stainless steel.	N/A
Chain Links	EN Grade 1.4162 (LDX 2101); or EN Grade 1.4401 (316) stainless steel.	N/A
Sprockets	EN Grade 1.4162 (LDX 2101); or EN Grade 1.4401 (316) stainless steel.	N/A
Chutes	EN Grade 1.4162 (LDX 2101); or EN Grade 1.4401 (316) stainless steel.	N/A
Covers and Doors	EN Grade 1.4162 (LDX 2101); or EN Grade 1.4401 (316) stainless steel.	N/A
Door hinges	Stainless steel.	N/A
Wiper Blade	Engineering polymer.	N/A
Fasteners	EN Grade 1.4401 (316).	N/A

Safety Closure Foot Plates	EN Grade 1.4401 (316) stainless steel.	Pickle and passivate.
Bearing Housings	Manufacturer's standard.	Corrosion protection of metallic bearing housings shall be to the very high – industrial category (C5-I) of SANS 12944-2
Motor casing	Cast iron.	Corrosion protection shall be to very high – industrial category (C5-I) of SANS 12944-2
Gearbox	Cast iron.	Corrosion protection shall be to very high – industrial category (C5-I) of SANS 12944-2

## 12. INSTALLATION

The Contractor shall be responsible for all installation work including grouting.

Screen frames which are installed into recesses in the channel walls shall be secured against movement by at least three EN Grade 1.4401 (316) anchors on each side before being grouted into position.

Screen frames which are mounted against the flat surfaces of channel walls and floor shall be provided with cradle brackets which securely position the screen.

No flow shall pass between the frame and the concrete.

Installation work shall comply with Zut 0001.

The Contractor shall submit to the Engineer a method statement describing the proposed installation method and providing the details of all fixing arrangements including anchoring and grouting techniques and materials.

## 13. CIVILS AND BUILDING

As required in terms of the General Conditions, the Contractor shall:

- provide the details of civil and building requirements to the Engineer.
- at an appropriate point, measure on Site.

The Contractor shall ensure that the design can accommodate a tolerance of +/- 40 mm for civil and building items constructed by others unless a tighter tolerance is called for by the Contractor in good time and approved by the Engineer.



## **14. SAFETY**

The Contractor shall design and install equipment installations in accordance with the requirements of the country's Occupational Health and Safety regulations. The Contractor shall provide adequate safeguards when the doors are closed to prevent a person intruding any part of their body into any area where the equipment might cause an injury.

The screen shall be enclosed above the top level of the channel.

Gaps at floor level shall be closed so that a person's foot cannot pass through. Such closure plates shall not visibly deflect under a person's weight and shall be of minimum 3 mm thick stainless steel with suitable stiffening ribs.

Each screen shall be provided with an emergency stop station on each side of it.

## **15. INSPECTIONS**

### **15.1 WORKSHOP/FACTORY**

The Contractor shall make all arrangements and carry all costs for the Engineer, or an Engineer approved inspection authority, to inspect the screen for acceptance prior to despatch to Site and prior to payment being made. If the equipment is manufactured locally, the Contractor shall arrange for the Engineer to inspect it in the manufacturer's works prior to despatch to Site. If the equipment is not manufactured locally, the Contractor shall arrange for the Engineer or an Engineer approved inspection authority to inspect the equipment in the manufacturer's works prior to dispatch. The Contractor shall submit the report by the inspection authority to the Engineer for acceptance. This report shall confirm compliance of the equipment with the specifications prior to despatch from the manufacturer's works.

### **15.2 SITE**

The Contractor shall make arrangements for the Engineer to inspect the completed, cleaned installation on Site prior to commissioning. The Contractor shall remove all litter, shall ensure floors are dry, that dust is not present and that all pipework has been wiped clean before the Engineer's inspection.

### **15.3 INSPECTION DURING DEFECTS NOTIFICATION PERIOD**

The Contractor shall inspect the operation of the Works three months after the start of the Defects Notification Period and shall provide a condition report on all equipment to the Engineer.

## **16. TESTING REQUIREMENTS**

The Contractor shall successfully demonstrate the following to the Engineer prior to the commissioning of the Works:

- a) equipment operation.
- b) achievement of the specified performance requirements.

- c) control system operation.
- d) motor power margin.

The Contractor shall submit site test reports to the Engineer and shall provide copies in the Manual.

# **SPECIFICATION: ZUT 4009**

## **Hand-Raked Screens**

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## 1. INTRODUCTION

Zut 4009 specifies the requirements for channel-mounted hand-raked screens for wastewater which are to be provided by the Contractor.

## 2. SCOPE OF WORKS

See project specification.

The installation shall be configured as shown on applicable drawings.

## 3. NORMATIVE REFERENCES

Where this specification is required for a project, the following documents shall form part of the Contract Document:

- Amendments, Additions and Detailed Requirements (Zut 4009).
- Zut 0001: General Mechanical Requirements.
- Zut 0003: General Corrosion Protection for Pipelines, Water and Waste Water Works.
- SANS 12944 2: Paints and varnishes – Corrosion protection of steel structures by protective paint systems; Part 2: Classification of environments.
- National Occupational Health and Safety Act and Regulations.

Equipment, materials and operational methods shall comply with the latest edition of relevant national and/or international standards.

## 4. PERFORMANCE REQUIREMENTS

The screen shall be suited to the application, shall function effectively and the rake shall be suited for use by a single person. The raking shall be done without spillage and the water from the screenings shall drain back into the channel.

The equipment shall be suited to the specified range of operating flows.

## 5. DESIGN AND CONSTRUCTION

### 5.1 GENERAL

The person raking the screen shall be provided with secure, non-slip surfaces for support. This is a requirement for both wet and dry conditions.

## **5.2 SCREEN**

The screen shall be permanently anchored in the channel. The screen element shall be sized so that the flow speed at average flow does not exceed 0,45 m/s. If the channel is not wide enough to achieve this, then it is acceptable that the screen element simply spans the full width and height of the channel.

The screen element shall stretch from the channel floor level to the collection trough; i.e. a deadplate is not acceptable.

The aperture spacing between bars shall be 20 mm unless otherwise specified.

The screen bars shall be formed from flat bar with cross sectional dimensions of at least 8 mm X 50 mm. The bars shall be arranged so that longitudinal raking using a rake comb is possible.

The bottom of the collection trough shall be above the top level of the channel wall. The collection trough's cross sectional dimensions shall be at least 320 mm wide and 170 mm deep and it shall be at least as wide as the channel. The bottom shall be perforated with holes of the same, or smaller, diameter as the screen aperture dimension. Standard perforated plate with the smooth side up is preferred.

One end of the trough shall be closed. The other end shall be provided with a chute so that screenings can be slid out of the trough and into a bucket or similar container without spillage. The chute shall be provided with a ramp to minimise water from flowing down the chute during raking.

The screen element shall be at an angle of about 45° to the vertical.

## **5.3 RAKE**

The rake shall be light but rigid and the comb head shall minimise obstruction to the water flow. A HDPE comb is acceptable.

The comb shall be of sawtooth pattern so that the teeth match and easily drop into the gap between the screen bars (even when the comb has been pushed into the flow and is not visible).

The rake shall not be of aluminium.

A wall hook shall be provided in a suitable position for the rake to hang on when not in use.

## **5.4 FLOOR AND GUARD RAIL**

The unit shall incorporate a platform for the raker to stand on whilst raking the screen. It shall be secure and safe and easy access, preferably via stairs, shall be provided.

The Contractor shall provide surrounding grid flooring and guard railing where this is required for safety.

Grid flooring and guard railing shall comply with Zut 0001.

## 6. MATERIALS AND COATINGS

### 6.1 GENERAL

Components shall be designed for corrosion resistance to the high corrosivity category (C4) of SANS 12944-2.

Corrosion protection shall comply with Zut 0003.

Materials shall comply with Zut 0001.

### 6.2 EQUIPMENT

Equipment shall comply with the table below.

ITEM	MATERIAL	COATING
Screen and collection trough	EN Grade 1.4301 (304) stainless steel; or better.	Pickle and passivate.
Platform and guard railing	Carbon steel.	Hot dip galvanised.
Fasteners	EN Grade 1.4401 (316) stainless steel.	N/A
Anchor fasteners	EN Grade 1.4401 (316) stainless steel.	N/A
Wall hook	Stainless steel.	Pickle and passivate.
Auxiliary metal components	EN Grade 1.4401 (316).	Pickle and passivate.
<p>Stainless steel shall be correctly pickled and passivated. Stainless steel surfaces shall be free of ferrous stain and heat tint at commissioning.</p> <p>Metal plating of ferrous materials is not acceptable as the corrosion protection system.</p> <p>Fabrications which are hot dip galvanised and then welded, cut, ground, drilled or have the steel exposed by any other means shall be rejected.</p>		

## 7. FABRICATION

Fabrication and welding shall comply with the requirements of Zut 0001.

## **8. INSTALLATION**

Installation work shall comply with Zut 0001.

The Contractor's design shall accommodate the inaccuracy specified for concrete works.

The maximum allowable gap between the screen element and the channel is the same as the specified screen bar spacing.

## **9. CIVILS AND BUILDING**

As required in terms of the General Conditions, the Contractor shall:

- provide the details of civil and building requirements to the Engineer.
- at an appropriate point, measure on Site in order to check for correctness for the Works.

The Contractor shall ensure that the design can accommodate a tolerance of +/- 40 mm for civil and building items constructed by others unless a tighter tolerance is called for by the Contractor in good time and accepted by the Engineer.

## **10. SAFETY**

The Contractor shall design and install all equipment installations in accordance with the requirements of the Occupational Health and Safety Act of South Africa.

Edges shall be rounded off so that accidental contact does not result in injury.

## **11. INSPECTIONS**

The Contractor shall make all arrangements and shall carry all costs for the Engineer to inspect the complete unit in the workshop prior to despatch to Site.

The Contractor shall make arrangements for the Engineer to inspect the installation on Site prior to commissioning.

## **12. TESTING REQUIREMENTS**

The Contractor shall demonstrate the correct operation of the equipment to the Engineer prior to the Works being commissioned.

# **SPECIFICATION: ZUT 4016**

## **Washer Compactor**

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## 1. INTRODUCTION

Zut 4016 specifies the requirements for washer compactors, to be provided by the Contractor, for wastewater screenings removed from wastewater.

## 2. SCOPE OF WORKS

See project specification.

The installation shall be configured as shown on applicable drawings.

All support arrangements, support brackets, pipework, valves, actuators, etc. required for the correct installation and operation of the washer compactor shall be provided by the Contractor.

## 3. NORMATIVE REFERENCES

Where this specification is required for a project, the following documents shall form part of the Contract Document:

- Amendments to Zut 4016.
- Zut 0001: General Mechanical Requirements.
- Zut 0003: General Corrosion Protection for Pipelines, Water and Waste Water Works.
- Zut 6004: Actuators.
- Zut 7023: Couplings and Flange Adaptors.
- SANS 12944 2: Paints and varnishes – Corrosion protection of steel structures by protective paint systems; Part 2: Classification of environments.
- National Occupational Health and Safety Act and Regulations.
- SANS 10108: The classification of hazardous locations and the selection of apparatus for use in such locations.

Equipment, materials and operational methods shall comply with the latest edition of relevant national and/or international standards.

## 4. EQUIPMENT ELIGIBILITY

The make and model of washer compactor provided shall have a successful record of use in similar applications locally and shall also have had at least three years of technical support locally. Service and spares shall currently be available. Upgraded versions of a manufacturer's earlier designs which comply with these criteria are acceptable.

Equipment which does not satisfy these requirements is not acceptable unless called for in the specifications or unless the Engineer agrees in writing.

## **5. CONFIGURATION**

The washer compactors shall receive screenings output from screens. One washer compactor shall serve one screen.

## **6. PERFORMANCE REQUIREMENTS**

The washer compactor shall effectively remove organic matter from screenings, return this organic matter to the wastewater flow and shall discharge the washed and compacted screenings.

The nature of the screenings will be varied and the washer compactor shall deal with rags, hard solids, stringy solids, plastic and other solids which can be expected from a mixture of domestic and industrial wastewater.

The washer compactor shall be sized to handle the solids loading fed into it from the mechanical screen.

The washer compactor shall achieve a screenings solids content of 30 % or higher. At least 95 % of organic matter shall be removed from the non-organic screenings.

Screenings shall not accumulate within the unit.

Spillage will not be acceptable.

All components of the installation shall perform reliably over the specified range.

## **7. OPERATION AND CONTROL**

### **7.1 GENERAL**

Overload protection shall be provided.

An emergency stop device shall be located within reach of each washer compactor.

Protections shall be active during manual operation.

The equipment shall be designed to shut down safely and without damage upon failure of the electrical supply.

### **7.2 NORMAL OPERATION**

Under normal operating conditions, the operation of the washer compactor shall be automated and shall be coordinated to work in conjunction with the upstream mechanical screen which discharges into it.

The washwater supply system and the downstream equipment, such as conveyors, etc., shall be similarly automated in order to perform the normal washing cycle.

### **7.3 MANUAL OPERATION**

Manual start of the washer compactor's cleaning cycle shall be provided. Manual start shall also initiate automatic operation of the downstream equipment in order that the screenings are cleared in the correct manner and blockages are avoided.

## **8. DESIGN AND CONSTRUCTION**

### **8.1 WASHER COMPACTOR**

The washer compactor shall collect, wash and dewater the material which has been discharged into its feed hopper. All material shall pass to the washer section without hangup.

The washer compactor shall consist of a washing section and a compaction section.

The washing section shall incorporate a turbulent bath in which organic matter is separated from other solids by the action of an impeller and then returned to the wastewater flow.

The compaction section shall incorporate a compacting screw which separates water from the solids before discharging them.

The unit shall discharge via a chute. The chute shall be supported so that it does not impose a large bending load on the compactor body.

Inspection hatches shall provide access to the washer impeller and the compaction screw.

Adequate guarding shall be provided to ensure compliance with safety legislation.

Wearing surfaces shall be of wear resistant materials and shall preferably be replaceable.

The complete unit shall be suitable for washing by hose.

### **8.2 VALVES**

Valves for the washwater supply to the unit and for controlling the water outflow from the washing bath shall be plastic ball valves or other full-bore valves. Butterfly valves will not be acceptable.

### **8.3 ACTUATORS**

Actuators for controlling the washwater inlet valve and the washer drain valve shall comply with Zut 6004.

## **9. PIPEWORK**

### **9.1 PIPE**

Water supply pipework shall be flanged steel.

PVC pipework shall have a minimum rating of Class 12.

## **9.2 COUPLINGS**

A flanged bellows type coupling shall be provided at each pipework connection to the washer compactor.

The bellows coupling shall comply with Zut 7023.

## **10. MOTOR**

The washer motor and the compactor motor shall comply with Zut 0001.

The continuously rated output of motors shall exceed the driven unit's shaft power required at maximum duty and at the worst operating condition by not less than 15 %.

Motors shall have ingress protection to at least IP 55.

## **11. GEARBOX**

Gearboxes shall have ingress protection to IP 55 and shall comply with the requirements of Zut 0001.

Gearbox service factors shall be a minimum of 2 and/or shall comply with the guidelines of AGMA for the duty.

## **12. INSTRUMENTATION**

Hour meters shall be provided for the washer motor and for the screw motor. They shall be of the type which cannot be reset.

A pressure gauge shall be provided on the washwater supply.

Instrumentation shall comply with Zut 0001.

## **13. MATERIALS AND COATINGS**

### **13.1 GENERAL**

Components shall be designed for corrosion resistance to the high corrosivity category (C4) of SANS 12944-2.

Corrosion protection shall comply with Zut 0003.

Materials shall comply with Zut 0001.

## 13.2 EQUIPMENT

Equipment shall comply with the table below.

ITEM	MATERIAL	COATING
Body, discharge chute and support legs	LDX 2101 duplex stainless steel or EN Grade 1.4401 (316) stainless steel.	Pickle and passivate.
Water supply pipework	Carbon steel.	Hot dip galvanise.
Drain pipework	PVC.	Not applicable.
Pipe bellows coupling	Elastomer, with carbon steel backing flanges.	Carbon steel to be hot-dip galvanised.
Fasteners	EN Grade 1.4401 (316).	Not applicable.
Motor casing, gearbox casing and bearing housings	Manufacturer's standard.	Corrosion protection to the high corrosivity category (C4) of SANS 12944-2.
Corrosion protection shall comply with Zut 0003.		
Stainless steel shall be correctly pickled and passivated. All stainless steel surfaces shall be completely clear of ferrous stain and heat tint at commissioning.		
Fabrications which are hot dip galvanised and then welded, cut, ground, drilled or have the steel exposed by any other means shall be rejected.		

## 14. FABRICATION

Fabrication and welding shall comply with Zut 0001.

## 15. FASTENERS

Fasteners shall comply with Zut 0001.

## **16. ELECTRICAL EQUIPMENT**

The electrical equipment and installations shall comply with the electrical specifications.

## **17. SPARES**

The spares which are to be provided are specified elsewhere.

## **18. INSTALLATION**

Installation work shall comply with Zut 0001.

## **19. CIVILS AND BUILDING**

As required in terms of the General Conditions, the Contractor shall:

- provide the details of civil and building requirements to the Engineer.
- at an appropriate point, measure on Site in order to check for correctness for the Works.

The Contractor shall ensure that the design can accommodate a tolerance of +/- 40 mm for civil and building items constructed by others unless a tighter tolerance is called for by the Contractor in good time and accepted by the Engineer.

## **20. SAFETY**

The Contractor shall design and install all equipment installations in accordance with the requirements of the Occupational Health and Safety Act of South Africa and, if applicable, in accordance with the requirements of SANS 10108 for hazardous areas.

Each motor shall be provided with an emergency stop station in an appropriate position.

The design shall ensure that there are no unprotected gaps through which a foot could pass.

## **21. INSPECTIONS**

### **21.1 FACTORY**

The Contractor shall make all arrangements and carry all costs for the Engineer, or an Engineer approved inspection authority, to inspect the washer compactors for acceptance prior to despatch to Site and prior to payment being made. If the equipment is manufactured locally, the Contractor shall arrange for the Engineer to inspect equipment in the manufacturer's works prior to despatch

to Site. If the equipment is not manufactured locally, the Contractor shall arrange for the Engineer or an Engineer approved inspection authority to inspect the equipment in the manufacturer's works prior to dispatch. The Contractor shall submit the report by the inspection authority to the Engineer for acceptance. This report shall confirm compliance of the equipment with the specifications prior to despatch from the manufacturer's works.

## **21.2 SITE**

The Contractor shall make arrangements for the Engineer to inspect the completed installation on Site for acceptance prior to commissioning.

## **21.3 INSPECTION DURING DEFECTS NOTIFICATION PERIOD**

The Contractor shall inspect the operation of the Works three months after the start of the Defects Notification Period and shall provide a condition report on all equipment to the Engineer.

# **22. TESTING REQUIREMENTS**

The Contractor shall successfully demonstrate the following to the Engineer on Site prior to the commissioning of the Works:

- a) equipment operation.
- b) achievement of the specified performance requirements.
- c) control system operation.
- d) motor power margin.

The Contractor shall submit site test reports to the Engineer and shall provide copies in the Manual.

# **SPECIFICATION: Zut 4026**

## **Grit Washer**

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## 1. INTRODUCTION

Zut 4026 specifies the requirements for grit washers for wastewater applications.

## 2. SCOPE OF WORKS

See project specification. The project specification takes precedence over Zut 4026.

The installation shall be configured as shown on applicable drawings.

## 3. NORMATIVE REFERENCES

The following form part of the Contract Document:

- Amendments, Additions and Detailed Requirements (Zut 4026).
- Zut 0001: General Mechanical Requirements.
- Zut 0002: Operating and Maintenance Manual.
- Zut 0003: General Corrosion Protection for Pipelines, Water and Waste Water Works.
- National Occupational Health and Safety Act and Regulations.
- SANS 12944-2: Paints and varnishes – Corrosion protection of steel structures by protective paint systems; Part 2: Classification of environments.
- SANS 10108: The classification of hazardous locations and the selection of apparatus for use in such locations.

Equipment, materials and operational methods shall comply with the latest edition of relevant national and/or international standards.

## 4. EQUIPMENT ELIGIBILITY

The make and model of grit washer provided shall have a successful record of use in similar applications locally and shall also have had at least three years of technical support locally. Service and spares shall currently be available. Upgraded versions of a manufacturer's earlier designs which comply with these criteria are acceptable.

## 5. CONFIGURATION

The grit washers will be located downstream of degritters and each shall discharge into a skip.

Water flow from the washers shall preferably gravitate back to the common intake of the degritters. If this cannot be achieved, return flow pumps shall be provided by the Contractor.

## 6. PERFORMANCE REQUIREMENTS

The grit washer shall be capable of performing the duties specified in the project specification and shall be rated for continuous operation at those duties unless non-continuous operation is specified or inherent in the system design.

All components shall perform reliably over the specified range.

The specified control functions shall operate correctly.

The specified motor power margin shall be complied with.

All components shall perform reliably over the specified range of duties.

Grit discharged from the washers shall comply with the following:

- Maximum of 5 % organic content,
- Maximum of 20 % moisture.
- Capture of at least 90 % of grit with a particle size of 106 microns and larger.

The washer shall be designed so that stringy, fibrous and solid material, found in screened water, does not clog or damage it.

## 7. OPERATION AND CONTROL

The operating system is specified in detail in the project specification.

The Contractor shall provide the following:

- Protections shall be active during manual operation.
- Manual start and stop of each grit washer shall be provided.
- The equipment shall be designed to shut down safely and without damage upon failure of the electrical supply.
- The washer motors shall have over-current protection and alarms shall sound in this event. The washers shall not be permitted to restart unless the alarm has been cleared.
- The washer cycle of starting, stopping and dormant periods shall be optimised by the Contractor prior to commissioning.

## 8. DESIGN AND CONSTRUCTION

The overflow from the grit washer's tank shall be larger than the inlet pipe to the washer. This overflow shall discharge to a position upstream of the degritters.

The grit chute shall angle downwards to direct grit into a skip or similar without spilling.

Bearings requiring re-greasing shall be provided with easy access to the grease nipple.

Bearings which operate underwater shall be provided with an electric greasing pumping system which is designed to feed the bearing correctly. One grease pump shall be provided per grit washer.

The washer nozzles and pipework shall be of stainless steel and shall be securely fastened.

The ingress protection rating of the complete unit shall be to IP 55 or higher and shall be suitable for washing by hose.

Trough covers shall be provided. The covers shall be removable, shall not be hinged and shall be positively located. They shall be light but rigid and easily removable. Covers shall be secured by stainless steel secure quick release devices and shall be provided with handles of non-snag design. Covers shall be approximately 1,5 metres long and no cover shall be longer than 2 metres. Neither the inspection covers nor the trough shall warp, bend or distort when grit is being extracted under full motor load.

A steel access platform for inspection of the internals of the washer shall be provided. It shall include steps; or a ladder if space is limited. The platform shall be fabricated from carbon steel and shall be hot dipped galvanised. Guard railing shall be provided if the platform level is higher than 900 mm above the surrounding area. Steps, grid flooring and guard railing shall comply with Zut 0001. Ladders shall comply with Zut 1001.

## **9. PIPEWORK**

Pipework shall be of stainless steel and shall comply with Zut 0001.

The manufacture of pipe specials shall comply with Zut 7001.

Pipework shall be flanged. Flanges shall comply with SANS 1123 with a minimum rating of PN10.

Pipe anchors shall comply with Zut 7024.

Manual drain valves shall be provided at low points in pipework and manual air release valve shall be provided at high points. The air release and drains shall incorporate a small bore stainless steel ball valve. The take-off points shall be of stainless steel and they shall be correctly welded and corrosion protected; all in accordance with Zut 0001.

The pipework from the grit washers shall be at least NB150.

The Contractor shall provide the following pipework:

- All pipework from the degritters.
- All pipework to upstream of the degritters.
- All interconnecting pipework between washers and degritters.
- All flushing and drainage pipework.

## **10. MOTOR**

The motor shall comply with the requirements for electric motors in Zut 0001.

The continuously rated output of motors shall exceed the driven unit's shaft power required at maximum duty and at the worst operating condition by not less than 20 %.

Motors shall have ingress protection to at least IP 55.

If the equipment is installed in an area classified in terms of hazardous locations; i.e. explosions, then the design of the motor shall comply with the requirements.

## 11. GEARBOX

Gearboxes shall have ingress protection to IP 55 and shall comply with Zut 0001. Gearbox service factors shall be chosen in accordance with this specification or shall comply with the guidelines of AGMA.

## 12. INSTRUMENTATION

### 12.1 GENERAL

Instrumentation shall comply with Zut 0001.

### 12.2 HOUR METER

An hour meter which cannot be reset shall be provided for each grit washer.

### 12.3 PRESSURE GAUGES

A pressure gauge shall be provided on pressure pipework.

## 13. MAINTENANCE AND ACCESS

All maintenance shall easily be performed without removal of the washer or dismantling adjacent components.

## 14. MATERIALS AND COATINGS

### 14.1 GENERAL

Components shall be designed for corrosion resistance to the high corrosivity category (C4) of SANS 12944-2.

### 14.2 EQUIPMENT

Equipment shall comply with the table below.

ITEM	MATERIAL	COATING
Washer body and legs	EN Grade 1.4401 (316) stainless steel.	Pickle and passivate.
Screw	Manufacturer's standard.	Manufacturer's standard.
Trough liner	Replaceable, wear resistant , dual colour polymer.	Not applicable.

Nozzles and washwater pipework	Stainless steel.	Pickle and passivate.
Pipework	Stainless steel.	Pickle and passivate.
Pipe anchors	Stainless steel.	Pickle and passivate.
	Carbon steel.	Hot dip galvanise.
General fasteners	EN Grade 1.4401 (316).	Not required.
Anchor fasteners	EN Grade 1.4401 (316).	Not required.
Auxiliary metal components	EN Grade 1.4401 (316).	Pickle and passivate.
Motor casing	Cast iron.	Manufacturer's standard system for the high corrosivity category (C4) of SANS 12944-2.
Platform, including flooring, stairs, ladder and guard rails.	Carbon steel	Hot dip galvanise
Corrosion protection shall comply with Zut 0003.		
Materials shall comply with Zut 0001.		
Stainless steel shall be correctly pickled and passivated. Stainless steel surfaces shall be free of ferrous stain and heat tint at commissioning.		
Metal plating of ferrous materials is not an acceptable corrosion protection system.		
Steel and cast iron items which have been hot dip galvanised but which are then welded, cut, ground, drilled or have the steel exposed by any other means shall be rejected.		

## 15. FABRICATION

Fabrication and welding shall comply with Zut 0001.

## 16. FASTENERS

Fasteners shall comply with Zut 0001.

## **17. ELECTRICAL EQUIPMENT**

Electrical equipment and installations shall comply with the electrical specifications.

## **18. SPARES**

The spares to be provided are specified elsewhere.

## **19. INSTALLATION**

Installation work shall comply with Zut 0001.

The washer shall be mounted firm and level with EN Grade 1.4401 (316) anchor fasteners and then grouted firmly into position.

## **20. CIVILS AND BUILDING**

The Contractor shall:

- provide the details of civil and building requirements to the Engineer.
- at an appropriate point, measure on Site in order to check for correctness for the Works.

The Contractor shall ensure that the design can accommodate a tolerance of +/- 40 mm for civil and building items constructed by others unless a tighter tolerance is called for by the Contractor in good time and accepted by the Engineer.

## **21. SAFETY**

The Contractor shall design and install equipment installations in accordance with the requirements of the country's Occupational Health and Safety regulations.

If applicable, the design and supply shall be in accordance with the requirements of hazardous location classification for the area.

Each motor shall be provided with an emergency stop station in an appropriate position.

The Contractor shall provide all safety signage required for the equipment installation.

## 22. INSPECTIONS

### 22.1 WORKSHOP/FACTORY

#### 22.1.1 Fabrications

The Contractor shall arrange for fabrications to be inspected by the Engineer for acceptance after fabrication is complete but prior to corrosion protection.

#### 22.1.2 Equipment

The Contractor shall make all arrangements and carry all costs for the Engineer, or an Engineer approved inspection authority, to inspect the equipment for acceptance prior to despatch to Site and prior to payment. If the equipment is manufactured locally, the Contractor shall arrange for the Engineer to inspect equipment in the manufacturer's works prior to despatch to Site. If the equipment is not manufactured locally, the Contractor shall arrange for the Engineer or an Engineer approved inspection authority to inspect the equipment in the manufacturer's works prior to dispatch. Prior to the equipment being despatched from the manufacturer's works, the inspection authority's report shall be submitted to the Engineer in sufficient detail to confirm compliance of the equipment with the specifications.

### 22.2 SITE

The Contractor shall make arrangements for the Engineer to inspect the completed, cleaned installation on Site for acceptance prior to commissioning.

The Contractor shall remove all litter, shall ensure floors are dry, that dust is not present and that all pipework has been wiped clean before the Engineer's inspection.

### 22.3 INSPECTION AFTER COMMISSIONING

The Contractor shall check the operation of the Works three months after commissioning and shall provide a condition report on all equipment to the Engineer.

## 23. TESTING REQUIREMENTS

The Contractor shall successfully demonstrate the following to the Engineer prior to the commissioning of the Works:

- a) equipment operation.
- b) compliance with the specification.
- c) achievement of the specified performance requirements.
- d) control system operation.
- e) motor power margin.

The Contractor shall submit site test reports to the Engineer and shall provide copies in the Manual.

# SPECIFICATION: ZUT 5013

## Self-Priming Pump

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## 1. INTRODUCTION

Zut 5013 specifies the requirements for Centrifugal Pumps to be provided by the Contractor which are self-priming (i.e. not relying on an auxiliary external priming device) and are driven by either electric motor or by diesel engine.

## 2. SCOPE OF WORKS

See project specification.

The installation shall be configured as shown on applicable drawings.

## 3. NORMATIVE REFERENCES

The following form part of the Contract Document:

- Amendments, Additions and Detailed Requirements (Zut 5013).
- Zut 0001: General Mechanical Requirements.
- Zut 0003: General Corrosion Protection for Pipelines, Water and Waste Water Works.
- Zut 5028: Engine Driven Pump.
- Zut 7001: Design and Manufacture of Medium Pressure Steel Specials.
- Zut 7023: Pipe Couplings and Flange Adaptors.
- Zut 7024: Pipe Anchors.
- The Occupational Health and Safety Act and Regulations.

Equipment, materials and operational methods shall comply with the latest edition of relevant national and/or international standards.

## 4. EQUIPMENT ELIGIBILITY

The make and model of the pump shall have a successful record of use in similar applications locally and shall also have had at least three years of technical support locally. Service and spares shall currently be available. Upgraded versions of a manufacturer's earlier designs which comply with these criteria are also acceptable.

## 5. PERFORMANCE REQUIREMENTS

Equipment shall perform reliably over the specified range.

No perceptible signs of cavitation shall be present at any point over the specified operating range.

## 6. OPERATION AND CONTROL

Manual start and stop of each item of equipment shall be provided.

Protections shall be active during manual operation.

Flow and pressure shall be measured and indicated.

The pumpset shall shut down safely and without damage upon failure of the electrical supply.

## 7. PUMPSET CONSTRUCTION AND DESIGN

The pump shall be of the single stage, end suction, back pull out centrifugal type. It shall have self-prime capability in order to operate successfully in a suction lift configuration. The volute and impeller configuration shall cause air to be exhausted from the pump and suction line when starting up (i.e. the priming shall not be performed by an auxiliary priming device).

The pump body shall have the same pressure rating as the discharge pipework.

Pumps shall be designed to handle unscreened wastewater as well as wastewater sludges with solids content up to 2 %. These fluids will contain rigid solids, fibrous material, grit, plastics and rags and the pumps shall operate without undue clogging.

The pump shall be motor driven (or diesel engine driven) via direct, flexible coupling or shall be belt driven. The pump and motor (or pump and engine) shall be mounted on a single baseplate.

Pumps with inlets smaller than 100 mm shall have a solids handling capability of at least 35 mm. Pumps with a 100 mm inlet shall have a solids handling capacity of at least 60 mm. Pumps with inlets larger than 100 mm shall have a solids handling capacity of at least 75 mm.

Pumps shall be of the open vane type and shall not be of the induced flow type (i.e. shall not be of the type with radial vanes on a disc backplate).

The pump shall be selected to operate close to best efficiency at duty point. Preference will be given to pumps which:

- operate at or to the left of the best efficiency point.
- have an impeller which does not exceed 95 % of the maximum impeller diameter for the volute/diffuser.
- have a nominal speed of 1 500 rpm or lower.

The shut-off head shall be at least 15 percent higher than the specified duty point.

The pump shall incorporate a suction flap valve for holding prime. This shall be replaceable without having to remove pipework.

Inlet and outlet connections shall be flanged. The flanges shall be dimensionally compatible with SANS 1123 or BS EN 1092 ("plate flanges for welding with either flat face or raised face").

The clearance between the impeller and the wear plate shall be adjustable without movement of the impeller shaft. At least 4 mm of adjustment shall be provided.

A cover shall provide access to the impeller eye for inspection and cleaning.

An expeller on the back side of the impeller shall restrict solids coming into contact with the shaft.

Shaft seals shall be cartridge type mechanical seals. The seal faces shall preferably be of silicon carbide but tungsten carbide will also be acceptable. The seal shall either be oil lubricated with an oil level sight glass or shall be provided with clean water flushing.

Bearings shall be designed for an L-10 life of not less than 100 000 hours. The bearings shall be oil lubricated and shall be provided with an oil level sight glass.

The bearings and the mechanical seal shall be separated so that failure of the seal does not lead to contamination of the bearings.

Rotating elements shall be balanced and the level of vibration severity used for the design shall not exceed  $V_{rms} = 1 \text{ mm/s}$  at the bearings.

The ingress protection rating of the bearings and seals shall be to IP 55 or higher and the complete pump shall be suitable for washing by hose.

## **8. AIR RELIEF SYSTEM**

### **8.1 SLUDGE**

The Contractor shall provide an air relief system for all sludge applications.

### **8.2 WATER AND WASTEWATER**

The Contractor shall provide an air relief system for water and wastewater applications if the centreline of the pump impeller is above the fluid level in the sump.

### **8.3 SYSTEM**

Air relief systems shall consist of a DN 25 line from the discharge to the sump. The line shall connect between the pump discharge and the check valve. The pipe shall end below the sump's low level in order to hold prime.

If the discharge head is greater than 5 metres, the air relief bypass pipe shall be fitted with a metallic automatic valve which closes upon prime being attained.

## 9. ELECTRIC MOTOR DRIVES

Electric motors shall comply with Zut 0001.

The continuously rated output of the motor shall exceed the shaft power required at maximum pump power draw by not less than 20 percent. If, however, the pump motor is started Direct-on-Line and with an open discharge valve, the motor rating shall exceed the maximum pump power draw by not less than 30 percent.

Motors shall have ingress protection to at least IP 55.

## 10. DIESEL ENGINE DRIVES

### 10.1 GENERAL

The engine and pump shall be mounted on anti-vibration mounts on a rigid baseframe.

The design of the installation shall meet the requirements and approval of the engine manufacturer.

### 10.2 SPEED AND POWER

The engine shall operate at no more than 85 % of its rated full speed.

The engine's continuous power output rating at operating speed shall be at least 26 % greater than the shaft input power required by the pump's maximum power draw at any point in its specified operating range. This engine rating shall be the net power, i.e. over and above the power consumed by all driven accessories. This requirement is expressed algebraically in the table below.

Factor	Power [kW]
Shaft input power required by pump at the maximum power draw	= X
Power required by engine accessories	= Q
<b>MINIMUM ALLOWABLE DIESEL ENGINE SHAFT OUTPUT CONTINUOUS POWER RATING AT OPERATING SPEED.</b>	<b>= Q + (1,26)(X)</b>

The power rating shall be in accordance with an approved British Standard or other approved by the Engineer.

### 10.3 ENGINE ENVIRONMENT

The Contractor shall provide an installed environment which allows the engine to deliver its design output continuously without overheating or other failure.

The installed environment shall provide the combustion air, the ventilation air and the cooling air requirements of the engine, including the radiation and convection heat losses. This air shall be drawn from an area free of the heated discharge(s) and free of the exhaust emission.

The allowable temperature rise to be used for the design of plant room ventilation, if applicable, shall be no higher than 10 °C.

If the engine cooling fan is not adequate for providing all cooling air and combustion air requirements for internal installations, the Contractor shall provide additional ventilation.

#### **10.4 ENGINE COOLANT**

Water-cooled engines shall be provided with the engine manufacturer's recommended anti-corrosive coolant.

#### **10.5 ENGINE LUBRICATION**

Engine oil filters shall be mounted in an accessible position.

An extension pipe shall be provided to facilitate draining oil from the sump if the sump plug is inaccessible. The pipe shall be provided with secure supports at each end. The supports shall accommodate vibration during operation. A threaded end-stop plug shall be provided in addition to any other isolation device. A drain pump shall not be provided.

#### **10.6 COMBUSTION AIR INTAKE**

A two stage cyclonic dry type air cleaner shall be fitted and shall have water and dust evacuators. It shall incorporate a condition monitor to indicate servicing. The air cleaner shall be amply rated for the application. The complete air induction system shall have the approval of the engine manufacturer.

The intake shall be designed to reduce noise breakout.

#### **10.7 ENGINE FUEL SYSTEM**

A primary and a secondary fuel filter of the replacement element type shall be provided. In addition, a water trap shall be provided.

Piping between the fuel tank and the engine shall be of stainless steel. A flexible section for absorbing vibration shall be provided.

The nominal flow velocity in the suction piping shall not exceed 0,8 metres per second (the calculation shall use a flow rate of 3 times the fuel consumption at the rated load). The tank suction connection shall be positioned at least 50 mm above the tank bottom.

A fuel return line from the engine shall be connected to the tank at the same level as the suction line and its diameter shall be the same or larger than the suction line.

A heat fusible link shall be mounted above the engine and failure of this shall lead to closure of a fuel isolation valve in the event of fire. A manual shut off valve shall also be installed upstream of this valve.

## **10.8 EXHAUST AND SILENCING SYSTEM**

The Contractor shall provide the engine's exhaust system with a reactive silencer for low frequency noise attenuation and an absorptive silencer for high frequency noise attenuation.

The reactive silencer shall be as recommended by the engine manufacturer.

Engines smaller than 100 kW may be provided with a combined reactive/absorptive silencer.

The exhaust pipework, silencers and pipe support brackets shall be of stainless steel.

A flexible connection of the stainless steel bellows type shall be installed close to the exhaust manifold(s) to reduce vibration transfer and to allow expansion under heating.

The exhaust system and silencers shall be thermally insulated with a preformed mineral wool inner layer which is clad with stainless steel or aluminium sheeting.

The exhaust outlet shall be arranged so that it is not possible for wind driven rain to enter.

## **10.9 STARTING SYSTEM**

The starting system shall be 24 Volt lead acid battery. Two, 12 Volt batteries in series are acceptable.

A mains supply charging system shall be provided for permanently installed units and shall maintain the batteries at full voltage.

A lockable battery box shall be provided. The box shall support the battery above the surface of the floor. It shall be sized to provide at least 50 mm clearance around the battery on all sides and shall be very well ventilated.

Battery health shall be monitored and indicated.

## **10.10 ENGINE HEATER**

Engines of 100 kW or larger and which are permanently installed shall be provided with engine heaters which are connected to the mains power. These shall be controlled so that they only operate whenever the engine is not operating.

## **10.11 NOISE ATTENUATION**

Where the pumpset is installed inside a room, the Contractor shall reduce the noise breakout from the room by providing the air supply and discharge openings with double acoustic louvres. The louvres shall be of hot-dip galvanised steel or of stainless steel. The Contractor shall also provide the openings with a weather louvre and an internal mesh screen.

The Contractor shall provide vibration insulation pads (Tico, or equivalent) between the baseframe skids and the concrete floor.

## **11. PLINTH & BASEFRAME**

### **11.1 GENERAL**

Plinths and baseframes shall comply with Zut 0001.

The pump and driver shall be mounted on a common baseframe. The Contractor shall confirm that the forces from the pump and driver have been accommodated in the design of the mounting arrangement. The Contractor shall submit the baseframe and anchor design to the Engineer for review.

Baseframes shall be of hot-dip galvanised carbon steel. The Contractor shall arrange for the Engineer to inspect the baseframes after fabrication is complete but before galvanising.

The Contractor shall install the baseframe, including anchoring and grouting in accordance with Zut 0001.

### **11.2 ENGINE DRIVEN PUMPS**

The pump and engine shall be mounted on anti-vibration mounts within a skid baseframe. The baseframe shall be rigid enough to be placed, with all equipment mounted, on an uneven surface without visible deflection. The anti-vibration mounts shall be resistant to oil and diesel fuel.

Duplex base arrangements are acceptable (and are preferred).

The baseframe shall be provided with four jacking points and four lifting eyes.

If the unit is permanently mounted on a concrete base, then anti-vibration pads, Tico or equivalent, shall be provided between the baseframe and the concrete base and the frame shall be secured against horizontal movement.

### **11.3 ELECTRIC MOTOR DRIVEN PUMPS**

The Contractor shall design the pumpset plinth and shall submit the design calculations to the Engineer for review. The calculations shall confirm that the pumpset's enforcing vibration will cause no damaging resonant condition and that the design is suitable for the ground conditions or foundations, as applicable.

Construction of the plinths and provision of all materials, including the provision of vibration isolating elements required by the design, will be done by others in accordance with the Contractor's design.

Baseframes for pumpsets shall have both pump and motor mounted on a single baseframe which is anchored to a concrete plinth. Welding on the baseframe shall be continuous all round and without crevices. The baseframe shall be designed so that liquids do not pool on it.

The Contractor shall anchor the baseframe to the plinth.

### **11.4 MOBILE UNITS**

Mobile units shall comply with Zut 5028.

**12. PIPEWORK FOR PERMANENTLY INSTALLED PUMPSETS****12.1 GENERAL**

Pipework shall comply with Zut 0001. This, inter alia, specifies that the design and manufacture of pipework shall comply with Zut 7001.

Pipework shall be flanged and the flanges shall comply with BS EN 1092 for the pressure rating.

Manual drain valves shall be provided at low points in pipework.

**12.2 SUCTION SIDE PIPEWORK**

Suction side pipework shall comply with Zut 0001.

**12.3 DISCHARGE SIDE PIPEWORK**

Discharge side pipework shall have a pressure rating which is greater than the highest pressure that the pump can produce.

**12.4 PIPE COUPLINGS**

Couplings shall comply with Zut 7023.

Pipe couplings shall have the same pressure rating as their pipework.

Two flange adaptors shall be provided on the suction side of the pump and two shall be provided on the discharge side. Each pair of flange adaptors shall be separated by a stainless steel plain ended pipe. This pipe shall be coated in order to prevent galvanic action.

For sizes DN 200 and below, a single pipe coupling of the flanged rubber tyre type may be used on the discharge side. The coupling shall incorporate stainless steel flanges if the pipework is of 3CR12 or stainless steel. The coupling shall incorporate hot dip galvanised (not metal-plated) flanges if the pipework is of low carbon steel.

Coupling restraints shall be provided only where necessitated by the Contractor's overall design.

**12.5 ANCHORS**

Pipework shall be correctly anchored and no load shall be put on the pump by the pipework.

Thrust forces in the pipework from bends, isolation valves, check valves and reducers shall be restrained either by suitable pipe anchor or by harnesses which provide restraint across couplings.

**13. INSTRUMENTATION****13.1 GENERAL**

Instrumentation shall comply with Zut 0001.



### 13.2 GAUGES

A suction/pressure gauge shall be provided on the suction side of each pump, a pressure gauge shall be provided on the discharge side of each pump (between the pump and the check valve) and a pressure gauge shall be provided on the manifold.

Each gauge shall be protected by a ball valve and diaphragm seal in order to prevent the fluid from entering the gauge.

### 13.3 HOUR METER

An hour meter which cannot be reset shall be provided.

## 14. MATERIALS AND COATINGS

### 14.1 EQUIPMENT

Equipment shall comply with the table below. Components not specified in the table shall be designed to the high corrosivity category (C4 of SANS 12944-2).

ITEM	MATERIAL	COATING
Pump body	Grey cast iron, ductile cast iron or stainless steel	Not required.
Pump body; abrasive conditions	Abrasive resistant cast iron	Not required.
Impeller	Ductile iron or stainless steel	Not required.
Shaft	Martensitic Stainless Steel	N/A
Priming air relief valve spring	Stainless Steel	N/A
Air relief pipework	Stainless Steel	N/A
Baseframe	Carbon steel sections	Hot-dip galvanise
Motors	Cast iron	Corrosion protection system which is suitable for the high corrosivity category, C4, of SANS 12944-2.

Fasteners	EN Grade 1.4401 (316)	Not required.
Coatings shall be applied in accordance with the coating supplier's instructions but abrasive blasting of wetted surfaces to Sa 3 prior to coating application is a minimum requirement. Surface abrasive blasting to Sa 2,5 is a minimum requirement prior to the application of non-wetted corrosion protection coating (with the exception of hot dip galvanising).		
Corrosion protection shall comply with Zut 0003.		
Materials shall comply with Zut 0001.		
Stainless steel shall be correctly pickled and passivated. Stainless steel surfaces shall be free of ferrous stain and heat tint at commissioning.		
Metal plating of ferrous materials is not an acceptable corrosion protection system.		
Steel and cast iron items which have been hot dip galvanised but which are then welded, cut, ground, drilled or have the steel exposed by any other means shall be rejected.		

## 15. FABRICATION

Fabrications shall comply with Zut 0001.

## 16. FASTENERS

Fasteners shall comply with Zut 0001.

## 17. INSTALLATION

Installation work shall comply with Zut 0001.

## 18. CIVILS AND BUILDING

As required in terms of the General Conditions, the Contractor shall:

- provide the details of civil and building requirements to the Engineer.
- at an appropriate point, measure on Site.

The Contractor shall ensure that the design can accommodate a tolerance of +/- 40 mm for civil and building items constructed by others unless a tighter tolerance is called for by the Contractor in good time and approved by the Engineer.

## **19. TRANSPORT**

The Contractor shall avoid damage to bearings during transport by securing equipment shafts.

## **20. SAFETY**

Each pumpset shall be provided with an emergency stop station in an appropriate position.

Moving parts shall be guarded in accordance with legislation and it shall not be possible to insert a hand or finger to come into contact with them.

Where hazardous zoning has been specified, the Contractor shall design and install all equipment installations in accordance with the requirements of SANS 10108.

## **21. INSPECTIONS**

### **21.1 WORKSHOP/FACTORY**

The Contractor shall arrange for fabrications to be inspected by the Engineer for acceptance after fabrication is complete but prior to corrosion protection.

The Contractor shall make all arrangements and carry all costs for the Engineer, or an Engineer approved inspection authority, to inspect equipment for acceptance prior to despatch to Site and prior to payment being made. If the equipment is manufactured locally, the Contractor shall arrange for the Engineer to inspect equipment in the manufacturer's works prior to despatch to Site. If the equipment is not manufactured locally, the Contractor shall arrange for the Engineer or an Engineer approved inspection authority to inspect the equipment in the manufacturer's works prior to dispatch. The Contractor shall submit the report by the inspection authority to the Engineer for acceptance. This report shall confirm compliance of the equipment with the specifications prior to despatch from the manufacturer's works.

### **21.2 SITE**

The Contractor shall make arrangements for the Engineer to inspect the completed installation on Site prior to commissioning.

### **21.3 INSPECTION DURING DEFECTS NOTIFICATION PERIOD**

The Contractor shall inspect the operation of the Works three months after the start of the Defects Notification Period and shall provide a condition report on all equipment to the Engineer.

## **22. TESTING REQUIREMENTS**

### **22.1 FACTORY TESTING**

A factory test report shall be submitted to the Engineer before delivery of the pump to Site. The test shall confirm the pump's specified performance for head, flow and power consumption at the duty point.

### **22.2 SITE**

The Contractor shall successfully demonstrate the following to the Engineer prior to the commissioning of the Works:

- a) equipment operation, including operation of fuel valve closure upon simulated failure of the heat fusible link (engine driven pumps).
- b) achievement of the specified performance requirements.
- c) control system operation.
- d) motor power margin.

The Contractor shall submit site test reports to the Engineer and shall provide copies in the Manual.

# SPECIFICATION: ZUT 5016

## Rotary Screw Air Compressors

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## 1. INTRODUCTION

Zut 5016 specifies the requirements to be provided by the Contractor for acoustically packaged rotary screw air compressors for compressed air installations with nominal operating pressures of 690 kPa to 800 kPa and with integral refrigerant dryers.

## 2. SCOPE OF WORKS

See project specification.

The installation shall be configured as shown on applicable drawings.

## 3. NORMATIVE REFERENCES

The following form part of the Contract Document:

- Amendments, Additions and Detailed Requirements (Zut 5016).
- Zut 0001: General Mechanical Requirements.
- Zut 0003: General Corr. Protection for Pipelines, Water and Waste Water Works.
- Zut 1013: Air Receivers.
- Zut 7024: Pipe Supports.
- Zut 10007: Compressed Air Systems.

Equipment, materials and operational methods shall comply with the latest edition of the relevant national and/or international standard.

## 4. EQUIPMENT ELIGIBILITY

The make and model of compressor provided shall have a successful record of use in similar applications locally and shall also have had at least three years of technical support locally. Service and spares shall currently be available. Upgraded versions of a manufacturer's earlier designs which comply with these criteria are acceptable.

Equipment which does not satisfy these requirements is not acceptable unless called for in the specifications or unless the Engineer agrees in writing.

## 5. PERFORMANCE REQUIREMENTS

The unit shall operate reliably in providing the specified supply of compressed air over the specified pressure range.

The maximum noise levels specified shall not be exceeded.

## **6. OPERATION AND CONTROL**

Controls and instruments shall be mounted within the compressor enclosure but shall be visible and accessible with all doors closed. The compressor's discharge pressure and the refrigerant dryer's operating temperature shall be displayed.

The volume of air delivered by a compressor shall be regulated to match the demand and this shall be achieved by cycling in order to maintain the system pressure. The compressor shall operate in a low power, idling mode if not compressing but shall stop if there is no demand for a set period. It shall restart automatically when demand is re-established.

Duty and standby mode shall be cycled between all installed compressors on a timed basis.

Dryers shall accommodate the compressor output.

An hour meter which cannot be reset shall be provided for the compressor motor.

A discharge pressure gauge shall be provided and shall comply with Zut 0001.

An emergency stop device shall be provided for each compressor.

The equipment shall shut down safely and without damage upon failure of the electrical supply.

## **7. DESIGN AND CONSTRUCTION**

### **7.1 GENERAL**

The compressor shall be of the packaged, rotary screw type, driven by electric motor and provided with a professionally designed and factory fitted acoustic enclosure incorporating hinged access doors. The unit shall be provided with a refrigerant dryer.

The nominal operating pressure range shall be 690 kPa – 800 kPa.

The equipment shall either be mounted on anti-vibration mounts within the package frame or the complete package shall be separately mounted on anti-vibration mounts. The unit shall be installed on a concrete plinth with a minimum height of 70 mm.

Air inlet and outlet silencing shall be provided.

Pipework shall comply with Zut 10007.

The installation shall be configured so that unheated air enters the compressor inlet.

### **7.2 COMPRESSOR**

The compressor shall be of the rotary screw type; i.e. not of the reciprocating type. It may be of the oil injected type or of the oil free type. It may be of the single screw type or of the double screw type. It may be of the single stage type or of the multi-stage type. The preferred configuration, however, is an oil injected, single stage, double screw type.

### 7.3 REFRIGERANT DRYER

Each compressor shall be provided with one dedicated dryer.

The dryer shall preferably be integral to the compressor unit and shall be rated for the maximum compressor flow. Separate refrigerant dryers are acceptable on condition that these are each sized to handle the maximum output from one compressor.

### 7.4 PRESSURE VESSELS

Oil separator vessels which are integral to the compressor package classify as pressure vessels in terms of the definition in the OHS Act and shall comply with it. Such pressure vessels shall also comply with the requirements of Zut 1013 but handholes will not be required if the diameter of the separator is too small to accommodate them physically.

### 7.5 ACOUSTIC ENCLOSURE

The acoustic enclosure shall be a standard manufacturer's design. The acoustic performance of the unit with the doors closed shall be submitted to the Engineer. The enclosure shall surround the equipment; i.e. shall consist of four walls, the floor and the roof. Acoustic louvres shall be provided on the cooling air inlets and outlets.

The enclosure shall be provided with hinged doors for all regular maintenance activities.

When operating, each individual unit shall produce a maximum sound pressure level of 70 dBA at 3 metres from the outer surface.

### 7.6 SAFETY

A lockable pressure relief valve shall be fitted to each compressor discharge. It shall be calibrated and the calibration certificate shall be provided in the Manual.

The equipment may be in an area which should be classified as zone 2, or another zone classification, in terms of hazardous locations; i.e. explosions. The Contractor shall design and install all equipment installations in accordance with SANS 10108 if this is applicable to the application.

Air compressors with a FAD of 8,5 m<sup>3</sup>/min and above and in which compression occurs in the presence of lubricating oil shall comply with Regulation 14 of the Driven Machinery Regulations of the Occupational Health and Safety Act and Regulations; i.e. shall have a suitably positioned fusible plug at every stage of compression.

## 8. FILTRATION

Inlet filters shall incorporate a renewable filter element with a servicing indicator.

Pressure side filter elements shall provide interception, coalescence and adsorption. If combined filters are provided, each shall incorporate its own separate element saturation indicator. Pressure filters may be integral to the compressor or mounted separately. If mounted separately, they shall be well secured to a suitable wall surface and all pipework shall be mounted at least 1 metre



above ground level, shall be supported in accordance with Zut 7024 and shall not be vulnerable to damage.

## **9. MOTOR**

The motor shall comply with Zut 0001.

The continuously rated output of the motor shall exceed the compressor's shaft power required by not less than 15 %.

Motors mounted inside permanent enclosures need not have ingress protection to IP 55.

If the equipment is installed in an area which should be classified as Zone 2, or another zone classification in terms of hazardous locations; i.e. explosions, then the design of the motor shall comply with the requirements.

## **10. PIPEWORK**

Pipework shall comply with Zut 0001 and pipework supports shall comply with Zut 7024.

Manual drain valves shall be provided at low points in all pipework.

Corrosion Protection shall comply with Zut 0003.

## **11. INSTRUMENTATION**

Instrumentation shall comply with Zut 0001.

## **12. MATERIALS AND COATING**

### **12.1 GENERAL**

Components shall be suitably designed for corrosion resistance to the high corrosivity category (C4) of SANS 12944-2.

Corrosion protection shall comply with Zut 0003.

Materials shall comply with Zut 0001.

### **12.2 EQUIPMENT**

Equipment shall comply with the table below.

ITEM	MATERIAL	COATING
Pipework	Carbon steel.	Hot dip galvanise.
Fasteners	EN Grade 1.4401 (316)	N/A
Auxiliary metal components	EN Grade 1.4401 (316)	Pickle and passivate.
<b>NOTES</b> <ul style="list-style-type: none"> <li>- Stainless steel shall be correctly pickled and passivated. Stainless steel surfaces shall be free of ferrous stain and heat tint at commissioning.</li> <li>- Metal plating of ferrous materials is not acceptable as the corrosion protection system.</li> </ul>		

### 13. FABRICATION

Fabrication and welding shall comply with Zut 0001.

### 14. FASTENERS

Fasteners shall comply with Zut 0001.

### 15. ELECTRICAL EQUIPMENT

Electrical equipment shall comply with the electrical specifications.

### 16. INSTALLATION

Installation work shall comply with Zut 0001.

If it is required that the drain from the dryer must be led to a remote discharge point, the connection of the pipe to the dryer outlet shall be provided with an easily de-coupled union for inspection.

### 17. CIVILS AND BUILDING

As required in terms of the General Conditions, the Contractor shall:

- provide the details of civil and building requirements to the Engineer.
- at an appropriate point, measure on Site in order to check for correctness for the Works.

The Contractor shall ensure that the design can accommodate a tolerance of +/- 40 mm for civil and building items constructed by others unless a tighter tolerance is called for by the Contractor in good time and approved by the Engineer.

## **18. INSPECTIONS**

The Contractor shall make all arrangements and carry all costs for the Engineer, or an Engineer approved inspection authority, to inspect equipment for acceptance prior to despatch to Site and prior to payment being made.

If the equipment is manufactured locally, the Contractor shall arrange for the Engineer to inspect equipment in the manufacturer's works prior to despatch to Site. If the equipment is not manufactured locally, the Contractor shall arrange for the Engineer or an Engineer approved inspection authority to inspect the equipment in the manufacturer's works prior to dispatch. The Contractor shall submit the report by the inspection authority to the Engineer for acceptance. This report shall confirm compliance of the equipment with the specifications prior to despatch from the manufacturer's works.

## **19. TESTING REQUIREMENTS**

The Contractor shall successfully demonstrate the following to the Engineer prior to the commissioning of the Works:

- a) equipment operation.
- b) achievement of the specified performance requirements.
- c) control system operation.
- d) motor power margin.

The Contractor shall submit site test reports to the Engineer and shall provide copies in the Manual.

# **SPECIFICATION: ZUT 5020**

## **Submersible and Immersible Centrifugal Pumps**

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## 1. INTRODUCTION

Zut 5020 specifies the requirements for submersible and immersible centrifugal pumps to be provided by the Contractor.

Immersible pumps are pumps which can be operated continuously either in air or submerged under water. They are suitable for dry well pump stations which are susceptible to flooding.

## 2. SCOPE OF WORKS

See project specification.

The installation shall be configured as shown on applicable drawings.

## 3. NORMATIVE REFERENCES

The following form part of the Contract Document:

- a) Amendments, Additions and Detailed Requirements (Zut 5020).
- b) Zut 0001: General Mechanical Requirements.
- c) Zut 0003: General Corrosion Protection for Pipelines, Water and Wastewater Works.
- d) Zut 7024: Pipe Supports.

Equipment, materials and operational methods shall comply with the latest edition of relevant national and/or international standards.

## 4. EQUIPMENT ELIGIBILITY

The pumps provided shall have a successful record of use in similar applications locally and shall also have had at least three years of technical support locally. Service and spares shall currently be available. Upgraded versions of a manufacturer's earlier designs which comply with these criteria are also acceptable.

Pumps which do not satisfy these requirements are not acceptable unless specifically called for in the specifications or unless the Engineer agrees in writing.

## 5. PERFORMANCE REQUIREMENTS

During performance testing at the guarantee point(s), the guaranteed performance for differential pressure across the pump, volume flow, efficiency and  $NPSH_{required}$  shall be confirmed within the standard's tolerances.

No perceptible sign of cavitation shall be present across the full specified operating range of the pumps.

Pumps handling wastewater, primary sludge, activated sludge or similar products shall be capable of handling a solid size of 100 mm diameter. They shall be capable of handling rags, hard solids, stringy solids, plastic and other solids which can be expected from a mixture of domestic and industrial wastewater and shall still continue pumping effectively.

## **6. OPERATION AND CONTROL**

### **6.1 GENERAL REQUIREMENTS**

The requirements for the normal operating system for the equipment installation are specified elsewhere.

Manual start and stop of each pump shall be provided.

The equipment shall shut down safely and without damage upon failure of the electrical supply.

Protections shall be active during manual operation.

An hour meter which cannot be reset shall be provided for each pump.

Each pump shall be provided with a discharge pressure gauge and the manifold shall be provided with one pressure gauge.

Each pumpset shall be provided with an emergency stop station in an appropriate position.

The pump shall start and stop automatically in accordance with the level in the sump as measured by ultrasonic level meters. Cycling between the available pumps shall be provided in order to alternate usage.

Check valves for sludge and for wastewater shall be provided with a lever arm and with a proximity switch which shall be used by the control system to stop its pump if the lever does not move from its closed position after the pump has started operating.

The Contractor shall provide the following:

- Manual start and stop of each pump.
- Protections shall be active during manual operation.
- The ability to remove floating solids by pumping down below normal minimum level. This shall be done by manual control of a non-latching switch positioned to give the operator a view of the sump so that the pumping can be stopped immediately that the pump begins to suck air. The appropriate alarms shall be suppressed during this procedure to allow pumping down to below normal switching levels.
- Moisture ingress to the pump's separation chamber shall be alarmed and shall cause the pump to shut down.
- Thermal protection of the motor windings.

## 7. PUMPS

### 7.1 GENERAL REQUIREMENTS

Pumps handling wastewater, primary sludge, activated sludge or similar products shall be of the non-clog type.

Pumps for abrasive duties such as pumping wastewater or sludges shall be designed for abrasion resistance. The pump casing shall be of an abrasion resistant material or shall be provided with an abrasion resistant coating designed for this application.

Adjustment of clearance to accommodate for wear shall be provided.

Pumps with a speed of 1 500 rpm or lower are preferred.

### 7.2 CURVE SELECTION

The required operating range is specified elsewhere.

The specified operating conditions shall be within the pump manufacturer's recommended operating range for the pump. This is required whether there is one operating point or multiple operating points or a range of operating points. Constant speed pumps shall have a shut off head at least fifteen percent higher than the specified duty head. Constant speed pumps shall be selected so that an increase in flow of 20 % above the duty point will not cause the pump to operate outside the manufacturer's recommended range for continuous pump operation.

The pump shall be selected to operate close to best efficiency at duty point.

Preference shall be given to pumps which have an impeller which does not exceed 95 % of the maximum impeller diameter for the pump.

### 7.3 SUBMERSIBLE PUMPS

Submersible pumpsets shall be suitable for permanent submersion at the depth specified and in accordance with the drawings.

Each pump shall be provided with a docking device which shall consist of a duckfoot pipe which is securely anchored to the concrete structure in the sump. The docking device shall be supplied by the pump manufacturer.

The Contractor shall provide two stainless steel guiderails for each pump. These shall be suitable for lowering the pump into position onto a duckfoot bend.

Pumpsets shall operate in vertical position and shall be provided with a slide shoe suitable for being lowered into position onto the docking device via guide rails. The guide rails, the docking device, the lifting chain and the vertical pipework shall be provided by the Contractor.

The lifting chain shall have a load rating of at least three times the mass of the pumpset, shall be provided with suitable hook attachment cleats and shall be permanently secured above maximum water level by EN Grade 1.4401 (316) anchors.

### 7.4 IMMERSIBLE PUMPS

Immersible pumps shall be installed in dry wells and shall be capable of operating continuously in ambient air temperatures up to 40 degrees Centigrade but their design and installation shall allow for operation, without damage, should the dry well be flooded and the pumps submerged for long periods.

Motors shall be provided with an integral jacket cooling system designed for non-immersed operation at full power.

The cooling fluid shall be self-contained; i.e. shall not rely on external cooling flow. The cooling fluid shall inhibit corrosion. It shall not be the pumped liquid. Positive circulation of the cooling fluid within the jacket is preferred.

## **8. LIFTING EQUIPMENT**

If the lifting equipment is to be provided by the Contractor, this is specified elsewhere.

## **9. PIPEWORK**

Pipework shall comply with Zut 0001.

Pipe supports shall comply with Zut 7024.

## **10. MOTORS**

The motor shall be separated from the pump by a chamber with a water ingress sensor. Mechanical shaft seals shall isolate this separation chamber. The seal between the separation chamber and the pumped liquid shall have tungsten carbide or silicon carbide faces.

Motors for immersible pumps shall be provided with an integral jacket cooling system which is self-contained; i.e. shall not rely on external cooling flow. The cooling fluid shall inhibit corrosion and shall not be the pumped liquid.

The motor shall comply with Zut 0001 but shall be close coupled to the pump and shall be of the submersible or immersible type and suited to the application.

Pump motors which are configured to start Direct-on-Line and with an open discharge valve shall have a rating for continuous operation which exceeds the pump's shaft power required at maximum duty by not less than 30 %. The margin required for pump motors for other applications is 20 %.

The motor cable shall be factory terminated at the motor terminals and shall be at least 27 metres in length unless otherwise specified. The upstream cable termination shall be at least 1 500 mm above the dry well full flood level.

## **11. INSTRUMENTATION**

### **11.1 GENERAL**

Instrumentation shall comply with Zut 0001.



## 11.2 INSERTION MAGNETIC FLOW METER

One insertion magnetic flow meter shall be provided on each pump leg. The meter shall be installed in a position which will ensure steady, uniform flow.

The meter shall feature both local readout and transmission capability.

The output shall be used to shut the pump down if a no flow condition exists.

## 11.3 GAUGES

Gauges for water shall comply with Zut 0001.

Gauges and their diaphragm seals for sludge and wastewater shall comply with Zut 0001.

A flanged nozzle or stainless steel socket shall be provided for each gauge. The nozzle, or socket, shall comply with Zut 0001.

## 11.4 FLOW METER

One full bore magnetic flow meter, with both ends flanged, shall be provided on the discharge manifold.

One flange adaptor shall be provided at each end of the flow meter; i.e. a total of two.

The flow meter shall comply with Zut 8004 and shall be provided with both local readout and transmission capability.

# 12. SPARES

The spares which are to be provided are specified elsewhere.

# 13. MATERIALS AND COATINGS

## 13.1 GENERAL

Components shall be designed for immersion.

Corrosion protection shall comply with Zut 0003.

Materials shall comply with Zut 0001.

## 13.2 EQUIPMENT

Equipment shall comply with the table below. Components not specified in the table shall be designed to the very high (industrial) corrosivity category (C5-I) of SANS 12944-2.

ITEM	MATERIAL	COATING
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Docking device	Stainless steel.	N/A
	Cast iron.	Abrasion resistant coating system with a minimum thickness of 150 micron.
Impeller for non-abrasive fluid (e.g. treated water)	Bronze, CF8M, nickel or aluminium bronze.	Not required.
Impeller – mildly abrasive fluid (e.g. river water with fine grit).	Bronze.	As per note #1.
	CF8M stainless steel.	As per note #1.
Impeller for abrasive fluid (e.g. river water with grit; wastewater; sludge)	High chrome iron.	As per note#1.
Pumpset casing for water; external surface	Cast iron.	Heavy duty epoxy or polyurethane coating system with a minimum thickness of 300 micron.
Pump casing for water; internal surface	Cast iron.	Not required.
Pumpset casing for raw water, wastewater and sludge; external surface	High chrome iron.	Heavy duty epoxy or polyurethane coating system with a minimum thickness of 300 micron.
	Cast iron.	Heavy duty epoxy or polyurethane coating system with a minimum thickness of 300 micron.
	Stainless steel.	Not required.
Pump casing for raw water, wastewater and sludge; internal surface	High chrome iron.	Not required.
	Cast iron.	Coating as per note #1.

Pumpset casing for raw water, wastewater and sludge; external surface	High chrome iron.	Heavy duty epoxy or polyurethane coating system with a minimum thickness of 300 micron.
	Cast iron.	Heavy duty epoxy or polyurethane coating system with a minimum thickness of 300 micron.
	Stainless steel.	Not required.
Shaft	Stainless steel.	N/A
Pipework	Carbon steel.	Hot-dip galvanise.
	Stainless steel.	Pickle and passivate.
Motor casing	Stainless steel.	Not required.
	Cast iron	As for pump external surface.
Slide shoe	Stainless steel.	N/A
	Cast iron.	Abrasion resistant coating system with a minimum thickness of 150 micron.
Guide rails for slide shoe	Stainless steel.	N/A
Chain	Stainless steel.	N/A
External metal components	EN Grade 1.4401 (316)	Pickle and passivate.
Fasteners	EN Grade 1.4401 (316)	N/A
#1	The item shall be provided with a specialist abrasion resistant coating. The system's dft shall be about 1 500 microns and shall not be less than 1 200 microns. The coating shall be specifically suitable for abrasion resistance in pump internals such as a solids bearing vinyl ester copolymer such as Corrocoat Armagel, or a ceramic carbide such as Belzona 1811/1812, or Carboline CAR 300, or equivalent.	

#2	Stainless steel shall be correctly pickled and passivated. All stainless steel surfaces shall be completely clear of ferrous stain at commissioning.
#3	Metal plating of ferrous materials is not acceptable as the corrosion protection system.

## 14. INSTALLATION

Installation work shall comply with Zut 0001.

Submersible pumps shall be installed so that they will be fully submerged under all operating conditions (except during the pump down procedure).

## 15. CIVILS AND BUILDING

As required in terms of the General Conditions, the Contractor shall:

- provide the details of civil and building requirements to the Engineer for incorporation into the structure.
- at an appropriate point, measure on Site.

The Contractor shall ensure that the design can accommodate a tolerance of +/- 40 mm for civil and building items constructed by others (unless a tighter tolerance is called for by the Contractor in good time and approved by the Engineer).

## 16. SAFETY

The Contractor shall design and install equipment installations in accordance with the requirements of the country's Occupational Health and Safety regulations.

The Contractor shall design and install all equipment installations in accordance with the requirements of SANS 10108 as applicable.

## 17. INSPECTIONS

### 17.1 WORKSHOP/FACTORY

#### 17.1.1 General

The Contractor shall make all arrangements and carry all costs for the Engineer, or an Engineer approved inspection authority, to inspect equipment for acceptance prior to despatch to Site and prior to payment being made. If the equipment is manufactured locally, the Contractor shall arrange for the Engineer to inspect equipment in the manufacturer's works prior to despatch to Site. If the equipment is not manufactured locally, the Contractor shall arrange for the Engineer

or an Engineer approved inspection authority to inspect the equipment in the manufacturer's works prior to dispatch. The Contractor shall submit the report by the inspection authority to the Engineer for acceptance. This report shall confirm compliance of the equipment with the specifications prior to despatch from the manufacturer's works.

#### 17.1.2 Pumps

Pumps with motor size of 110 kW or larger shall be inspected at the factory. The impellers and shafts shall be available for inspection.

#### 17.2 SITE

The Contractor shall make arrangements for the Engineer to inspect the completed installation on Site for acceptance prior to commissioning.

#### 17.3 INSPECTION DURING DEFECTS NOTIFICATION PERIOD

The Contractor shall inspect the operation of the Works three months after the start of the Defects Notification Period and shall provide a condition report on all equipment to the Engineer.

### 18. TESTING REQUIREMENTS

#### 18.1 FACTORY TESTS

The Contractor shall make all arrangements for the Engineer to witness the following for pumps with motor ratings of 110 kW and above:

- a) the casing shall be pressure tested to 1,5 times design pressure for a period of 30 minutes.
- b) the pump shall be tested for flow, head, efficiency and  $NPSH_{required}$  at the guarantee point. The pump shall be tested in accordance with and shall meet the allowable tolerances of ISO 9906 Grade 1B; preferably at the manufacturer's works.
- c) the power demand for the motor shall be measured in order to confirm that the specified motor power margin has been provided.

The Contractor shall arrange that a test report for the following shall be submitted to the Engineer for pumps with motor sizes smaller than 110 kW:

- d) the casing shall be pressure tested to 1,5 times design pressure for a period of 30 minutes.
- e) the pump shall be tested for flow, head, efficiency and  $NPSH_{required}$  at the specified guarantee point. The pump shall be tested in accordance with and shall meet the allowable tolerances of ISO 9906 Grade 2B.
- f) the power demand for the motor shall be measured in order to confirm that the specified motor power margin has been provided.

Non-conforming pumps shall be corrected or replaced.

The performance tests shall be done at full speed unless agreed otherwise by the Engineer.

## **18.2 REPORT**

The Contractor shall submit reports for all specified tests to the Engineer prior to the equipment being transported to Site and prior to payment being made.

## **18.3 SITE**

The Contractor shall successfully demonstrate the following to the Engineer prior to the commissioning of the Works:

- a) operation of all equipment.
- b) achievement of the specified performance requirements.
- c) correct operation of the control system.
- d) motor power margin (unless already established at the factory).

The Contractor shall provide site test reports to the Engineer and shall submit copies in the Manual.

# SPECIFICATION: ZUT 5030

## Multi-Stage Pump (In-Line, Vertical Shaft)

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## 1. INTRODUCTION

Zut 5030 specifies the requirements for in-line, vertical shaft, multi-stage pumps.

## 2. SCOPE OF WORKS

The scope of work for which the Contractor is responsible is specified elsewhere.

The equipment installation to be provided shall be configured as shown on any applicable drawings.

## 3. NORMATIVE REFERENCES

Where this specification is required for a project, the following documents shall form part of the Contract Document:

- Amendments to Zut 5030.
- Zut 0001: General Mechanical Requirements.
- Zut 7023: Pipe Couplings and Flange Adaptors.
- SANS 1123.
- BS EN 1092.
- ISO 9906.
- The Occupational Health and Safety Act and Regulations.

Equipment, materials and operational methods shall comply with the latest edition of relevant national and/or international standards.

## 4. EQUIPMENT ELIGIBILITY

The pump tendered shall have a successful record of use in South Africa in similar applications. It shall also have had at least three years of technical support in South Africa and service and spares shall currently be available. Upgraded versions of a manufacturer's earlier designs which comply with these criteria are also acceptable.

Equipment which does not satisfy these requirements is not acceptable unless specifically called for in the specifications or unless the Engineer agrees in writing.

## 5. PERFORMANCE REQUIREMENTS

The specified operating points (whether there will be one operating point or multiple operating points or a range of operating points) shall be within the pump manufacturer's recommended operating range for the pump.



The pump shall be capable of performing the specified duties and shall be rated for continuous operation at those duties. All components shall perform reliably over the specified range.

During performance testing at the guarantee point(s), the tender's guaranteed performance for differential pressure across the pump, volume flow, energy efficiency and NPSH<sub>required</sub> shall be confirmed within the standard's tolerances.

During testing of the pump casing, there shall be no leakage or evidence of structural weakness.

## 6. OPERATION AND CONTROL

### 6.1 GENERAL

The Contractor shall provide the following specific requirements:

- **Protections shall be active during manual operation.**
- Manual start and stop of each pump shall be provided.
- The equipment shall be designed to shut down safely and without damage upon failure of the electrical supply.
- Each pumpset shall be provided with an emergency stop station in an appropriate position.

### 6.2 NORMAL OPERATION

The project specifications specify requirements for normal operation.

### 6.3 SHUT-DOWN CONDITION

The pump shall be shut down upon unacceptably high flow or unacceptably low flow once it has reached equilibrium operation.

## 7. EQUIPMENT CONSTRUCTION AND DESIGN

Pumps shall be centrifugal units of the vertical shaft, multi-stage type with in-line inlet and outlet flanges.

The pump operating point shall be to the left of the pump's best efficiency point for the chosen impeller size and speed (unless there is another overriding technical factor which affects the choice of pump).

The pumps inlet and outlet shall be flanged. The flanges shall be dimensionally compatible with SANS 1123 or BS EN 1092; plate flanges for welding.

Flanges for PN 25 rating and above shall be of raised face configuration.

The pump inlet and outlet shall be oriented horizontally and in-line and the suction and discharge pipework shall be horizontal.

Pumpset speed shall not exceed 1 500 rpm unless allowed by the project specification.

Pump bodies, impellers and diffusers shall be of stainless steel.

The pump shaft shall be of chrome steel or of stainless steel.

The pump nameplate shall be of stamped or engraved stainless steel and shall include the manufacturer, model, year, serial number, inlet diameter, outlet diameter, duty point head and flow (or range), impeller diameter, speed, maximum allowable casing pressure and mass.

## **8. SHAFT SEALS**

The seals shall be cartridge type mechanical seals rated for the application.

A pump in series with another upstream pump shall be provided with a shaft seal which is rated for the shut off pressure of the upstream pump (minus any permanent difference in elevation).

The face materials shall be to the approval of the Engineer.

It shall be possible to replace the seal without dismantling the pump.

## **9. PLINTH AND BASEFRAME**

The pump shall be mounted on a stainless steel baseframe which ensures that the footing of the pump is raised at least 25 mm above the concrete plinth or floor on which the pump is installed.

The pump-to-baseframe bolts and the baseframe anchor bolts shall be of EN 1.4401 (316) stainless steel or of a duplex stainless steel.

The baseframe shall comply with the requirements of Zut 0001.

## **10. PIPEWORK**

Pipework configuration shall comply with Zut 0001 and pipework construction shall comply with Zut 7001.

Two flange adaptors shall be provided on the suction side of the pump. Two flange adaptors shall be provided on the discharge side of the pump. These shall comply with Zut 7023.

## **11. MOTOR**

The motor shall comply with the requirements for electric motors in Zut 0001.

Motors shall have ingress protection to at least IP 55 and shall comply with the electrical specifications.

The motor rating shall exceed the pump's shaft power required at maximum duty by not less than 20 %.

## **12. FASTENERS**

Fasteners shall comply with the requirements of Zut 0001.

## **13. INSTRUMENTATION**

### **13.1 GENERAL**

Instrumentation shall comply with the requirements of Zut 0001.

### **13.2 HOUR METER**

An hour meter which cannot be reset shall be provided for each pump.

### **13.3 PRESSURE GAUGES**

One gauge shall be installed on the suction side of each pump. One gauge shall be installed on the discharge side of each pump. One gauge shall be provided on the discharge manifold.

Gauges shall be selected to match the design pressure range and shall comply with Zut 0001.

The gauges shall be positioned so that they achieve stable operation.

### **13.4 FLOW MEASUREMENT**

One magnetic flow meter shall be provided on the suction or on the discharge pipework of each pump and in the best position to ensure uniform flow. The meters shall be used primarily for control to ensure that the pumps do not operate at either too high flow or too low flow but shall also indicate the flow through the individual pump.

## **14. AUXILIARY EQUIPMENT**

A drain shall be provided on the suction pipework.

A manually operated air relief valve shall be provided on the suction side and on the discharge side.

The nozzle sockets for the drain and for the air valves shall be of stainless steel and the adjacent area of pipework shall be adequately corrosion protected.

The valves shall be small bore, stainless steel ball valves.

## **15. ELECTRICAL EQUIPMENT**

The Contractor shall provide all associated electrical equipment as specified in the electrical specifications.

## **16. SPARES**

The spares which are to be provided are specified elsewhere.

## **17. DELIVERY AND INSTALLATION**

### **17.1 DELIVERY**

When assembled pumps are transported, care shall be taken to prevent damage to bearing elements. Either the shaft shall be secured against relative movement or the pump base shall be mounted on suitable anti-vibration mounts during transport.

### **17.2 INSTALLATION**

Equipment shall be mounted firm and level.

Auxiliary small bore pipework, including fittings, shall be of stainless steel. Flexible lengths shall be of stainless steel braided hose.

Installation work shall comply with Zut 0001.

## **18. CIVIL AND BUILDING MATTERS**

As required in terms of the General Conditions, the Contractor shall:

- provide the details of all civil and building requirements to the Engineer for incorporation into the structure.
- at an appropriate point, measure on Site.

The Contractor shall ensure that the design can accommodate a tolerance of +/- 40 mm for civil and building items constructed by others (unless a tighter tolerance is called for by the Contractor in good time and approved by the Engineer).

## **19. SAFETY**

The Contractor shall design and install equipment installations in accordance with the requirements of the country's Occupational Health and Safety regulations.

If applicable, the design and supply shall be in accordance with the requirements of SANS 10108 for hazardous areas.

Each motor shall be provided with an emergency stop station in an appropriate position.

## **20. INSPECTIONS**

### **20.1 INSPECTION BEFORE COMMISSIONING**

Fabrications will generally be inspected by the Engineer after fabrication is complete.

The Contractor shall make arrangements for the Engineer to inspect the equipment for compliance prior to payment being made.

The Contractor shall make arrangements for the Engineer to inspect the installation on Site for review prior to commissioning.

### **20.2 INSPECTION DURING DEFECTS NOTIFICATION PERIOD**

The Contractor shall inspect the operation of the installation three months after the start of the Defects Notification Period and shall provide a condition report to the Engineer.

## **21. TESTING REQUIREMENTS**

### **21.1 FACTORY**

The body shall be pressure tested to the manufacturer's recommended test pressure.

The pump shall be performance tested for flow, head and efficiency at the specified duty point.

The test shall be performed in accordance with ISO 9906 Grade 2B.

The Contractor shall submit the factory test report to the Engineer.

### **21.2 REPORT**

The Contractor shall submit reports for all specified tests to the Engineer prior to the equipment being transported from the factory to Site or payment being made.

### **21.3 SITE**

The Contractor shall successfully demonstrate the following to the Engineer prior to the commissioning of the Works:

- a) operation of all equipment.
- b) achievement of the specified performance requirements.
- c) correct operation of the control system.

The Contractor shall measure the power demand for the motor measured on Site in order to confirm that the specified motor power margin has been obtained.

The Contractor shall provide site test reports to the Engineer and shall submit copies in the Manual.

## **22. DOCUMENTATION TO BE PROVIDED**

### **22.1 TENDER**

Large scale curves of the pump offered shall be provided with the tender offer. These shall include pressure, power and NPSHr vs flow.

Adequate information shall be provided in the tender to confirm that the specified operating points (whether there will be one operating point or multiple operating points or a range of operating points) are within the pump manufacturer's recommended operating range for the pump.

### **22.2 MANUAL**

The pump manufacturer's installation, operation and maintenance manual shall be provided in the Manual. The model installed in terms of this Contract shall be clearly indicated within the manufacturer's manual.

# SPECIFICATION: ZUT 6004

## Actuators for Valves and Sluice Gates

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## **1. INTRODUCTION**

Zut 6004 specifies the requirements for actuators to be provided by the Contractor. It deals with electric actuators, hydraulic actuators and pneumatic actuators for valves and sluice gates.

## **2. SCOPE OF WORKS**

See project specification.

The installation shall be configured as shown on applicable drawings.

## **3. NORMATIVE REFERENCES**

Where this specification is required for a project, the following documents shall form part of the Contract Document:

- a) Amendments, Additions and Detailed Requirements (Zut 6004).
- b) Zut 0001: General Mechanical Requirements.

Equipment, materials and operational methods shall comply with the latest edition of relevant national and/or international standards.

## **4. EQUIPMENT ELIGIBILITY**

The actuators provided shall have a successful record of use in similar applications locally and shall also have had at least three years of technical support locally. Service and spares shall currently be available. Upgraded versions of a manufacturer's earlier designs which comply with these criteria are also acceptable.

Actuators which do not satisfy these requirements are not acceptable unless called for in the specifications or unless the Engineer agrees in writing.

## **5. OPERATION AND CONTROL**

The actuator shall remain in position upon power supply failure unless otherwise specified.

Manual start and stop shall be provided.

The detailed operational functions required are specified elsewhere.



## **6. CONSTRUCTION AND DESIGN**

### **6.1 GENERAL**

Actuators shall be provided with manual override. The opening and closing force on the handwheel at a differential pressure equal to the rated pressure difference shall be less than 240 Newtons (i.e. the sum of the forces on both sides shall be less than 240 Newtons over the full opening and closing distances). The open and close directions of handwheels shall be indicated.

Visual indication of the actuator's position shall be provided

Actuators shall be mounted using stainless steel mounts, couplings and fasteners.

The ingress protection rating shall be to IP 68.

### **6.2 TYPE**

Actuators shall have duty of one of the three following types:

<b>TYPE</b>	<b>DESCRIPTION</b>
Open/Close	The actuator will move from fully open to fully closed, or vice versa, but will not be required to stop at any intermediate position.  The opening and closing rate might be significant.
Regulating	The actuator will be required to open, or close, either fully or partially. When partially open, it will be required to remain in that position for long periods until a change is required.  The opening and closing rate might be significant.
Modulating	The actuator will continuously open and close in order to track some process variable.  Modulating actuators are normally part of a control loop function.

### **6.3 REGULATING DUTY AND OPEN/CLOSE DUTY ACTUATORS**

The continuous actuator torque rating for regulating duty and for open/close duty shall be at least 150 % of the start/opening or the end/close torque, whichever is higher, specified by the valve or sluice gate manufacturer for this application (after any gearbox mechanical advantage has been taken into account).

### **6.4 MODULATING DUTY ACTUATORS**

Actuators to be provided for modulating duties shall be specifically designed for modulation on a continuous basis.

The torque rating for actuators for modulating duty shall be at least 200 % of the valve's torque requirement.

Modulating actuators shall use solid state relays. Mechanical contactors are not acceptable.

Gearing backlash and dead band shall be minimized.

## **6.5 GEARBOXES**

The gearbox ratings shall be provided for an ambient temperature of 40 degrees Centigrade.

The service factor to be used for the design of gearboxes in uniform load duty shall be at least 1,25 for electric motor driven applications. A minimum service factor of 1,5 shall be used for moderate shock applications and a minimum service factor of 2 shall be used for heavy shock applications.

Rolling element bearings shall be designed for an L-10 life in excess of 100 000 hours.

Gearbox external surfaces shall be provided with a coating suitable for the high corrosivity category (C4 of SANS 12944-2) and the dry film thickness shall not be less than 200 micron.

An over torque limiting device shall be incorporated.

Grease lubrication points shall be easily accessible. Grease nipples shall be of stainless steel.

A breather designed to prevent moisture from entering shall be fitted.

## **6.6 CORROSION PROTECTION**

Corrosion protection of steel and cast iron external components shall comply with SANS 12944-2 (EN ISO 12944-2) classification C5 (I or M).

External fasteners shall be of stainless steel.

Metal plating of ferrous materials, (e.g. zinc or cadmium plating) is not an adequate corrosion protection system and such items shall be provided with an additional coating of a semi setting, thick protective layer, such as a suitable Tectyl product, or equivalent.

# **7. PNEUMATIC ACTUATORS**

Pneumatic actuators shall be fabricated of non-corrosive materials.

The air supply immediately upstream of each actuator shall be fitted with a dedicated filter/regulator/lubricator unit. The filter shall incorporate an automatically operating water drain trap.

If the specification calls for automatic closing upon power failure or failure of the air supply, a back-up power source such as a suitably sized accumulator or stainless steel spring shall be provided.

Pressure within an accumulator shall be indicated on a gauge which complies with Zut 0001. All applicable pressure vessel safety regulations shall be complied with.

Linear pneumatic actuators shall be provided with stainless steel pistons, attachments and hard chromed cylinder rods.

## **8. ELECTRIC ACTUATORS**

### **8.1 GENERAL**

The actuator motor and gearbox shall be one integrated unit.

Motors shall be for three phase, 400 Volt, 50 Hz supply, shall be Class F insulated (or higher) and shall have an embedded thermostat for overload protection. The complete unit, including installation work, glands and controls shall be ingress protected to IP 68 and the terminal compartment shall be accessible for cable termination without exposing the internal electrical control components.

Motors for modulation duty shall be designed for at least 600 starts/hour.

An emergency stop shall be provided.

The actuator shall provide an impact effect to overcome tightly seated valves.

It shall be possible to set the control mode without removing covers.

### **8.2 OPERATION AND CONTROL**

If the opening or closing period is specified, this period shall be achieved by incorporating a suitable gear ratio to allow the motor to operate continuously from fully open to fully closed. In other words, the motor shall not repeatedly stop and start over this period.

If it is required that the actuator must close automatically when electrical supply fails, then a spring return or a suitably sized UPS shall be provided.

Actuators shall be provided with protection against damage under the following conditions:

- (a) overload torque.
- (b) overheating of motor windings.
- (c) failure to move a valve.
- (d) an unintended loss of movement.

The following information shall be fed back to the control system and shall be indicated:

- (a) valve position.
- (b) torque on output shaft.

### **8.3 MULTI-TURN ACTUATORS**

Rotation direction shall be correctly controlled regardless of the phase sequence connection.

## **9. HYDRAULIC ACTUATORS**

Hydraulic actuators shall be provided with a suitable electric motor driven hydraulic power pack. It is acceptable that a single power pack supplies more than one actuator.

Oil filtration shall be provided by easily replaceable spin off filters.

Pipework shall be of stainless steel or shall be of braided stainless steel reinforced hosing.

A pressure gauge shall be provided at the power pack and at each actuator.

The oil reservoir tank shall be provided with a drain at the lowest point.

The pressure relief valve on the pump discharge shall return the relief flow to the reservoir tank. Operation of the pressure relief valve shall be alarmed.

If it is required that the actuator must close automatically when the electrical supply fails and the device will not close itself under gravity, then a suitable back up power source such as suitably sized accumulator shall be provided. Pressure within the accumulator shall be indicated on a gauge which complies with Zut 0001. All applicable pressure vessel safety regulations shall be complied with.

## **SPECIFICATION: ZUT 7001**

**Design and manufacture of medium-pressure steel  
specials**

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## 1. SCOPE

This Specification covers the design, manufacture and delivery to site of electrically welded low carbon steel specials of outside diameter up to 2 280 mm, for transporting water and sewage at ambient temperatures and under working pressures of up to 2,5 MPa.

This Specification shall be read in conjunction with SANS 1200 L. Where conflict between this specification and SANS 1200 L occurs, the provisions of this specification shall apply.

Interpretations and variations of this specification are set out in the Amendments preceding this Specification.

## 2. NORMATIVE REFERENCES

### 2.1 SUPPORTING SPECIFICATIONS

Where this Specification is required for a project, the following specifications shall, inter alia, form part of the Contract Document:

- a) Amendments;
- b) SANS 1200 Series of Standardized Specifications;
  - i. SANS 1200 L: Medium-pressure pipelines (see 1. above)
- c) Specification ZUT 7002 : Manufacture of medium-pressure steel pipes
- d) Specification ZUT 0003 : Painting and corrosion protection for water and wastewater works
- e) Specification ZUT 7003 : Laying, jointing and testing of medium-pressure steel pipes and specials

The latest issues of the specifications listed in Appendix A shall be deemed to apply to the design and manufacture of welded steel specials manufactured using approved welding techniques.

## 3. DEFINITIONS AND ABBREVIATIONS

### 3.1 DEFINITIONS

For the purposes of this Specification the definitions and abbreviations given in the applicable clauses of the specifications listed in 2.1 and the following definitions shall apply:

<b>Cut-and-shut bend</b>	:	A bend formed by cutting out one or more V-shaped sections equally disposed about a line at right angles to the axis of the pipe, preparing the cut-out edges for welding; bending the pipe to form the bend and welding the pipe shut along the prepared edges to complete the bend (see BS 2633, Fig 25)
<b>Fitting</b>	:	<ul style="list-style-type: none"> <li>a) A special or valve.</li> <li>b) Any process of jointing (except welding) straight pipes to one another and to specials and valves.</li> </ul>
<b>Flexible pipe</b>	:	A pipe of which the diameter is reduced by more than 1% under an external radial force before the appearance of cracks.
<b>"H"</b>	:	The cross-sectional shape of a weld at a skelp.



## Manual shielded

### electric arc

<b>process welding</b>	:	Electric arc welding done by hand using a filler electrode coated with a material that gasifies at the point of arc and excludes oxygen from the weld, thus improving the metallurgical quality of the completed weld.
<b>Mitre welds</b>	:	Welds which join two lengths of pipe at an angle point in such a manner that the axis of both lengths of pipe proceed in a straight line to the point of intersection.
<b>Nominal diameter (size):</b>		A numerical designation of diameter which is common to all components in the piping system other than components designated by OD or by thread size. It is a convenient round number for reference purposes and is only loosely related to manufacturing dimensions.
<b>Nominal pressure</b>	:	A numerical designation which is a convenient round number for reference purposes.  All equipment of the same DN designated by the same PN number shall have compatible mating dimensions.
<b>Pinhole</b>	:	A very small hole indicating a flaw in the weld.
<b>Pipe end bevel</b>	:	A bevel cut made on the end of a pipe to afford a groove between abutting joints in order to receive weld metal.
<b>Pipework</b>	:	Includes all pipes, joints, specials, fittings and valves.
<b>Skelp</b>	:	The jointing edges of steel coils used in the manufacture of spiral welded pipe.
<b>Special</b>	:	Any pipe other than a straight pipe.  Note: Under this definition shall be included all sizes of specials of shapes such as bends, tees, crosses, angle branches, reducers, tapers and flexible couplings with or without centre registers.
<b>Straight pipe</b>	:	A straight pipe of uniform bore and of standard or non-standard length.
<b>Welding icicles</b>	:	Congested droplets of metal which extend through the weld to the interior of the pipe, caused by excessive heat or improper welding technique.

## 3.2 ABBREVIATIONS

The following abbreviations (additional to those referred to in 3.1) shall have the meanings given:

AISI	:	American Iron and Steel Institute
DN	:	Nominal diameter (e.g. DN 200 = 200 mm nominal diameter)
DS-AW	:	Double submerged-arc welded
FBE	:	Flanged both ends
FOE	:	Flanged one end
ID	:	Internal diameter
MS	:	Mild Steel

OD	: Outside diameter, which shall mean the internal diameter + 2x(lining thickness + pipe wall thickness)
p.e.	: Plain ended.
PN	: Nominal working pressure (eg. PN 10 = 1 000 kPa)
Scab	: Unbonded piece of plate in tight contact with the plate
SS	: Stainless Steel
t	: Wall thickness of pipes
TP	: Test pressure
WP	: Weld preparation

## 4. REQUIREMENTS

### 4.1 MATERIALS

#### 4.1.1 General

Specials and fittings shall be of the types shown on drawings or billed and, unless otherwise required in terms of the Amendments, they and their couplings shall be capable of withstanding the applicable test pressure. All specials and fittings shall be supplied complete with couplings and jointing material.

#### 4.1.2 Types of steel

Unless otherwise billed or shown on drawings, specials and fittings shall be manufactured from the following materials:

##### 4.1.2.1 Nominal diameter equal to or less than 150 mm

Medium or heavy class steel, complying with the applicable requirements of SANS 62.

##### 4.1.2.2 Mild steel

Steel grade	Minimum Yield Stress (MPa)	Chemical Composition and Physical Properties
B	241	SANS 719, Table 1
300WA	300	SANS 1431
X42	289	API 5L Table 3.1 & 4.1
X46	317	API 5L Table 3.1 & 4.1
X52	358	API 5L Table 3.1 & 4.1
X56	386	API 5L Table 3.1 & 4.1
X60	413	API 5L Table 3.1 & 4.1
X65	450	API 5L Table 3.1 & 4.1

#### **4.1.2.3 3CR12 Corrosion resistant steel**

3CR12 corrosion resistant steel plate shall have a No.1 finish and shall be supplied ex-factory ready pickled and passivated.

#### **4.1.2.4 Stainless steel**

Stainless steel shall be either EN Grade 1.4301 (304L stainless steel) or EN Grade 1.4401 (316L stainless steel).

#### **4.1.2.5 Super duplex stainless steel**

Duplex stainless steel shall be either EN Grade 1.4162 (2101) or EN Grade 1.4462 (2205). Super Duplex stainless steel shall be EN Grade 1.4410 (2507).

#### **4.1.3 Flanges**

Flanges on pipe ends, where applicable, shall be manufactured from the same material as the pipe, unless otherwise specified in the Amendments.

Where mild steel flanges are specified, flanges shall be manufactured from steel plate conforming to BS 4360 or SANS 1431 Grade 300W for working pressures up to PN 25. Flanges rated more than PN 25 and up to PN 60 shall be made from steel manufactured in accordance with BS EN 10222 Grade 460 or as approved. Flanges for pressures exceeding PN 60 and up to PN 250 shall be special flanges and gaskets manufactured by Hydro Power Engineering or equal approved.

#### **4.1.4 Certification**

The Contractor shall submit to the Engineer the steel maker's certificates covering all steel used in the manufacture of the specials as required in Clause 4.4 of SANS 719. In addition, all information relevant to pipework fabrication shall be made available to the Engineer during the course of the manufacturing process.

### **4.2 DESIGN**

#### **4.2.1 General**

The Contractor shall be responsible for the design of all specials in accordance with the general arrangement shown on the drawings and/or described in the Bill of Quantities and in conformity to BS 534.. He shall submit his design calculations and shop drawings to the Engineer for approval before manufacturing commences. The design of saddle type reinforcement shall be in accordance with AWWA M11.

Specials shall be fabricated by welding from pipes which have been tested to SANS 719 and that conform to the requirements applicable to the Manufacture of medium-pressure steel pipes.

Lifting eyes (lugs) shall be welded to all unwieldy specials and to all specials of DN 600 and larger to facilitate handling and minimise damage to the protective coating.

#### **4.2.2 Wall thickness**

Specials shall be designed so that 50% of the minimum yield stress of the steel is not exceeded under maximum working pressure and so that 75% of the minimum yield stress of the steel is not exceeded under maximum surge pressure.

An OD/t ratio of more than 100 will not be permitted unless specifically indicated otherwise on the drawings or in the Bill of Quantities.

For all branch connections (tees) the plate thickness of the barrel and branch shall be such that the maximum stress shall not be greater than that for an uncut pipe of the theoretical required minimum thickness. Where it is more economical to provide external reinforcement in the form of collar type rings or crotch plates, as shown on the drawings, these forms of reinforcement shall be used to achieve the same results

#### **4.2.3 Bends**

Unless otherwise indicated on the drawings or scheduled in the Bill of Quantities, the dimensions for bends shall be determined in accordance with AWWA C208.

Bends shall either be smooth formed (hot bent) or segmented. The maximum angle between oblique butt-ends of segments for mitred bends shall not exceed 22.5°. Cut-and-shut bends are not permitted. Segmented bends shall be classified as short, medium and long with radii equal to one, two or three diameters respectively. All bends shall be of the long radii type, unless otherwise shown on the drawings or specified in the Amendments or Bill of Quantities.

Mitres for bends (kinks) of 10 degrees and less shall be made in the field as part of the pipe laying operation for buried pipelines.

#### **4.2.4 Branches and nozzles**

The attachment of reinforcement to the pipe branches shall be by full penetration welding. The extent and positioning of external reinforcement is to be determined in accordance with AWWA M11.

Branch connections shall be as remote as possible from the seam weld on the barrel and shall generally be placed as follows, except where specifically indicated to the contrary on the drawings:

- a) For air valve tees the centre lines of the air valve branch and the barrel shall intersect at right angles or vertically, as shown on the drawings, depending on the type of tee specified. The branch shall be flanged and have a nominal diameter greater than 50% of the main pipe diameter.
- b) For scour valve tees the branch, consisting of a 90 degree bend, shall be located centrally on the pipe invert and point vertically downwards with the horizontal section at right angles to the barrel of the pipeline. The branch flange shall be set so that the scour valve spindle points vertically upwards, as shown on the drawings.

Nozzles shall be "stub in" in accordance with ANSI B31.3 and of minimum size DN25. Such nozzles shall be threaded to BSPT and provided with appropriate reinforcement. The Contractor shall ensure that the design will withstand the test pressure of the system.

#### **4.2.5 Reducer pieces**

Taper pieces shall not have more than two longitudinal weld seams and shall have a maximum angle of divergence of 10 degrees, as shown on the drawings.

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#### **4.2.6 Pipe supports**

Supports for pipework, valves and specials inside chambers and pump stations shall be designed by the Contractor to adequately secure the pipework to the walls and floors. Details and locations of the supports shall be submitted for approval by the Engineer.

#### **4.2.7 Dimensions**

The dimensions of the pipe specials and fittings are shown on the drawings.

#### **4.2.8 Provision of cadwelding pads**

Where specials are to be jointed by means of flexible couplings the manufacturer shall weld steel plates not less than 50 x 75 x 6 mm thick, 250 mm from each end of all pipes, during the pipe manufacturing process (i.e. before lining and coating) to provide adequate area for cadwelding bonding cables to the piping to make it electrically continuous and enable a cathodic protection system to be applied without damage to the coating.

#### **4.2.9 Shop drawings**

The Contractor shall, before issuing of shop drawings for manufacture, provide detailed pipework layout drawings for approval in principle by the Engineer. Such drawings shall contain general arrangements and assemblies for the pipes, pipe auxiliaries, pipe specials and valves and include materials schedules, standard parts, etc. Drawings shall provide all the information necessary to demonstrate full compliance with the drawings and specifications and to facilitate subsequent submission of shop drawings free of fit-up error. The Contractor shall be fully responsible for determining the actual dimensions of the specials.

Pipe layout drawings shall incorporate all relevant prime and subsidiary dimensions (primarily, but not necessarily limited to, face-to-face dimensions).

Drawings shall be prepared to acceptable industry standards, an example of which shall be submitted for approval before draughting commences. Due account is to be taken in preparing drawings of the necessity, inter alia, to facilitate straight-forward subsequent fit-up on site, without undue site trimming and site preparation for butt welding, so minimizing also the necessity for extensive site repairs to, or extensions of, internal and external corrosion protection.

Only after approval of final pipework layout drawings by the Engineer shall shop drawings for manufacture of pipes and specials commence. For subsequent approval by the Engineer these shall be in such detail as is appropriate for manufacture. No manufacturing of pipework shall be permitted without approval of the shop drawings by the Engineer.

Approval by the Engineer of any drawing shall not relieve the Contractor of responsibility for correct manufacture and subsequent fit-up on site.

### **4.3 JOINTING**

#### **4.3.1 Flexible couplings**

Flexible couplings for plain-ended steel pipe and adaptor couplings shall be either of the slip-on type complying with Clause 15 of BS 534 or of the slip-on type without centre register conforming to the drawings, as scheduled. Slip-on flange adaptors for steel pipes shall conform to the relevant drawings.

A coupling shall be able to withstand without failure a hydrostatic test pressure of twice the working pressure specified for the pipe for which the coupling is required, and coupling flanges shall be capable of

withstanding without damage all stresses caused by proper tightening of the bolts. Rubber rings shall comply with the relevant requirements of SANS 974: Part I and shall have a hardness of 66 to 75 IRHD.

All grinding off of welds shall conform accurately with the profile of the rolled section and so that no flats occur on surfaces that are supposed to be curved. The centre register (where present) shall be ground off on either side of the weld in such a manner that all sharp edges which would result in weakening of the protective coating are removed. Flexible couplings shall be supplied complete with all necessary bolts, nuts and rubber jointing rings.

#### **4.3.2 Flanges**

Flanges shall be designed and manufactured to BS EN 1092 Part 1 for steel flanges and Part 2 for cast iron flanges, unless otherwise specified on the Drawings. Flanges not covered by BS EN 1092 shall be manufactured according to the detailed dimensions and requirements shown on the Drawings.

All flanges shall be suitable for Site welding (SW) to pipes and specials and shall conform to BS 2633, Section 7 with preparation of plate flanges as shown in Fig 41 ("slip-on") for pipes and specials up to DN 100 and Fig 39 or 40 ("bore and fillet") for pipes and specials DN 125 and larger.

The drilling of steel and cast iron flanges shall be off-centre and shall conform to the requirements of SANS 1123, BS EN 1092: Section 3.1, or ISO 7005: Part 1 as applicable, appropriate to the class of pipe specified, except that in the case of flanges, where M27 and M33 bolts are specified in BS EN 1092: Section 3.1, M24 and M30 bolts respectively shall be used as specified in SANS 1123.

Any pipe that has flanges which are incorrectly drilled will be rejected. Reaming of bolt holes to oversize dimension in order to make a particular piece fit will not be permitted.

All flanges shall be machined overall with gramophone finish in accordance with SANS 1123, or as specified below:

- a) Flange sizes up to and including DN 400 with a pressure rating up to and including 1600 kPa shall have flat joint faces, and where the pressure rating exceeds 1600 kPa, shall have a raised face sealing arrangement;
- b) Flange sizes exceeding DN 400 up to and including DN 1000 shall have a raised face sealing arrangement for all pressure ratings up to and including 2500 kPa.

For flanges not covered by BS EN 1092, and for domes and conical ends, thicknesses shall be calculated and where applicable the flanges manufactured in accordance with Section 3 of BS 5500.

#### **4.3.3 Insulated flanges**

Where called for, insulating flanges and materials shall be arranged as set out in Code of Practice No. SAECC/1 or SANS 15589-1.

The design, manufacturing, supplying, installation and testing of the insulating flanges complete with spark gap arrestors shall be in accordance with drawing no. 1A-C6-066 and to the approval of the Engineer. Insulating flanges shall be provided at locations as indicated on the Drawings.

All insulating gaskets, irrespective of pressure rating, shall be full-face gaskets to prevent foreign material from collecting and creating a bridge, thus shorting out the isolation.

#### **4.3.4 Loose flanges**

Loose flanges for welding onto steel pipes on Site shall be manufactured from at least the same steel as specified for the pipes and shall be in accordance with SANS 1123 where applicable (see also 4.3.2), or alternatively in accordance with BS EN 1092.

Loose flanges shall be suitable for field welding to pipes and specials and shall conform to 4.3.2 in respect of attachment.

#### **4.3.5 Gasketing**

Each flanged pipe and fitting of less than DN 400 and rated for PN 16 or less shall be supplied complete with one insertion piece (gasket) of the appropriate diameter and made of a material that is suitable for the maximum test pressure, and one set of bolts, nuts and washers.

Unless otherwise specified in the Amendments, asbestos gaskets in accordance with BS 1832 Grade B, and having a minimum thickness of 1,5 mm, shall be supplied for working pressures not exceeding PN 16.

Where working pressures exceed PN 16, and for DN 400 and over, rubber "O" rings dimensioned in accordance with BS EN 1092 Section 3.1, Fig. 4 for Types G and H flanges, shall be supplied to suit appropriately machined flanges.

Where flanges have not been machined in accordance with the above, spiral wound gaskets, style CG to BS 3381 shall be used. The external ring shall be made of carbon steel and electro plated. The metal windings shall consist of Grade 316 L stainless steel with asbestos filler.

Where flanges with flat faces as specified in 4.3.2, paragraph 1, are jointed, the gaskets shall be of the type manufactured by HPE and as specified below:

The gasket shall consist of a seal ring made from ultra high molecular weight polyethylene (UHMWPE) (section 10 mm x 5 mm minimum) which fits snugly inside a 3 mm thick x 30 mm wide (minimum) flat steel outer ring. The reuse of UHMWPE seal rings is inadmissible.

The outer ring shall consist either of:

- a) A mild steel ring, hot-dip galvanized in accordance with SANS 121 to a minimum mean coating thickness of 65 µm. The finish shall be of even thickness to ensure that the ring bears evenly throughout between the two flanges.

or

- b) A 3CR12 steel ring where specified in the Amendments.

#### **4.3.6 Bolts, nuts and washers**

Bolts and nuts shall comply with the relevant requirements of SANS 1700 or, where high strength friction grip bolts are specified in the Amendments or considered necessary by the Contractor, the bolts shall comply with the requirements of BS 3139, and their use and design shall be as specified in BS 3294: Part 1 and BS 4604.

Locking devices for nuts shall be provided wherever there is a possibility of the nuts becoming loose during service. Bolts shall be of sufficient length for at least two screw-threads to protrude from the nut when assemblies are fully tightened. Two washers complying with SANS 1700 shall be supplied with each bolt.

All bolts, nuts and washers shall be of a material with equal or better corrosion properties than the pipe materials being joined. All anchor bolts and nuts shall be Grade 316 stainless steel or as approved.

#### **4.3.7 Screwed joints**

The threads for screwed joints shall comply with the relevant requirements of SANS 1109. Male ends shall have taper threads and female ends shall have parallel threads.



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#### **4.3.8 Plain ended specials**

Each plain ended or spigot ended special, as shown on the drawings, shall be supplied with one sleeve coupling (or such other type of coupling as is shown on the drawings) to suit the particular pipe with which the special mates. The coupling shall fit the larger end of the barrel in the case of a reducer.

#### **4.4 PLANT**

All specials and fittings shall be manufactured in an approved works which has the necessary tools, plant and equipment to manufacture pipework consistently in accordance with the specifications.

Manufacturing at only one works will be permitted. No site fabrication of specials, other than kinks of 10 degrees or less on buried pipelines, will be permitted.

#### **4.5 FABRICATION**

##### **4.5.1 Qualified welders**

Only qualified welders, certified as having passed the qualification tests as specified in Clauses 6.1 to 6.7 inclusive of API Standard 1104 or alternatively, SANS 10044: Part IV, shall be used to do all welding required. Copies of the certificates shall be made available to the Engineer.

##### **4.5.2 Welding**

Welding and inspection of welds shall be in accordance with Clauses 7 to 11.4 inclusive of API Standard 1104 or alternatively, SANS 10044: Part III. Where radiographic inspection is specified in the Amendments, the procedure followed shall be in accordance with Clause 11.1 of API Standard 1104. Only qualified radiographers as specified in API Standard 1104 shall be employed to do the radiography.

All butt welds and branch fillet welds on specials shall where practicable have an internal weld. The weld bead of this internal weld shall not protrude above the prolongation of the original inside surface of the special by more than 1 mm.

Internal reinforcement in the form of backing rings at weld seams shall not be permitted.

##### **4.5.3 Preparation of special ends for:**

###### **4.5.3.1 Mechanical couplings**

Ends for use with mechanical couplings shall be square cut or bevelled plain ends, cut square to the pipe axis, with all edge burrs, weld splatter and scratches removed. The outside of the pipe shall be free of indentations, projections or roll marks for a distance of 250 mm from each end to permit proper make-up of the coupling. Longitudinal or spiral welds on the outside of the plain end shall be ground to plate or sheet surface for a minimum distance of 250 mm.

###### **4.5.3.2 Fillet welds**

Ends for use with fillet welded sleeve joints shall be prepared as specified in 4.5.3.1.

###### **4.5.3.3 Butt welds**

Specials which require joints to be butt welded on site shall be supplied with ends bevelled in accordance with the requirements of SANS 719, Clause 5.1.5. Square cut ends will require approval.



For specials to be jointed by butt welding, the internal weld bead shall be ground flush with the internal surface of the pipe or special for a length of 200 mm from the ends to be jointed.

#### **4.5.3.4 Beveling**

All bevelling, where required, shall be delayed until after all non-destructive testing has been completed.

#### **4.5.3.5 Flanges**

Ends to be fitted with flanges shall have the longitudinal or spiral welds ground to plate or sheet surface for a distance from the ends sufficient to accommodate the flange.

#### **4.5.4 Rectification of defects**

If a special fails to pass any of the tests specified, it will be rejected but the Engineer may permit repairs or alterations to be made to enable the special to pass the test.

Repairs of welded joints will be permitted during the process of manufacture. Where repairs are required the defective weld metal shall be cut out, and the parent metal prepared by grinding, and re-welded, to the satisfaction of the Engineer.

The repair procedure and performance on repairs shall be in accordance with Section 10 of API Specification 5L where not in conflict with SANS 719. Only qualified welders shall be employed. Each repair weld shall be marked with the welder's identifying stamp.

When the repair has been made, it shall be radiographically tested (X-rayed) over the full length of the repair.

On discovery of defective welds the Engineer may, at his discretion, call for additional radiographic examination until it is shown that the necessary standard is being maintained.

Should a weld repair be required on a special subsequent to hydraulic testing, the repaired special shall be retested in accordance with Clause 5.3.2 Hydraulic testing of this specification.

#### **4.6 COATINGS AND LININGS**

Coatings and linings of specials shall be undertaken in accordance with the requirements of Specification ZUT 0003.

#### **4.7 MARKING**

Upon fabrication, each special shall be hard stamped with a unique reference number to ensure traceability. The stamp is to be 100mm from the pipe end and next to a weld. On completion of the contract or at reasonable intervals during the contract, the following pipe information shall be supplied to the Engineer in Microsoft Excel ® format:

- a) Pipe reference number
- b) Contract number
- c) Date of manufacture
- d) Outside diameter
- e) Wall thickness/pressure rating
- f) Grade of steel
- g) Coating type and nominal thickness

- h) Lining type and nominal thickness
- i) Mass of uncoated and unlined special in kg/m
- j) Applicable drilling tables stamped on the periphery of all flanges
- k) Bends shall have their "centre plane" marked with two small punch marks close to both ends of the bends to facilitate correct positioning of the bends during laying.

#### **4.8 STORAGE, HANDLING AND TRANSPORT**

##### **4.8.1 Handling and rigging**

Specials shall be protected against damage at all stages from manufacture to delivery. Particular care shall be taken to protect the ends of all specials against denting.

In the transportation, loading and unloading of specials, an adequate fleet of vehicles shall be operated and maintained at all times to ensure that specials and their protective linings and coatings are not damaged.

Specials shall be so transported, stored and handled that they are not overstressed at any time and fittings are not damaged in any way. All thin-walled and soft-coated specials shall be handled with particular care and shall be so stored that they are not subjected to concentrated pressure from stones or other objects. Specials damaged or cracked in any way shall be removed from the Site at no cost to the Employer.

If cradles are used to transport the specials they must be rubber lined to avoid damage to the coating. During transportation specials shall be safely secured.

The Contractor shall be responsible for dispatching and transporting of the pipes to site and off-loading.

##### **4.8.2 Protection of pipe ends**

Satisfactory temporary end covers shall be provided for the protection of flanges, prepared ends of plain-ended fittings, and threads, and to prevent damage to the internal lining during transportation and during handling on Site.

##### **4.8.3 Material that deteriorate under the action of sunlight**

All rubber rings or other materials which will deteriorate under the action of sunlight, ozone or inclement weather, shall be stored in permanent shade in lockable weather-proof sheds. Welding and the running of welding machines and electric machinery shall not be permitted in or near places where rubber or plastic products are stored and care shall be taken at all times to prevent contamination of these products by oil or other petroleum derived products.

## **5. COMPLIANCE WITH REQUIREMENTS**

### **5.1 FACILITIES FOR TESTING**

The Contractor shall provide at his own cost, all facilities and equipment required for testing and shall carry out all tests at his own expense. Complete records of test results shall be kept.

The testing machines shall be of a design which will allow a steady application of the test pressure and shall be equipped with an accurate pressure gauge. Provision shall be made for expelling all air from any special under test during filling and before application of the pressure.

Test calibration certificates from an independent laboratory, verifying the accuracy of all measuring and testing instruments requiring calibration, shall be provided by the Contractor. Recalibration shall be carried out as necessitated by circumstances but at intervals not exceeding 3 months.

## **5.2 QUALITY ASSURANCE**

All steel specials shall be fabricated and tested in accordance with an approved quality control plan and procedure. The quality assurance of all specials rated over PN 16 shall be in accordance with ISO 9002 and the manufacturer shall be in possession of a current ISO 9002 certificate.

Manufacture shall not commence until such time as the quality control plan and procedure has been approved by the Engineer.

The quality control plan and procedure shall address, as a minimum, the following tests/inspections:

- a) Material certification
- b) Non Destructive Evaluation (NDE) testing
- c) Verification of tolerances
- d) Workmanship
- e) Surface preparation (e.g. cleanliness and blast profile for coatings and linings)
- f) Material identification
- g) Personnel certification (including welders and NDE)
- h) Welding procedures and certification
- i) Weld preparation
- j) Compliance with drawings
- k) Hydrostatic testing

## **5.3 INSPECTIONS**

### **5.3.1 Visual inspections**

All finished pipework shall be visually inspected and shall be free of injurious defects as defined in API 5L Section 10.7.

### **5.3.2 Hydraulic testing**

When all aspects of fabrication have been completed, but before being cleaned, lined or coated, each and every special is to be tested to a hydrostatic pressure test of P,

Where  $P = \text{the lesser of: } 2 \times 0.85 \times Y \times t/D \quad \text{or} \quad 7 \text{ MPa}$

$Y = \text{Minimum Specified Yield Stress (MPa)}$

$t = \text{Nominal Wall Thickness of pipe (mm)}$

$D = \text{Nominal Diameter of Pipe (mm)}$

Pipe end plugs shall be restrained during the test to ensure that no longitudinal stresses are induced in the pipe wall. Upon completion of the hydraulic test, the ends of the pipe specials shall be tested by means of Go, No-go gauges to check whether flaring or cupping has occurred. If necessary the ends shall be expanded or ground until they comply with the specification.

The test pressure in the pipe special shall be maintained for at least 10 seconds and thereafter shall be inspected for weeps, leaks or deformation. The special will be deemed defective and may be rejected if any leaks, weeps or deformation are evident. Where defects are repaired, the special shall be re-tested. Should the special, after repair, fail to pass the second hydraulic test the Engineer may order its rejection.

### **5.3.3 Non-destructive testing**

Non-destructive testing shall be in accordance with Section 9 of API Specification 5L.

On completion of the hydrostatic testing (see 5.3.2) and before the ends of the specials are bevelled, non-destructive tests shall be carried out on all manual or semi-automatic welds, as follows:

- a) All welds shall initially be radiographically tested (X-rayed) over 100% of the weld length. When consistently acceptable results are obtained, the number of welds to be so tested may be reduced on a sound statistically controlled basis by mutual agreement between the Engineer, Inspectorate and Contractor. At least 10% of all welds shall be radiographically tested.
- b) Repairs to welds (see 4.5.4), shall be radiographically tested (X-rayed) over the full length of the repair.

Each radiograph, the test-pieces and results and interpretations of examinations and tests shall be submitted to the Engineer within 24 hours of the particular examination or test.

### **5.3.4 Testing of specials**

Where hydrostatic testing of specials is not practicable, the welds shall be subjected to 100% dye penetrant tests to determine surface cracks, and/or where ordered by the Engineer, to one of the tests specified in 5.3.3 to determine internal defects. Dye penetrant testing shall be done as specified in Subclause 7.2.1 of SANS 1200 L.

### **5.3.5 Magnetic particle testing**

Where requested by the Inspectorate, magnetic particle testing shall be done in accordance with ASME Boiler and Pressure Vessel Code, Section V, Article 7.

## **5.4 INSPECTORATE**

The Engineer may at his sole discretion appoint an independent inspection authority to carry out additional Quality Surveillance at the premises of the manufacturer. The manufacturer shall provide all facilities and shall facilitate access to their premises at reasonable times as may be necessary for the independent inspectorate to perform its function.

The manufacturer's quality control records shall be available for inspection by the independent inspectorate at all reasonable times, and copies of such records shall be made available on request.

Notwithstanding any surveillance carried out by, or on behalf of the Engineer, the Contractor shall retain full responsibility for the quality of specials supplied.

## **5.5 MARKING PROCEDURE**

All weld lengths to be radiographed shall be clearly marked by the Inspector using his identification symbol. This symbol shall appear on the respective radiograph. The radiographed weld and symbol shall not be obliterated by finishing processes until the respective weld has been accepted by the Inspector.

## **5.6 COATINGS AND LININGS**

The testing of the coatings and linings of specials shall be undertaken in accordance with the requirements of Specification ZUT 0003.

# **6. TOLERANCES**

Refer to Clauses 4 and 5 above.

## **7. TESTING**

Refer to Clause 5 above.

## **8. MEASUREMENT AND PAYMENT**

### **8.1 BASIC PRINCIPLES**

#### **8.1.1 Corrosion protection**

Unless specific provision is made in the Bill of Quantities, no separate payment will be made for corrosion protection. The rates tendered for item 8.2.1 will be held to cover the cost of any protection system specified.

### **8.2 BILLED ITEMS**

#### **8.2.1 Supply of specials**

Unit: number (No)

Specials will be measured by the number of each type, class, and size.

The unit rates shall cover the cost of the provision of each special, complete with couplings and/or other jointing materials as appropriate, and for the design of all specials including all drawings and shop drawings.

Unless specific provision is made in the Bill of Quantities, no separate payment will be made for the supply and delivery to Site of any additional couplings and jointing materials which may be required for the connection of the specials.

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## Annexures

### APPENDIX A. APPLICABLE STANDARDS

Reference is made to the latest issues of the following standards:

API Specification 5L	American Iron and Steel Institute - Specification for LINEPIPE
API Standard 1104 related facilities	American Iron and Steel Institute - Standard for welding pipelines and related facilities
ASME	Boiler and Pressure vessels Code, Section V, Article 7
AWWA M 11	Steel pipe - A guide for design and installation (3rd edition)
BS 534	Steel pipes and specials for water and sewage
BS 639 carbon-manganese steels	Covered electrodes for the manual metal-arc welding of carbon and carbon-manganese steels
BS 1387	Steel tubes and tubulars suitable for screwing to BS 21 pipe threads
BS 1640	Steel butt-welding pipe fittings for the petroleum industry: Part 1 : Wrought carbon and ferritic alloy steel fittings
BS 1832	Compressed asbestos fibre jointing
BS 2633	Class 1 arc welding of ferritic steel pipe work for carrying fluids
BS 3139	High strength friction grip bolts for structural engineering
BS 3294	The use of high strength friction grip bolts in structural steelwork : Part 1 : General grade bolts
BS 3381	Metallic spiral wound gaskets for use with flanges to BS 1560 : Part 1 and 2
BS 4360	Weldable structural steels
BS 4604	The use of high strength friction grip bolts in structural steelwork (metric series)
BS EN 1092	Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories. Steel flanges
BS EN 10222	Steel forgings for pressure purposes
PD 5500	Unfired fusion welded pressure vessels
ISO 7005	Metallic Flanges: Part 1 : Steel flanges
ISO 9000	Quality management
ISO 9002	Quality systems. Model for quality assurance in production, installation and servicing
SANS 62	Steel pipes Part 1 Pipes suitable for threading and of nominal size not exceeding 150 mm Part 2 Screwed pieces and pipe fittings of nominal size not exceeding 150 mm.
SANS 121	Hot dip galvanized coatings on fabricated iron and steel articles - Specification and test methods
SANS 719	Electric welded low carbon steel pipes for aqueous fluids (ordinary duties)

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SANS 974	Rubber joint rings (non-cellular)  Part I : Joint rings for use in gas, water, sewer, and drainage systems
SANS 1109	Pipe threads where pressure-tight joints are made on the threads Part 1 Dimensions, tolerances and designation Part 2 Verification by means of limit gauges
SANS 1123	Pipe flanges
SANS 1431	Weldable structural steels
SANS 1476	Fabricated flanged steel pipework
SANS 1700	Fasteners
SANS 10044	Welding
SANS 10121	Cathodic protection of buried and submersed structures
SANS 1200 L	Medium-pressure steel pipelines
SAECC/1	Code of Practice

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## 1. SCOPE

This Specification covers the design, manufacture and delivery to site of electrically welded low carbon steel pipes of outside diameter up to 2 280 mm, for transporting water and sewage at ambient temperatures and under working pressures of up to 2,5 MPa.

This Specification shall be read in conjunction with SANS 1200 L. Where conflict between this specification and SANS 1200 L occurs, the provisions of this specification shall apply.

Interpretations and variations of this specification are set out in the Amendments preceding this Specification.

## 2. NORMATIVE REFERENCES

### 2.1 SUPPORTING SPECIFICATIONS

Where this Specification is required for a project, the following specifications shall, inter alia, form part of the Contract Document:

- a) Amendments;
- b) SANS 1200 Series of Standardized Specifications;
- c) SANS 1200 L: Medium-pressure pipelines (see 1. above)
- d) Specification ZUT 7001 : Design and manufacture of medium-pressure steel fittings and specials
- e) Specification ZUT 0003 : Painting and corrosion protection for water and wastewater works
- f) Specification ZUT 7003 : Laying, jointing and testing of medium-pressure steel pipes and specials

The latest issues of the specifications listed in Appendix A shall be deemed to apply to the manufacture of pipes using either submerged arc spiral welding or longitudinal welded “cans” rolled from low carbon or steel plate and joined by submerged arc circumferential welding to form suitable pipe lengths.

## 3. DEFINITIONS AND ABBREVIATIONS

### 3.1 DEFINITIONS

For the purposes of this Specification the definitions and abbreviations given in the applicable clauses of the specifications listed in 2.1 and the following definitions shall apply:

<b>Cut-and-shut bend</b>	:	A bend formed by cutting out one or more V-shaped sections equally disposed about a line at right angles to the axis of the pipe, preparing the cut-out edges for welding; bending the pipe to form the bend and welding the pipe shut along the prepared edges to complete the bend (see BS 2633, Fig 25)
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<b>Fitting</b>	:	a) A special or valve. b) Any process of jointing (except welding) straight pipes to one another and to specials and valves.
<b>Flexible pipe</b>	:	A pipe of which the diameter is reduced by more than 1% under an external radial force before the appearance of cracks.
<b>"H"</b>	:	The cross-sectional shape of a weld at a skelp.
<b>Manual shielded electric arc process welding</b>	:	Electric arc welding done by hand using a filler electrode coated with a material that gasifies at the point of arc and excludes oxygen from the weld, thus improving the metallurgical quality of the completed weld.
<b>Nominal diameter (size)</b>	:	A numerical designation of diameter which is common to all components in the piping system other than components designated by OD or by thread size. It is a convenient round number for reference purposes and is only loosely related to manufacturing dimensions.
<b>Nominal pressure</b>	:	A numerical designation which is a convenient round number for reference purposes.  All equipment of the same DN designated by the same PN number shall have compatible mating dimensions.
<b>Pinhole</b>	:	A very small hole indicating a flaw in the weld.
<b>Pipe end bevel</b>	:	A bevel cut made on the end of a pipe to afford a groove between abutting joints in order to receive weld metal.
<b>Pipework</b>	:	Includes all pipes, joints, specials, fittings and valves.
<b>Skelp</b>	:	The jointing edges of steel coils used in the manufacture of spiral welded pipe.
<b>Special</b>	:	Any pipe other than a straight pipe.  Note: Under this definition shall be included all sizes of specials of shapes such as bends, tees, crosses, angle branches, reducers, tapers and flexible couplings with or without centre registers.
<b>Straight pipe</b>	:	A straight pipe of uniform bore and of standard or non-standard length.
<b>Welding icicles</b>	:	Congested droplets of metal which extend through the weld to the interior of the pipe, caused by excessive heat or improper welding technique.

### 3.2 ABBREVIATIONS

The following abbreviations (additional to those referred to in 3.1) shall have the meanings given:

AISI	:	American Iron and Steel Institute
DN	:	Nominal diameter (e.g. DN 200 = 200 mm nominal diameter)

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DS-AW	: Double submerged-arc welded
E-RW	: Electric-resistance welded
FBE	: Flanged both ends
FOE	: Flanged one end
ID	: Internal diameter
MSEAP	: Manual Submerged Electric Arc Process
MS	: Mild Steel
OD	: Outside diameter, which shall mean the internal diameter plus 2 x (lining thickness + pipe wall thickness)
p.e.	: Plain ended.
PN	: Nominal working pressure (eg. PN 10 = 1 000 kPa)
SA-AW	: Semi-automatic arc welded
SAW	: Submerged arc weld
Scab	: Unbonded piece of plate in tight contact with the plate
SS	: Stainless Steel
t	: Wall thickness of pipes
TP	: Test pressure
WP	: Weld preparation

## 4. REQUIREMENTS

### 4.1 MATERIALS

#### 4.1.1 General

Steel pipe shall be manufactured in accordance with SANS 719:2011 Edition 3.2, except as added or amended hereunder. Where the amendments hereunder are in conflict with SANS 719, the amendments shall take precedence.

#### 4.1.2 Chemical composition (SANS 719, Clause 4.2)

*Delete Clause 4.2 and replace with:*

Unless otherwise billed or shown on drawings, pipes shall be manufactured from the following materials:

Nominal diameter equal to or less than 150 mm:

Medium or heavy class steel, complying with the applicable requirements of SANS 62.

Nominal diameter larger than 150 mm:

Table 1a

Steel grade	Minimum Yield Stress (MPa)	Chemical Composition and Physical Properties
B	241	SANS 719, Table 1
300WA	300	SANS 1431
X42	289	API 5L Table 3.1 & 4.1
X46	317	API 5L Table 3.1 & 4.1
X52	358	API 5L Table 3.1 & 4.1
X56	386	API 5L Table 3.1 & 4.1
X60	413	API 5L Table 3.1 & 4.1
X65	450	API 5L Table 3.1 & 4.1

Flanges on pipe ends, where applicable, shall be manufactured from steel plate conforming to BS 4360 or SANS 1431 Grade 300W for working pressures up to PN 25. Flanges rated more than PN 25 and up to PN 60 shall be made from steel manufactured in accordance with BS EN 10222 Grade 460 or as approved. Flanges for pressures exceeding PN 60 and up to PN 250 shall be special flanges and gaskets manufactured by Hydro Power Engineering or equal approved.

#### 4.1.3 Physical properties (SANS 719, Clause 4.3)

*Insert in the first sentence after “the requirements given in table 1” the following:*

“and table 1a”.

#### 4.1.4 Certification (SANS 719, Clause 4.4)

*Add the following sentence:*

“All information relevant to pipe fabrication shall be made available to the Engineer during the course of the manufacturing process.”

## 4.2 DESIGN

### 4.2.1 Dimensional requirements

#### 4.2.1.1 Pipe length (SANS 719, Clause 5.1.1)

##### 4.2.1.1.1 General (SANS 719, Clause 5.1.1.1)

*Add the following under Clause 5.1.1.1:*

“Unless otherwise specified, all pipes shall be manufactured in one fixed standard length between 9 m and 19.5 m. The standard lengths of pipes supplied shall be 9.14 m, 12.19 m or 18.28 m.”

**4.2.1.1.2 Random lengths (SANS 719, Clause 5.1.1.2)**

*Delete the wording of Clause 5.1.1.2 and replace with:*

“Pipes of random length will be accepted subject to their total length not exceeding 10% of the supplied length for each category of pipe and subject to the length of each pipe being within 10% of a standard pipe length.

Standard pipes from which samples for destructive testing have been cut may be jointed together by butt-welding to form single pipe lengths of the required standard length.

Each change in steel grade, pipe diameter or wall thickness will be classes as a separate category.”

**4.2.1.1.3 Exact lengths (SANS 719, Clause 5.1.1.3)**

The exact lengths of pipes shall be to a tolerance of -0 mm and +50 mm.

**4.2.2 Dimensions (SANS 719, Clause 5.1.2)**

*Insert the following after b):*

“The tolerances on outside diameters of pipe ends for pipe diameters greater than 1250mm and less than 2230mm shall be as for pipes of 1250mm diameter (refer to Table 3 of SANS 719).”

**4.2.3 Wall thickness (SANS 719, Clause 5.1.3)**

Delete “+10% or – 8%” and replace with:

“+13.5% or – 0%”

**4.2.4 Pipe ends (SANS 719, Clause 5.1.5)**

*Add at the beginning of Clause 5.1.5 the following:*

“Pipes shall be supplied with each end complying with one of the following criteria:

- a) Bevel ended to be joined by field welding
- b) Plain ended to be joined by flexible couplings
- c) Bell and spigot (plain) ended to be joined by fillet weld as specified in the Amendments and Additions or Bill of Quantities
- d) Flanged ends to be joined by bolts, nuts and washers.

Where both ends are specified as bevel ended or plain ended the requirements of SANS 719 Clause 5.1.5 shall apply.

Bell and spigot ends will generally be specified on pipe diameters of 508 mm or smaller.

The welding requirements for the preparation of these pipe ends shall comply with Clause 4.4.7 of this specification."

#### **4.2.5 Flanges**

Flanges shall be designed and manufactured to BS EN 1092 Part 1 for steel flanges and Part 2 for cast iron flanges, unless otherwise specified on the Drawings. Flanges not covered by BS EN 1092 shall be manufactured according to the detailed dimensions and requirements shown on the Drawings.

All flanges shall be suitable for Site welding (SW) to pipes and specials and shall conform to BS 2633, Section 7 with preparation of plate flanges as shown in Fig 41 ("slip-on") for pipes and specials up to DN 100 and Fig 39 or 40 ("bore and fillet") for pipes and specials DN 125 and larger.

The drilling of steel and cast iron flanges shall be off-centre and shall conform to the requirements of SANS 1123, BS EN 1092: Section 3.1, or ISO 7005: Part 1 as applicable, appropriate to the class of pipe specified, except that in the case of flanges, where M27 and M33 bolts are specified in BS EN 1092: Section 3.1, M24 and M30 bolts respectively shall be used as specified in SANS 1123.

Any pipe that has flanges which are incorrectly drilled will be rejected. Reaming of bolt holes to oversize dimension in order to make a particular piece fit will not be permitted.

All flanges shall be machined overall with gramophone finish in accordance with SANS 1123, or as specified below:

- a) Flange sizes up to and including DN 400 with a pressure rating up to and including 1600 kPa shall have flat joint faces, and where the pressure rating exceeds 1600 kPa, shall have a raised face sealing arrangement;
- b) Flange sizes exceeding DN 400 up to and including DN 1000 shall have a raised face sealing arrangement for all pressure ratings up to and including 2500 kPa.

For flanges not covered by BS EN 1092, and for domes and conical ends, thicknesses shall be calculated and where applicable the flanges manufactured in accordance with Section 3 of BS 5500.

#### **4.2.6 Provision of cadwelding pads**

Where pipes are to be jointed by means of flexible couplings the manufacturer shall weld steel plates not less than 50 x 75 x 6 mm thick, 250 mm from each end of all pipes, during the pipe manufacturing process (i.e. before lining and coating) to provide adequate area for cadwelding bonding cables to the piping to make it electrically continuous and enable a cathodic protection system to be applied without damage to the coating.

### **4.3 PLANT**

Pipes shall be manufactured in an approved works which has the necessary tools, plant and equipment to manufacture pipes consistently in accordance with the specifications.

### **4.4 FABRICATION**

#### **4.4.1 General**

Only qualified welders, certified as having passed the qualification tests as specified in Clause 6 of API Standard 1104 or alternatively, SANS 10044: Part IV, shall be used to do all welding required. Copies of the certificates shall be made available to the Engineer.

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#### **4.4.2 Forming (SANS 719, Clause 5.2.1)**

*Delete the sub-clause and replace with the following:*

“Unless otherwise specified in the Amendments and Additions, pipes shall be formed in accordance with one of the following forming techniques:

- a) Electric resistance welding (ERW). This technique may be used for pipes ranging in outside diameter from 219mm to 610mm and ranging in wall thickness from 3.5mm to 12mm.
- b) Submerged arc welding (SAW). This technique may be used for manufacturing spirally welded pipes ranging in outside diameter from 219mm to 2230mm and wall thicknesses ranging from 4.5mm to 18mm.

Where automatic submerged arc welding is employed, at least one pass shall be made on the inside and at least one pass on the outside of all pipes.

The number of longitudinal weld seams on pipes shall not exceed 1 for pipes up to and including DN 1000, and 2 for pipes larger than DN 1000 up to DN 2200.

The fabrication of larger diameters and/or use of thicker plate using these techniques may be agreed between the Manufacturer and the Engineer. In both techniques, circumferential joints shall be at least 1.5m apart and longitudinal welds of mated sections shall be at least 30° apart.”

#### **4.4.3 Welds (SANS 719, Clause 5.2.2.1)**

*Add the following as the first sentence:*

“All X-grade steel is to be welded in accordance with API 1104 ‘Welding of Pipelines and Related Facilities’.”

#### **4.4.4 Weld reinforcements (SANS 719, Clause 5.2.2.2.7)**

All butt welds and branch fillet welds on pipes shall where practicable have an internal weld. The height of the inner weld shall not exceed 1mm.

Internal reinforcement in the form of backing rings at weld seams shall not be permitted.

#### **4.4.5 Seams**

Longitudinal seams, spiral seams and shop girth seams shall all be butt welded.

#### **4.4.6 Rounding of pipe and sizing of ends**

If it is necessary to reshape pipes after they have been welded, reshaping shall be performed by rerolling or by pressure. Reshaping of pipes by dropping or hammering is not permitted. Sizing of pipe ends to come within specified end tolerances is permitted. This may include expanding pipe ends either mechanically or hydraulically up to a maximum of 1,5% of its original diameter.



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**4.4.7 Preparation of pipe ends for:**

**4.4.7.1 Mechanical couplings**

Ends for use with mechanical couplings shall be square cut or bevelled plain ends, cut square to the pipe axis, with all edge burrs, weld splatter and scratches removed. The outside of the pipe shall be free of indentations, projections or roll marks for a distance of 250 mm from each end to permit proper make-up of the coupling. Longitudinal or spiral welds on the outside of the plain end shall be ground to plate or sheet surface for a minimum distance of 250 mm.

**4.4.7.2 Fillet welds**

Ends for use with fillet welded sleeve joints shall be prepared as specified in 4.4.7.1.

**4.4.7.3 Butt welds**

Pipes which require joints to be butt welded on site shall be supplied with ends bevelled in accordance with the requirements of SANS 719, Clause 5.1.5. Square cut ends will require approval.

For pipes to be jointed by butt welding, the internal weld bead shall be ground flush with the internal surface of the pipe or special for a length of 200 mm from the ends to be jointed.

**4.4.7.4 Spigot and socket**

Spigot and socket ends shall be rolled or fabricated from plate, sheet or special sections to the required shape without hammering. Longitudinal or spiral welds on the inside of the socket and the outside of the spigot shall be ground to plate or sheet surface for a distance not less than the depth of insertion of the spigot into the socket.

**4.4.7.5 Bevelling**

All bevelling, where required, shall be delayed until after all non-destructive testing has been completed.

**4.4.7.6 Flanges**

Ends to be fitted with flanges shall have the longitudinal or spiral welds ground to plate or sheet surface for a distance from the ends sufficient to accommodate the flange.

**4.4.8 Rectification of defects (SANS 719, Clause 5.2.3)**

*Add the following to Clause 5.2.3:*

"If a pipe fails to pass any of the tests specified, it will be rejected but the Engineer may permit repairs or alterations to be made to enable the pipe to pass the test.

Repairs of welded joints will be permitted during the process of manufacture. Where repairs are required the defective weld metal shall be cut out, and the parent metal prepared by grinding, and re-welded, to the satisfaction of the Engineer.

The repair procedure and performance on repairs shall be in accordance with Section 10 of API Specification 5L where not in conflict with SANS 719. Only qualified welders shall be employed. Each repair weld shall be marked with the welder's identifying stamp.

When the repair has been made, it shall be radiographically tested (X-rayed) over the full length of the repair.

On discovery of defective welds the Engineer may, at his discretion, call for additional radiographic examination until it is shown that the necessary standard is being maintained.

Should a weld repair be required on a pipe subsequent to hydraulic testing, the repaired pipe shall be retested in accordance with Clause 5.5 Hydraulic testing of this specification.

Dents shall, where practicable, be jacked out."

#### **4.5 COATINGS AND LININGS**

Coatings and linings of pipes shall be undertaken in accordance with the requirements of Specification ZUT 0003.

#### **4.6 MARKING (SANS 719, CLAUSE 7)**

*Delete this clause and replace with the following:*

Upon fabrication, each pipe shall be hard stamped with a unique reference number to ensure traceability. The stamp is to be 100mm from the pipe end and next to a weld. On completion of the contract or at reasonable intervals during the contract, the following pipe information shall be supplied to the Engineer in Microsoft Excel ® format:

- a) Pipe reference number
- b) Contract number
- c) Date of manufacture
- d) Outside diameter
- e) Wall thickness
- f) Grade of steel
- g) Coating type and nominal thickness
- h) Lining type and nominal thickness
- i) Forming technique
- j) Length
- k) Mass of uncoated and unlined pipe in kg/m
- l) Applicable drilling tables stamped on the periphery of all flanges

In addition to the hard stamping, all pipes shall be clearly marked with the unique reference number in appropriate height characters in durable paint on a black background at one end of each pipe. The supplier's and Employer's name and logo shall be stencilled on each pipe.

Where specified in the Amendments, all pipes shall also be clearly marked with colour bands to reflect the grade steel and wall thickness."

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**4.7 STORAGE, HANDLING AND TRANSPORT****4.7.1 Handling and rigging**

The plant and rigging equipment used for the handling of pipes shall be such that no pipe shell is overstressed during any operation.

In the transportation, loading and unloading of pipes, an adequate fleet of vehicles shall be operated and maintained at all times to ensure that pipes and their protective linings and coatings are not damaged. In particular, the use of excavation equipment for handling of pipes will not be permitted.

Coated pipes shall be moved with the use of padded slings of width sufficient to prevent damage to the coating. The slings shall be at least 500mm wide for pipes up to DN600, 600mm wide for pipes of DN700 and up to DN1200, and 800mm wide for pipes of DN1400 and larger, or as approved by the Engineer. Chain slings, hooks, wire ropes, rope slings without canvas covers, composition belt slings with protruding rivets and any other equipment liable to damage the coating shall not be used.

Slings shall be suitably rated for the loads to be handled and in good condition. The use of deteriorating and frayed slings is prohibited.

All pipes are to be lifted and handled with the aid of a "spreader" lifting beam. Special care shall be taken to ensure that no damage occurs to pipes or coatings as a result of pipes sliding on or hitting adjacent pipes. The dragging or skidding of pipes in contact with the ground is not permitted.

If cradles are used to transport the pipes they must be rubber lined to avoid damage to the pipe coating.

During transportation pipes shall be safely secured to its final destination with slings of an adequate width.

The Contractor shall be responsible for dispatching and transporting of the pipes to site and off-loading.

**4.7.2 Dunnage and storage**

Whenever pipes are stacked or otherwise stockpiled or are transported (unless special cradles are used), use shall be made of suitably resilient material as dunnage which shall not disintegrate or deteriorate when exposed to the elements for prolonged periods. Pipes of 6m length shall be stacked with a minimum of 2 dunnage supports. Pipes of 9m and 12m lengths shall be stacked with a minimum of 3 supports (one support at each pipe end and one at mid-span). Pipes of 18m length shall be stacked with a minimum of 4 supports at equal spacing. The supports shall have a minimum width of 500mm for pipes up to DN500 and 1000mm wide for larger pipes. The length of the support shall be a minimum length of 1.5 times the diameter of the pipe to be supported and shall be profiled to match the coated outside radius of the pipe. Pipes shall be stacked with a minimum clearance of 50mm between adjacent pipe walls and a minimum of 200mm clear of the ground.

Pipes shall be stacked with sufficient supports to prevent permanent longitudinal deflections or deformation of the pipe body in excess of 2 per cent of the pipe diameter. Pipes shall also be stacked in a manner that limits loading on lower layers of pipes. Any pipe showing permanent ovality as a result of surcharge loading shall be rejected. Dents causing a protrusion in excess of 3mm into the interior of a pipe may also result in the pipe being rejected.

Each class and size of pipe shall be stacked and stored separately.

Coated steel pipes shall always be supported on a sufficient number of approved soft bolsters to prevent damage or the permanent deformation of coatings. Coated steel pipes shall not be stacked more than two pipes high, each layer separated by bolsters.

The number of layers of bare steel pipes in a stockpile shall not exceed:

$$N = \frac{1730 \cdot f \cdot t}{(D - t)^2}$$

Where N is the permissible number of layers, D is the outside diameter of the pipe in mm, f is the guaranteed minimum yield strength in MPa for the steel plate, and t is the nominal wall thickness in mm.

Any material which is not delivered and off-loaded on Site in the same condition as it left the factory may be rejected by the Engineer.

#### **4.7.3 Protection of pipe ends**

Before transportation all pipes are to be fitted with end caps made from plastic or other suitable material. Each end cap must remain in place until its pipe has been laid and the pipe end is no longer open to the elements. It must, therefore, remain in place until it is no longer needed to protect the pipe from ingress of foreign material.

In addition, bevel-ended pipes are to be fitted with bevel protectors before leaving the Manufacturer's premises. These are to remain in place until removed to permit the welding operation.

## **5. COMPLIANCE WITH REQUIREMENTS**

### **5.1 FACILITIES FOR TESTING**

The Contractor shall provide at his own cost, all facilities and equipment required for testing and shall carry out all tests at his own expense. Complete records of test results shall be kept.

The testing machines shall be of a design which will allow a steady application of the test pressure and shall be equipped with an accurate pressure gauge. Provision shall be made for expelling all air from any pipe under test during filling and before application of the pressure.

Test calibration certificates from an independent laboratory, verifying the accuracy of all measuring and testing instruments requiring calibration, shall be provided by the Contractor. Recalibration shall be carried out as necessitated by circumstances but at intervals not exceeding 3 months.

### **5.2 QUALITY ASSURANCE**

All steel pipes shall be fabricated and tested in accordance with an approved quality control plan and procedure. Manufacture shall not commence until such time as the quality control plan and procedure has been approved by the Engineer.

The quality control plan and procedure shall address, as a minimum, the following tests/inspections:

- a) Material certification
- b) Non Destructive Evaluation (NDE) testing
- c) Verification of tolerances
- d) Workmanship
- e) Surface preparation (e.g. cleanliness and blast profile for coatings and linings)

- f) Material identification
- g) Personnel certification (including welders and NDE)
- h) Welding procedures and certification
- i) Weld preparation
- j) Compliance with drawings
- k) Hydrostatic testing

### **5.3 INSPECTIONS**

#### **5.3.1 Visual inspections**

All finished pipes shall be visually inspected and shall be free of injurious defects as defined in API 5L Section 10.7.

#### **5.3.2 Dimensions (SANS 719, Clause 6.1.1)**

*Add the following as the first sentence:*

“The outside diameter, ovality and straightness of each pipe is to be checked in accordance with this clause.”

#### **5.3.3 Welds (SANS 719, Clause 6.1.2)**

*Add the following at the end of the clause:*

“The welds of each pipe are to be tested using one of the two options below. If not specifically stated elsewhere, pipes manufactured by ERW are to be tested as per Option 2 and spirally welded pipes as per Option 1.

##### **a) Option 1 (excluding ERW pipes)**

100% of the welds of all pipes shall be tested by fluoroscopic means. Where defects are detected they shall be adjudicated in accordance with API 5L and, if necessary, repaired in accordance with the requirements of API 1104.

##### **b) Option 2 (ERW pipes)**

100% of the welds of all pipes shall be tested by ultrasonic means. Where defects are detected in a pipe by means of ultrasonic testing, the defection section of pipe shall be 100% re-tested by means of X-ray and adjudicated in accordance with API 5L and, if necessary, repaired in accordance with the requirements of API 1104.

For rail, road, river and stream crossings, 100% of the total length of all welds shall be examined radiographically.”

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**5.4 DESTRUCTIVE TESTS (SANS 719, CLAUSE 6.2)**

At least one set of the three tests described in SANS 719, Clauses 6.2.1, 6.2.2 and 6.2.3, shall be carried out for each pipe diameter and wall thickness combination. The Engineer may require that, after the first pipe, every 500th subsequent pipe of each diameter and wall thickness combination be tested.

**5.5 HYDRAULIC TEST (SANS 719, CLAUSE 6.3)**

*Delete this clause and substitute with the following:*

“When all aspects of fabrication have been completed, but before being cleaned, lined or coated, each and every pipe is to be tested to a hydrostatic pressure test of P,

Where  $P = \text{the lesser of: } 2 \times 0.85 \times Y \times t/D \quad \text{or} \quad 7 \text{ MPa}$

$Y = \text{Minimum Specified Yield Stress (MPa)}$

$t = \text{Nominal Wall Thickness of pipe (mm)}$

$D = \text{Nominal Diameter of Pipe (mm)}$

Pipe end plugs shall be restrained during the test to ensure that no longitudinal stresses are induced in the pipe wall. Upon completion of the hydraulic test, the ends of the pipes shall be tested by means of Go, No-go gauges to check whether flaring or cupping has occurred. If necessary the ends shall be expanded or ground until they comply with the specification.

The test pressure in the pipe shall be maintained for at least 10 seconds and thereafter shall be inspected for weeps, leaks or deformation. The pipe will be deemed defective and may be rejected if any leaks, weeps or deformation are evident. Where defects are repaired, the pipe shall be re-tested. Should the pipe, after repair, fail to pass the second hydraulic test the Engineer may order its rejection.”

**5.6 INSPECTORATE**

The Engineer may at his sole discretion appoint an independent inspection authority to carry out additional Quality Surveillance at the premises of the pipe manufacturer. The manufacturer shall provide all facilities and shall facilitate access to their premises at reasonable times as may be necessary for the independent inspectorate to perform its function.

The manufacturer's quality control records shall be available for inspection by the independent inspectorate at all reasonable times, and copies of such records shall be made available on request.

Notwithstanding any surveillance carried out by, or on behalf of the Engineer, the Contractor shall retain full responsibility for the quality of pipes supplied.

**5.7 MARKING PROCEDURE**

All weld lengths to be radiographed shall be clearly marked by the Inspector using his identification symbol. This symbol shall appear on the respective radiograph. The radiographed weld and symbol shall not be obliterated by finishing processes until the respective weld has been accepted by the Inspector.

## **5.8 COATINGS AND LININGS**

The testing of the coatings and linings of pipes shall be undertaken in accordance with the requirements of Specification ZUT 0003.

## **6. TOLERANCES**

Refer to Clauses 4 and 5.

## **7. TESTING**

Refer to Clause 5.

## **8. MEASUREMENT AND PAYMENT**

### **8.1 BASIC PRINCIPLES**

#### **8.1.1 Corrosion protection**

Unless specific provision is made in the Bill of Quantities, no separate payment will be made for corrosion protection. The rates tendered for item 8.2.1 will be held to cover the cost of any protection system specified.

#### **8.1.2 Pipes tested to destruction**

Pipes tested to destruction and the repair of the tested pipes for use in the Works, if ordered by the Engineer, will be measured and paid on a daywork basis.

### **8.2 BILLED ITEMS**

#### **8.2.1 Supply of pipes**

Unit: metre (m)

The supply of pipes will be measured by length. The maximum length measured will be equal to the length as laid, no deductions being made for specials and valves and no extra length measured for waste. (See Subclause 8.2 of SANS 1200 L)

Separate items will be billed for each diameter and wall thickness.

The unit rates shall cover the cost of the fabrication and supply of the pipes, complete with couplings where applicable, the cost of handling where applicable, and the cost of factory testing, inspection and transportation to Site and shall, where it is necessary to limit ovality to within the specified limits, also cover the cost of bracing the pipes internally.

Separate items are provided in the Bill of Quantities for the laying, jointing, testing and commissioning of the pipes.

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## Annexures

### APPENDIX A. APPLICABLE STANDARDS

Reference is made to the latest issues of the following standards:

API Specification 5L	American Iron and Steel Institute - Specification for LINEPIPE
API Standard 1104	American Iron and Steel Institute - Standard for welding pipelines and related facilities
ASME	Boiler and Pressure vessels Code, Section V, Article 7
AWWA M 11	Steel pipe - A guide for design and installation (3rd edition)
BS 534	Steel pipes and specials for water and sewage
BS 639	Covered electrodes for the manual metal-arc welding of carbon and carbon-manganese steels
BS 1387	Steel tubes and tubulars suitable for screwing to BS 21 pipe threads
BS 1640	Steel butt-welding pipe fittings for the petroleum industry: Part 1 : Wrought carbon and ferritic alloy steel fittings
BS 1832	Compressed asbestos fibre jointing
BS 2633	Class 1 arc welding of ferritic steel pipe work for carrying fluids
BS 3139	High strength friction grip bolts for structural engineering
BS 3294	The use of high strength friction grip bolts in structural steelwork : Part 1 : General grade bolts
BS 3381	Metallic spiral wound gaskets for use with flanges to BS 1560 : Part 1 and 2
BS 4360	Weldable structural steels
BS 4604	The use of high strength friction grip bolts in structural steelwork (metric series)
BS EN 1092	Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories. Steel flanges
BS EN 10222	Steel forgings for pressure purposes
PD 5500	Unfired fusion welded pressure vessels
ISO 7005	Metallic Flanges: Part 1 : Steel flanges
ISO 9000	Quality management
ISO 9002	Quality systems. Model for quality assurance in production, installation and servicing



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SANS 62	Steel pipes Part 1 Pipes suitable for threading and of nominal size not exceeding 150 mm Part 2 Screwed pieces and pipe fittings of nominal size not exceeding 150 mm.
SANS 121	Hot dip galvanized coatings on fabricated iron and steel articles - Specification and test methods
SANS 719	Electric welded low carbon steel pipes for aqueous fluids (ordinary duties)
SANS 974	Rubber joint rings (non-cellular)  Part I : Joint rings for use in gas, water, sewer, and drainage systems
SANS 1109	Pipe threads where pressure-tight joints are made on the threads Part 1 Dimensions, tolerances and designation Part 2 Verification by means of limit gauges
SANS 1123	Pipe flanges
SANS 1431	Weldable structural steels
SANS 1476	Fabricated flanged steel pipework
SANS1700	Fasteners
SANS 10044	Welding
SANS 10121	Cathodic protection of buried and submersed structures
SANS 1200 L	Medium-pressure steel pipelines
SAECC/1	Code of Practice
Specification ZUT 0003	Painting and corrosion protection for water and wastewater works
Specification ZUT 7001	Design and manufacture of medium-pressure steel specials
Specification ZUT 7003	Laying and jointing of medium-pressure steel pipes and specials

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## 1. SCOPE

This Specification covers the laying and jointing of electrically welded low carbon steel pipes and specials of diameter up to 2 280 mm, for transporting water and sewage under working pressures of up to 2,5 MPa.

This Specification shall be read in conjunction with Specifications ZUT 7001 and ZUT 7002.

This Specification contains clauses that are generally applicable to the laying and jointing of medium-pressure steel pipes and specials. Interpretations and variations of this specification are set out in the Amendments preceding this Specification.

## 2. NORMATIVE REFERENCES

### 2.1 SUPPORTING SPECIFICATIONS

Where this Specification is required for a project, the following specifications shall, inter alia, form part of the Contract Document:

- a) Amendments;
- b) Specification ZUT 7002 : Manufacture of medium-pressure steel pipes;
- c) Specification ZUT 7001 : Design and manufacture of medium-pressure steel specials;
- d) Valves specifications
- e) Flow meter specifications
- f) Specification ZUT 0003 : General corrosion protection for pipelines, water and wastewater works; and
- g) Standards listed in Appendix A.

## 3. DEFINITIONS AND ABBREVIATIONS

For the purposes of this Specification the definitions and abbreviations given in the specifications listed in 2.1 shall apply.

## 4. REQUIREMENTS

### 4.1 MATERIALS

#### 4.1.1 General

Refer to Subclause 4.1.1 of ZUT 7001 and Subclause 4.1.1 of ZUT 7002.

Pipes and fittings shall be of the types specified in the Bill of Quantities or in the project specification and, unless otherwise required in terms of the project specification, they and their couplings shall be capable of withstanding the applicable test pressure specified in the Amendments. All pipes and fittings shall be supplied complete with couplings and jointing material.

Satisfactory temporary end covers shall be provided for the protection of threads, flanges, and prepared ends of plain-ended pipes and fittings, and to prevent damage to internal lining during transportation and during handling on Site.

#### 4.1.2 Flanges

Refer to Subclauses 4.1.3 and 4.3.2 of ZUT 7001 and Subclauses 4.1.2 and 4.2.5 of ZUT 7002.

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#### **4.1.3 Insulating flanges**

Refer to Subclause 4.3.3 of ZUT 7001.

#### **4.1.4 Gaskets**

Refer to Subclause 4.3.5 of ZUT 7001.

#### **4.1.5 Bolts, nuts and washers**

Refer to Subclause 4.3.6 of ZUT 7001.

#### **4.1.6 Bricks**

Bricks shall be obtained from an approved manufacturer and shall be either general purpose (special), burnt clay, or engineering bricks that comply with the applicable requirements of SANS 227, or Class S14 calcium silicate bricks that comply with the applicable requirements of SANS 285.

The Contractor shall submit to the Engineer samples of the bricks he intends using in the construction of the Works. The samples of bricks that are approved will be retained by the Engineer.

#### **4.1.7 Precast cylinders**

Precast cylinders may be of spun concrete, glass reinforced polyester, or PVC, except where particular materials are required in terms of the Bill of Quantities or the project specification. Precast concrete cylinders shall comply with the applicable requirements of SANS 1294. Sectional spun concrete cylinders shall comply with the requirements for pipes of SC type, Class A, of SANS 677. Jointing between cylinders shall be of the interlocking self-centring type suitable for sealing.

#### **4.1.8 Concrete**

Concrete shall comply with the requirements of SANS 1200 G or SANS 1200 GA, as applicable.

#### **4.1.9 Welding rods**

The Contractor shall supply all the necessary welding electrodes, which shall be of the shielded type. The chemical composition of weld metal and parent metal shall be similar. Electrodes that show signs of deterioration or damage shall be removed from Site and replaced at the Contractor's expense. Electrodes shall comply with the requirements of BS 639.

#### **4.1.10 Corrosion protection**

Refer to Specification ZUT 0003.

#### **4.1.11 Records of materials on site**

The Contractor shall keep and maintain a complete and comprehensive record of each pipe, special and fitting delivered to Site. The record shall at least denote the reference number, size, pressure class, location in the pipeline, date and condition of delivery and the location of delivery and the location of storage. Copies of the record shall be submitted to the Engineer at the end of each month or whenever requested by the Engineer.

Where pipes, specials and fittings are delivered without reference numbers, same shall be provided by stencilling, labelling or other methods approved by the Engineer.

## **4.2 PLANT**

### **4.2.1 Packing**

Goods shall be suitably packed in such a manner as will ensure safe and efficient transport by road or rail, and the Contractor shall include in his prices for whatever packing may be necessary in this respect. Small items particularly liable to damage or loss in transit should be crated. All crates and packing material shall, after use, become the property of the Employer, unless distinctly specified otherwise, or if returnable, shall be so at the Contractor's expense.

### **4.2.2 Handling and rigging**

The plant and rigging equipment used by the Contractor for the handling and placing of pipes shall be such that no pipe shell is over-stressed during any operation covered by the specification.

### **4.2.3 Setting out**

The Contractor may use any acceptable device, including one incorporating a laser beam, to control the alignment and laying of the pipeline.

### **4.2.4 Site equipment**

The Contractor shall furnish all equipment, tools, and supplies, including the necessary welding electrodes. Welding machines shall be operated within the amperage and voltage ranges recommended for each size and type of electrode. Any equipment that does not meet these requirements shall be repaired or replaced upon request of the Engineer. (Refer also API 1104 Clause 1.3.)

### **4.2.5 Testing**

The Contractor shall provide all equipment, materials, tools, and fittings required for the performance of the tests given in Clause 5.

## **4.3 METHODS AND PROCEDURES**

### **4.3.1 Laying**

#### **4.3.1.1 General**

The pipelines shall be laid and bedded to even grades and to the levels and alignments shown on the drawings or as directed. It shall be laid centrally in the trench in such a manner that the side allowance conforms to the applicable value specified in Clause 8 of SANS 1200 DB. For ease of inspection and testing the pipes shall be laid with the manufacturer's class and quality identification marks visible from the top of the trench, unless, in the case of large pipes, the position of lifting eyes render this impracticable.

Control of laying and bedding shall be by means of boning rods and sight rails or an acceptable laser beam device. Sight rails shall be painted black and white and shall be fixed securely and accurately.

#### **4.3.1.2 Damage**

Each pipe, pipe special and fitting shall be thoroughly cleaned and carefully examined for damage and defects prior to laying. Should any damaged or defective pipe, pipe special or fitting be laid, it shall be removed and replaced at the Contractor's expense and to the satisfaction of the Engineer.

During laying, the anti-corrosion lining of pipes being joined by butt welding shall be protected against damage by foot traffic or weld spatter, to the satisfaction of the Engineer and in the manner described in Clause 4.3.2.4.6.

#### **4.3.1.3 Keeping pipelines clean**

Every reasonable precaution shall be taken to prevent the entry of foreign matter and water into the pipe(s). At the close of each day's work, or at any time when work is suspended for a significant period, the last laid section of the pipeline shall be plugged, capped or otherwise tightly closed until laying is recommenced.

The interior of pipes shall be perfectly clean before being laid and the Engineer may instruct that the pipe interior be cleaned or washed before the pipes are lowered into the trench. All brushes, trowels, welding rod stumps, pieces of mortar, dust and all foreign matter shall be removed from pipes immediately before laying. Once a section of pipeline has been cleaned, it shall be sealed off and not be entered again unless permitted by the Engineer.

During laying and jointing of pipes and until the pipeline has passed the required acceptance tests and the trench has been backfilled, the trench shall be kept in a state which, in the opinion of the Engineer, is reasonably dry.

The Contractor shall at his own expense make good any damage to valves and fittings or clogging of off-takes or malfunctioning of fittings which result from his failure to keep the pipeline in a thoroughly clean condition.

#### **4.3.1.4 Depths and cover**

Unless otherwise specified in the Amendments, shown on the Drawings, or ordered by the Engineer, the minimum cover for pipelines shall be 1.0 m.

The minimum clearance between the outside of a pipeline being laid and the outside of any other pipe that it crosses shall be 300 mm. Where this requirement conflicts with the requirements for cover over the pipeline the Contractor shall ask the Engineer for written instructions and shall carry out the work in accordance with those instructions.

#### **4.3.1.5 Cold stresses and deflection in pipe curvature**

Pipes shall be laid free from cold stresses. No deflections shall be taken in curvature of pipes, but shall be taken with approved bends with exceptions as hereinafter specified. All deflections in pipes with flexible couplings shall not exceed those recommended by the manufacturer of the couplings after making allowance for ground movements.

#### **4.3.1.6 Mitres to effect pipe deflections**

All deflections in the axis of butt-welded steel pipelines of 10 degrees or less shall be made by mitring equally the ends of the two pipes to be joined so that the maximum mitre in any one pipe shall be 5 degrees. Where the total deflection is 3 degrees or less, the mitring may be made in one pipe end only. Ends to be mitred shall be carefully and accurately marked and then either machine cut or machine planed.

Hand planing will not be permitted. After mitring, the pipe ends shall be re-chamfered as described in Clause 5.1.5 of SANS 719. The minimum gap between pipe end root faces before welding shall be 1,5 mm and the maximum gap shall be 3,0 mm. After mitring all pipe ends shall be thoroughly cleaned before the field weld is carried out.

#### **4.3.1.7 Cold bends**

Where the Engineer gives written approval for cold bends on pipes with diameters of 450 mm and smaller, they shall be made by the cold stretch method in such a manner as to preserve the cross-sectional shape of the pipe. The minimum radius of any such bend shall be twenty five times the outside diameter of the pipe. Approved bending shoes shall be used for bending of the pipes.

#### **4.3.1.8 Snaking**

Snaking into the trench of butt-welded sections of steel pipeline which has been factory lined and/or coated will not be permitted without the written approval of the Engineer.

#### **4.3.1.9 Stringing of pipes**

The Contractor shall ensure that pipes are strung in accordance with a method statement to be approved by the Engineer. The method statement shall cover the proper placement by diameter, wall thickness and specifications. Any movement of pipes resulting from failure to comply with the approved method statement shall be rectified at the Contractor's expense.

#### **4.3.1.10 Handling and transporting**

Pipes and specials shall be handled as specified in Clause 4.8 of ZUT 7001 and Clause 4.7 of ZUT 7002.

Wrapped pipes shall be protected from grit and other sharp objects while the pipe is in the trench prior to bedding. Walking on wrapped pipes will not be allowed. The Engineer may reject any length of wrapping on which physical damage due to any cause whatsoever is visible.

Cement mortar lined pipes shall not be moved or transported for a period of 14 days after the date of lining.

#### **4.3.1.11 Skids**

Skids of sufficient number shall be supplied to support the pipe to proper height. If a pipe is supported over the trench, skids shall be of sufficient length to prevent collapsing of the trench and of sufficient strength to carry the pipe.

For coated pipe a sufficient number of skids shall be used to prevent damage to the coating.

### **4.3.2 Jointing methods**

#### **4.3.2.1 Flexible couplings**

The joints of steel pipes by flexible couplings shall be made only in their final laid position. Before assembling the joint, care shall be taken to ensure that pipe ends and couplings are clean and free from burrs and ridges. Such burrs and ridges shall be removed if present. Pipe ends shall be mated carefully before joints are made. Pipe ends shall be concentric and perfectly lined up and the coupling shall not be relied upon to line up or to support the pipe.



Joints shall be made and couplings assembled to the manufacturer's instructions. Two-thirds of the number of coupling bolts, equally spaced, shall first be partially tightened up in a regular sequence, using a short spanner. The remaining bolts shall then be similarly tightened. After checking the coupling alignment, the bolts shall then be finally tightened evenly, using a torque wrench.

Where couplings without central registers are used, precautions shall be taken to ensure that the pipe ends are apart by the same distance as if a coupling with central register had been used and the coupling shall be carefully centred over the pipe ends.

Flexible couplings shall be provided with external protection as soon as the pipeline has been hydrostatically tested and electrically bonded, where applicable.

#### **4.3.2.2 Flanged joints**

All flanges shall be installed with bolt holes off-centre and symmetrically off-set from the vertical centre lines of the flanges. Flanges shall be installed truly square to the axis of the pipe.

In the jointing of steel pipes with flanges, special care shall be taken to align, grade and level the pipes, specials and valves to avoid straining of the flanges. All bitumen and paint shall be removed from the mating face of each flange immediately before jointing. Epoxy paints shall not be removed from flange faces. Insertion pieces that have accurately cut holes for bolts shall be placed to form a continuous one-piece ring between the flanges. Bolts shall be tightened up to ensure uniform bearing on the insertion. Care shall be taken to avoid damage to the internal surface of the pipes during assembly of the pipeline.

Wherever loose flanges are welded onto pipelines, the Contractor shall ensure that the inner lining is restored to the thickness specified for such lining and that the new repaired lining is soundly jointed to the existing lining.

In making the joint the Contractor shall ensure that the flanges are truly parallel with all bolts evenly firm before being finally drawn up with torque wrenches to watertightness. Taper gauges shall be used to check that there is a uniform gap before and after final tightening up of bolts. Bolts shall be tightened in an approved sequence with bolts equally spaced and tightened equally at opposite ends first. The Contractor shall ensure that the correct jointing materials, i.e. gaskets and bolts and nuts are available when required. The gaskets shall be in accordance with Subclause 4.3.5 of ZUT 7001. In the case of insulated joints the insulated materials shall be arranged as set out in Code of Practice No. SAECC/1.

Flanged fittings shall be so installed that there are no stresses induced into the pipework specials or fittings by forcing ill-fitting units into position or by bolting up flanges with faces not uniformly in contact with their gaskets over their whole faces.

#### **4.3.2.3 Bolts and nuts**

Bolts and nuts shall be in accordance with Subclause 4.3.6 of ZUT 7001.

Only correct diameters and lengths of bolts and studs shall be used. Flat washers shall be used under all nuts and bolt heads. The length of bolts and studs shall be such that approximately two threads protrude from the nut when fully tightened. The threads of bolts, studs and nuts shall be thoroughly cleaned and then coated with a graphite-grease compound immediately prior to assembly.

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#### **4.3.2.4 Field welding**

##### **4.3.2.4.1 General**

Field welding of pipes which have been lined will only be permitted in pipes of DN 450 and larger where a man is able to enter the pipe to make good the lining after welding and testing in accordance with Clause 5.1 has been completed. Pipes of lesser diameter may be field welded where concrete linings will be made after the pipeline has been laid and all welds have been tested and approved.

At the discretion of the Engineer, roll welding will be permitted, provided an alignment is maintained by use of skids or of structural framework to accommodate two or more lengths of pipe with an adequate number of roller dollies to prevent sag in the pipe. The entire root bead, however, shall be made with the pipe in a stationary position.

All pipes welded in the trench shall be properly laid and aligned before welding commences. Joint holes shall be excavated at all field welds. The Contractor shall not lift the pipe to provide adequate access for the welders to enable them to weld the joint.

The alignment of abutting ends shall be such that the offset will not exceed 1.5 mm. Line up clamps shall be used for joint "fit-ups". The use of "bridges and wedges" or any method that may induce unnecessary stresses will not be permitted.

Both ends of coated and lined pipes shall be wrapped for a distance of at least 800 mm on either side of the weld by means of an asbestos mat or other approved material to ensure that weld spatter or other damage is not caused to the coating and lining during the welding process. The pipe trench shall be kept free of all dirt and water in the vicinity of the weld until after all corrosion protection measures have been completed and approved.

Destructive testing as specified in Clause 5.1.2.2 shall be carried out. The Contractor shall submit to the Engineer for approval a full procedure specification as detailed in API 1104 Clause 5.3 prior to any field welding being allowed.

##### **4.3.2.4.2 Welding procedure and qualification of welders**

Welding shall only be done by qualified welders who satisfy the requirements of API Std. 1104, Clause 6 and who have been tested at the Contractor's expense by an Independent Inspectorate.

Before any welding of pipeline materials commences, the qualification of welders shall have been approved, all detailed welding procedure specifications with weld diagrams required for their completion shall have been submitted for approval in a neat form and the welding procedure qualification tests shall have been successfully concluded all in accordance with the relevant standard specifications. Each welder shall mark the pipe adjacent to the weld with the figure assigned to him.

Sufficient records shall be kept by the Contractor to ensure that all field welds can be subsequently identified with the welder concerned.

As far as practicable all out of trench welding shall preferably be done by an automatic submerged process and the Contractor shall provide all necessary plant to carry out this process. Manual submerged electric arc process (MSEAP) welding may be used where in-trench welding is done.

Pre- and post-heat treatment for welding shall be in accordance with API Std. 1104 if required by same and the Contractor shall provide an approved shield to protect the pipe joint from wind and weather during heat treatment and welding.

#### 4.3.2.4.3 Line up

Pipes shall be lined up in such a manner as to prevent damage thereto. If the pipe to be used has a longitudinal seam, these seams shall be staggered by not less than twenty degrees and welded sections, or single lengths, shall be assembled in such a manner that this seam shall remain in the top quadrant of the pipe during coating operations and after lowering into the trench.

#### 4.3.2.4.4 Cleaning of pipe ends

Before welding, all foreign matter shall be removed from the bevelled ends. If any of the ends of the pipe joints are damaged to the extent that satisfactory welding contact cannot be obtained, the damaged pipe ends shall be cut and bevelled with an approved bevelling machine. These field bevels of pipe ends shall be made to the satisfaction of the Engineer. Should laminations, split ends, or other defects in the pipe be discovered, the joints of pipes containing such defects shall be cropped, repaired, or removed from the line as designated by the Engineer.

#### 4.3.2.4.5 Weather conditions

No welding shall be carried out during rain or high wind unless the welder and joint are adequately protected and sheltered, to ensure that the welding is not impaired.

#### 4.3.2.4.6 Protection of paintwork

Before welding commences, a suitable apron at least 800 mm wide shall be wrapped around both sides of the area to be welded to ensure that weld spatter or fallout from arc weld does not damage the paintwork.

During the welding of joints, the Contractor shall ensure that either rubber mats or other suitable material is laid in the pipe invert of epoxy lined steel pipes to protect the lining against damage by traffic or fall-out from arc welding at the joint. The mats shall be placed the full distance from the point of access up to the point of weld or weld inspection and shall be of sufficient width.

Workmen shall wear soft rubber soled shoes before entering lined pipes. Care shall be taken not to stroke arcs on the epoxy lined areas adjacent to the weld joint. Immediately before welding of joints, the protective tape between the ends of concrete or epoxy linings and coatings and pipe ends shall be removed.

#### 4.3.2.4.7 Butt-welding

Pipes and specials to be joined by field welding shall be supplied with ends bevelled for welding. All welding of joints shall comply with API Std. 1104 and only approved type welding rods shall be used.

If backing rings are used, they shall be placed in position and wedged up or adjusted so that the pipe ends are completely circular and properly mated. The space between abutting pipe ends, when aligned for welding, shall be such as to ensure complete penetration without burn-through. For pipes having the same dimensions, the spacing shall be approximately 1,5 mm.

The alignment of the abutting pipe ends shall be such as to minimize the offset between pipe surfaces. For pipes of the same nominal wall thickness, the offset shall not exceed 1,5 mm. Internal line-up clamps shall be used wherever practicable and may be removed after the root bead is 50 % completed, provided that the completed part of the root bead is in segments of approximately equal lengths, spaced about the circumference of the pipe. If conditions make it difficult to prevent movement of the pipe, or if the weld will be unduly stressed, the root bead shall be completed before releasing clamp tension.

External line-up clamps shall be used where it is impracticable to use internal line-up clamps. Partial root beads made when using external clamps shall be uniformly spaced about the circumference of the pipe,

and shall have an accumulative length of not less than 50% of the pipe circumference before the clamps are removed.

Tack-welding shall be carried out to maintain the root gap and position of the pipe ends during the welding proper. The number of tack-welds shall be kept to a minimum but shall not be less than four around the circumference of the pipe.

After proper preparation and tack-welding, the root bead shall be carried out followed by successive filler passes, and capper finish pass in accordance with the approved welding procedure.

The filler and finish beads shall be deposited by an acceptable method and each filler bead shall be approximately 3 mm in thickness. Completed welds shall have a reinforcing of not less than 0,8 mm and not more than 1,5 mm above the pipe surface around the entire perimeter of the weld, and the width of the finish or cover shall be not more than 3 mm greater than the original groove.

The number of beads required shall be governed by the wall thickness of the pipe, so that the completed weld will have the reinforcement previously specified; provided, however, that each weld shall consist of at least three beads. No two beads shall be started at the same point. No mitre welds will be permitted, and all welds are to be at ninety degrees ( $\pm 5$  degrees) to the axis of the pipe. All slag and scale shall be removed from each bead for visual inspection immediately after each bead is run.

In all field butt-welds where it is possible to work inside the pipe, the inside weld shall be done first. The chemical composition of weld metal and parent metal shall be similar and the inner weld metal or reinforcement shall not extend more than 1 mm above the inside metal surface of a pipe or special, and any excess shall be removed by grinding.

Defects caused by stray welding arc flashes shall be removed by grinding, provided that the pipe wall thickness is not reduced to less than the specified minimum thickness, otherwise the portion shall be cut out and repaired.

#### 4.3.2.4.8 Fillet welding

Welding shall be as for butt-welding as applicable. All pipes of DN 600 and over shall be welded on both the outside and the inside.

#### 4.3.2.4.9 Welding alongside the trench

The Contractor may butt-weld factory coated and/or lined steel pipes together alongside the edge of the trench to form continuous welded pipeline sections up to a maximum length of 45 m and to lower each section into the trench, provided the pipe, coating and/or lining are in no way damaged during these operations and provided furthermore that the deflection of the pipe barrel at any point during any stage of the operation does not exceed 2% of pipe outside diameter.

The linings and coatings of factory coated and/or lined pipes jointed together outside the trench shall be made good at these joints outside the trench.

#### 4.3.2.5 Repair of welds

Rectification of defective welds shall be in accordance with API Std. 1104 and to the satisfaction of the Engineer. All costs related to the repair of defective welds shall be borne by the Contractor. Defective welds shall be repaired immediately once they are found to be defective. The Engineer has the right to stop the Contractor proceeding with further pipe laying in the event of the Contractor delaying the rectification of defective welds. Furthermore, no consideration will be given to any claims arising from delays in construction resulting from such action.

### **4.3.3 Installation of specials and fittings**

#### **4.3.3.1 General**

Welding shall comply with API Std. 1104. All specials and other fittings shall be installed in accordance with the drawings and instructions of the Engineer. Where "slip-on" or sleeve couplings are to be fitted, all surfaces shall be thoroughly cleaned to a smooth finish, care being taken to remove as little of the protective coating as possible.

#### **4.3.3.2 Bends**

Bends shall be installed true to line, level and deflection and shall be anchored in concrete where required to counteract thrust. Bends shall normally be supplied with "centre planes" marked with two small punch marks close to both ends of the bends to facilitate correct positioning of the bends in laying.

#### **4.3.3.3 Tees**

Tees for air valves shall be installed with branch barrels pointing vertically upwards. Tees for scour valves shall be installed with branch barrels pointing vertically downwards or at the gradients indicated on the drawings. Tees for off-takes shall be installed as shown on the drawings.

Field installation of the off-takes from the pipelines for air and scour valve connections or any other form of off-take shall not be permitted. All tees for these off-takes and connections shall be factory manufactured.

#### **4.3.3.4 Flanges**

All flanges shall be installed with bolt holes off-centre and symmetrically off-set from the vertical centre lines of the flange. Flanges shall be installed truly square to the axis of the pipe.

#### **4.3.3.5 Insulated flanged joints**

Insulated flange joints shall be provided and installed by the Contractor where specified or instructed by the Engineer. The Contractor shall supply all materials, labour and plant required and shall complete and prove that each insulated joint after installation in the pipeline has a resistance well in excess of the resistance to earth of the pipeline on both sides of the insulating joint.

#### **4.3.3.6 Temporary closure pipes**

Temporary closure pieces shall be of the same standard, diameter and wall thickness as the pipeline, except where otherwise specified or instructed by the Engineer.

#### **4.3.3.7 Permanent closure pipes**

Permanent closure pipes shall be provided and installed as pipe laying proceeds. They shall be either butt welded to adjacent pipes, or jointed to access pipes, fittings or specials by means of slip-on couplings.

### **4.3.4 Temporary sealing of pipeline**

#### **4.3.4.1 Night-caps**

Metal night-caps shall be used to close off all ends of each laid section of pipework when work is stopped at the end of each day or for longer periods and shall be left on the ends of sections of completed pipework until such sections are tied-in with the remainder of the completed pipeline. The night-caps shall consist of

a steel plate welded into a half slip-on coupling which shall be provided with a sufficient number of lugs to secure the ring and gasket and shall be strong enough to withstand external water and earth pressure in the event of flooding or collapse of earth. The joint shall be watertight.

The Contractor shall also, at his own expense, blank-off all air valve, scour valve and off-take tees with at least 6 mm thick blank flanges which shall be bolted with at least four bolts to tee flanges or shall be fixed to plain ended tee branches by using half couplings welded to the blank flanges. These shall be watertight and shall not be removed until the valves or other fittings are about to be fitted.

Notwithstanding the use of night-caps, the Contractor shall, at his own expense, make good all damage to pipe linings and fittings caused by the ingress of dirty water, silt, sand, debris, vermin, insects and other foreign matter. The Contractor shall, at his own expense and to the satisfaction of the Engineer, clean the interior of the pipeline of such contaminants.

#### **4.3.5 Prevention of flotation**

Pipes to be encased in concrete shall be prevented from flotation during concreting operations. Apart from this special case during concreting operations, the Contractor shall prevent the flotation of pipe work due to storm runoff or groundwater entering the trench before backfilling has been completed.

Methods adopted to prevent flotation shall not damage coatings or linings and shall be approved by the Engineer. Notwithstanding this the Contractor shall at his own expense repair all damage to pipework caused by flotation and/or by the methods adopted to prevent it.

#### **4.3.6 Installation of valves and meters**

Unless otherwise specified or directed, gate valves shall be set upright and butterfly valves shall be set with the main shafts horizontal. All valves and meters shall be correctly set, supported, and placed in position as the work proceeds, and shall be properly jointed to their respective pipes.

All valves and fittings shall be left in working order and shall be housed in chambers as shown on the Drawings.

Valves, meter bodies and fittings shall be supplied, painted externally and internally. The Contractor shall thoroughly clean damaged exterior painted surfaces of all valves, meter bodies and fittings of all dirt, rust, grease and other foreign matter by methods approved by the Engineer and shall make good all damaged surfaces in accordance with the requirements of ZUT 0003.

Valves requiring special adjustment after installation such as self-closing valves shall be commissioned by representatives of the valve manufacturers. Similarly, meters shall be commissioned by the respective suppliers after installation by the Contractor.

All valves and meters supplied under separate contracts, which are defective due to circumstances outside the Contractor's control shall be repaired, replaced or modified by the valve suppliers who will also be responsible for commissioning the valves.

The mass of valves or water meters shall at no time be carried by the pipe, the flange or the coupling. Support stools shall be constructed as soon as practicable after the installation of valves and meters, and shall generally be constructed of steel, concrete or masonry work. Where fabricated steel stools are approved or specified they shall comply with the requirements of SANS 10044-3 and shall be fabricated to the Engineer's approval. Supports shall be welded to the pipe only where specified and linings of pipes and specials shall be made good after welding.

Hydrostatic testing of individual sections of the pipeline shall only be carried out when all scour valves, air valves and control valves have been installed, except where otherwise instructed by the Engineer in writing.



Should line control valves or other equipment not be delivered timeously to enable the Contractor to lay continuously and to test the pipeline, the Engineer may order the Contractor to substitute specially made temporary flanged closure pieces. Such temporary closure pieces shall be supplied and installed by the Contractor to enable laying and testing to proceed. Subsequently after installation of the control valves, etc., they shall be removed and shall become the Contractor's property. These temporary closure pipes shall have the same face to face dimensions as the line control valves and shall be fitted with a suitably reinforced control diaphragm plate for sealing of the section of pipeline where it is fitted.

Wall thickness and diameter of the closure pipes shall be the same as the pipeline. A 100 mm nominal bore valve-controlled by-pass shall be fitted externally around the diaphragm plate.

#### **4.3.7 Casings, anchor blocks and chambers**

##### **4.3.7.1 Concrete casing**

Where the Engineer requires pipes to be encased in concrete, a strength 20 MPa/19 mm, or such other strength as is scheduled, shall be used. The work shall be done as follows:

- a) Concrete casing shall be discontinuous at flexible couplings in the pipeline.
- b) The pipe trench for the concrete encased pipeline shall be excavated to the depth below the bottom surface of the pipe, as ordered or shown on the drawings, and to sufficient width to allow for the concrete to be placed to the full specified width. The bottom of the trench shall be trimmed true to line and grade.
- c) The in situ concrete bed 150 mm thick shall be cast and the pipeline laid thereon true to line and level leaving a gap nowhere less than 50 mm between the pipe and the bed.
- d) After jointing the pipes shall be secured to steel loops left in the bed. Concrete shall then be punned under and around the pipes from one side only until the bottom quarter of circumference of the pipes is in contact with the concrete bed.
- e) The pipe shall be tested in accordance with the applicable tests given in Clause 5, care being taken to ensure that the pipe do not move during testing.
- f) After the pipeline has been tested, suitable formwork shall be erected and concrete carefully placed and vibrated in position up both sides of the pipe. The concrete level shall be raised equally on both sides of the pipe until encasement is complete and a cover over the surface of the pipe is provided that is nowhere less than that ordered or shown on the drawings.
- g) No earth filling over the concrete shall be commenced until at least 7 days after the concrete has been placed.

##### **4.3.7.2 Anchor blocks**

At tees, bends, terminal valves, end caps and where otherwise directed, anchor/thrust blocks shall be constructed to dimensions ordered or shown on the Drawings. Unless otherwise specified or indicated on the Drawings, anchor/thrust blocks and pedestals shall be constructed of 20 MPa/19 mm concrete or such other class as is scheduled.

The concrete shall be well punned round the pipe and, if in trenches, against the undisturbed faces and bottom of the trench. Backfilling behind or under thrust faces will not be permitted. Excess excavation shall be replaced with the prescribed mix concrete given above for anchor/thrust blocks at the Contractor's expense unless an item is scheduled to cover payment for overbreak. Care shall be taken to leave the

joints accessible. No anchor/thrust blocks and pedestals shall be concreted until the approval of the Engineer has been obtained.

#### **4.3.7.3 Valve chambers**

Valve chamber shall be constructed as indicated on the Drawings. Concrete chambers shall be constructed in accordance with the relevant clauses of SANS 1200 G or GA.

Lifting and relaying of existing pipes

#### **4.3.8 Brickwork in chambers and manholes**

Each chamber and manhole shall be built to the details shown on a particular drawing or as shown on the applicable type drawing. The walls shall be constructed in an approved bond comprising header and stretcher courses with the fair face on the inside. No false headers shall be built in and only whole bricks shall be used except where closures are required to form bond.

The bricks shall be well soaked in water immediately before being laid and the course of bricks last laid shall be well wetted before fresh bricks are laid upon it. All walls shall be carried up regularly so that no part of the walling is more than 1,3 m higher than any adjoining wall.

Joints shall be flushed up solid at every course throughout the whole width of each course, which shall be laid on a solid bed of mortar of thickness not exceeding 10 mm, and, when applicable, the joints shall be raked out as the works proceeds to form a key for plaster.

Mortar for brickwork and plasterwork shall be composed of one part of cement to three parts of sand. Sand shall be clean pit sand free from clay and other impurities and, if so directed, shall be properly screened and washed.

If required, step irons for a manhole shall be built into the straight of the wall at 300 mm intervals staggered right and left in vertical rows. Cast iron fittings shall be bitumen painted. Each cast iron cover and frame shall be grouted solidly onto the shaft. Concrete surrounds of each manhole shall be finished off to suit surrounding surfaces.

#### **4.3.9 Lifting and relaying of existing pipes**

Where shown on the drawings and where scheduled, existing pipes and fittings that are to be removed shall be lifted and the materials recovered as far as is practicable. The pipes and couplings shall be removed from the trench and placed in the Contractor's site store where they shall be cleaned, sorted, and listed. A copy of the list of undamaged material recovered shall be handed to the Engineer.

Unless, in terms of the contract, other pipes are to be laid in the same trench, each trench shall be backfilled as specified in SANS 1200 DB.

Where recovered pipes are scheduled to be relaid, rubber rings, insertion packings, damaged joints, and rusted bolts shall be replaced.

Before they are relaid, an acceptable number of pipes shall be tested for compliance with the requirements of the application specification for resistance to hydraulic pressure.

#### **4.3.10 Disinfection of potable water pipelines**

After completion of the laying and testing, each potable water pipeline shall be disinfected. The Contractor will be required to submit a detailed method statement for approval by the Engineer. A minimum requirement will be that the method statement deals with the method of dosing and how the dosing rate will



be controlled to ensure a uniform distribution throughout the pipeline to be disinfected, the chemicals to be used, the anticipated range of dosing rates and equipment to be used, and the name and qualification the Contractor's person supervising the disinfection.

Once a successful hydraulic test of the entire pipeline has been achieved and the connections have been completed, the pipeline shall be drained. The pipeline shall then be re-charged in accordance with Clause 5.1.3.5 "Initial Filling of the Pipeline". Whilst being charged, a sodium hypochlorite solution shall be introduced into the pipeline in such a manner as to ensure that a theoretical total chlorine concentration of at least 25 ppm (mg/l) is achieved throughout the pipeline.

Once the entire pipeline has been filled in this manner, it shall be left for a 24-hour period. Thereafter, total chlorine concentrations shall be measured at each scour and off-take point. A concentration of 20 ppm total chlorine will be considered acceptable. Should this concentration not be achieved at all scours and off-takes, the Contractor shall take all steps considered necessary by the Engineer to achieve satisfactory disinfection, at his/her own cost.

Once satisfactory disinfection has been achieved, the pipeline shall be drained via the scour valves (or by other means approved by the Engineer) and sufficient sodium thiosulphate (typically 1 part of total chlorine) shall be dosed into the scour-wet wells to fully neutralise the chlorine before discharging to watercourses.

The pipeline shall then be re-charged in accordance with the stated procedure and, after 24 hours, samples will be taken by the Engineer for analysis (at no cost to the Contractor). Should the following limits not be achieved, the Contractor shall carry out at his/her own cost, all steps deemed necessary by the Engineer to achieve satisfactory disinfection:

- a) E.coli: Count = 0
- b) Coliforms: Count = 0
- c) Faecal Streptococci: Count = 0
- d) In addition to a), b) and c), the water quality shall meet the requirements for potable water of the local authority or of the authority supplying such water to the area.

#### **4.3.11 Corrosion protection**

##### **4.3.11.1 Final painting**

After successful hydrostatic testing of the pipeline, and after completion of all construction work under this Contract, all external surfaces of uncoated steelwork and surfaces of all valves and fittings shall be prepared and painted as specified in the relevant clauses of Specification ZUT 0003. In addition, all surfaces of materials which had received first coats of paint in the course of the Contract in accordance with the specifications shall receive final coats of paint of the same colour or such other colours as may be specified or instructed by the Engineer.

All paint used shall be out of the original containers of the manufacturer and such containers are to be brought onto the site unopened. No adulteration will be permitted and paints shall be used strictly in accordance with the manufacturer's instructions.

Painting shall not be done in wet or humid weather.

#### **4.3.11.2 Butt-welded steel pipes**

As soon as practicable, but not more than 24 h after the welding of joints in the field has been approved and accepted by the Engineer, the internal lining of pipes and specials shall be made evenly continuous over the joints.

Materials for this work shall have the same properties as those used respectively for the adjacent lining or coating and shall be so applied that the finished work over the joint shall have the same quality as specified respectively for the adjacent lining or coating and shall be capable of passing the same tests as specified for adjacent lining or coating.

#### **4.3.11.3 Metal couplings**

In addition, all buried metal couplings and all metal couplings located inside chambers, shall be protected with "Denso" petrolatum as per the requirements of Specification ZUT 0003.

### **5. COMPLIANCE WITH REQUIREMENTS**

#### **5.1 TESTING**

##### **5.1.1 General**

Testing shall be in accordance with this clause and Specifications ZUT 0003, 7001 and 7002, as relevant.

As the work proceeds, pipelines shall be hydrostatically tested by means of test equipment supplied by the Contractor.

Each test shall be carried out in the presence of the Engineer or his representative. The Contractor shall be responsible for carrying out all tests and for all expenses incurred.

When carrying out the hydrostatic tests, the Contractor shall ensure that all valves, tees, and bends are properly secured and shored to prevent movement of pipes and fittings and, should any such movement occur, the Contractor shall, at his own expense, reposition and, if necessary, repair the pipes and fittings and the securing means.

Until each section of the pipeline has been subjected to the hydrostatic test and has complied with the applicable requirement for leakage rate, the pipeline will not be accepted. The hydrostatic test shall be repeated until the Engineer is satisfied that the section under test complies with the said requirement.

##### **5.1.2 Testing of field welds**

###### **5.1.2.1 Destruction tests**

Tests as specified in API 1104 Clause 6.5 shall be carried out and approved prior to any field welding being done.

###### **5.1.2.2 Radiographic testing**

Radiographic tests and adjudication of test records shall be carried out by an Independent Inspectorate, appointed by the Engineer to act on his behalf. The Inspectorate shall be afforded every facility during the course of pipeline construction and testing to enable the inspection to be carried out effectively. 10% of the total length of all manual field butt welds and 2,5% of the total length of field welds done by an approved automatic process shall be examined radiographically with particular reference to weld intersections, using

equipment supplied and staffed by the Inspectorate. All welds on critical sections such as river, rail and road crossings shall be 100% radiographically tested.

The Engineer reserves the right to increase the length of welds to be radiographed if results obtained are not satisfactory or to reduce the length of welds radiographed to a minimum of 4% if the standard of welding is sufficiently high to warrant such a reduction.

The Inspectorate shall process and adjudicate radiographs on site. The standard of acceptability shall be in accordance with API 1104. All welds which are found to be unsatisfactory shall be repaired and 100% re-radiographed at the Contractor's expense. The additional radiography of repaired welds shall not be deemed to be included in the overall 10% or 2,5% radiography.

Field welds may be examined by radiographic inspection as stated in API 1104. Should two or more welders participate in making the weld, the welding foreman and the Engineer's Representative shall decide which welder is responsible for the defective work. The Engineer shall be privileged in the judgement of his inspector to cut out welds for further tests. The test welds (except the initial free test referred to in 5.1.2.1) that meet the Engineer's requirements and specifications when properly tested shall be replaced with a satisfactory tie-in at the Employer's expense. Should any test weld cut from the line prove unsatisfactory to the Engineer when properly tested, it shall be replaced at the Contractor's expense. Test welds shall be cut from the line as soon as practicable after completion to avoid unnecessary delay and expense, and shall consist of an annular ring not less than 230 mm long with the weld in the middle.

When welding the line together at places where the test welds have been cut out, one weld will be used if it is practicable to pull the line back into position; otherwise, two welds will be made by setting in a short length of pipe with a minimum length of 750 mm.

The Contractor shall furnish approved types of machines for testing. A record of the results of each test weld shall be made by the Engineer's inspector and jointly signed by the Engineer's Representative and Contractor's Representative. The Contractor will be reimbursed for extra welds at the rates tendered if scheduled in the Contract as a separate item. Extra welds shall be construed to mean those welds cut out at the Engineer's request which, after specified tests, are found to meet the Engineer's specifications, except those free initial test welds referred to herein.

Claims arising from delays in construction caused by justifiable additional radiography which may be ordered by the Engineer or re-radiography of repairs, will not be considered.

#### **5.1.2.3 Dye-penetrant testings**

A 100% dye penetrant test shall be carried out by the Contractor on all field welds except where radiographic testing is undertaken.

The dye-penetrant test shall be carried out in accordance with BS 4416 and as detailed below:

- a) The Contractor shall obtain the approval of the Engineer for the group of dye-penetrant and developer that he proposes to use for the test;
- b) As pipe laying progresses, field welds shall be subjected to the test soon after each weld is completed;
- c) In order to obtain a surface that is dry, clean and free from scale, dirt and grease, the Contractor may grind but he shall not grit blast the surface;
- d) The temperature of the surface to which the developer and the penetrant are applied shall not be below 16°C or above 52°C;
- e) Observations for indications shall be made not less than 15 minutes and not more than 60 minutes after the application of the penetrant;

- f) Any surfaces on which non-relevant indications are observed shall be explored by visual methods and, if considered necessary by the Engineer, such surfaces shall be cleaned and retested; and
- g) Welds that show no relevant trace of dye on the developer will be accepted.

#### **5.1.2.4 Visual testing**

All field welds shall be inspected visually throughout their entire length by the Contractor for signs of possible faults. Full records of the testing of each joint shall be kept by the Contractor and his findings reported to the Engineer. The Contractor shall allow the Engineer and/or the Inspectorate to also inspect up to 10% of the number of field welds visually.

#### **5.1.2.5 Testing of fillet welds**

In addition to the dye penetrant tests, each fillet weld on pipes of DN 600 and over shall be air and bubble tested by pumping air into the annular space between the welds to a pressure of at least double the specified working pressure. While this pressure is maintained, all welds and connections shall be tested with soap or primer. Defects found during testing shall be repaired by the Contractor, and testing continued all at the Contractor's expense until a satisfactory result is obtained.

The test tapping point shall then be plugged in an approved manner.

#### **5.1.2.6 General**

The pipeline shall be hydrostatically tested on completion of pipe laying and after installation of all valves and fittings. Test sections shall be blanked off by making use of end-caps. Installed isolating valves within the test section shall not be used as end-caps.

The Contractor shall submit to the Engineer a detailed method statement describing the timing, methodology and scheduling of each hydrostatic pressure test to be undertaken. No test shall proceed before approval of such method statement by the Engineer.

If sections of a pipeline are encased in concrete, or where concrete anchor blocks or other structural concrete structures had been provided, the Contractor shall allow for a minimum concrete setting period of 28 days prior to the hydrostatic test being executed.

The Contractor shall supply water from an approved source for hydraulic testing of the pipeline. Pipelines designed for potable use shall be hydraulically tested and disinfected using potable water. Water used for one filling of the pipeline for hydraulic testing, one filling for disinfection and one filling after draining the disinfection water will be provided by the Employer to the Contractor, free of charge, at the connection points stated in the project specifications. Items have been provided in the Bill of Quantities to cover the cost of receiving and conveying water from the supply point to the test section of pipeline. Additional water supplied by the Employer owing to unsuccessful disinfection and/or hydraulic testing will be charged to the Contractor.

#### **5.1.2.7 Test pressure and time of test**

After the pipe trench has been backfilled the pipeline shall be tested in sections between end caps, blank flanges, or other isolating devices, at the pressures appropriate to the pipeline section under test. The Engineer may require that blank flanges or "spades" be inserted and that the pipeline be tested in reduced lengths and, in addition, at the point of maximum pressure.

Unless otherwise specified, shown on the drawings, or approved by the Engineer, the average test pressure for field testing shall be 1,25 times the pressure rating of the pipe.

Where the pipeline is tested in sections, the Contractor will have the discretion to determine the sections in which the pipeline may be tested provided that:

- a) The test sections shall be determined, taking any differences in elevation along the pipeline into account, such that the:
  - i) maximum field test pressure at any point along the section is not higher than 1,5 times the pressure rating of the pipe or the maximum field test pressure permitted by the pipe manufacturer; and
  - ii) minimum field test pressure at any point along the section is not less than the greater of:
    - 1) the pressure rating of the pipe, or
    - 2) 1,25 times the maximum working pressure at these points.
- b) The first km (+200m,-100m) of pipeline laid is successfully tested before the subsequent section may proceed.
- c) The Contractor shall make due allowance in the construction programme and in the tendered rates for the entire testing operation including for the provision of temporary end stops (flanges or bullnoses) and any other costs associated with testing the pipeline in intermediate sections.

Once filled, the pipe shall be left for 24 hours to permit maximum saturation. The section to be tested shall then be pressurised to the specified pressure and left for a further 24 hours, during which period, the pressure drop (if any) and the quantity of water required to be pumped in to restore the test pressure shall be measured and recorded. In addition, all flexible and flanged joints shall be visually inspected and there shall be no sign of leakage.

At all times when there is water in the pipeline, and particularly during filling, testing and draining of the pipeline, all air valves shall be in operation and their individually isolating valves shall be open.

#### **5.1.2.8 Visible leaks**

- a) Except as allowed in b) the specified test pressure shall be maintained for a period of at least 24 hours (or such longer period as is necessary for inspection of the pipeline) during which period all pipes, pipe specials, joints, and fittings shall be carefully inspected for leaks. All visible leaks shall be made good and any pipe, pipe special, or fitting found to be defective shall be removed and replaced at the expense of the Contractor and such replacement material shall, after installation, be tested at the expense of the Contractor.
- b) In the case of pipes of DN 400 and under, the test period may be reduced proportionally to the nominal diameter of the pipe, provided that in no case shall the test period be less than 1 hour.

#### **5.1.2.9 Permissible leakage rates**

The test pressure shall be maintained for a further period of 1 hour after the completion of the test period specified in Clause 5.1.3.3, during which time the volume of water required to be pumped into the pipeline for maintenance of the pressure shall be measured.

The permissible leakage for welded and flanged steel pipelines is zero (0) litres.

#### **5.1.2.10 Initial filling of pipeline**

The entire process for filling the pipeline at any time during testing or disinfection shall be carried out under the supervision of the Engineer. Under no circumstances will the Contractor be allowed to carry out filling

of the pipeline without the supervision of the Engineer, neither shall the Contractor permit any other persons to carry out such filling without the written permission of the Engineer.

Unless otherwise specified or approved in writing by the Engineer, filling of the pipeline for hydraulic testing shall be carried out at a velocity in the main pipeline not exceeding 0.5 m/s.

Any damage to the pipeline caused by non-compliance with this clause shall be rectified at the Contractor's expense.

#### **5.1.2.11 Connections after testing**

The connections of the new pipework to the existing pipework shall only be carried out after the pipeline testing has been completed and accepted by the Engineer. For this reason, testing must be carried out against a blank flange or bullnose end cap at these locations.

#### **5.1.2.12 Remedial measures**

In the event that a pipe section fails a test, the Contractor shall carry out all remedial measures necessary to obtain a successful test of each individual section and the entire pipeline, at his/her own expense. Such remedial measures shall in no way compromise the requirements stipulated in the specifications.

#### **5.1.2.13 Draining of the pipeline**

The pipeline may have to be drained to carry out remedial measures and it must be drained before the disinfection process commences. The pipeline shall be drained via the scour valves in a manner that does not cause erosion of the streambeds or negatively impact on the environment in any way. All such drainage of the pipeline shall be carried out under the supervision of the Engineer.

### **5.1.3 Commissioning**

The pipeline will be considered to have been commissioned and practically complete once all the associated structures are sufficiently complete to carry out their structural and hydraulic function and the hydraulic test and disinfection of the entire pipeline has been successfully completed.

#### **5.1.4 Water tightness testing for chambers**

Refer to the SANS 1200 G or 1200 GA, as applicable.

#### **5.1.5 Tests on epoxy linings**

Once all work in the pipeline has been completed bar the hydrostatic testing and backfilling, the pipeline shall be cleaned by sweeping with a soft broom and rinsing. Access to this section shall be restricted from this point forward and will only be allowed on the written consent of the Engineer.

Holiday detection testing is to be undertaken by the Contractor on the lining in order to ensure that it remained intact during the transport, handling, placing and backfilling processes. Holiday testing may also be undertaken by the Independent Inspectorate. The testing and repair procedures shall be in accordance with the requirements stipulated in Specification ZUT 0003.

#### **5.1.6 Pipe coating integrity surveys**

The Contractor shall perform the pipe coating integrity survey as defined in the cathodic protection specifications.

**5.2 TOLERANCES****5.2.1 General**

No deviation will be permitted from the minimum pipe cover specified or shown on the Drawings.

**5.2.2 Control points**

For the purposes of this Clause, valves and pipe specials set on the centre line of the pipeline and designated changes in gradient shall be regarded as control points and shall be located with a permissible vertical deviation of  $\pm 100$  mm on the centre line. The same deviation will be permissible laterally except where the pipeline is laid at a designated distance from a fence line, kerb line, or boundary, in which case the permissible deviation shall be  $\pm 20$  mm.

Unless otherwise directed and subject to a permissible deviation (measured along the centre line) of  $\pm 2$  m, scour valves shall be located at the lowest points in pipelines and air valves at the highest points.

**5.2.3 Alignment**

**PLAN** (horizontal alignment): Unless otherwise directed, the permissible deviation from the defined alignment of the pipeline, when measured on the top centre of the pipeline, shall be  $\pm 100$  mm or  $\pm 10\%$  of the nominal diameter of the pipe, whichever is the larger, and the permissible deviation per pipe length shall be  $\pm 20$  mm.

**LEVEL** (vertical alignment): The permissible deviation from the designated level at any point on the invert of the pipeline shall be  $\pm 50$  mm or  $\pm 10\%$  of the nominal diameter of the pipe, whichever is the larger.

**5.2.4 Manholes, valve chambers, etc.**

Manholes, valve chambers and the like shall be constructed centrally on the control points and, with the exception of tolerances that affect access to bolts, nuts, etc., with a permissible deviation of  $\pm 50$ mm on all clearance dimensions. The clearance dimension between the outside of each nut and bolt-head and the inside face of the wall of a structure or any other fitting shall be at least the specified value.

**6. TOLERANCES**

Refer to Clauses 4 and 5.

**7. TESTING**

Refer to Clause 5.

**8. MEASUREMENT AND PAYMENT****8.1 BASIC PRINCIPLES****8.1.1 General**

Excavation and backfilling of trenches, and laying of medium-pressure pipelines, will be measured separately under SANS 1200 DB and Clause 8.2 of this Specification.



### 8.1.2 Night-caps

No extra payment will be made for night-caps. The supply and use of night-caps will be held to be included in the unit rate tendered for pipe laying.

### 8.1.3 Permanent closure pipes

#### 8.1.3.1 Butt welding

Where closures are butt welded to other pipes, the cost of cutting the pipe, preparing the end for welding and welding as specified in SANS 719, repairing the lining and coating as specified in Specification ZUT 0003 will be held to be included in the unit rate for laying of pipes.

#### 8.1.3.2 Slip-on couplings

Where closures are jointed to either access pipes, fittings or specials by means of slip-on couplings, no additional payment will be made for extra cutting of the pipe, preparing the end for welding, welding on the loose collar (approved 150 x 20 mm mild steel, machined round to suit coupling) or making good the lining.

Unless separately billed, the supply, transport and handling of the collar and slip-on coupling will be held to be included in the unit rate for the supply of pipes, fittings and specials.

### 8.1.4 Extra welds

Payment for all extra welds shall be covered by variation orders showing the location of the welds according to stake value and other necessary details. Such variation orders shall be signed by the Engineer's Representative and the Contractor's Representative in the field on the day the work is done. No payment will be made for test welds not covered by variation orders as stated above.

## 8.2 BILLED ITEMS

### 8.2.1 Lay and bed steel pipes and specials complete with couplings

a) Pipes	Unit:	metre (m)
b) Specials	Unit:	number (No.)

Pipes will be measured linearly as laid in the trench. No deduction will be made for specials and valves. Separate payment will be made for each type, size and class of pipe laid.

Specials will be measured separately by number of each type.

The unit rates tendered in the Bill of Quantities for laying of pipes and specials shall cover the cost of the following:

- Inspecting, accepting, taking delivery, providing storage, taking delivery from storage on site, transporting, handling, inspecting, stringing alongside trench, forming joint ("fox") holes, laying, jointing, cutting, scarfing, cutting mitre deflections up to 10 degrees (5 degrees per side), bevelling, maintaining line and level, jacking for ovality if necessary, provision and use of shield for heat treatment and welding if required;
- maintenance of cleanliness including all night caps and temporary blank flanges, etc., necessary to keep the inside of the pipe dry;
- removal, where necessary, and making good of lining and coating over the joints;



- d) radiographic examination of field welds and holiday testing of the lining, visual and dye penetrant testing;
- e) testing of welders and issuing of the necessary certificates;
- f) making good all linings and coatings;
- g) hydrostatic testing, testing equipment and anything required to do this work, including temporary end caps and blank flanges;
- h) sterilizing the pipeline where used for potable water;
- i) bolts, nuts, washers, gaskets and insulating material;
- j) supply and installation of steel and or concrete pipe supports (not necessarily shown on drawings);
- k) building in of specials (Refer to Item 8.2.11)

No extra payment over and above the rates tendered in the Bill of Quantities will be made in respect of additional cutting and jointing of pipes required to locate valves, specials, etc., exactly.

No separate payment will be made for the supply and fitting, chipping of lining, cutting, trimming, bevelling and making good on Site of any additional couplings and jointing materials which may be required for the connection of shortened pipe closures, unless specific provision is made in the Bill of Quantities.

The unit rate tendered for laying of steel pipes and specials shall cover the cost of the laying, jointing, etc., as specified and, in addition, for final painting and surface preparation when applicable. No extra-over payment shall be made for protecting metal couplings with petrolatum wrappings as per Specification ZUT 0003.

Notwithstanding the use of night-caps the Contractor shall at his own expense make good all damage to pipe linings and fittings caused by the ingress of dirty water, silt, sand, debris, vermin, insects and other foreign matter. The Contractor shall at his own expense and to the satisfaction of the Engineer clean the interior of the pipeline of such contaminants.

A maximum payment of 85 % of the tendered rate may be made for the completed section of pipeline which has not yet been hydraulically pressure tested and disinfected. A further payment of 10% of the tendered rate will be made upon successful completion of the pressure testing for the relevant section of pipeline. The final 5% of the tendered rate will be made upon completion of disinfection of the pipeline.

### **8.2.2 Extra-over for mitre deflections**

Unit: number (No.)

Where additional mitre deflections (up to 10 degrees) are ordered by the Engineer, these will be measured by number.

The rate shall cover the all the costs associated with mitre deflections detailed in Item 8.2.1 (a) to (f).

### **8.2.3 Installation of valves and meters**

Unit: number (No.)

The unit rate for installation of valves and meters shall cover the cost of taking delivery of these items from storage on site, inspecting each item for visible signs of damage, transporting to the laying site, off-loading, installing and, except where separately billed, of testing and commissioning of the valves and meters in position in accordance with the manufacturer's instructions and to the satisfaction of the Engineer.

No extra payment over and above the rate will be made in respect of any additional cutting, turning and jointing of pipes required for the location of a valve, meter, etc. where a precise position is given on the drawings.

The tendered rate shall also cover all jointing materials and, except where separately billed, support pedestals. The rate tendered for installation of valves and meters shall also include the cost of necessary oiling and greasing of moving parts and for minor routine initial maintenance work such as tightening up leaking glands.

The unit rates shall include for the cost of making good and the repair of paintwork and final painting as specified.

#### **8.2.4 Recover old pipeline**

Unit: metre (m)

The total length of the pipeline ordered to be recovered will be measured by length for each stated depth range. No deductions will be made for valves, specials, and the like.

The rate shall cover the cost of the excavation and removal of pipes, valves, and fittings from the trench, the handling and transportation to the Contractor's store on site, the cleaning and listing of the salvaged recovered materials, and the backfilling of the trench.

#### **8.2.5 Test and relay recovered pipe**

##### **8.2.5.1 Test recovered pipes on site before relaying**

Unit: number (No.)

The rate shall cover the cost of the provision of suitable testing equipment and the carrying out of the specified test.

##### **8.2.5.2 Relay pipeline**

Unit: metre (m)

The rate shall cover the cost of transporting, handling, laying, and bedding, as well as the provision of new rubber rings or insertions, as the case may be. Couplings and bolts that have to be replaced will be paid for at daywork rates unless a suitable item such as 8.2.4.3 below has been provided in the Bill or, in the opinion of the Engineer, the need for their replacement arose from the fault or negligence of the Contractor.

##### **8.2.5.3 Joints and couplings for recovered pipeline (Provisional)**

Unit: number (No.)

The rate shall cover the provision of complete sets, each comprising a new rubber ring or insertion, as the case may be, as well as all elements of the coupling and bolts that need replacement.

#### **8.2.6 Anchor/thrust blocks**

a) Dimensions stated or given on drawing – Unit: No. or Sum

OR

b) Where, at the tender stage, no detailed drawings or dimensions are given or where only typical drawings are given:

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Concrete – Unit: m<sup>3</sup>Formwork – Unit: m<sup>2</sup>

Reinforcement – Unit: ton

Except where measured by number or sum, anchor/thrust blocks will be measured as the volume of concrete, areas of formwork, and mass of reinforcement, as relevant, placed to dimensions ordered or given on the drawings and schedules of reinforcement. The relevant terms of Clause 8 of SANS 1200 G or SANS 1200 GA, as applicable, shall apply.

Where measured by number or sum, the rate or sum shall cover the cost of excavation and trimming, formwork, reinforcement (if any), and screeding of top surfaces.

**8.2.7 Concrete casing**Unit: m<sup>3</sup>

The concrete will be measured net by volume to the specified width and depth in excess of the external volume of the pipe (i.e. the volume of the pipe will be deducted).

The rate shall cover the cost of formwork (including stop ends at flexible joints), reinforcement (if any) and concrete.

**8.2.8 Valve chambers**

Unit: number (No.)

Valve chambers will be measured as complete units.

The rate shall cover additional excavation (see Subclauses 8.2.2 and 8.2.3 of SANS 1200 DB), materials, plant, and labour necessary for the complete construction including the installation of covers, ladders and ancillaries shown on the drawing.

**8.2.9 Manholes**

Unit: number (No.)

Manholes will be measured as complete units for which separate items will be scheduled for each type of manhole and depth categories.

The rate shall cover additional excavation, materials, plant, and labour necessary for the complete construction including the installation of the covers, ladders and ancillaries shown on the drawing.

**8.2.10 Temporary closure pipes (Provisional)**

Unit : number (No.)

Temporary closure pipes will be measured as provisional items by number only where ordered by the Engineer.

The unit rate shall cover the cost of the supply, installation, removal and making good of the pipe.

Excavation, backfilling and supply of bedding material will be measured and paid for separately as specified in SANS 1200 DB and SANS 1200 LB.

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**8.2.11 Items cast or built into concrete**

Unit: number (No.)

The building in (or casting into concrete) of the pipes and pipe specials will be measured by the number of each item built in.

The unit rate shall cover the installation of the pipe or pipe special as well as all additional costs of formwork, concreting and fixing of pipes and specials which are not covered by the normal tendered rates for formwork and concrete.

**8.2.12 Pipe lining integrity tests**

Unit: lump sum (Sum) or metre (m)

Payment for tests on linings will include for all labour, the cost of supplying fuel and production related wearing parts (bucket teeth, cutters etc) for equipment utilised, and materials to perform all tests and repair work as defined in Specification ZUT 0003. Payment for the pipeline section tested and repaired will be certified for payment only on written acceptance of successful testing and repair work as defined in Clause 5.1.6.

**8.2.13 Concrete/steel valve and pipe supports**

Unit: number (No.)

Except where billed separately, payment for the supply and installation of concrete or steel supports to valves, meters, pipe specials, etc. shall be included in the rates tendered for the installation of these items.

Where billed separately, the rate for supports shall cover all material, plant and labour required for the supply and installation of the support, including all anchor bolts and jointing material. In the case of steel supports, the cost of the corrosion protection shall be included in the rate tendered for the support.

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## Annexures

### APPENDIX A : APPLICABLE STANDARDS

API 1104	:	Standard for welding of pipe lines and related facilities.
SANS 719	:	Electric welded low carbon steel pipes for aqueous fluids (Ordinary duty)
SANS 10044-3	:	The fusion welding of steel (including stainless steel): Tests for approval of welding procedures and production welds.
SANS 1200 G	:	Concrete (structural)
SANS 1200 GA	:	Concrete (small works)
SANS 1200 L	:	Medium-pressure pipelines
SAECC/1		
Specification ZUT 7002	:	Manufacture of medium-pressure steel pipes
Specification ZUT 7001	:	Design and manufacture of medium-pressure steel specials
Specification ZUT 0003	:	General corrosion protection for pipelines, water and wastewater works

# SPECIFICATION: ZUT 7007

## SLUICE GATES

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## 1. INTRODUCTION

Zut 7007 specifies the requirements for sluice gates to be provided by the Contractor for general water and wastewater applications and also for dam applications.

## 2. SCOPE OF WORKS

See project specification.

The installation shall be configured as shown on applicable drawings.

## 3. NORMATIVE REFERENCES

The following form part of the Contract Document:

- a) Amendments, additions and detailed requirements (Zut 7007).
- b) Zut 0001: General Mechanical Requirements.
- c) Zut 0003: General Corrosion Protection for Pipelines, Water and Wastewater Works.
- d) Zut 6004: Actuators.
- e) SANS 12944-2: Paints and varnishes – Corrosion protection of steel structures by protective paint systems; Part 2: Classification of environments.
- f) National Occupational Health and Safety Act and Regulations.
- g) SANS 10108: The classification of hazardous locations and the selection of apparatus for use in such locations.

Equipment, materials and operational methods shall comply with the latest edition of the relevant national and/or international standard.

## 4. EQUIPMENT ELIGIBILITY

The sluice gates provided shall have a successful record of use locally in similar applications and shall also have had at least three years of technical support locally. Service and spares shall currently be available locally. Upgraded versions of a manufacturer's earlier designs which comply with these criteria are also acceptable.

Equipment which does not satisfy these requirements is not acceptable unless specifically called for in the specifications or unless the Engineer agrees in writing.

## **5. PERFORMANCE REQUIREMENTS**

### **5.1 OPERATION**

The sluice gate shall open and close smoothly and without snag or slew under all pressures and over its full travel.

The opening and closing force for manually operated sluice gates shall be less than 240 Newtons (i.e. the sum of the tangential force on the wheel shall be less than 240 Newtons over the full opening and closing distances).

### **5.2 PRESSURE**

Wall and aqueduct mounted sluice gates can be subject to substantially higher pressures than channel mounted sluice gates and sluice gates for dam structures can be subjected to significant pressure. Sluice gates and all components shall be designed to withstand the maximum pressure which could be experienced during all specified operational conditions and shall seal acceptably when subject to this pressure.

### **5.3 LEAKAGE**

Permissible leakage rates apply to the full range of pressures.

The acceptable leakage rate for off-seating sluice gates is 0,02 litres per second per metre of seating perimeter under normal operating conditions.

The acceptable leakage rate for on-seating sluice gates is 0,01 litres per second per metre of seating perimeter under normal operating conditions.

The acceptable leakage between the sluice gate frame and the concrete structure is zero.

### **5.4 FREQUENT OPERATION**

Sluice gates which operate frequently shall be designed to perform correctly after at least five years of operation before requiring replacement parts. This includes wearing surfaces.

## **6. OPERATION AND CONTROL**

Manual operation shall be provided in addition to any powered actuation specified.

Actuated sluice gates shall remain in position upon failure of the electrical supply unless automatic shut-down is specified.

Each actuator shall be provided with an emergency stop station in an appropriate position.

If the Contract includes a SCADA system, monitored parameters shall appear on the SCADA/HMI mimics.

## **7. DESIGN AND CONSTRUCTION**

### **7.1 GENERAL**

The sluice gate shall incorporate the frame, gate, headstock and actuation device.



The design shall allow removal of the gate and replacement of the seals without damage to the frame structure.

The headstock support shall accommodate the gate opening and closing forces with no visible deflection.

Sluice gates shall be designed so that solid material in the flow cannot snag on protrusions such as adjusters and/or prevent closing of the gate.

Fabricated gates which require reinforcing ribs shall have these ribs welded onto the gate. Bolted ribs are not acceptable. Welds shall be continuous and without crevices.

Gates in off-seating applications shall incorporate guides which provide a seating force. Such guides shall be of low friction polymer or of non-ferrous metal.

Wide gates (gates with a width to depth ratio greater than 1,8) shall be provided with dual spindles which are connected by gearing.

Sluice gates shall be of the rising spindle configuration unless not feasible in the application.

Line shafting shall be provided with shaft guides at a maximum spacing of 1 800 mm.

Handwheels shall be mounted approximately 1 000 mm above the operator's floor level.

Manually operated units shall be provided with matched gearboxes and handwheels of a size and construction in order to comply, when subjected to a differential pressure equal to the maximum specified pressure difference across the gate, with the performance requirements for manual operating forces. Suitable gearboxes shall be fitted to achieve the specified manual operating forces.

The open and close directions of handwheels shall be indicated.

The gate, when open, shall be out of the path of the maximum design flow. The gate opening height of channel mounted sluice gates shall be at least 200 mm above the maximum specified water depth in the channel.

The complete unit shall have environmental protection which is suitable for washing by hose.

## **7.2 WALL MOUNTED SLUICE GATES**

Wall mounted sluice gates shall seal on all 4 sides.

Gates, frames and guides shall be structurally capable of resisting the specified differential pressure at any degree of opening and shall operate correctly under this differential pressure.

## **7.3 FREQUENTLY OPERATED GATES**

Sluice gates for regulation and modulation and/or which will be operated daily shall comply with the following additional requirements:

- The gate shall slide between polymer or non-ferrous alloy materials. Sliding contact between similar metals is not acceptable.
- Guides, seals, gate nuts and thrust nuts shall be easily replaceable.

## **7.4 ACTUATORS**

Sluice gate actuators shall comply with Zut 6004.

## **7.5 GEARBOXES**

Gearboxes shall comply with Zut 0001. They shall have ingress protection to IP 55.

The service factor for motor driven gearboxes shall be chosen in accordance with Zut 0001 or shall comply with the guidelines of AGMA.

## 7.6 FABRICATION

Fabrication and welding shall comply with Zut 0001.

## 7.7 SEALS

### 7.7.1 Dams

Elastomer seals on dam applications are only acceptable if the design allows seals to be replaced by a diver underwater whilst the sluice gate is in situ. Seals on dam applications shall, otherwise, be metal on metal.

### 7.7.2 General

Elastomer seals shall be suited to the application. Elastomers in wastewater applications shall be of nitrile or viton.

## 8. MATERIALS & COATINGS - DAMS

### 8.1 PREAMBLE

Sluice gates for dams shall comply with this Clause.

### 8.2 GENERAL

Corrosion protection shall be suitable for the very high - marine corrosivity category (C5-M) of SANS 12944-2.

Corrosion protection shall comply with Zut 0003.

Materials shall comply with Zut 0001

### 8.3 EQUIPMENT

The materials of construction of sluice gates for dams (i.e. for all sluice gates coming into contact with dammed reservoir water) shall comply with the table below.

ITEM	MATERIAL	COATING
Frame and gate.	EN Grade 1.4462 duplex stainless steel (2205) or EN Grade 1.4410 duplex stainless steel (2507).	Pickle and passivate.
Sliding surfaces	Stainless steel on engineering plastic or non-ferrous alloys.	Not applicable.
	Metal on metal (preferred)	Not applicable.

Seals – not normally exposed to ultra violet rays.	Stainless steel on elastomer	Not applicable.
Seals – normally exposed to ultra violet rays; including diffused radiation.	Metal on metal.	Not applicable.
Spindles, line shafting, universal joints, muff couplings, spindle adaptors, pins and linkages	EN Grade 1.4401 stainless steel (316) or EN Grade 1.4462 duplex stainless steel (2205).	Pickle and passivate.
Line shaft support brackets	EN Grade 1.4462 duplex stainless steel (2205); EN Grade 1.4401 stainless steel (316) is also acceptable.	Pickle and passivate.
Line shaft support bracket bearing surfaces	Engineering plastic.	Not applicable.
Spindle covers	Stainless steel.	Pickle and passivate.
	Polycarbonate.	Not applicable.
Motors, gearboxes and bearing housings.	Manufacturer's standard.	Corrosion protection suitable for the very high corrosivity category (C5-M) of SANS 12944-2.
Handwheels	Stainless steel	Pickle and passivate.
	Cast iron	Fusion bonded epoxy.
	Cast aluminium	Not required.
Fasteners, including anchor fasteners.	EN Grade 1.4462 duplex stainless steel (2205)	Not applicable.
Carbon steel is not acceptable for any component of the sluice gates.		
Stainless steel shall be correctly pickled and passivated. Stainless steel surfaces shall be free of ferrous stain and heat tint at commissioning.		

## 9. MATERIALS & COATINGS - GENERAL

### 9.1 PREAMBLE

Sluice gates for applications other than for dams shall comply with this Clause.

### 9.2 GENERAL

Corrosion protection shall be suitable for the high corrosivity category (C4) of SANS 12944-2.

Corrosion protection shall comply with Zut 0003.

Materials shall comply with Zut 0001.

### 9.3 EQUIPMENT

Equipment shall comply with the table below.

ITEM	MATERIAL	COATING
Frame and gate.	EN Grade 1.4401 stainless steel (316) or LDX 2101.	Pickle and passivate.
Sliding surfaces; frequent operation.	Stainless steel on engineering plastic.	Not applicable.
Sliding surfaces; less than once per day.	Stainless steel on engineering plastic or on rubber or on non-ferrous alloys.	Not applicable.
Seals	Elastomer; suitable for the fluid.	Not applicable.
Seating surface	Stainless steel.	Pickle and passivate.
Spindles, line shafting, universal joints, muff couplings, spindle adaptors, pins and linkages	EN Grade 1.4401 stainless steel (316) or LDX 2101 or a suitable Martensitic stainless steel.	Pickle and passivate.
Line shaft support brackets	EN Grade 1.4401 (316) stainless steel or LDX 2101.	Pickle and passivate.
Line shaft support brackets bearing surfaces	Engineering plastic.	Not applicable.

Spindle covers	Stainless steel.	Pickle and passivate.
	Polycarbonate.	Not applicable.
Motors, gearboxes and bearing housings.	Manufacturer's standard.	Corrosion protection suitable for the high corrosivity category (C4) of SANS 12944-2.
Handwheels	Stainless steel.	Pickle and passivate.
	Cast iron.	Fusion Bonded epoxy or equivalent.
	Aluminium.	Not required.
Fasteners, including anchor fasteners.	EN Grade 1.4401 (316) stainless steel or LDX 2101.	Not applicable.
<p>On wastewater applications, copper alloys shall not be used unless completely encapsulated; i.e. thrust nuts for sluice gates for wastewater applications shall not be of brass or bronze unless completely separated from the environment in a gearbox or equivalent.</p> <p>On applications not involving wastewater, thrust nuts shall be of manganese bronze or better.</p>		
Carbon steel is not an acceptable material for any component of the sluice gate.		
Stainless steel shall be correctly pickled and passivated. Stainless steel surfaces shall be free of ferrous stain and heat tint at commissioning.		

## 10. INSTALLATION

### 10.1 GENERAL

Installation work shall comply with Zut 0001.

Sluice gates shall be installed by personnel skilled in such installations.

Grout shall be of the non-shrink type and shall be applied strictly in accordance with the manufacturer's instructions.

All concrete surfaces to be grouted shall be scabbled to the approval of the Engineer and shall be blown clean immediately prior to grouting.

### 10.2 CHANNEL MOUNTED SLUICE GATES

Channel mounted sluice gate frames to be mounted within recesses in the channel walls shall be positioned accurately and held securely with at least six permanent anchors before grouting.

Smooth and easy operation of the gate along its full operating distance shall be demonstrated to the Engineer before and after the frame is grouted into position.

Channel mounted sluice gate frames to be mounted on the flat surfaces of channel walls and floor shall be bolted into position using chemical anchors before grouting. Suitable gaps shall be left for the application of grout. Smooth and easy operation along its full operating distance shall be demonstrated to the Engineer before and after the frame is grouted into position.

### **10.3 WALL MOUNTED SLUICE GATES**

The frame of a wall-mounted sluice gate shall be secured using anchors. The frame shall be aligned before grouting. Suitable gaps shall be left for the application of grout. Smooth and easy operation of the gate along its full operating distance shall be demonstrated to the Engineer before and after the frame is grouted into position.

## **11. CIVILS AND BUILDING**

As required in terms of the General Conditions, the Contractor shall:

- provide the details of all civil and building requirements to the Engineer for incorporation into the structure.
- at an appropriate point, measure on Site in order to check for correctness of the Works.

The Contractor shall ensure that the design can accommodate a tolerance of +/- 40 mm for civil and building items constructed by others (unless a tighter tolerance is called for by the Contractor in good time and approved by the Engineer).

## **12. SAFETY**

The Contractor shall design and install equipment installations in accordance with the requirements of the country's Occupational Health and Safety regulations.

If applicable, the design and supply shall be in accordance with the requirements of SANS 10108 for hazardous areas.

## **13. INSPECTIONS**

### **13.1 FACTORY, ETC.**

The Contractor shall make all arrangements and carry all costs for the Engineer to inspect the sluice gates prior to despatch to Site and prior to payment being made.

If the equipment is manufactured and assembled locally, the Contractor shall make all arrangements and carry all costs for the Engineer to inspect equipment in the manufacturer's works prior to despatch to Site. If the equipment is not manufactured and assembled locally, the Contractor shall make all arrangements and carry all costs for the Engineer or for an Engineer approved inspection authority to inspect the equipment in the manufacturer's works prior to despatch. The inspection authorities' inspection shall include a full report on compliance of the

equipment with the specifications and this report shall be acceptable to the Engineer prior to dispatch of the unit from the manufacturer's works.

**13.2 SITE**

The Contractor shall make arrangements for the Engineer to inspect the installation on Site prior to commissioning.

**13.3 INSPECTION DURING DEFECTS NOTIFICATION PERIOD**

The Contractor shall inspect the operation of the Works three months after the start of the Defects Notification Period and shall provide a condition report to the Engineer.

## **14. TESTING REQUIREMENTS**

The Contractor shall successfully demonstrate the following to the Engineer prior to the commissioning of the Works:

- a) operation on Site, including smooth and easy operation of the gate along the full operating distance without snag or slew.
- b) achievement of the specified performance requirements for leakage testing after all installation work has been completed.
- c) compliance with the maximum peripheral force required for operation of the handwheel.
- d) correct operation of the control system.

The Contractor shall provide site test reports to the Engineer and shall submit copies in the Manual.

# SPECIFICATION: ZUT 7010

## Knife Gate Valves

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## **1. INTRODUCTION**

Zut 7010 specifies the requirements for knife gate valves to be provided by the Contractor.

## **2. SCOPE OF WORKS**

See project specification.

The installation shall be configured as shown on applicable drawings.

## **3. NORMATIVE REFERENCES**

Where this specification is required for a project, the following documents shall, inter alia, form part of the Contract Document:

- a) Amendments, Additions and Detailed Requirements (Zut 7010).
- b) Zut 0001: General Mechanical Requirements.
- c) Zut 0003: General Corrosion Protection for Pipelines, Water and Waste Water Works.
- d) SANS 12944 2: Paints and varnishes – Corrosion protection of steel structures by protective paint systems; Part 2: Classification of environments.
- e) National Occupational Health and Safety Act and Regulations.
- f) SANS 10108: The classification of hazardous locations and the selection of apparatus for use in such locations.

Equipment, materials and operational methods shall comply with the latest edition of relevant national and/or international standards.

## **4. EQUIPMENT ELIGIBILITY**

The make and model of valve provided shall have a successful record of use in similar applications locally and shall also have had at least three years of technical support locally. Service and spares shall currently be available. Upgraded versions of a manufacturer's earlier designs which comply with these criteria are acceptable.

Valves which do not satisfy these requirements is not acceptable unless called for in the specifications or unless the Engineer agrees in writing.

## **5. PERFORMANCE REQUIREMENTS**

Valves shall be droptight in at least one direction.

Body seals shall not leak.

Operation shall be smooth.

Handwheels shall not require a peripheral force greater than 250 Newtons (i.e. the sum of the forces on the wheel shall not be greater than 250 Newtons) during all positions of valve opening and closing.

## **6. OPERATION AND CONTROL**

Power actuated valves shall also be provided with manual operation.

Where specified, actuated valves shall be fail-to-safe upon loss of motive power. Pneumatically actuated valves of DN 200 and below shall incorporate spring return. Other valves shall incorporate either pneumatic or electric fail-to-safe action.

Valves shall be clockwise closing.

## **7. DESIGN AND CONSTRUCTION**

Knife gate valves shall be of a type suitable for water sludges, wastewater, primary sludges, waste activated sludges and digested sludge duties.

Valves shall be designed and constructed to ensure reliable operation after long periods of non-operation. Except for those in line with the blade, all flange bolts shall be through-bolts.

Valves and their method of actuation shall be designed to operate under the full pressure rating of the valve.

Manually operated valves shall be provided with handwheels of a size and construction which permit easy opening of the gate when subjected to a differential pressure equal to the rated pressure difference across the gate. Suitable gearboxes shall be fitted to achieve the specified maximum allowable handwheel force.

Blade faces shall be surface ground or otherwise provided with two flat, parallel surfaces. Valves above DN 250 shall have both faces ground flat and parallel.

The body seal shall be protected by a non-metallic scraper or similar device.

It shall be possible to adjust the body seal while the valve is in line under pressure.

## **8. GEARBOXES**

Valve gearboxes shall comply with Zut 0001 and shall have ingress protection to IP 55.

The service factor for motor driven gearboxes shall be chosen in accordance with Zut 0001 or shall comply with the guidelines of AGMA.

## 9. INSTRUMENTATION

Instrumentation shall comply with Zut 0001.

## 10. MATERIALS AND COATINGS

### 10.1 GENERAL

Components shall be designed for corrosion resistance to the high corrosivity category (C4) of SANS 12944-2.

Corrosion protection shall comply with Zut 0003.

Valves shall have no carbon steel parts. Materials shall comply with Zut 0001.

### 10.2 EQUIPMENT

Equipment shall comply with the table below.

ITEM	MATERIAL	COATING
Valve body	Cast iron.	Rilsan coating; or, Water resistant, non-toxic and non-tainting, fusion bonded epoxy pipe coating to a dry film thickness of 250 micron on internal and external surfaces.
	Stainless steel.	N/A
Spindle	Stainless steel.	N/A
Gate	EN Grade 1.4401 (316) stainless steel or better.	Pickle and passivate.
Valve fasteners	EN Grade 1.4401 (316) stainless steel, or better.	
Gearbox	Manufacturer's standard.	Suitable system for corrosion resistance to the high corrosivity category (C4) of SANS 12944-2.
Fasteners	EN Grade 1.4401 (316) stainless steel.	N/A
Handwheels.	Stainless steel.	Pickle and passivate.
	Cast iron.	Fusion bonded epoxy.
	Cast aluminium.	N/A
Flange fasteners	As for mating pipework.	As for mating pipework.

Auxiliary metal components	EN Grade 1.4401 (316) stainless steel.	Pickle and passivate.
Stainless steel shall be correctly pickled and passivated. Stainless steel surfaces shall be free of ferrous stain and heat tint at commissioning. Valves shall have no carbon steel parts.		

## 11. FASTENERS

Fasteners shall comply with Zut 0001.

## 12. INSTALLATION

The valve shall be installed in a position which will provide reasonable access to operate the handwheel.

Valve spindles shall be installed vertically unless the Engineer agrees otherwise.

## 13. SAFETY

The Contractor shall design and install all equipment in accordance with the requirements of the country's Occupational Health and Safety regulations.

If applicable, the design and supply shall be in accordance with the requirements of SANS 10108 for hazardous areas.

## 14. INSPECTIONS

### 14.1 WORKSHOP/FACTORY

The Contractor shall make all arrangements and carry all costs for the Engineer, or an Engineer approved inspection authority, to inspect the valves for acceptance prior to despatch to Site and prior to payment being made. If the equipment is manufactured locally, the Contractor shall arrange for the Engineer to inspect equipment in the manufacturer's works prior to despatch to Site. If the equipment is not manufactured locally, the Contractor shall arrange for the Engineer or an Engineer approved inspection authority to inspect the equipment in the manufacturer's works prior to dispatch. The Contractor shall submit the report by the inspection authority to the Engineer for acceptance. This report shall confirm compliance of the equipment with the specifications prior to despatch from the manufacturer's works.

### 14.2 SITE

The Contractor shall make arrangements for the Engineer to inspect the completed installation on Site for acceptance prior to commissioning.

**14.3 INSPECTION DURING DEFECTS NOTIFICATION PERIOD**

The Contractor shall inspect the operation of the Works three months after the start of the Defects Notification Period and shall provide a condition report on all equipment to the Engineer.

**15. TESTING REQUIREMENTS**

**15.1 FACTORY, ETC.**

Valves shall be leak tested in accordance with the pressure rating specified.

Valves shall be tested after the specified coating systems have been applied.

The Contractor shall submit reports for tests to the Engineer prior to the equipment being transported to Site and prior to payment being made.

**15.2 SITE**

The Contractor shall successfully demonstrate the following to the Engineer prior to the commissioning of the Works:

- a) equipment operation.
- b) control system operation.

# **SPECIFICATION: ZUT 7016**

## **Resilient Seal Gate Valve**

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## **1. INTRODUCTION**

Zut 7016 specifies the standard requirements for resilient seal gate valves of the type with rubber lined gate.

## **2. SCOPE OF WORKS**

### **2.1 GENERAL**

The equipment installation to be provided by the Contractor shall be configured as shown on any applicable drawings.

### **2.2 WORKS TO BE PROVIDED BY THE CONTRACTOR**

The detail of the work for which the Contractor is responsible is specified elsewhere.

## **3. NORMATIVE REFERENCES**

The following documents are applicable to this specification:

- Zut 0001 - General Mechanical Requirements.
- Zut 0003 - Painting and Corrosion Protection for Water and Wastewater Works.

## **4. EQUIPMENT ELIGIBILITY**

The valve provided shall have a successful record of use in South Africa in similar applications and shall also have had at least three years of technical support in South Africa. Service and spares shall currently be available in South Africa. Upgraded versions of a manufacturer's earlier designs which comply with these criteria are also acceptable.

Equipment which does not satisfy these requirements is not acceptable unless specifically called for in the specifications or unless the Engineer agrees in writing.

## **5. PERFORMANCE REQUIREMENTS**

The body shall withstand the internal pressure rating of the valve.

The valve shall open and close smoothly at a pressure difference across the gate equal to the valves' rated pressure.

The gate liner shall, in accordance with SANS 665-3, be so firmly bonded, vulcanised and accurately moulded that, when the valve is tested, the resilient material shall not become torn, loose or detached. Also in accordance with SANS 665-3, the gate shall ensure drop tightness

over the full pressure range of the valve and the lining shall have the capacity to accept foreign matter up to 1 mm in particle size.

## **6. OPERATION AND CONTROL**

The valve shall be positively held in position over all degrees of opening whether under pressure or not.

Clear indication of current valve position shall be provided.

Valve opening and closing direction shall be indicated.

All actuated valves shall be provided with manual operation override. Electric actuators shall also be provided with manual start and stop functions on the actuator.

## **7. DESIGN AND CONSTRUCTION**

### **7.1 GENERAL**

Valves shall be of the double flanged configuration.

Manually operated valves shall be provided with handwheels of a size and construction which permit easy opening of the gate when subjected to a differential pressure equal to the rated pressure difference across the gate. Handwheels shall not require a peripheral force greater than 250 Newtons (i.e. the sum of the forces on both sides shall not be greater than 250 Newtons). Suitable gearboxes shall be fitted to achieve this.

The gate shall be fully lined so that the fluid does not contact any metallic part of the gate.

The gate shall be provided with guides. Sliding surfaces of cast iron are not acceptable.

Valves shall have rising spindles unless otherwise specified or necessary because of space restrictions. Valves with non-rising spindles shall be fitted with an indication of the closing and/or the opening direction.

The spindle shall be of stainless steel.

Manually operated gearboxes shall be provided with a stainless steel grease nipple.

Valves shall be designed and constructed to ensure reliable operation after long periods of non-operation.

Valves shall comply with SANS 665 where applicable.

Handwheels shall be of cast metal. The handwheel shall be clockwise closing.

### **7.2 VALVES > DN 150**

Valves larger than DN 150 shall be provided with a bypass which incorporates a small bore, flanged, metal seated wedge gate valve.

Valves above DN 150 shall have the manufacturer's name, size and working pressure cast on the valve body.



A slipping clutch, or equivalent mechanism, shall prevent over torque which would cause damage. Shear pins and other torque limiting devices which have to be replaced after activation are not acceptable.

## **8. FASTENERS**

Fasteners shall comply with Zut 0001.

Fasteners on the valve shall be of EN Grade 1.4401 (316) stainless steel.

Flange fasteners shall comply with the specification for the pipeline's flange fasteners.

## **9. MATERIALS AND CORROSION PROTECTION**

The specific application shall be taken into account in the corrosion protection of valves.

The gate liner shall be of vulcanised EPDM.

Valve bodies shall be of ductile iron or of cast steel.

Cast iron valve components, including valve bodies, shall be protected internally and externally with either a fusion bond epoxy or Rilsan (or equivalent) and shall comply with Zut 0003. Dry film coating thickness shall not be less than 200 micron.

Metal plating of ferrous materials is not an acceptable corrosion protection system.

## **10. INSTALLATION**

Valves shall be mounted firm and level.

The weight of the valve shall be fully supported. Valves of DN 250 and over shall be provided with at least one dedicated vertical support.

Spindles shall be vertical unless approved otherwise by the Engineer.

The handwheel shall be easily accessible to the operator.

Installation shall comply with Zut 0001.

## **11. CIVIL AND BUILDING MATTERS**

As required in terms of the General Conditions, the Contractor shall:

- provide the details of civil and building requirements to the Engineer for incorporation into the structure.
- at an appropriate point, measure on Site.

The Contractor shall ensure that the design can accommodate a tolerance of +/- 40 mm for civil and building items constructed by others (unless a tighter tolerance is called for by the Contractor in good time and approved by the Engineer).

## **12. INSPECTIONS**

The Contractor shall make arrangements for the Engineer to inspect the equipment for compliance prior to payment being made.

If the equipment is manufactured and assembled in South Africa, the Contractor shall make all arrangements and carry all costs for the Engineer to inspect equipment in the workshop prior to despatch to Site.

If the equipment is manufactured and assembled outside South Africa, the Contractor shall make all arrangements and carry all costs for an Engineer approved inspection authority to inspect the equipment in the workshop prior to dispatch. The inspection shall include a full report on compliance of the equipment with this specification and this report shall be submitted to the Engineer prior to dispatch of the unit from the workshop.

## **13. TESTING REQUIREMENTS**

The valve shall be tested to be drop tight at a pressure equal to 1,1 times the nominal design pressure difference across the gate and the test certificate shall be submitted to the Engineer.

The body and gate shall be tested to an internal pressure of 1,5 times the nominal design internal pressure and the test certificate shall be submitted to the Engineer.

The correct operation of the valve shall be demonstrated to the Engineer prior to the commissioning of the Works.

## **14. GENERAL**

The equipment shall have been successfully used in similar applications in South Africa.

# SPECIFICATION: ZUT 7017

## Single Door Check Valve

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## 1. INTRODUCTION

Zut 7017 specifies the standard requirements for single door check valves; with pressure ratings between 10 bar and 25 bar, for water applications in sizes up to DN 1200, and for wastewater and sludge applications in sizes up to DN 800; to be provided by the Contractor.

## 2. SCOPE OF WORKS

See project specification.

The installation shall be configured as shown on applicable drawings.

## 3. NORMATIVE REFERENCES

Where this specification is required for a project, the following documents shall, inter alia, form part of the Contract Document:

- a) Amendments, Additions and Detailed Requirements (Zut 7017).
- b) Zut 0001: General Mechanical Requirements.
- c) Zut 0003: General Corrosion Protection for Pipelines, Water and Waste Water Works.

Equipment, materials and operational methods shall comply with the latest edition of relevant national and/or international standards.

## 4. EQUIPMENT ELIGIBILITY

The valve provided shall have a successful record of use locally in similar applications and shall also have had at least three years of technical support locally. Service and spares shall currently be available. Upgraded versions of a manufacturer's earlier designs which comply with these criteria are also acceptable.

Equipment which does not satisfy these requirements is not acceptable unless specifically called for in the specifications or unless the Engineer agrees in writing.

## 5. PERFORMANCE REQUIREMENTS

Valves shall seal drop tight at the PN rating.

The body shall withstand the test pressure.

The valve shall be sized to open fully at the lowest specified flow rate of the system.

The valve shall close before the flow direction can reverse (unless external control and/or damping is specified).

Valves shall be designed and constructed to ensure reliable operation after long periods of non-operation.

## **6. CONSTRUCTION AND DESIGN**

### **6.1 GENERAL REQUIREMENTS**

Valves shall be double flanged.

Flanges shall comply with BS EN 1092 for the PN rating of the valve unless required to match flanges with a different specification.

The door position shall be indicated.

In accordance with SANS 1551-1, each valve shall be provided with indelible markings which include the manufacturer's name, PN rating, DN size and the direction of flow.

Valves of DN 150 and larger shall incorporate a bypass of DN 25 or larger. The bypass shall incorporate a flanged metal seated wedge gate valve for isolation.

Valves larger than DN 500 shall be provided with damping at closure. The damping shall be provided by external hydraulic oil dashpot or similar.

### **6.2 SIZE AND RATING**

The nominal flow speed at the minimum design flow rate shall not be less than 1,3 m/s.

The pressure rating for the valve shall match the rating for the pipework. The valve's pressure rating shall not, however, be lower than PN 10.

### **6.3 PIPEWORK CONFIGURATION**

The configuration of the valve and its pipework shall ensure that the flow requirements of the valve are accommodated.

At least three pipe diameters of straight pipe shall be provided immediately upstream of the valve.

The valve shall be able to open and close without interference from physical obstruction such as an isolation valve, a bend, mortar lining, etc.

The force of the valve closing shall be securely restrained under the worst hydraulic condition expected. It is preferred that a support is provided for the valve itself but it is also acceptable that this thrust force is restrained via properly anchored pipework.

Orientation of the valve shall comply with the manufacturer's recommendation.

Check valves shall be separated from downstream isolation valves by a straight pipe for a distance of at least 1,5 times the diameter.

### **6.4 SINGLE DOOR CHECK VALVES FOR WATER**

Single door check valves for sizes up to DN 1200 for water which is not expected to contain suspended solids shall be of the slanted seat, tilting door configuration ("Tilting Disc" type).

The valve shall have a side lever and adjustable weight for gravity-assisted closing (unless external damping and/or control is specified for the valve).

Damping shall slow down the movement of the door as it approaches the closed position.

## 6.5 SINGLE DOOR CHECK VALVES FOR WASTEWATER

Single door check valves for wastewater, for wastewater sludge and for water which is expected to contain foreign matter shall be of the type which allows the door to move fully out of the flow so that solid matter does not catch on it ("Swing Check" type).

The seal shall be of a suitable resilient material.

A side lever and adjustable weight shall provide gravity-assisted closing.

The body shall incorporate a bolted cover to provide access to the disc for cleaning without having to dismantle or remove the valve.

## 7. MATERIALS AND COATINGS

### 7.1 GENERAL

Materials shall comply with the requirements for materials in Zut 0001.

Corrosion protection shall comply with Zut 0003.

Stainless steel shall be correctly pickled and passivated. Stainless steel surfaces shall be completely clear of ferrous stain and heat tint at commissioning.

Metal plating of ferrous materials is not acceptable.

### 7.2 ENVIRONMENT

Environmental corrosion protection shall be suitable for the high corrosivity category (C4 of SANS 12944-2).

### 7.3 EQUIPMENT

Equipment shall comply with the table below.

ITEM	MATERIAL	COATING
Valve body and door	Cast iron, cast steel or cast stainless steel.	Cast iron and cast steel shall be provided with a coating in accordance with "Fusion Bonded Epoxy (Heavy Duty)" in Zut 0003. Equivalent systems for water immersion, such as Rilsan or equivalent, are also acceptable.
Shaft (hinge pins)	Stainless steel.	Not required.

Bushes	Engineering plastic; Self-lubricated, non-ferrous metal.	Not required.
Seat	Stainless steel or better.	Not required.
Seal	Elastomer; or metal suitable for contact with seat.	Not required.
Valve fasteners, both internal and external	EN Grade 1.4401 (316).	Not required.
Flange fasteners	Hot dip galvanised carbon steel.	Chromate passivated.
External metal components	EN Grade 1.4401 (316).	Pickle and passivated.

## 8. INSTALLATION

Installation work shall comply with Zut 0001.

## 9. SAFETY

Guarding shall be provided if the movement of the lever arm could cause injury.

## 10. INSPECTIONS

The Contractor shall make arrangements for the Engineer to inspect the valve for compliance prior to payment being made.

## 11. TESTING REQUIREMENTS

### 11.1 ALL VALVES

Valves bodies shall be hydraulically tested in accordance with 8.1 of SANS 1551-1 to a test pressure of 1,5 times the PN rating.

Valves shall be tested for seat leakage in accordance with 8.2 of SANS 1551-1 and the acceptable leakage shall be as per clause 4.3.4. The test pressure shall be the PN rating unless otherwise specified by the Engineer. Compliance with the testing procedures and requirements of similar equivalent international standards is also acceptable.

A test certificate shall be submitted to the Engineer for each valve.

The correct operation of the equipment and achievement of the specified performance requirements shall be demonstrated to the Engineer prior to commissioning of the Works.

## **11.2 VALVES DN 250 AND LARGER**

The Contractor shall arrange for the Engineer to witness the testing of valves of sizes DN 250 and larger.

Travel and accommodation arrangements and costs for witnessing of testing shall be the responsibility of the Contractor.



# **SPECIFICATION: ZUT 7023**

## **Pipe Couplings**

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## 1. INTRODUCTION

Zut 7023 specifies the requirements for pipe couplings to be provided by the Contractor.

Pipe couplings shall be provided for flexibility and to allow dismantling of pipework. Pipe couplings shall also be provided to accommodate possible pipe movement from settlement, etc, and to isolate machine vibration.

## 2. SCOPE OF WORKS

See project specification.

The installation shall be configured as shown on applicable drawings.

## 3. NORMATIVE REFERENCES

Where this specification is required for a project, the following documents shall, inter alia, form part of the Contract Document:

- a) Amendments, Additions and Detailed Requirements (Zut 7023).
- b) Zut 0001: General Mechanical Requirements.
- c) Zut 0003: General Corrosion Protection for Pipelines, Water and Waste Water Works.

Equipment, materials and operational methods shall comply with the latest edition of relevant national and/or international standards.

## 4. EQUIPMENT ELIGIBILITY

The couplings provided shall have a successful record of use locally in similar applications and shall also have had at least three years of technical support locally. Service and spares shall currently be available locally. Upgraded versions of a manufacturer's earlier designs which comply with these criteria are also acceptable.

Couplings which do not satisfy these requirements are not acceptable unless specifically called for in the specifications or unless the Engineer agrees in writing.

## 5. PERFORMANCE REQUIREMENTS

The coupling shall provide a flexible joint between the two items being connected.

The coupling shall withstand the pipework pressure rating.

## **6. CONSTRUCTION AND DESIGN**

### **6.1 GENERAL**

The pressure rating of the coupling shall be not less than the rating for its pipework.

Where the type of coupling is not indicated on the drawing, pipe couplings may be of the mechanical type (VJ coupling or flange adaptor), of the stainless steel bellows type or of the rubber bellows type but, in each case, the type chosen shall be suitable for the duty.

Restraints shall only be provided where required. Restraints shall incorporate three tie bars or more.

### **6.2 MECHANICAL COUPLINGS**

Mechanical couplings shall be of the rubber ring compression type (i.e. VJ-type flange adaptors or VJ type couplings) and shall be provided in pairs in order to accommodate axial misalignment and/or settlement. All fasteners, including studs welded to flanges, shall be of stainless steel and provided with a solids lubricant to prevent galling. Metal castings shall be of ductile iron or of stainless steel.

Couplings for stainless steel and 3CR12 pipework shall be fully of EN Grade 1.4401 (316) stainless steel construction (except for the seal).

Carbon steel and cast iron components shall be protected against corrosion by Rilsan coating.

### **6.3 RUBBER BELLOWS COUPLINGS**

Suitably rated rubber bellows type couplings with metal backing flanges are acceptable for pipe diameters of DN 300 and below.

The bellows shall be provided with two backing flanges drilled to match their mating flanges. Bellows for low carbon steel pipework shall be provided with hot dip galvanised flanges (i.e. not zinc plated). Bellows for 3CR12 or stainless steel pipework shall be provided with matching flange material.

Rubber bellows couplings are not acceptable for bolting directly to the inlet of centrifugal pumps and mechanical couplings shall be used for this application.

### **6.4 STAINLESS STEEL BELLOWS COUPLINGS**

Where stainless steel bellows type couplings are required, the flanges and the flange fasteners shall also be of stainless steel.

## **7. FABRICATION**

Fabrication and welding shall comply with Zut 0001.

## **8. FASTENERS**

Fasteners shall comply with Zut 0001.

## **9. CASTINGS**

Castings shall comply with Zut 0001.

## **10. CORROSION PROTECTION**

Corrosion Protection shall comply with Zut 0003.

Stainless steel shall be correctly pickled and passivated. All stainless steel surfaces shall be completely clear of ferrous stain upon commissioning.

## **11. INSTALLATION**

Installation work shall comply with Zut 0001.

Pipework shall be aligned correctly and the pipe coupling shall not be used to accommodate visible misalignment in any direction.

## **12. INSPECTIONS**

The Contractor shall make arrangements for the Engineer to inspect the couplings for compliance prior to payment being made.

## **13. TESTING REQUIREMENTS**

The correct operation of the couplings and achievement of the specified performance requirements shall be demonstrated to the Engineer prior to the commissioning of the Works.

# **SPECIFICATION: ZUT 7024**

## **Pipework Anchors**

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## **1. INTRODUCTION**

ZUT 7024 specifies the requirements for anchors for pipework to be provided by the Contractor.

## **2. SCOPE OF WORKS**

See project specification.

## **3. NORMATIVE REFERENCES**

Where this specification is required for a project, the following documents shall, inter alia, form part of the Contract Document:

- a) Amendments, Additions and Detailed Requirements (Zut 7024).
- b) Zut 0001: General Mechanical Requirements.
- c) Zut 0003: General Corrosion Protection for Pipelines, Water and Waste Water Works.

Equipment, materials and operational methods shall comply with the latest edition of relevant national and/or international standards.

## **4. PERFORMANCE REQUIREMENTS**

Pipe anchors shall resist the forces from pressure and from inertial flow changes. The pipe anchors shall restrain and anchor the pipework, valves and other heavy fittings and shall withstand loads and thrust forces and prevent them from being transferred to pump flanges and other equipment which might be damaged or have shortened lifespans.

Pipework shall accommodate settlement, expansion and contraction.

Pipework shall be structurally capable of withstanding the vibration to which it is subjected without fatigue fracture. Vibration shall be restricted to the source and shall not be transferred via pipework.

Pipe supports shall not restrict dismantling of equipment.

## **5. DESIGN & CONSTRUCTION**

### **5.1 GENERAL**

In order to achieve the specified performance requirements, the Contractor shall analyse the forces at isolation valves, check valves, bends, reducers and any other cause which are present

during normal operation, during dormant conditions, during testing, during start up and during shut down of each pump individually and during operation of the pump station as a whole. The steel pipe anchors shall be designed to transfer all such forces to the concrete structure.

Pipe anchors shall be provided so that pipework does not place any external loading on items of rotating mechanical equipment such as pumps, compressors, etc.

Provision shall be made for settlement as well as for expansion and contraction due to variations in temperature or pressure.

Pipe anchors shall be designed and located so that when an item of mechanical equipment, such as a pump or blower, is removed, the associated pipework and equipment is still adequately anchored.

Pipe anchors shall be provided at or close to all heavy items such as valves of size DN 200 and larger.

Pipe anchors which only anchor the weight of horizontal pipework may be of the sliding type and shall be vertically adjustable.

Pipework anchors, other than cast-in puddle pipes, shall be of carbon steel or of stainless steel.

Pipe anchors which resist thrust forces shall incorporate doubler plates welded on the pipe and shall be as short as feasible. The doubler plates shall be of the same or greater thickness than the pipe wall thickness and shall be contoured to match the pipe. Other reinforcing designs will also be acceptable.

Low carbon steel pipe anchors shall be fabricated from heavy duty hot rolled steel sections. The complete assembly shall be hot-dip galvanised after all fabrication is completed. Welds shall be continuous "all round"; i.e. no crevices.

Stainless steel pipe anchors shall be fabricated of plate with a minimum thickness of 4,5 mm or shall be fully triangulated, boxed or closed sections. Welds shall be continuous "all round"; i.e. no crevices.

Where appropriate, 3 mm thick neoprene strips shall be placed between pipes and pipe anchors or clamps to protect the paintwork and to limit corrosion.

Where roller or sliding anchors are used to accommodate movement, suitable wear blocks shall be fixed to the pipe to prevent damage to the pipe structure from sliding and corrosion.

## **5.2 PIPE ANCHORS FOR STEEL PIPEWORK**

The maximum allowable spacing between pipe anchors for steel (including stainless steel) pipe of diameter,  $d$  [mm], shall be calculated as follows:

$$\text{Spacing (mm)} = 1\,500 + 6d.$$

This applies to pipe only. Valves and other heavy items shall be anchored separately.

## **5.3 PIPE ANCHORS FOR PLASTIC PIPEWORK**

The maximum allowable spacing between pipe anchors for plastic pipe of diameter,  $d$  [mm], shall be calculated as follows:

$$\text{Spacing (mm)} = (1\,500 + 6d) / 2.$$

This applies to pipe only. Valves and other heavy items shall be anchored separately.

## **5.4 FASTENING**

At least four anchor fasteners shall be provided for the foot of each pipe anchor.

Cantilevered pipe anchors are not preferred. Their spacing between anchor fasteners on the foot shall be not less than one quarter of the cantilevered length. Gussets between the column and the foot are normally required and these shall be positioned so as to minimise the distance between the gusset and the anchor fastener. The requirements in this paragraph do not apply to cantilevered pipe anchors which only provide vertical support.

Pipe anchors shall be aligned using nuts above the foot and stainless steel shims below the foot. Anchor fasteners shall be tensioned when their nuts are tightened; i.e. it is not acceptable to use a nut below the baseframe to position it; and the holding down force shall be loaded into the concrete structure.

Concrete surfaces under foot plates shall be scabbled before the pipe anchor is placed and shall be blown clean using compressed air immediately before grouting. A space of at least 20 mm shall be left and this space shall be filled using non-shrink grout once alignment has been completed. Grouting shall be done in accordance with the manufacturer's instructions. Alternative designs and installations may be submitted by the Contractor.

## **5.5 CONCRETE ANCHORS**

Concrete pipe anchors shall be designed for purpose.

# **6. FABRICATION**

Fabrication and welding shall comply with Zut 0001.

Pipe anchors will be inspected by the Engineer after fabrication is complete.

# **7. FASTENERS**

Anchor fasteners shall be of EN Grade 1.4401 (316) stainless steel.

Nuts for anchor fasteners shall be provided with both a spring washer and a flat or fender washer.

Fasteners shall comply with Zut 0001.

# **8. CORROSION PROTECTION**

Corrosion Protection shall comply with Zut 0003.

Stainless steel shall be correctly pickled and passivated. All stainless steel surfaces shall be completely clear of ferrous stain upon commissioning.

Carbon steel shall be hot dip galvanised after all fabrication has been completed.



## **9. INSTALLATION**

Installation work shall comply with Zut 0001.

## **10. INSPECTIONS**

The Contractor shall make arrangements for the Engineer to inspect the pipe anchors for compliance prior to payment being made.

## **11. DOCUMENTS TO BE PROVIDED**

Proposed designs of pipe anchors, preferably indicated on the General Arrangement design drawings, shall be submitted to the Engineer for review prior to manufacture.

The calculations for pipe anchors designed to withstand the thrust from reducers, bends and check valves shall be included.

# **SPECIFICATION: ZUT 10 007**

## **Compressed Air Systems**

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## 1. INTRODUCTION

Zut 10 007 specifies the requirements for compressed air systems to be provided by the Contractor.

## 2. SCOPE OF WORKS

See project specification.

The installation shall be configured as shown on applicable drawings.

## 3. NORMATIVE REFERENCES

The following form part of the Contract Document:

- a) Amendments, Additions and Detailed Requirement (Zut 10 007).
- b) Zut 0001: General Mechanical Requirements.
- c) Zut 0003: General Corrosion Protection for Pipelines, Water and Waste Water Works.
- d) Zut 1013: Air Receivers.
- e) Zut 5016: Rotary Air Compressors.
- f) Zut 7024: Pipe Supports.
- g) Zut 10014: Ventilation for Plant Rooms.

Equipment, materials and operational methods shall comply with the latest edition of the relevant national and/or international standard.

## 4. EQUIPMENT ELIGIBILITY

The equipment to be provided shall have a successful record of use in similar applications locally and shall also have had at least three years of technical support locally. Service and spares shall currently be available. Upgraded versions of a manufacturer's earlier designs which comply with these criteria are also acceptable.

Equipment which does not satisfy these requirements is not acceptable unless called for in the specifications or unless the Engineer agrees in writing.

## **5. PERFORMANCE REQUIREMENTS**

The complete system shall be rated to handle the maximum pressure that the compressor can produce.

Each item of equipment provided by the Contractor shall comply with the performance requirements of the relevant Zut specification.

## **6. OPERATION AND CONTROL**

The plant shall automatically maintain the system pressure between 690 kPa and 800 kPa.

A gauge which indicates system pressure shall be provided.

A flow meter shall be provided on the discharge manifold. The meter shall be capable of indicating flow rates of one tenth of the compressor flow rating (compressed volume). The meter may be of the mechanical type. Local only readout will be acceptable. The meter shall be double flanged.

## **7. DESIGN AND CONSTRUCTION**

### **7.1 GENERAL**

The compressed air installation shall consist of two rotary screw compressor units, each with a matched refrigerant dryer, two air receivers, filters, water traps, gauges, pipework, valves and pipe supports and an adequately sized room ventilation system for the installation.

Pipework design shall comply with good standard practice for compressed air installations.

Automatic lubrication devices shall be provided at take offs to equipment requiring lubricated air.

The complete installation shall be suitable for washing down using a hose spray.

The installation shall be configured so that unheated air enters the compressor inlet and the motor inlet.

### **7.2 COMPRESSORS AND DRYERS**

Compressors and their refrigerant dryers shall comply with Zut 5016: Rotary Screw Air Compressors.

### **7.3 AIR RECEIVERS**

Air receivers shall comply with Zut 1013: Air Receivers.

The Contractor shall provide two air receivers. One shall be installed immediately downstream of the compressor and the second receiver shall be installed downstream of the filter and dryers. The second receiver shall have a capacity equal to the maximum system demand over a period of one minute.

**7.4 FILTRATION**

The Contractor shall provide filters on the pressure side. These shall perform interception, coalescence and adsorption. If combined filters are provided, each shall incorporate its own separate element saturation indicator.

Pressure filters shall be well secured to a suitable wall.

Pipework shall be mounted at least 1 metre above ground level and shall not be vulnerable to damage.

**7.5 PIPEWORK**

Pipework shall be neatly installed and well supported.

Pipework shall have a fall in the direction of flow of not less than 1 in 100. Condensate traps and manual drains shall be provided at every low point.

Pipework shall be supported at distances not exceeding two metres and shall be supported on both sides of each flexible connection. Pipe supports shall comply with Zut 7024.

Flanged pipework is preferred. If threaded pipework is provided, a union for dismantling shall be provided at every bend and at distances not exceeding 10 metres along straight pipe.

Take-offs shall be from the top surface of the mains pipes.

Pipe diameter shall not be less than 25 mm. Larger pipes shall be sized on the basis of the maximum flow speed not exceeding 6 metres per second (using the compressed volume in the calculation).

A flexible connection shall be provided between the pipework and the compressor.

Plastic pipework is not acceptable for compressed air installations.

**7.6 VALVES**

Isolation valves shall be provided for isolation of each compressor.

A check valve shall be provided on the outlet of each compressor.

**7.7 VENTILATION**

A ventilation system shall be provided for the room in which the compressors are located and this shall be designed to cope with the energy loading from the compressor motors as well as the air requirements of the compressors during maximum demand conditions.

It shall also take into account the configuration of the enclosure's inlets and outlets.

The system shall comply with Zut 10014.

**8. INSTRUMENTATION**

Instrumentation shall comply with Zut 0001.

## 9. MATERIALS AND COATINGS

Equipment shall comply with the table below. Components not specified in the table below shall be suitably designed for corrosion resistance to the high corrosivity category (C4) of SANS 12944-2.

ITEM	MATERIAL	COATING
Pipework	Carbon steel.	Hot dip galvanise and paint externally (see note 3). Colour code.
	Stainless steel.	Pickle and passivate. Colour code.
	Copper	Colour code.
Pipework supports	As for pipework.	As for pipework.
Fasteners	EN Grade 1.4301 (304)	N/A
Anchor fasteners	EN Grade 1.4401 (316)	N/A
Auxilliary metal components	EN Grade 1.4401 (316)	Pickle and passivate.
<b>NOTES</b> 1      Stainless steel shall be correctly pickled and passivated. Stainless steel surfaces shall be free of ferrous stain and heat tint at commissioning. 2      Metal plating of ferrous materials is not acceptable as the corrosion protection system. 3      Hot-dip galvanised steel pipework shall be provided with a suitable external paint coating after installation is complete. The hot-dip galvanised surface shall be suitably cleaned prior to application of the coating. The primer shall be an etch primer designed for hot-dip galvanised surfaces.		

## 10. FABRICATION

Fabrication shall comply with Zut 0001.

## 11. FASTENERS

Fasteners shall comply with Zut 0001.

## **12. INSTALLATION**

Installation work shall comply with Zut 0001.

## **13. CIVILS AND BUILDING**

As required in terms of the General Conditions, the Contractor shall:

- provide the details of civil and building requirements to the Engineer.
- at an appropriate point, measure on Site in order to check for correctness for the Works.

The Contractor shall ensure that the design can accommodate a tolerance of +/- 40 mm for civil and building items constructed by others unless a tighter tolerance is called for by the Contractor in good time and approved by the Engineer.

## **14. SAFETY**

The Contractor shall design and install equipment installations in accordance with the requirements of the country's Occupational Health and Safety regulations.

## **15. INSPECTIONS**

The Contractor arrange for the Engineer to inspect the installation for compliance.

The Contractor shall perform the air receiver inspections specified in Zut 1013.

## **16. TESTING REQUIREMENTS**

The Contractor shall successfully demonstrate the following to the Engineer prior to the commissioning of the Works:

- a) equipment operation.
- b) achievement of the specified performance requirements.
- c) control system operation.

The system, including pipework, filters, air receivers and dryers shall be pressure tested. With the compressors switched off, the system shall hold a pressure of 690 kPa for 30 minutes without decrease below 670 kPa.

The Contractor shall perform the air receiver testing specified in Zut 1013.

The Contractor shall submit site test reports and shall provide copies in the Manual.

# **SPECIFICATION: ZUT 10014**

## **Ventilation for Plant Rooms**

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## 1. INTRODUCTION

Zut 10014 specifies the requirements for ventilation systems to be provided by the Contractor.

## 2. SCOPE OF WORKS

See project specification.

The installation shall be configured as shown on applicable drawings.

## 3. NORMATIVE REFERENCES

Where this specification is required for a project, the following documents shall, inter alia, form part of the Contract Document:

- a) Amendments, Additions and Detailed Requirements (Zut 10014).
- b) Zut 0001: General Mechanical Requirements.
- c) Zut 0003: General Corrosion Protection for Pipelines, Water and Waste Water Works.

Equipment, materials and operational methods shall comply with the latest edition of relevant national and/or international standards.

## 4. EQUIPMENT ELIGIBILITY

Equipment provided shall have a successful record of use in similar applications locally and shall also have had at least three years of technical support locally. Service and spares shall currently be available. Upgraded versions of a manufacturer's earlier designs which comply with these criteria are acceptable.

Equipment which does not satisfy these requirements is not acceptable unless called for in the specifications or unless the Engineer agrees in writing.

## 5. PERFORMANCE REQUIREMENTS

The installation shall provide the air flow required for each room volume and/or shall limit the temperature rise in each room, whichever is specified.

The specified sound pressure level for each fan shall not be exceeded.

## 6. OPERATION AND CONTROL

At least one fan shall operate continuously in order to provide through flow for minimising corrosion and preventing stagnant volumes. Backflow prevention dampers shall be provided in multi-fan systems in order to prevent short circuit flow.

Multi fan systems shall be arranged so that the second, third, etc. fans switch on as the temperature in the plant room rises (the second fan shall switch on at thirty degrees Centigrade, the third fan at thirty two degree Centigrade, etc.).

A flow switch for each fan shall lead to an alarm if the flow fails.

Differential pressure measurement shall be provided at each fan and at each filter.

An hour meter which cannot be reset shall be provided for each fan motor.

Each fan shall be provided with an emergency stop station in an appropriate position.

Manual start and stop of each fan shall be provided at the MCC.

## 7. DESIGN AND CONSTRUCTION

### 7.1 FLOW

The design of the ventilation system shall deal with the following:

- heat generated by equipment.
- air consumption by equipment (such as compressors, blowers and internal combustion engines).
- provision of cross flow through the room even if the main entrance door is open.
- prevention of short circuit flow in multiple fan installations.
- avoidance of stagnant volumes.
- friction losses (at least 250 Pa shall be allowed for resistance loss at each filter).
- a safety factor shall be incorporated in the calculation of the fan flow and pressure so that reasonable modification to ductwork during installation can be made.

Motor cooling air flow for mechanically ventilated plant rooms shall not be less than four litres per second per total kilowatt of motor rating in plant duty mode.

### 7.2 FANS

#### 7.2.1 General

Fans and motors shall preferably have a nominal speed of 1 500 rpm or lower and motors shall have a nominal voltage of 400 Volts.

Fans shall be flexibly supported using spring or rubber-in-shear mountings having a minimum static deflection of 20 mm.

Guarding shall totally enclose drives.

Fans shall be dynamically balanced to ISO 1940, grade G6,3.

### **7.2.2 Axial Flow Fans**

Direct drive, axial flow fans shall incorporate manually adjustable pitch, cast aluminium, aerofoil section blades, clamped in split, metallic hubs. Fan casings shall cover the full axial length of the fan and motor assembly. Terminal boxes shall be mounted on the fan unit.

Suspended fans shall be restrained to prevent excessive movement during start-up.

Axial flow fans installed in corrosive flows shall have their motors protected by bifurcated airstreams.

### **7.2.3 Centrifugal Fans**

Centrifugal fans shall be constructed of sheet metal with inlet cones and with machined shafting supported on rolling bearings mounted in sealed bearing housings provided with stainless steel grease nipples.

Fans shall be mounted on steel channel base frames accommodating the fan and its drive motor.

Belt drives, where applicable, shall be accurately aligned.

## **7.3 MOTORS**

Motors shall have a nominal rating of at least 15 % above the maximum power requirement of the fans as installed.

Motors shall comply with Zut 0001.

Motors shall have ingress protection to at least IP 55.

Motors shall comply with the requirements of the hazardous location zone for the area in which they are installed.

## **7.4 DAMPERS**

Dampers shall be fabricated from the same material as the ductwork.

Adjustment, position indication and a locking arrangement shall be provided for each regulating damper.

## **7.5 DUCTWORK**

Ductwork shall be manufactured in accordance with SANS 1238.

A flexible connection shall be provided on each side of each fan/attenuator assembly in order to isolate the ductwork from the fan vibration. Flexible collars shall have sufficient free movement to take up the deflection of the connected moving equipment. They shall not be used as a means of accommodating misalignment. Collars shall not restrict the free area of the ductwork.

Take off sockets shall be provided where grilles are mounted in distribution ductwork. Sockets shall be long enough to ensure that no part of the grille or its associated control mechanism projects into the duct cross-section. Grilles shall be provided with regulating dampers.

Rectangular ductwork shall be supported on trapeze type hangers with stainless steel hanger rods. Support spacing shall be less than 2 000 mm. Circular ductwork shall be supported in hoops suspended from stainless steel rod with spacing less than 3 000 mm.

Rod diameter shall be not less than 10 mm.

Drain points shall be provided in ductwork where condensed water could pool. Permanently open 8 mm holes are acceptable as drains in positions where noise breakout would not be a problem.

The nominal flow speed in ductwork shall not exceed 7 m/s.

## **7.6 FILTERS**

Filters elements shall consist of pleated media in modular frames. The elements shall be individually replaceable and shall be mounted in proprietary frames with zero discernible bypass. Clip-fixed units are acceptable but in-line, slide frame mounted units are preferable.

Each filter bank shall have a differential manometer connected across it. The range shall be selected for the application and the units shall be provided with red gauge oil. The difference level at which filter elements require replacement shall be indicated.

The nominal flow speed through filter elements shall be not greater than 3,2 m/s.

## **7.7 SOUND**

### **7.7.1 General**

The sound pressure level of each fan, as installed, shall not exceed 80 dBA at 3 metres from the outer surface.

### **7.7.2 Acoustic Attenuators for Axial Flow Fans**

Axial flow fans shall be provided with upstream and downstream circular acoustic attenuators. The attenuator internal diameter shall correspond with the fan diameter. Each attenuator's length shall be at least two diameters.

Each attenuator shall be provided with a central pod with aerodynamic end fairings.

Attenuators shall be directly connected to the fan flanges.

### **7.7.3 Acoustic Attenuators for Centrifugal Fans**

Centrifugal fans shall be provided with upstream and downstream splitter attenuators and these shall be mounted as close to the fan as feasible. Each attenuator's length shall be at least twice the fan's outlet dimension (if the outlet is not square, the larger dimension shall be used).

### **7.7.4 General Requirements for Attenuators**

Attenuators shall be designed by a manufacturer which specialises in acoustic applications and who can provide attenuation graphs for the units.

Acoustic infill material shall be "Eurolon" by Donkin, or equivalent. Where velocities exceed 20 m/s, the infill material shall be supported by perforated stainless steel sheet. Where

attenuators are to be used in grease or oil laden atmospheres, a polyester membrane shall also be provided.

External surfaces of the attenuators shall be painted as for the ductwork.

#### **7.7.5 Acoustic Louvres**

The Contractor shall provide double acoustic louvres at each air inlet and each air outlet.

Acoustic louvres shall be designed by a manufacturer which specialises in acoustic applications and can provide attenuation graphs for the units.

The installation of acoustic louvres in wall inlets and outlets shall be neat and all edges shall be fully sealed in order to prevent acoustic breakthrough.

#### **7.7.6 Equipment Bases in Acoustically Sensitive Areas**

In acoustically sensitive areas, concrete inertia bases shall be provided for fans and motors. The bases shall be at least 150 mm deep and shall be reinforced with Ø 13 mm reinforcing bars located at 150 mm centres each way.

The mass of bases shall be chosen to avoid operation at critical frequencies and the ratio of the mass of the base to the mass of the equipment shall be higher than 1:1. Bases shall be large enough to accommodate the motors, driven equipment and any required supports and fittings.

The equipment shall be mounted on hot-dip galvanised baseframes anchored to the concrete inertia bases.

A floor plinth shall be provided under each base. It shall be large enough to accommodate the concrete inertia base and its spring isolators.

Spring isolators shall be provided between the inertia bases and the floor plinth. Either free standing stable spring units or caged spring units with snubbers may be used. Isolators shall themselves be mounted on ribbed elastomer acoustic pads. Spring diameters shall be large enough to prevent excessive rocking of equipment during start-up as well as during normal operation.

### **7.8 LOUVRES AND SCREENS**

The Contractor shall provide storm resistant weather louvres at each air inlet and air outlet.

The nominal flow speed through inlet louvres shall not exceed 2 m/s. The flow speed through outlet louvres may be higher.

Louvres shall be guarded with wire mesh screen barriers. The screens shall be of approximately 20 mm mesh and 1,6 mm minimum gauge wire.

The screens shall be easily removable for cleaning.

## **8. INSTRUMENTATION**

Instrumentation shall comply with Zut 0001.

## 9. FABRICATION

Fabrication and welding shall comply with Zut 0001.

## 10. FASTENERS

Fasteners shall comply with Zut 0001.

## 11. SPARES

The spares which are to be provided are specified elsewhere.

## 12. MATERIALS AND COATINGS

### 12.1 GENERAL

Components for water treatment works shall be suitably designed for corrosion resistance to the high corrosivity category (C4) of SANS 12944-2.

Components for wastewater treatment works shall be suitably designed for corrosion resistance to the very high - industrial corrosivity category (C5-I) of SANS 12944-2.

Corrosion protection shall comply with Zut 0003.

Materials shall comply with Zut 0001.

### 12.2 EQUIPMENT

Equipment shall comply with the table below.

ITEM	MATERIAL	COATING
Axial Flow Fan bodies.	Hot dip galvanised steel	Colour code externally.
Centrifugal fan bodies in dry applications.	Hot dip galvanised steel.	Colour code externally.

ITEM	MATERIAL	COATING
Centrifugal fan bodies in moist air applications.	EN Grade 1.4401 (316) stainless steel.	Colour code externally.
Baseframes	Carbon steel.	Hot dip galvanised and painted.
Acoustic attenuators for fans	EN Grade 1.4401 (316) stainless steel.	Colour code externally.
Ductwork inside wet wells.	Welded polypropylene.	N/A
Internal ductwork conveying moist air.	Welded polypropylene	N/A
External ductwork conveying moist air.	EN Grade 1.4401 (316) stainless steel.	Colour code externally.
	EN Grade 1.4162 stainless steel (LDX 2101)	Colour code externally.
Ductwork in dry areas.	Hot dip galvanised carbon steel.	Colour code externally.
Acoustic louvres in dry air applications.	Hot dip galvanised steel.	Nil
Weather louvres in dry air applications.	Hot dip galvanised steel.	Nil
Acoustic louvres in moist air applications.	EN Grade 1.4401 (316) stainless steel.	N/A
Weather louvres in moist air applications.	EN Grade 1.4401 (316) stainless steel.	N/A
Inlet and outlet mesh screens.	EN Grade 1.4401 (316) stainless steel.	N/A
Filter frames in dry air applications.	Hot-dip galvanised steel.	N/A

ITEM	MATERIAL	COATING
Filter frames in moist air applications.	Stainless steel.	N/A
Dampers.	As for ductwork.	As for ductwork.
Supports for polypropylene ductwork and for stainless steel ductwork.	EN Grade 1.4401 (316) stainless steel.	N/A
Supports for hot-dip galvanised ductwork.	Stainless steel hanger rods with hot-dip galvanised steel frames.	N/A
Fasteners.	EN Grade 1.4401 (316) stainless steel.	N/A
Auxiliary metal components.	EN Grade 1.4401 (316) stainless steel.	N/A
Motor casing; water treatment plant.	Manufacturer's standard.	Corrosion resistance to the high corrosivity category (C4) of SANS 12944-2.
Motor casing; wastewater treatment plant.	Manufacturer's standard.	Corrosion resistance to the very high - industrial corrosivity category (C5-I) of SANS 12944-2.
Bearing housings; water treatment plant.	Manufacturer's standard.	Corrosion resistance to the high corrosivity category (C4) of SANS 12944-2.



ITEM	MATERIAL	COATING
Bearing housings; wastewater treatment plant.	Manufacturer's standard.	Corrosion resistance to the very high - industrial corrosivity category (C5-I) of SANS 12944-2.
<b>NOTES</b> <ul style="list-style-type: none"> <li>- Stainless steel shall be correctly pickled and passivated. Stainless steel surfaces shall be free of ferrous stain and heat tint at commissioning.</li> <li>- Metal plating of ferrous materials is not acceptable for corrosion prevention purposes.</li> <li>- Hot dip galvanising damaged by welding, cutting, grinding or any other means shall be rejected.</li> </ul>		

### 13. INSTALLATION

Installation work shall comply with Zut 0001.

The installation shall be of neat and workmanlike appearance, solidly and evenly supported, true to line, level and plumb.

Bifurcated fans shall be mounted with the motor tunnel vertical.

Where ductwork penetrates brickwork, a timber frame shall be built in to locate and mount the ductwork. Plaster shall be used for infill to prevent sound breakout.

Where ductwork penetrates concrete slabs or walls, a flange shall be provided on one side to stabilize the duct. Weak grout or fire stopping shall be applied to the spaces between the ductwork and the structure to effectively seal the clearance.

Where ductwork penetrates between areas having differing fire risk or mandatory fire separation, fire dampers to SANS 193 shall be installed.

### 14. CIVILS AND BUILDING

As required in terms of the General Conditions, the Contractor shall:

- provide the details of civil and building requirements to the Engineer.
- at an appropriate point, measure on Site in order to check for correctness for the Works.

The Contractor shall ensure that the design can accommodate a tolerance of +/- 40 mm for civil and building items constructed by others unless a tighter tolerance is called for by the Contractor in good time and approved by the Engineer.

## **15. SAFETY**

The Contractor shall design and install all equipment installations with due regard to any hazardous areas requirements.

## **16. INSPECTIONS**

The Contractor shall make arrangements for the Engineer to inspect the installation for compliance.

The Contractor shall inspect the operation of the installation three months after the start of the Defects Notification Period and shall provide a condition report to the Engineer.

## **17. TESTING**

The Contractor shall successfully demonstrate the following to the Engineer prior to the commissioning of the Works:

- a) operation of all equipment.
- b) achievement of the specified performance requirements.
- c) correct operation of the control system.

The Contractor shall provide site test reports to the Engineer and shall submit copies in the Manual.

## **HVAC Specification – Zut 10 015**

Isipingo Waste Water Treatment  
Works – Mechanical Works

### **Ethekwini Municipality**

Reference: 1002680

Submission date: 2024/12/09

Volume # 1 of 1

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# 1 GENERAL

The detailed project specification together with all other documentation such as the standard specifications, bill of quantities, and all schedules and drawings as described in this tender document, constitute the specification and will be the basis of the contract.

## 2 PROPRIETY MATERIALS, SYSTEMS, ETC

Any reference in these Bill of Quantities to trade or brand names (and catalogue numbers, etc.,) shall be deemed to be followed by the words “or other approved only” by the Engineer.

The Tenderer’s attention is drawn to the fact that in connection with the aforementioned wherever any wording with meanings equating with similar to, equal to, equivalent to, etc, are used in combination with a trade or brand names (and catalogue numbers, etc.,) they shall be deemed to be omitted and entirely replaced by the trade or brand names (or catalogue numbers, etc.,) followed by the words “OR OTHER APPROVED ONLY”. This will take precedence over any contradictory clause or note appearing anywhere on these Bills of Quantities.

The approval must be sought in a reasonable time by the tenderer prior to tender closing. The engineer shall have the final decision whether approval is granted for alternate brands.

## 3 SCOPE OF WORK

The Work to be performed under this contract includes the supply, procurement, delivery, erection, testing, commissioning and handing over of a complete air conditioning and ventilation installation for this MCC room, fully operational to the Employer and the guarantee and comprehensive maintenance thereof for a further period of 12 months.

The installation includes the following:

- ▶ Supply and installation of new medium static concealed ducted split units complete with outdoor units, piping, ducting and associated equipment and plant required as per manufacturer’s requirements.
- ▶ Supply and installation of ventilation air grilles.
- ▶ Testing and Commissioning
- ▶ 12 months service and maintenance

## 4 REGULATIONS AND STANDARDS

- a) SANS 10400: The Application of the National Building Regulations.
- b) SANS 10400: Part O: Lighting and ventilation.
- c) SANS 10400: Part XA: Energy usage in buildings.
- d) SANS 204: Energy efficiency in buildings.
- e) SANS 10142: The wiring of premises
- f) The Occupational Health and Safety Act of 1993 (OHS Act).
- g) SANS 10103: The measurement and rating of environmental noise with respect to annoyance and to speech communication.
- h) SANS 121: Hot dip galvanized coatings on fabricated iron and steel articles: Specifications and test methods.
- i) SANS 1473-1: Low-voltage switchgear and control gear assemblies.
- j) SANS 10147: Refrigerating systems, including plants associated with air-conditioning systems.
- k) SANS 10173: The installation, testing and balancing of air-conditioning ductwork
- l) SANS 1125: Room air conditioners and heat pumps. m) SANS 193: Fire dampers.
- m) SANS 5151: Non-ducted air conditioners and heat pumps- Testing and rating for performance.
- n) SANS 13253: Ducted air-conditioners and air-to-air heat pumps- Testing and rating for performance.
- o) SANS 1325: The installation, maintenance, replacement and repair of domestic air source water heating heat pump systems. 23 June 2023 Page 3 of 34
- p) SANS 10177: Part 3: Fire testing of materials, components and elements used in buildings
- q) Relevant by-laws of local or other authorities.
- r) The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).
- s) Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).

## 5 SITE, SITE CONDITIONS & FACILITIES

This site is located on the Isipingo WWTW site, KZN. Site location GPS co-ordinates are Lat: 29°59'22.92"S Long: 30°54'20.17"E.

The Contractor shall acquaint himself fully of the prevailing site conditions, access to the site, storage and other facilities prior to submitting a tender since no claim in this regard will be considered.

Arrangements to visit the site during the tender period shall be made with the Engineer if considered necessary.

The Contractor shall allow in their tender price for the cost of hoisting and handling of all material and equipment.

The contractor shall allow in his tender price for site establishment including the provision of an area to store materials and equipment.

Site and other procedures will be issued from time to time by the Employer such as security arrangements, access control etc.

## 6 DESIGN DATA

Altitude	:	112 m
Outdoor Design	:	30°C DB / 26°C WB
Indoor Design	:	30°C DB
Condenser Coil	:	33°C
Inside Design Conditions (Air Cond)	:	22.5°C DB $\pm$ 2°C (Summer)
	:	20°C DB $\pm$ 2°C (Winter)

## 7 BUILDING CONSTRUCTION

The Contractor shall be responsible to study the building and associated structures on site before installing his equipment.

## 8 CO-ORDINATION

Prior to setting out of the HVAC system, wireways, equipment, pipework's, etc, the HVAC contractor shall arrange a co-ordination meeting with all service providers and/or contractors, to review the drawings and co-ordination requirements. Prior to any wireways and/or equipment being installed, the services shall be coordinated, and any clashes shall be identified and issued to the engineer in writing for clarification / rulings.

Extra expenditure because of failure to complete the above-mentioned service co-ordination requirements impacting on the fire suppression contractor's work will not be considered. If any additional equipment is required because of the service co-ordination meeting, which was not allowed in the contract, the engineer shall be informed in writing for a formal response.

## 9 EXISTING SERVICES

The fire suppression contractor shall be held responsible for damage to any existing services brought to his attention by relevant authorities. The repairs to such services will be to the fire suppression contractor's account.

## 10 QUALITY OF MATERIALS

Only materials of first-class quality shall be used, and all materials shall be subject to the approval of the Engineer.

Wherever applicable, material is to comply with the relevant South African Bureau of Standards Specifications, or to British Standard Specifications, where no SABS Specifications exist.

Materials, wherever possible, must be of South African manufacture.

All fittings, material and equipment and component parts thereof are to be in accordance with the Specification and must have the approval of the Engineer. In addition, all equipment shall be designed, manufactured, and tested in accordance with the relevant South African Bureau of Standards Specification, or otherwise, the relevant British Standard Specification.

All material and equipment must be suitable for the application and operating conditions and hazard.

To assist the Contractor in order that corrective action can be taken in good time, the Engineer requires that at least the following quality control programme be implemented.

- ▶ Engineer's approval of Data Sheets for all major equipment prior to placing of orders.
- ▶ Approval of Circuit Diagrams and General Arrangement Drawings of all Control Boards.
- ▶ Approval of all shop drawings before commencing installation.

Written approval shall be obtained from the Engineer prior to proceeding after each Hold Point is reached.

## 11 REJECTION OF INFERIOR WORK AND MATERIALS

All inferior work or work containing inferior material shall be rejected by the Engineer whereupon the Contractor shall immediately remove and rectify/replace the faulty work and/or material and bear all costs in connection therewith.

## 12 MAKING GOOD

The successful tenderer will be responsible for making good in all trades of any damage to buildings or other services which he or his employees may have incurred during the construction of the works. The Contractor will be responsible for keeping the site clean and tidy and shall remove from the site all rubble and litter resulting from the construction work.



## 13 MATERIALS ETC. TO BE PROVIDED BY HVAC CONTRACTOR

The Contractor shall provide all materials, equipment, labour, appliances, and all sundries necessary for the successful completion of the contract, whether mentioned in the specification or not; he shall provide for all necessary handling, transport and storage and shall be responsible for all materials delivered to the site in connection with the contract.

Major system components shall be produced by a SANS approved supplier (no alternatives) and shall be installed by an authorized SAQA accredited person. Only new and unused materials and equipment must be used for the system.

## 14 COMPLETION

On completion of the contract, any damage, which may have been done to the plasterwork, floors, ceilings, wood, and paintwork, etc., during the progress of the installation, shall be repaired and made good to original finishes by the contractor or principal contractor for the account of the contractor, to the satisfaction of the principal agent.

## 15 EQUIPMENT SUPPORTS

Where equipment supports, stands, platforms and suspension brackets are indicated, specified or necessary for ductwork, pipework, etc, the Sub-Contractor shall provide supporting structures capable of carrying the load without distortion, affixed to the building structure in such a manner as not to subject it to undue stress.

Details of all methods of suspension or supports shall be submitted to the Structural Engineers for approval where necessary, prior to manufacture or installation.

Supporting of any rotating equipment shall incorporate anti-vibration mountings of the type and selection specified in the applicable clauses referring to equipment bases herein.

Supports shall preferably be proprietary products such as UNISTRUT, or failing this, shall be of galvanised mild steel sections, purpose fabricated for their application. Under no circumstances whatsoever will sheet metal straps be accepted as a supporting method. All supports shall cradle the item to be supported; supports shall not be riveted or welded to the equipment to be carried except in exceptional circumstances approved by the Engineers. Rod hangers shall not exceed 1000mm in length and be of minimum diameter 12mm. For longer suspensions use mild steel angles. Angle iron supports shall be galvanised, of 38 x 5mm minimum section.

REDHEAD OR RAWLBOLT anchor bolts, or their equivalent shall be used for fixing supports to the building structure, it not being permissible to utilise gunpowder shot-driven bolts for this purpose unless prior permission has been obtained.

Pipework holderbats shall be the product of a recognised manufacturer of such equipment, shop-fabricated saddles or similar devices being unacceptable unless limited space available necessitates their use. On insulated pipework, hardwood inserts consisting of two half-round machine cut pieces of

timber shall be clamped around the pipe, insulation being cut away at such points, to allow proper support fitting.

It shall not be permissible to suspend ductwork on sheet metal straps under any circumstances whatsoever. Use UNISTRUT, rod hangers or M.S. angle supports to carry ductwork.

For support of single electrical cables or cables in not more than a group of three, use may be made of UNISTRUT die-cast cable cleats with UNISTRUT P-1000 channel, fixed to walls or overhead slab at not exceeding 1,5 metre pitch. Cables supported in this manner shall be properly straightened and neatly run to the full satisfaction of the Engineers. Where more than three cables run together, use slotted galvanised cable tray properly supported at intervals of 1200mm maximum on mild steel angles. Cables run on tray/rack shall be run neatly parallel to each other, not bunched, and shall be properly secured to the tray at regular intervals with galvanised steel strapping and appropriate buckles.

Cable tray shall be run in strictly horizontal or vertical planes, any change of level however, being done with a 45° slope. Where cables leaving trays drop down to equipment, use a minimum tray width of 150mm and two vertical UNISTRUT supporting channels fixed to horizontal tray at top and floor at bottom.

## 16 CABLE TRAYS

Cable trays, where required, shall be of the heavy-duty 2.5 mm thickness hot dipped galvanised steel type or approved equivalent trays. The cable tray width shall be as specified on the bill of quantities and drawings. Only purpose-made splices, risers, offsets and bends shall be used. Trays shall be fastened onto 500 mm lengths of P2000 or similar approved Unistrut. Each Unistrut section shall be fixed to the roof or wall steel sheeting with galvanized 10 mm x 50mm Ø Fisher or similar approval anchors. Unistrut spacing shall be 600 mm maximum. Only purpose-made accessories shall be used.

Where a sheet steel cable tray is required, this shall consist of approved galvanised sheet-metal perforated medium duty tray supported with approved substantial brackets or hangers at suitable intervals to reduce sag to a maximum of 10mm. Where necessary to achieve this, the run of cable tray shall be reinforced along its length with angle iron or similar stiffening members, or shall be of the heavy-duty type.

When wire mesh trays are required, these shall be of heavy duty hot dipped galvanised type, or stainless steel, left bright as required. Mesh trays shall be installed in a similar manner to perforated tray.

All cable tray accessories such as bends, tees, etc., shall be as supplied by the tray manufacturer and made-up components will not normally be allowed.

Trays shall be installed vertically or opening up horizontally as specified. Brackets and hangers shall be constructed to permit the easy removal of any cable from the tray. Flat horizontal runs of tray suspended from slabs shall be installed at least 200mm clear of the soffit. Trays crossing under beams shall be spaced off the beam soffit to allow the removal of the largest pipe/cable(s) in the group.

Earth continuity shall be maintained throughout the complete run of cable tray.

Trays shall be sized to afford at least 20% spare space. Control cables may be installed touching, but not bunched. Pipes/

Power cables shall be laid up spaced apart not less than the diameter of the largest adjacent cable, unless otherwise specified.

Cables shall be fixed to trays using stainless steel cable strap and buckles fixed every 500mm, or fixing-rung intervals for edge-on rack tray installations and at 1000mm or every second fixing-rung interval for cables laid flat and also where installed vertically.

## 17 NOISE AND VIBRATION

The Contractor shall select equipment and shall ensure that the noise ratings are attained as far as noise generation by air conditioning and ventilation equipment are within industry norms.

The increase in noise due to any air conditioning and ventilation equipment shall be limited to an increase of 3 dB above back-ground noise, measured on the boundary of the site.

Internal measurements shall be measured anywhere within the air-conditioned space, but not closer than 1200 mm from any air inlet or outlet.

All equipment generating vibration shall be mounted on anti-vibration mountings and springs to prevent any vibration carry-over to the building structure.

## 18 SCHEDULE OF EQUIPMENT

The schedule of equipment is referenced on the drawings and bill of quantities. No other alternatives may be used without written approval from the engineer.

## 19 AIR DISTRIBUTION SYSTEM

### **Ducting**

All duct penetrations through exterior walls/dog boxes shall slope away from the outer walls by 5° to prevent water leaking into the building.

### **Round Air Conditioning Ducting (Air Conditioning)**

Ducting shall be low pressure galvanised spiral sheet metal ducting. Unless otherwise indicated on the drawings ducting shall be externally insulated with 50mm Duct Wrap insulation. The first 2400mm of ducting from the HVAC unit to be internally lined with acoustic liner.

### **Rectangular Air Conditioning Ducting (Air Conditioning)**

Ducting shall be low pressure rectangular galvanised sheet metal ducting. Unless otherwise indicated on the drawings ducting shall be externally insulated with 50mm Isover FRK insulation. The first 2400mm of ducting from the HVAC unit to be internally lined with acoustic liner.

### **Internal Ducting for Ventilation Systems**

Ducting shall be uninsulated galvanised steel ducting to SANS 1238: 2005 and SANS 10173: 2003 unless otherwise specified on the drawings.

### **External Ducting for Ventilation Systems**

Ducting shall be internally insulated galvanised steel ducting to SANS 1238: 2005 and SANS 10173: 2003 unless otherwise specified on the drawings.

### **Diffusers, disc valves, grilles and louvres**

The size, type and number of diffusers, disc valves, grilles and louvres are indicated on the bill of quantities and/or drawings.

Technical submittals shall be submitted timeously to the engineer for technical and aesthetic approval before equipment may be ordered, the engineer may also request samples of any items.

Diffusers, disc valves, grilles and louvres shall be powder coated to a colour as specified on the drawings and must be priced for in the BOQ. If not specified, the colour shall be white.

Low pressure insulated flexible ducting shall be used to connect diffusers/grilles with reducers if required. Connections shall be strapped and riveted to eliminate disconnection. No flexible ducting longer than 1.5m will be allowed. All flexible ducting shall be non-flammable.

All fixings shall be concealed.

### **Ventilation Grilles**

All ventilation and/or door grilles shall be of the TROX non vision grilles type with fixed inverted vee blades.

### **Sound attenuators**

Sound attenuators shall be manufactured by an approved reputable manufacturer such as DONKIN SILAX P-Series or WOODS. Any alternative to these manufacturers has to be specified in the tender document.

## **20 DUCTED SPLIT TYPE AIRCONDITIONING UNITS**

The ducted split units shall comprise of an indoor evaporator unit and an external condensing unit.

The specification is:

Indoor Unit: 6.8 kW Ducted type Indoor Evaporator unit (FBA71A9), Fan model - QD16A1CM, Fan motor - 230 W, Sound Pressure Level - Medium 28.0 dBA, Air flow rate - 15m<sup>3</sup>/min, External nominal static pressure - 30 Pa

Outdoor unit: 6.8 kW Outdoor Condensing unit complete with wall mounted bracket (AZAS71MV1)

## **COMPRESSOR**

- ▶ The compressor shall be a hermetically sealed unit.
- ▶ The compressor shall be mounted on springs with rubber seating.

## **EVAPORATOR**

- ▶ The evaporator shall be a multi pass copper coil with aluminium fins unless otherwise specified.
- ▶ The fin spacing shall be at least 2 mm to ensure that even with build-up of dirt on the fins, the units still meets its capacity as stated.

## **EVAPORATOR FAN**

- ▶ The fan shall be rated for continuous duty.
- ▶ The fan shall be of the non-overloading type.
- ▶ The fan shall be of the direct coupled centrifugal type.
- ▶ The fan motor shall be a multi speed or variable speed motor.

## **CONDENSER**

- ▶ The condenser shall be a single or multi pass copper coil with mechanically bonded copper or aluminium fins. Copper fins shall be used in corrosive atmospheres or in coastal areas when specified in the Project Specification.
- ▶ The fin spacing shall be at least 1,8 mm.

## **CONDENSER FAN**

- ▶ The fan shall be rated for continuous duty.
- ▶ The fan shall be of the non-overloading type.
- ▶ The fan motor shall be a totally enclosed motor.

## **SUPPLY AIR GRILLES**

- ▶ The outlet grilles shall be adjustable.
- ▶ The grilles shall not rattle, hum or vibrate under any operational conditions.
- ▶ The grilles shall not melt with the outlet grilles blocked and the heaters on at full capacity for 30 minutes.

## **FILTERS**

- ▶ The unit shall filter outside air as well as return air.
- ▶ The filter shall be of the washable type.
- ▶ The filter shall be easily accessible for cleaning purposes.
- ▶ The filter shall prevent the clogging of the evaporator coil.

## CASING

- ▶ The casing shall be constructed from heavy gauge steel, galvanised or zinc coated.
- ▶ The casing shall be powder coated to provide a durable colour fast scratch resistant surface finish.
- ▶ The casing shall be acoustically and thermally insulated.
- ▶ The casing shall not drum, vibrate or emit noises when the compressor comes in operation.
- ▶ The casing shall be treated for corrosion.

## CONDENSATE

- ▶ The unit shall be constructed to collect the condensate from the evaporator coil.
- ▶ The fan shall not carry condensate over into the conditioned space.
- ▶ The collected condensate shall adequately be removed by a slinger ring or other device. The manufacturer of the unit shall provide proof of the rate at which condensate can be removed.
- ▶ The thermal and acoustic isolation shall not absorb condensate.
- ▶ Provision shall be made for all heat pump units for a drain pipe for condensate water which shall be piped to the nearest drain point.

## ELECTRIC HEATERS

- ▶ When specified electrical heating elements shall be electric resistance heaters of the rust proof type with Incalloy or monel sheeting. Open spiral wire type heater elements are not acceptable.
- ▶ All heater elements shall be low heat density types, i.e. less than 3,2 watt/cm<sup>2</sup>. Heaters shall provide black heat at a minimum air speed of 1m/s.
- ▶ The heater element shall be rated for continuous operation at the full supply voltage.
- ▶ Wiring of the heater batteries shall be carried out in silicon-rubber insulated wiring of adequate cross section.
- ▶ All electrical air heating devices shall comply with the relevant requirements of SANS 160.
- ▶ The heaters shall be interlocked with the supply air fan motor.

## SAFETY CONTROLS

### COMPRESSOR

The compressor shall be protected against over current and over temperature with a Klixon type cut-out/auto restart device. "Low voltage" protection shall be provided.

### HEATERS

The heaters shall be fitted with manual reset safety thermostats to protect the heaters against over temperature.

## **CONTROLS**

- ▶ The units shall be fitted with a manually adjustable thermostat.
- ▶ The thermostat shall automatically select cooling, heating or recirculation according to the return air temperature.
- ▶ The thermostat shall be so designed that it will be impossible for the heater element to be energised simultaneously with the cooling cycle.
- ▶ The unit shall be fitted with an on-off switch.
- ▶ Proven electronic controls will also be acceptable.
- ▶ A "holding relay" function shall be provided in order that the units can be switched off remotely by interrupting the power supply.

## **ELECTRICAL**

The unit shall be able to operate on a single phase 50 Hz, 220 V three wire system.

The unit shall not draw more than 15 Amps when operating on either heating or cooling mode.

An electrical outlet point will be provided on the left-hand side when facing the console unit from inside the room, in the form of an isolator, unless otherwise specified.

Each unit shall be fitted with a cap tire cord of 1m and shall be shortened as required during installation by the (Sub) Contractor.

## **WALL SLEEVES**

Unless otherwise specified the (Sub) Contractor shall supply steel wall sleeves for units. The sleeves shall be handed to the Principal Contractor to build into walls.

## **WALL BOXES**

Unless otherwise specified wall boxes manufactured by the manufacturer of the units shall be fitted into the steel wall sleeves, where no aluminium external louvre has been specified.

The wall boxes shall be pre-powder coated in a colour to be specified by the Engineers and shall have pressed louvres approved by the manufacturer of the unit.

## **ALUMINIUM EXTERNAL LOUVRE**

When specified in the detail specification extruded aluminium louvres similar to TROX approved by the manufacturer of the console units and with a powder coated finish in a colour to be specified by the Engineer shall be fitted to the wall sleeves.

## **CONDENSATE DRAINAGE**

- ▶ Condensate drains shall be installed from the indoor unit to the nearest drain point. All condensate drain piping shall be 22 mm dia. hard drawn Class 0 copper tubing, 25 mm dia GMS or 25 mm dia uPVC.
- ▶ Drain piping shall be supported at 2,0 m intervals with a fall of at least 1:80
- ▶ The connection to the indoor unit shall be made in translucent plastic tubing of not more than 250 mm in length.
- ▶ A T-piece for a vertical venting pipe of 200 mm shall be provided close to the unit in the copper drain pipe.
- ▶ Provision shall be made for all heat pump units to drain the condensate of the outdoor unit to the nearest drain point.
- ▶ A galvanised sheet metal drip pan shall be provided under condensing units.
- ▶ All "Cassette" split units shall be fitted with drain pumps and unless otherwise specified in the Project Specification, approved drain pumps shall also be fitted to "In Ceiling" units.

## **REFRIGERATION PIPING**

- ▶ Refrigeration Grade hard drawn seamless, dehydrated, de-oxidised copper tubing shall be used, unless hand drawn piping has been specified.
- ▶ The sizing of refrigeration piping shall be in strict accordance with the unit manufacturer's specification.
- ▶ All refrigerant piping must be filled with nitrous oxide gas during welding and purged after welding and before charging with refrigerant gas as per manufacturers specifications.
- ▶ Oil traps shall be installed in the suction lines at all pipeA filter drier and moisture indicator shall be installed after the compressor.
- ▶ Charging connections shall be provided at the compressor.
- ▶ All suction lines shall be insulated with "ARMA FLEX" of 13 mm.

## **INSTALLATION**

### **INSTALLATION OF INDOOR UNITS**

- ▶ Mounting brackets for "Under ceiling" and wall mounted units shall be approved by the Engineer.
- ▶ "Cassette" and "In-ceiling" units shall be supported from the roof structure and not by the ceiling grid.
- ▶ Each indoor unit shall be complete with a wired wall mounted controller.



## INSTALLATION OF OUTDOOR UNITS

- ▶ Condensing units shall be mounted on walls by means of galvanised steel supports or shall be mounted on a 75 mm concrete base 200 mm larger than the footprint of the condensing unit.

## INSTALLATION OF PIPING

- ▶ All refrigeration piping and wiring external to the building or in visible positions shall be installed in galvanised steel wiring channels with removable cover plates or protected by means of 0,6 mm galvanised cladding.
- ▶ In concealed spaces and ceiling voids piping and wiring shall be strapped to a perforated/wire mesh galvanised cable tray or other acceptable means approved by the Engineer.
- ▶ Refrigerant piping in cable trays shall be fastened to the cable trays with Velcro straps of at least 10 mm in width and may not compress the insulation at any point around the refrigerant piping.
- ▶ All pipe insulation exposed to the weather or in visible positions shall be installed in galvanised steel wiring channels with removable cover plates or protected by means of 0,6 mm galvanised cladding.
- ▶ The refrigerant piping shall be marked tape/spray/paint every 3 m with the following colours:  
Supply: Blue  
Return: Yellow

## ELECTRICAL

- ▶ The HVAC contractor shall be responsible for final connection of the electrical power from the isolator to the units.

## 21 AC CONTROLLER

Air conditioners Controls for units in shall be wired. For the MCC room, an automatic transfer switch shall be supplied. One unit shall run in duty and the other as standby. In case of failure the standby unit will start up. The units will also be programmable to allow for setting of duty and standby units to prolong unit use. Server room units will be of cooling type only.

Controls shall have the following minimum functionality:

- ▶ Manual ON/OFF
- ▶ ON/OFF by 24 hour / 7 day timer
- ▶ Room temperature display
- ▶ Room temperature adjustment
- ▶ Cooling / heating / ventilation selection
- ▶ Automatic change over between cooling and heating

## 22 DRAIN PIPING

- ▶ The Air Conditioning subcontractor shall install all drain piping from the unit to a nearby drain point.
- ▶ Drainpipes shall be 40mm dia mild steel securely fastened with a slope towards the final drain point.

## 23 ELECTRICAL INSTALLATION

- ▶ The complete electrical installation for the operation of the air conditioning and ventilation installations shall form part of this Sub-Contract. SANS 10142-1 will be applicable.
- ▶ The making off all supply cables and wiring and the connection of all supplies form part of this sub-contract.

## 24 DRAWINGS

### Engineer's Drawings

Unless otherwise specified, the Engineer's Tender drawings are not manufacturing drawings and the dimensions given are only sufficient for tendering purposes or to enable the Contractor to complete manufacturing drawings. It is the responsibility of the Contractor to verify all dimensions.

### Contractor's Drawings

The Contractor will be furnished, on request, with the following drawings, as applicable or pertinent to the project:

- a) The Engineer's drawings.
- b) The Architect's drawings.
- c) The Structural Engineer's drawings.
- d) The Engineer's drawings of other disciplines.
- e) The drawings of other service installations that are relevant for co-ordination and
- f) installation purposes.
- g) The installation drawings of other Contractors.

Unless otherwise stated, three (3) sets of the Engineer's drawings, Specifications and Schedules (if any), and one set of (b) and (c) above, will be issued free of charge to the Contractor for installation purposes. (Refer to Part III, SAACE - 1978).

The Contractor shall supply to the Engineer four (4) copies of marked up structural or other drawings showing any changes and/or additional requirements to be made in the structure in order to meet the dimensional requirements of the equipment and materials to be installed by him. These builder's work drawings shall be supplied to the Engineer within four (4) weeks after notification by the Engineer that his tender was successful.

The Contractor shall supply four (4) copies of each detail design drawing for comment.

The Contractor shall allow the Engineer three (3) weeks for drawing comment. After a marked up copy with all the Engineer's' comments has been returned, the Contractor shall update the original which shall then be submitted to the Engineer for approval. This will ensure that all prints used for construction will be certified as approved.

Four (4) copies of the certified drawing shall be issued to the Engineer for distribution.

The Contractor will be required to produce the following detail design drawings:

a) Builder's Work Drawings

b) Mechanical Drawings (HVAC):

- i. These are all Workshop and Equipment Layout Drawings required for the manufacture and erection of the Installations.

c) Instrumentation Drawings, such as:

- i. Schematic Control Diagrams.

d) Electrical Power Drawings, such as:

- ii. General Arrangement Drawing of Switchboard.
- iii. Circuit Diagrams and interconnecting diagram giving cable schedules with numbers and sizes corresponding with the circuit diagrams and interconnection diagram.

Unless otherwise specified, cable routes shall be superimposed on the Mechanical Layout Drawings, showing the runs and fixing details.

Any work done by the Contractor without an approved signed drawing, will be at the risk of the Contractor.

The Contractor shall update all drawings ("as built drawings") once the Installation has been completed. Three (3) sets of paper prints shall be supplied to the Engineer as part of the O & M Manual. An additional electronic copy of O & M Manuals and as built drawings shall be provided to the Engineer.

The Contractor will be required to keep a separate set of all approved drawings on site and to continually "mark-up" any alteration, additional information in order that he can produce "as installed" drawings.

## 25 OPERATION & MAINTENANCE MANUALS

The contractor shall provide at practical completion 3 sets of the following operational and maintenance manuals. The manuals shall be in hard copies with also each including an electronic format stored on a USB stick. Three USBs shall thus be provided. Practical completion will not be taken if the manuals are not submitted in their entirety.

SECTION	DESCRIPTION	DOCUMENTS
1	Introduction and Guide	Table of contents How to use guide Emergency Information Contractual and Legal Information
2	Health and Safety	Guidance to relevant legislation H&S Safety procedures of system Disposal information
3	General Description of the Project	System operation System components/equipment Design parameters
4	Operating Procedures	General How to use the electrical system and subsystems.  Routine inspections fault conditions Emergency procedures Fault finding First Aid
5	Maintenance Procedures	Maintenance procedures for equipment or links to specific manufacturer's information.  Maintenance schedule and periods
6	Manufacturer's Schedules	List of all equipment and plant (product brand, product code/serial/model number, description, nameplate rating, etc). Asset Register Spares List manufacturer's contact details

7	Commissioning data and Certification	All certificate of compliance and associated certification listed and linked
8	Manufacturer's Literature	All equipment listed and linked directly to Section 6
9	Drawings	All as built drawings listed and linked in AutoCAD format electronically with hard copies.

## 26 INSPECTION, TESTING, COMMISSIONING AND HANDING OVER

On completion of the entire installation the contractor shall complete a Certificate of Compliance and any other form or forms as required by the SANS and the Engineer.

## 27 TRAINING OF EMPLOYER'S PERSONNEL

The contractor shall allow for the training of the client's staff on the operation, troubleshooting and maintenance procedures of the system.

## 28 TOOLS, EQUIPMENT AND TEST INSTRUMENTS AND MAINTENANCE TOOLS

The contractor shall supply all required maintenance tools required for the system.

## 29 GUARANTEE PERIOD

The Contractor shall guarantee the complete installation for a period of 12 months after the Final Completion Certificate - Form D has been issued, or as agreed to by the Engineer.

## 30 MAINTENANCE PERIOD

The Contractor shall comprehensively maintain the Installation for a period of 12 months after the Final Completion Certificate - Form D has been issued

The Contractor shall attend promptly within 24 hours to all complaints received by email and shall report to the Employer's nominated representative (maintenance manager) on arrival and departure and shall ensure that his written report is countersigned in the "Logbook".

The 12-month maintenance shall include monthly visits to site to wash filters and check all operating components and parameters, as well as one major annual service.

All chemicals required during the maintenance period will be for the account of the Employer.

The 12 Month maintenance shall include all required material and labour, i.e. no cost to employer (Filters, Gas, etc.).

## 31 CERTIFICATE OF COMPLIANCE

The Engineer will not issue a Final Completion Certificate - Form D until he is in receipt of a Certificate of Compliance.

## 32 PRACTICAL TESTING

Practical completion shall take place only after the whole installation has been accepted by the engineer and:

- ▶ All damage that may have been done by the Contractor or other parties in the process of the installation has been repaired and made good
- ▶ All tests of the installation have been done and tests results have been submitted to the Engineer,
- ▶ The completed Certificate of Compliance for the installation have been submitted to the Engineer,
- ▶ All equipment guarantees, if any, have been submitted to the Engineer,
- ▶ Correct As-Built drawings have been submitted and accepted by the Engineer,
- ▶ The building has been cleared of all debris and electrical waste materials and left in a neat and tidy condition,
- ▶ All practical operation of the complete system and witnessed by the Engineer.

**The contractor shall ensure that all works have been completed, tested and contractor snagged and system being successfully operational for at least 7 days prior to the contractor notifying the engineer to inspect the works in readiness for practical completion.**

## 33 FINAL COMPLETION

Final Completion shall be taken on expiration of the maintenance period which is stated in the Contract Data calculated from the date of taking the Practical Completion.

## 34 TESTING AND INSPECTION

The Contractor shall inspect, test and commission the entire installation in conjunction with and to the satisfaction of the Engineer and in the presence of the Engineer in accordance to the SANS, NBR and applicable manufacturer's commissioning requirements.

The Contractor shall make all arrangements for testing and inspection, the costs thereof being included in the tender price.

The Engineer reserves the right to witness all tests.

The Contractor shall advise the Engineer in writing of all results and furnish copies of all certificates.

The Contractor shall provide all the necessary instruments for the proper testing of the complete installation. If there is reason to doubt the accuracy of such instruments, the Contractor shall take the necessary action to prove their accuracy.

**If the results of the first delivery tests are favourable and the installation is found to be in order, there will be no charge for the test. If the test is found to be unfavourable, a levy of R2000-00 will be charged to the Contractor for each subsequent test in the form of a Variation Order omitting such costs from his contract price.**

The Contractor shall ensure that the installation is complete in every respect and that there are no major defects prior to notifying the Engineer (in writing) of a first delivery inspection.

Should there be any minor defects upon final inspection, the Engineer will terminate that inspection and request that an additional final inspection be arranged by the Contractor.

## 35 GENERAL NOTES TO BILLS OF QUANTITIES FOR THE MECHANICAL INSTALLATIONS

1. The attached Bills of Quantities form part of the Tender Document and shall be read in conjunction therewith.
2. Reference shall be made to the Specifications for the full meaning and description of work to be done and material/equipment to be used.
3. The Bills of Quantities shall be fully completed and returned to form part of a valid tender before the tender closing time.
4. No alterations, addition or erasure may be made to the text of the Bills. If such an alteration, addition or erasure is made it shall not be acknowledged and the original wording of the text shall apply.
5. All prices or rates shall be given against each item of the Bills of Quantities irrespective of any quantities given or not. The cost of items if not priced shall be taken as being included in other price or rates in the Bills of Quantities.
6. "Rates only" items, as all other rates and item prices will be used for costing variations.
7. Provisional Amounts and Contingency Sums are budgetary costs for use by the Engineer at his discretion and may be omitted in total without any compensation to the Contractor whatsoever.
8. Since the Specifications call for complete operational systems, the rates submitted shall cover the cost of associated items not specifically listed, but which are required for a complete operational installation in terms of the Specifications. Should the Tenderer wish to list such items separately, or if any requirements of the Specifications are not specifically covered by items in the Bills of Quantities, the Tenderer shall allow for these as additional items or in his Tender covering letter.
9. Unless otherwise measured all rates shall include for the detail design, engineering, procurement, supply, delivery, erection, waste, storage, commissioning, testing, maintenance and guarantee of material or equipment in terms of the Specifications.
10. The Engineer will use his discretion to correct conspicuous arithmetical errors when adjudicating the tenders.
11. No orders shall be placed on the basis of the quantities in the bills, but shall be verified on site by the Contractor prior to placement of orders.



In diversity there is beauty and  
there is strength.

MAYA ANGELOU

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### **C3.9: ELECTRICAL AND ELECTRONIC SPECIFICATIONS**

#### **C3.9.1 PROJECT SPECIFICATIONS**

This Electrical Specification discusses the Electrical and Electronic works to be carried out by the Contractor for Isipingo WWTW.

#### **PSE 1 SCOPE OF WORK**

##### **PSE 1.1 *Electrical Scope of Work***

The electrical portion of this contract shall include the following:

- (a) Liaison with the supply authority (eThekweni Electricity) to coordinate to coordinate the required electrical supply upgrade and change-over from the existing 11kV/400V 500kVA Distribution transformer to the proposed 11kV/400V 1250kVA Distribution transformer including removal and transportation of existing MV equipment including inspections of new installations and connections Liaison with the Employer to coordinate the shutdown, decommissioning of equipment, swing over of supply for certain existing equipment, removal and transportation of the other existing electrical infrastructure as well as to accommodate and coordinate the new electrical works described in this specification.
- (b) Standby Generator
- (c) Earthing and bonding
- (d) Lightning protection
- (e) Protection and power quality logging and studies
- (f) Power factor correction and harmonic filtering (if required from the above study)
- (g) 3 new Motor Control Centres, namely:
  - Main / Biofilter Pump Station MCC (MCC01)
  - Inlet works MCC (MCC02)
  - Second Class Water (MCC03)
- (h) Small power and lighting within the buildings
- (i) LV cables including labelling
- (j) Cable supports
- (k) Area lighting
- (l) Factory testing, site testing and commissioning of the electrical installation
- (m) Site quality assurance documentation
- (n) Certificates(s) of compliance
- (o) Original equipment manufacturing drawings
- (p) As-built drawings
- (q) Operation and maintenance manuals
- (r) Training
- (s) Maintenance of equipment during the 12-month defects liability period for Electrical and Electronic Equipment
- (t) Spares

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**PSE 1.2     *Electronic Scope of Work***

The electronic portion of this contract shall include the following:

- (a) PLC panel with hot standby PLC and HMI
- (b) Programming
- (c) New fibre optic network connecting all site PLCs and SCADA  
New Full SCADA for the entire facility including the existing MCC's.
- (d) Establishment of VPN connection
- (e) Uninterruptible power supplies for the PLCs, HMI, field instrumentation and SCADA system
- (f) Field Instrumentation
- (g) Control and instrumentation cables including data communications cables and associated peripherals
- (h) Earthing and surge protection for power, instrumentation and electronic equipment
- (i) Labelling of all instrumentation and control equipment and cables.
- (j) Testing and commissioning of the instrumentation and control system.
- (k) Witnessed Factory Acceptance Tests (FATs)
- (l) Site testing and commissioning
- (m) Calibration certificates
- (n) As-built drawings
- (o) Operation and maintenance manuals
- (p) Training manuals and training

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**PSE 2      GENERAL REQUIREMENTS****PSE 2.1      *General***

- (a) These general requirements apply to both the electrical and electronic scope
- (b) All disciplines within the Contractor's team are expected to communicate and coordinate during project delivery
- (c) Lack of communication or coordination within the Contractor team shall not be regarded as a valid reason for designs not to be correctly and timeously executed.
- (d) Where activities are to be undertaken by anyone outside the Contractor team, the Contractor shall liaise with the applicable person(s) for feedback regarding expected timelines to incorporate in the program
- (e) The Contractor shall not supply equipment that is expected to be discontinued by manufacturers in less than 5 years.
- (f) The Contractor shall only procure, manufacture, and install equipment once he/she has received approval from the Engineer. Therefore, the Contractor shall be responsible to ensure that all inputs required for the Engineer's approval are submitted on time, and the approval process is factored into the project program.
- (g) The Contractor's documents, as a minimum, shall have the same level of detail as provided in similar documents and drawings in the Engineer's design for this Tender. However, the Engineer may require more information. To avoid delays, the Contractor shall submit typical drawings and tables of headings for the Engineer to comment and approve prior to populating any equipment and cable schedules or doing detailed drawings.
- (h) All deviations to the Engineer's design shall be communicated to the Engineer for approval, prior to procurement, manufacturing, installation, and or execution.
- (i) The Contractor shall ensure that changes to designs or schedules in new revisions of submissions are clearly indicated for the Engineer's attention. Any changes that are not clearly indicated shall be presumed to be unchanged from the initial revision or last revision they were highlighted, whichever is latest.
- (j) The Contractor shall ensure that all the Engineers comments are addressed before submitting a new revision. Should any comments not be incorporated, and the reason why is not indicated, discussed and agreed upon with the Engineer prior to submission, the submission shall not be deemed to be a new revision and shall be sent back to the Contractor without review.
- (k) The Contractor shall ensure that submitted documents and designs align with the preceding approved documents (e.g. tag numbers and descriptions must be the same across all multidisciplinary Contractor documents). If it is evident to the Engineer that the Contractor has not critically assessed the submission and or has not applied internal quality checks, the submission shall not be deemed to be a new revision and shall be sent back to the Contractor without review.
- (l) Incomplete documents shall not be deemed to be a new revision and shall be sent back to the Contractor without review
- (m) The following sequence of approvals of drawings, schedules, and tests for electrical panels prior to commissioning shall be adhered to by the Contractor. Where a sequence number has more than one item this shall be regarded to mean that all documents/drawings/testing/etc. under that sequence number shall be completed in parallel and are dependent on each other for approval. Approval shall not be given if the items in the preceding sequence number have not been approved by the Engineer.
  - Process and Instrumentation Diagrams (P&IDs) and control philosophy
  - Motor and Equipment Lists (Motors / Instruments/Actuators) complete with datasheets
  - Panel load calculations

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- General arrangement drawings
  - Detail door layouts and schematics
  - Factory Acceptance Tests - Steelwork
  - Factory Acceptance Tests (hardware) – Manual operation and safety interlocks
  - Functional Design Specification
  - Factory Acceptance Tests (software) – Automatic operation (incl. PLC, HMI, SCADA etc.), process and safety interlocks, alarming etc.
  - Certificates of Compliance
  - Instrument calibration certificates
  - Installation inspection by Engineer (discipline specific Contractor must be present)
  - (Commissioning)
- (n) The Contractor shall ensure that all approvals listed in the approval sequence for panels, and the other documents, drawings, activities etc. specified in this document are indicated and factored into the project program.
- (o) The Contractor shall be responsible for understanding the Engineer's requirements for submissions as well as the approval processes of the Engineer and Employer for project programming. The Contractor shall organize meetings if clarification is required and ensure that the Engineer is included in these meetings.
- (p) Witnessed Factory Acceptance Tests (FAT) shall be carried out by the Contractor. Travel costs for persons shall be included in the tender pricing for travel outside of eThekweni where flights are required to reach the factory. The number of persons shall be one person from the Employer's Agent and 3 persons from the Employer's side. It shall be assumed all persons shall be travelling from eThekweni. Should follow-up witnessed FATs be required due to incomplete or incorrect work by the Contractor, the Contractor shall cover the costs for the same number of persons.
- (q) The travel costs shall include the following (as required):
- Airport shuttles
  - Flights
  - Rental vehicles
  - Accommodation
  - Meals (3 x daily)
- (r) Prior to commissioning, the Engineer shall inspect the complete electrical and electronic installation with the discipline specific Contractor's representative present. The Contractor shall arrange the inspection with the Engineer once installation is complete. Any safety related or major snags identified by the Engineer must be addressed by the Contractor, and corrections checked and approved by the Engineer prior to commissioning
- (s) The Contractor shall notify the Engineer and the Employer that they are required to attend a testing or inspection, by way of formal invitations via Microsoft Outlook. This notification shall be sent at least 2 weeks prior to the event
- (t) The Contractor shall provide a plan to mitigate interfering with ongoing operations or tempering with existing equipment/programming for approval by Engineer, prior to working on existing infrastructure
- (u) The Contractor shall take care in ensuring that all works required of him/her specified in this document are accounted for and priced in the BOQ. It shall be assumed that all equipment or works required to achieve full and specified functionality have been priced in the bill. Where an item is not available for a specified function, the Contractor shall add omissions in the section provided at the end of each bill.

- (v) The requirements for training, testing, commissioning shall comply with SPE-EE-0002.  
See Section C3.9.3.

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**PSE 3 COMPLIANCE**

The electrical works shall be provided in accordance with the following:

**PSE 3.1 *Technical Datasheets***

Equipment requirements and materials of construction are provided in the technical datasheets, which form part of this detailed specification. The technical datasheets for the electrical works are:

- (a) TD01 11kV / 400V Transformer
- (b) TD02 Busbar Trunking System
- (c) TD03 11kV Cables
- (d) TD04 LV Generator
- (e) TD05 MCC's
- (f) TD06 LV Cables
- (g) TD07 Cable Supports
- (h) TD08 Luminaire Schedule
- (i) TD09 VFCs
- (j) TD10 Soft Starters
- (k) TD11 Electrical Motors
- (l) TD12 Electrical Actuators
- (m) TD13 Small Power and Lighting
- (n) TD14 PLC
- (o) TD15 SCADA
- (p) TD16 C&I Cabling
- (q) TD17 Instrumentation
- (r) TD18 CCTV
- (s) TD19 Networking Infrastructure

**PSE 3.2 *EWS Standard Specifications***

- (a) EWS Electrical Standard Specifications for Wastewater Pump Stations
- (b) EWS Control & Instrumentations Specification
- (c) EWS Network and SCADA Specifications

**PSE 3.3 *Design Schedules***

- (a) 1002680-ZUT-SCH-EE-001-Biofilter MCC Schedule
- (b) 1002680-ZUT-SCH-EE-002-Inlet Works MCC Schedule
- (c) 1002680-ZUT-SCH-EE-003-Second Class Water MCC Schedule
- (d) 1002680-ZUT-SCH-EE-004-Admin DB Schedule

**PSE 3.4 Drawings**

DRAWING NUMBER	DRAWING TITLE
60471/E/GW/001	Power Distribution Block Diagram
60471/E/GW/002	Typical Earthing Arrangement
60471/E/GW/003	Typical MV/LV Cable Trench Arrangement
60471/E/GW/004	Single Line Diagram Legend
60471/E/GW/005	Site Electrical Layout
60471/E/GW/006	Admin Building SLD
60471/E/GW/007	Admin Building Earthing & Cable Containment Layout
60471/E/GW/008	Admin Building Small Power & Lighting Layout
60471/E/GW/009	Admin Building Fire Detection Layout
60471/E/GW/010	Second Class Water System: Raw Water Pump Station Electrical Layout
60471/E/GW/011	Second Class Water System: MCC Building Combined Electrical Layout
60471/E/GW/012	Second Class Water System: MCC SLD & GA
60471/E/LI/013	New Inlet Works MCC Building Combined Electrical Layout
60471/E/LI/014	New Inlet Works Structure Combined Electrical Layout
60471/E/LI/015	New Inlet Works MCC SLD & GA
60471/E/LS/016	Biofilter Pump Station Building Combined Electrical Layout
60471/E/LS/016	Main/Biofilter MCC SLD & GA
60471/E/LS/017	Main/Biofilter DB SLD
60471/E/LS/018	Raw Water Pump Station Electrical Layout
60471/I/GW/001	Control Network Architecture
60471/I/GW/002	Typical Field Control Station
60471/I/GW/003	Typical Door Arrangement - DOL Motor Starter
60471/I/GW/004	Typical Door Arrangement - SS Motor Starter
60471/I/GW/005	Typical VFC Panel Door Arrangement
60471/I/GW/006	Typical MCC Wiring Schematic
60471/I/GW/007	Typical Single Door PLC Panel GA
60471/I/GW/008	Typical Instrument Cabinet or Junction Box GA
60471/I/GW/009	Typical Hookup Level Instruments
60471/I/GW/010	Typical Hookup Pressure Instruments
60471/I/GW/011	Typical Hookup Instrumentation Motors Sized 15kW to 55kW
60471/I/GW/012	Typical Hookup Limit Switches
60471/I/GW/013	Typical Hookup Proximity Switches
60471/I/GW/014	Typical Hookup Flow Switches
60471/I/GW/015	Typical Hookup - Open Channel Flow Instrument
60471/I/GW/016	Typical Hookup - Differential Level Transmitter
60471/I/GW/017	Typical Hookup Pressure Switches



## **PSE 4      LV SWITCHGEAR AND CONTROLGEAR ASSEMBLIES**

### **PSE 4.1      *General***

- (a) New Motor Control Centres (MCC) shall be installed in dedicated MCC rooms. These MCC shall be used to power and control equipment in the new Inlet Works, Biofilter pump station and second-class water system.
  - Main / Biofilter Pump Station MCC      MCC01
  - Inlet Works MCC      MCC02
  - Second Class Water MCC      MCC03
- (b) The Contractor shall inspect, test and makegood where required and integrate the MCC to the new SCADA system together with the above new MCC's
- (c) The MCC Schedules contains details of the starters, control and indication which shall be provided in the MCC.
- (d) MCC01 with a generator incomer which shall also be interlocked with the main LV incomer so that mains and generator power are not connected to the MCC at the same time
- (e) The Contractors shall program and sequence removal of the Existing Biofilter MCC and swing-over to the new MCC01 to ensure minimal downtime. The WWTW in general and the Biofilter pump station is a live operating plant and all activities and programming shall take this into account.

### **PSE 4.2      *Power Factor Correction***

- (a) The power factor correction will be designed in detail by the Contractor during the construction phase to correct the power factor at the Biofilter Pump Station MCC to achieve a power factor of 0.98.
- (b) A provisional allowance will be included for a full harmonic study to be conducted by the Contractor during the construction phase of the project after all equipment has been installed and commissioned to ensure that the electrical system complies with IEEE 519: Recommended Practice and Requirements for Harmonic Control in Electric Power Systems
- (c) MCC rooms are designed to be cooled to a safe equipment operating level by using forced ventilation as opposed to air-conditioning for increased maintainability
- (d) The Contractor shall also allow for manual control of the switching of the capacitors. A manual/off/auto selector switch (with key lock) shall be provided for the control of the PFC panel.
- (e) The Contractor shall size the PFC for minimum correction of power factor 0.98.
- (f) Power factor controllers shall be of the Vishay ESTAmat PFC-6 type or approved equivalent.
- (g) Capacitors shall comply with IEC 60831 or equivalent international standard for LV capacitors and shall be rated for a 20% continuous voltage overload (based on a nominal voltage of 400 V) and a 50% continuous current overload.
- (h) Power factor correction automatically shall be disconnected when the generator is in operation. Interlocking shall be provided to ensure that the PFC is not connected when the generator is running.
- (i) Capacitor banks shall be fixed in either 25, 50 or 75kVAr banks.
- (j) Cubicles in the MCC containing the power factor correction shall be correctly ventilated, using forced ventilation if required by the PFC supplier.

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**PSE 4.3    *Local Control Stations***

- (a) A pedestal mounted field control stations shall be installed within an arm's length of each motor.
- (b) Where relevant, a forward/reverse field control station shall be provided to enable local control in both directions.

**PSE 4.4    *MCC Compartment Labels***

- (a) Compartment labels for incomer sections shall have the following information:
  - Tag Number
  - Description e.g., Mains Incomer No.1
  - Power supply equipment and tag number e.g., "Fed from Main Distribution Board – MDB-01"
- (b) Compartment labels for equipment shall have the following information:
  - Tag Number
  - Description e.g., Screw Pump No.1
  - kW ratings
  - Full load current rating
  - Starter type
- (c) Circuit breaker and equipment labels in distribution section's legend shall include the following information:
  - Tag Number
  - Description e.g., Electrically Actuated Valve
  - kW ratings
- (d) All labels including labels for control and monitoring equipment such as push buttons, indicators, selector switches etc. shall be submitted to the engineer for approval as part of the detailed door layout drawings.

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**PSE 5      LV CABLES****PSE 5.1      *LV Cable Installation***

- (a) The single line diagrams and electrical cable schedules indicate LV cables based on the Engineer's design. The Contractor shall update and submit cable schedules based on his/her offered equipment and the cable routes.
- (b) The Contractor's electrical cable schedules shall be submitted to the Engineer for approval, prior to procurement and installation of cables. Cables shall be separated per panel they originate from/power. Only measured distances to equipment shall be used for calculations for cable schedules submitted for approval.
- (c) LV multicore cables shall be copper conductor, PVC insulated cables with steel wire armouring
- (d) LV single core cables shall be copper conductor, PVC insulated cables with aluminum wire armouring
- (e) EMC cables shall be used for the Variable Frequency Converter driven motors
- (f) Cables installed on cable supports shall be neatly installed and secured in parallel with minimum cross over
- (g) Control and instrument cables may be run on the same cable tray/ladder as power cables, except where electromagnetic interference may affect the instrumentation signals. Control and Instrumentation cables shall be installed at least 300 mm away from power cables.
- (h) The Contractor shall be responsible to size, supply and install the cables to each LV Distribution board and kiosks being supplied by panels supplied in this Contract.

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**PSE 6 CABLE SUPPORTS AND CABLEWAYS****PSE 6.1 General**

- (a) The Contractor shall be responsible for designing detailed cable routes (internal and external to buildings). These designs shall be done in collaboration with the Engineer but shall be the responsibility of the Contractor. Cable route drawings shall be submitted for the Engineer's approval prior to installation.
- (b) The Contractor's cable route drawings shall detail cable supports and cableways. These drawings shall include layouts and cross sections indicating size, quantity and location of cable ladders, cable trays, conduits, and sleeves. These drawings shall indicate all surface and in-structure routes. The in-structure routes shall be submitted to the Engineer for update of the structural drawings for construction, once approved.
- (c) The Contractor shall ensure that the quantity, sizes, and positions of sleeves and cable supports required to access equipment in the electrical and electronic scope are sufficient, taking into account cable way and cable support loading restrictions of SANS 10142-1. 20% spare capacity shall be allowed for future installations.
- (d) Cable supports and cable ways depicted in the cable route drawing(s) shall only be procured and installed when the cable route drawing(s) have been approved by the Engineer.
- (e) All incoming sleeves and openings into or at concrete structures and into buildings shall be thoroughly sealed as per the Engineer's specifications after the cable installation is complete to prevent fire and limit water ingress into sleeves, buildings and building trenches. The Contractor shall confirm with the Engineer the measure of sealing the sleeve openings during constructions, prior to execution.
- (f) All cables installed in building trenches shall be secured on cable ladders.
- (g) HDG cable ladders and trays shall be provided to support cables inside the MCC Rooms and Stainless Steel 316 cable ladders and trays shall be provided to support cables outdoors.
- (h) Control and instrument cables may be run on the same cable tray/ladder as power cables, except where electromagnetic interference may affect the instrumentation signals. Control and Instrumentation cables shall be installed at least 300 mm away from power cables.
- (i) Where cables are installed in ground, concrete cable markers with engraved steel plating shall be used at every direction change or at every 30 meters. Danger tape shall be laid to cover all cables as per the cable trench detail drawing.
- (j) Where the Contractor is required to carry out cable trenching, core drilling, chasing or the installation of sleeves, the Contractor shall coordinate such activities with the Civil Contractor.

**PSE 7      LV ELECTRIC MOTORS****PSE 7.1      *General***

- (a) The single line diagrams and the motor equipment schedules attached to the specifications indicate the Engineer's estimated ratings of motors and equipment.
- (b) The Contractor shall submit a motor list to the Engineer for approval prior to procurement and installation. The motors shall be grouped per panel.
- (c) Each Pump/motor set shall be supplied with the protection as shown on the Piping & Instrumentation Diagrams (P&ID's) and single line diagrams.
- (d) Refer to Electronic Detail Specification – Instrumentation section for additional requirements

**PSE 7.2      *Motor Starters - Variable Frequency Converters***

- (a) Variable Frequency Converters (VFCs) shall be provided as indicated on the single line diagrams and equipment list.
- (b) VFC's shall be sufficiently ventilated by means of forced ventilation to cater for all heat dissipated by the VFCs.

**PSE 7.3      *Motor Starters – Soft Starters***

- (a) Soft Starters (SS) shall be provided as indicated on the single line diagrams and equipment list.

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**PSE 8      STANDBY POWER**

- (a) The entire works shall be backed up by means of a prime power rated, Modified ISO container enclosed diesel generator set including generator base mounted, self-bunded fuel tank.
- (b) The diesel generators system shall be designed to accommodate the current estimated diversified, absorbed load of the WWTW during optimal operation (excluding the anticipated 300kW for future digester equipment).
- (c) Provision shall be made to add a future second generator to the Main / Biofilter MCC with the necessary equipment and controls to enable synchronous generator operation.
- (d) The genset is set to operate automatically during a mains power failure and will deliver power at nominal 400V, 3-phase + N, 50 Hz, 0.8PF

**PSE 9      EARTHING AND BONDING****PSE 9.1      *General***

- (a) All electrical equipment shall be earthed.
- (b) All exposed conductive parts and accessible extraneous conductive parts shall be bonded to earth in accordance with SANS 10142-1.
- (c) Each MCC room shall be equipped with a main copper earthing bar. The earth bar for MCC-IW shall be connected to this main earthing bar.
- (d) The generator set shall be earthed to the relevant building's main earthing bar.
- (e) The Contractor shall compile an earthing diagram showing how the installation shall be earthed.

**PSE 9.2      Earthing Conductors**

- (a) Earthing conductors shall be PVC-insulated copper conductors or bare earth copper conductors as indicated and sized in accordance with the single line drawings.

**PSE 9.3      *Earth Continuity Conductors***

- (a) Earth continuity conductors shall be provided with all MV and LV power cables to electrical equipment and as shown on the single-line diagrams.
- (b) Where no separate earth continuity conductor is shown on the single-line diagrams, the intention is that a spare core in the power cable shall serve this function.

**PSE 9.4      *Bonding***

- (a) As part of the installation inspection the Contractor shall measure earthing and bonding of the installation in the presence of the Engineer. Measurements taken and the soil resistivity report shall be incorporated into the O&M manual.

**PSE 10 ELECTRICAL ACTUATORS****PSE 10.1 General**

- (a) The valves installed under this contract shall be electrically actuated as indicated on the P&ID Drawings.
- (b) Control and feedback communications between the PLC's and the actuators shall be by means of hardwired digital and analogue signals to the relevant PLC (no fieldbus system is required)
- (c) The operations personnel shall be able to open or close the valve from the HMI and the SCADA.
- (d) No Selector Switches, Push Buttons or Indicators are required on the MCC panel for control of the actuators.

**PSE 10.2 Construction**

- (a) The actuator housing shall be double sealed, watertight enclosure and shall afford protection to IP 68.
- (b) Nameplate shall be made of stainless steel showing all relevant gearbox data. The nameplate shall be securely fixed to the gearbox, so that it cannot be removed or scratched off during shipment, installation, operation or maintenance.



**PSE 11      ELECTRONIC SYSTEM OVERVIEW**

- (a)    The New MCC's shall be fully automated with the use of programmable logic controllers, field instrumentation and a central supervisor control and equation computer system.
- (b)    Under this Contract a new PLC's, and the fibre cable connecting new and existing PLCs to the new SCADAs shall be provided.

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**PSE 12 GENERAL ELECTRONIC INSTALLATION****PSE 12.1 General**

- (a) The electronic installation shall be provided in accordance with EWS Instrumentation Specifications and EWS Network and SCADA Specifications.
- (b) The Contractor shall develop a complete control system architecture for the works and submit a diagrammatic representation thereof to the Engineer for approval prior to the detailed design of the Electronic systems.
- (c) The Contractor shall prepare a detailed design for approval by the engineer, prior to the purchase of any equipment and its installation.

**PSE 12.2 Electricity Supply**

- (a) All electronic equipment associated with the various treatment works sections, shall receive power from a single-phase 230V 50Hz supply which shall be sourced from each of the relevant new LV MCC load centres to the specific PLC panel. All equipment in the PLC shall be powered via a battery backed up single phase UPS. Electrical power (230V ac and 24V dc) shall be distributed to all equipment controlled by the PLC panels such as field instrumentation and peripherals.
- (b) Surge protection shall be provided on the supplies to all electronic equipment and instrumentation.
- (c) Isolation transformers shall be provided on all instrumentation and control supply circuits as per the single line diagrams.

**PSE 12.3 Control Cables**

- (a) Control cables shall be provided as detailed in the MCC Schedules. The Contractor shall however develop a final cable schedule and cable block diagram to suit his equipment offered under the tender and the Contractor shall be deemed to have allowed in his tender all control cabling required to complete the installation.
- (b) Multicore cables may be used to group several control signals in an area and connect them from a suitable Junction Box to the relevant PLC.

**PSE 12.4 Instrumentation Cables**

- (a) The Contractor shall develop a final cable schedule and cable block diagram and the Contractor shall be deemed to have allowed in his tender for all instrumentation cabling required to complete the installation.
- (b) Multi-pair cable may be used to group several instrument signals in an area and connect them from a suitable Instrument Cable Junction Boxes to the relevant PLC.

**PSE 12.5 Data Cables**

- (a) A fibre optic network shall be provided for the WWTW plant for connection of all PLCs, intelligent devices and the SCADA as shown on the control architecture drawing.
- (b) This ring network shall be for process control and CCTV for process monitoring purposes as indicated on the network Architecture Drawing 60471/I/GW/001 .
- (c) The Contractor shall provide an updated architecture drawing corresponding to his/her approved cable route drawings.
- (d) Fibre optic ring testing shall be done in the presence of the Engineer, with results submitted for approval.

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**PSE 13      UPS****PSE 13.1    *General***

- (a) UPSs shall comply with SANS 62040 and as varied by the Technical Detail Sheets as applicable.

**PSE 13.2    *Installation, Inspection and Testing***

- (a) An isolation transformer on the input side shall be included to ensure voltages remain constant when the neutral supply is cut during generator changeover.
- (b) A new UPS shall be installed in the new MCC's PLC panels, and at the SCADA in the administration building.
- (c) The UPS in the inlet works PLC panel shall provide power to the PLC panel, MCC Control voltage supply and to field instrumentation.
- (d) Adequate provision shall be made for ventilation of a UPS when it is installed in a PLC panel.
- (e) Each complete UPS system shall be tested on site and the Contractor shall ensure that the associated PLC and HMI shutdown and restart automatically without losing any information or requiring operator intervention should the UPS standby period expire before standby generator power is available.

**PSE 13.3    *Functional Design Specification***

- (a) The Contractor shall produce a detailed Functional Design Specifications (FDS) which shall be based on the Contractor's approved P&IDs, equipment lists and control philosophies.
- (b) The Contractor shall allow for 7 iterations the FDS in the pricing and programme.
- (c) Prior to commencing with the FDS the Contractor shall:
  - Submit P&IDs, control philosophies and equipment lists for approval. (These documents must be approved before compiling the FDS). The Contractor shall request the required format for the control philosophies from the Engineer before compiling the document
  - Set up a meeting with the Engineer and Employer to discuss FDS content requirements
  - Set up a meeting with the Engineer and Employer to discuss SCADA /HMI mimic requirements
  - Submit examples for HMI and SCADA mimics for review and comments before configuring the detailed mimics.
  - Submit FDS table of contents for review and comments

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**PSE 14     PROGRAMMABLE LOGIC CONTROLLERS****PSE 14.1     *General***

- (a) The PLC installation shall be in accordance with the EWS Network and SCADA Specifications and the Technical Datasheet TD14
- (b) The Control Architecture is depicted on drawing no. 60471-I-GW-001
- (c) A PLC panel shall be supplied as part of each new MCC.
- (d) Each new PLC panel shall be in accordance with the following:
  - Refer to Drawing GA 60471/I/GW/007 - Typical Single Door PLC Panel
  - The enclosure shall be properly ventilated by extractor fans with dust filters. Cooling shall include adequate cooling for the UPS and other equipment.
  - The panel shall be large enough to allow for all required equipment plus 20% spare physical space.
  - Power distribution and instrument supply circuit breakers shall be located in the front of the PLC panel.
  - A separate protective earth bar (front) and an insulated earth bar (marshalling rear) shall be supplied at the bottom of the PLC panel.
  - A 16A dedicated (red) SSO shall be provided in the front bottom of the PLC panel for the programmer's laptop.
  - A panel light, connected to a door switch shall be provided.
- (e) The PLC panel pricing shall include equipment and equipment requirements provided in the drawings, specifications, and technical datasheets. The pricing shall ensure that all equipment required for a fully functional and compliant PLC panel installation is provided. This shall include all mounting ls, wire trunking, wiring, labelling, glands and peripherals required.
- (f) Steelwork price shall be excluded in the PLC panel pricing. PLC panel steel work shall be included in the MCC pricing.

**PSE 14.2     *Programmable Logic Controller***

- (a) The new Inlet Works PLC shall be programmed to execute the control philosophy.
- (b) The PLC shall both monitor, control and protect equipment its designated equipment
- (c) All intelligent electronic devices, such as LV motor starters, soft starters, variable speed drives, generator controllers, digital power meters, PFC controllers, remote IO if applicable and instrumentation shall be connected to the PLC for monitoring and control purposes.
- (d) The PLC software and HMI configurations screens shall be submitted via Control System FDS and will be reviewed by the Engineer before these are released to site. Tenderers shall allow for at least five iterations in the design and review of the PLC code and HMI screens.

**PSE 14.3     *PLC Software***

- (a) The PLCs shall be programmed to allow automatic operation of the works according to the Engineer's specified Control Philosophy.
- (b) The PLCs shall be programmed using the IEC 61131 standard or compatible equivalent.
- (c) The PLCs programming shall be in accordance with the EWS Wastewater PLC programming standards and the appointed Contractor will be issued with approved examples from other Works.

**PSE 14.4 Input and Outputs**

- (a) Digital input / output cards shall be 24 Vdc and analog input / output cards 4- 20mA current loops.
- (b) The input / output modules shall be provided with their own power supply independent from the CPU power supplies.
- (c) An indicative I/O list is provided in the relevant MCC schedules. This shall only serve as a guide to Tenderers, and the Contractor shall be responsible for determining and providing all the required I/O including spares to provide the specified control and monitoring functions of his offered equipment.
- (d) The I/O list shall be finalised by the Contractor during the contract and shall be submitted for approval by the Engineer before final design and programming of the PLCs.
- (e) An additional I/O capacity of 25% shall be allowed per PLC

**PSE 14.5 Data Communication**

- (a) There shall be 3 network layers namely, supervisory layer, control layer, device layer
  - i) The supervisory layer ethernet network shall be implemented through the supervisory level three managed switch in the main SCADA rack and dedicated cores on the site wide fibre network.
  - ii) The control layer network is an isolated network to integrate the various Main PLCs and dedicated for transferring control data between PLCs and to the SCADA server.
  - iii) Device layer ethernet networks are provided in each process area and are for each main PLC for integration of the specific area's motor starters and drives, instrumentation, and field signals.
- (b) The following communications shall be utilised:
  - i) PLC to PLCs: MODBUS TCP/IP
  - ii) PLC to HMI: MODBUS TCP/IP
  - iii) PLCs to SCADA: MODBUS TCP/IP
  - iv) PLC to Generator controller: MODBUS TCP/IP
  - v) PLC to loop powered Instruments: Analog (4-20mA)/Digital
- (c) Only one industrial ethernet protocol will be allowed for the control layer and instrument layer i.e. Modbus TCP/IP or Ethernet IP and equipment shall be chosen that use this protocol natively. No additional gateways will be allowed to make equipment/instrumentation compatible.

**PSE 14.6 Human Machine Interfaces (HMI)**

- (a) One colour touch screen graphical human machine interface (HMI) shall be provided in the PLC panel for the Inlet Works PLC.
- (b) The HMI shall have SCADA like functionality such as pump control and status information, alarm lists, graphical trends and allow logging of most important data up to a month.
- (c) The HMI shall also allow control parameter (setpoint) changes to the PLC, which shall be password protected and logged. Operator actions, selections or setting updates described in the control philosophy shall be possible via the HMI interface.
- (d) The HMIs shall be configured with a simple default graphic display (mimic) showing all relevant equipment of the installation, including its status (running, tripped or stopped) and instantaneous and totalized instrument readings.
- (e) The HMI mimics shall include:

- 
- Navigation page
  - Diagrammatic Mains power summary page (showing kW, kVA, PF, A, V, Hz, kWh, with trends), and UPS power status
  - Diagrammatic generator power summary page (showing kW, kVA, PF, A, V, Hz, kWh, with trends) and (running hours, fuel level (litres and %), running load %, battery level %, with trends) (Mains and generator power pages can be merged into one page)
  - Diagrammatic network overview page
  - Process overview page (showing pump Hz, instantaneous and totalized readings of instruments, % levels of sumps, tanks, reservoirs, etc.)
  - Detailed process pages (if overview is not sufficient to show required information)
  - Motor faceplates (showing running frequency (if VFC), status, faults, bearing and winding temperature readings, etc.)
  - Actuator faceplates (with interface to manually control)
  - Setpoint pages
  - Active alarm pages
  - Historical alarm pages
  - Trend pages
  - As-built drawings
- (f) The pump/motor equipment statuses to be distinguished shall include:
- Running
  - Stopped and healthy
  - Fault/trip (to include safety interlocks)
  - Interlocked (Process)
  - Manual/Auto/Off
  - Open
  - Closed
  - Travelling
- (g) For sumps, reservoirs, tanks etc. levels shall be displayed as the required metric unit for volume unit and %
- (h) A trending page shall be provided showing all measured value readings over time. The trend page shall show live and historical data (which shall be logged to the HMI memory in a first in first out rolling log file). Trends shall be configured to show an hourly interval of readings. Trend data storage shall be first in first out
- (i) HMI runtime software and licensing shall be included in the supply of each HMI.

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**PSE 15      SCADA****PSE 15.1    *General***

- (a) The SCADA system shall be in accordance with the EWS Network and SCADA Specifications and the Technical Detail Sheets TD15.
- (b) The Contractor shall incorporate the new and existing PLC I/O tags into the new Master SCADA situated in the admin building.
- (c) The plant overall control system architecture is depicted on drawing no. 60471/I/GW/001
- (d) The Contractor shall configure the SCADA system to the agreed requirements and present the system to the Engineer and Employer in a control system FAT, along with all control components (PLCs etc.).
- (e) The Contractor shall allow for at least two scoping meetings between the Contractor, the SI, the Engineer and the Client to finalise the scope.

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**PSE 16 INSTRUMENTATION****PSE 16.1 General**

- (a) The Contractor shall provide instrumentation that is not an integral part of mechanical equipment as indicated on the P&IDs
- (b) Instrumentation shall be connected to the PLCs/remote IOs as indicated on the control architecture drawings and C&I cable schedules
- (c) The Contractor shall provide an instrumentation list to the Engineer for approval prior to procurement. Datasheets of each instrument shall be submitted with the instrumentation lists
- (d) All instrumentation equipment shall be supplied complete with mounting material and ancillary equipment required for a complete installation.
- (e) It shall be the Contractor's responsibility to supply the correct instrumentation for the applications, environmental conditions and size the inline flow meters nominal diameters.
- (f) Instrumentation installed outdoors shall have their transmitters installed in a stainless steel IP 65 weather proof enclosure near the point of measurement. All mounting material and brackets shall be Stainless Steel

**PSE 16.2 Pump/Motor Protection Instruments**

- (a) Pump and motor protection shall be provided as shown on the P&ID's and be in accordance with the relevant EWS specifications. The Contractor shall ensure all pumps and motors offered and supplied are adequately protected.
- (b) Instruments for critical pump protection (safety interlocks) shall also be wired to the MCCs (by means of relays logic using certified safety relays) to ensure tripping by hardwiring, even in the absence of PLC control.



## **APPENDIX A:**

### **ELECTRICAL LISTS**

1002680-ZUT-SCH-EE-001-Biofilter MCC Schedule  
1002680-ZUT-SCH-EE-002-Inlet Works MCC Schedule  
1002680-ZUT-SCH-EE-003-Second Class Water MCC Schedule  
1002680-ZUT-SCH-EE-004-Admin DB Schedule

### **TECHNICAL DATASHEETS (also included under T2.2.34)**

TD01 11kV / 400V Transformer  
TD02 Busbar Trunking System  
TD03 11kV Cables  
TD04 LV Generator  
TD05 MCC's  
TD06 LV Cables  
TD07 Cable Supports  
TD08 Luminaire Schedule  
TD09 VFCs  
TD10 Soft Starters  
TD11 Electrical Motors  
TD12 Electrical Actuators  
TD13 Small Power and Lighting  
TD14 PLC  
TD15 SCADA  
TD16 C&I Cabling  
TD17 Instrumentation  
TD18 CCTV  
TD19 Networking Infrastructure

**ELECTRICAL AND INSTRUMENTATION DRAWINGS**

<b>DRAWING NUMBER</b>	<b>DRAWING TITLE</b>
60471/E/GW/001	Power Distribution Block Diagram
60471/E/GW/002	Typical Earthing Arrangement
60471/E/GW/003	Typical MV/LV Cable Trench Arrangement
60471/E/GW/004	Single Line Diagram Legend
60471/E/GW/005	Site Electrical Layout
60471/E/GW/006	Admin Building SLD
60471/E/GW/007	Admin Building Earthing & Cable Containment Layout
60471/E/GW/008	Admin Building Small Power & Lighting Layout
60471/E/GW/009	Admin Building Fire Detection Layout
60471/E/GW/010	Second Class Water System: Raw Water Pump Station Electrical Layout
60471/E/GW/011	Second Class Water System: MCC Building Combined Electrical Layout
60471/E/GW/012	Second Class Water System: MCC SLD & GA
60471/E/LI/013	New Inlet Works MCC Building Combined Electrical Layout
60471/E/LI/014	New Inlet Works Structure Combined Electrical Layout
60471/E/LI/015	New Inlet Works MCC SLD & GA
60471/E/LS/016	Biofilter Pump Station Building Combined Electrical Layout
60471/E/LS/016	Main/Biofilter MCC SLD & GA
60471/E/LS/017	Main/Biofilter DB SLD
60471/E/LS/018	Raw Water Pump Station Electrical Layout
60471/I/GW/001	Control Network Architecture
60471/I/GW/002	Typical Field Control Station
60471/I/GW/003	Typical Door Arrangement - DOL Motor Starter
60471/I/GW/004	Typical Door Arrangement - SS Motor Starter
60471/I/GW/005	Typical VFC Panel Door Arrangement
60471/I/GW/006	Typical MCC Wiring Schematic
60471/I/GW/007	Typical Single Door PLC Panel GA
60471/I/GW/008	Typical Instrument Cabinet or Junction Box GA
60471/I/GW/009	Typical Hookup Level Instruments
60471/I/GW/010	Typical Hookup Pressure Instruments
60471/I/GW/011	Typical Hookup Instrumentation Motors Sized 15kW to 55kW
60471/I/GW/012	Typical Hookup Limit Switches
60471/I/GW/013	Typical Hookup Proximity Switches
60471/I/GW/014	Typical Hookup Flow Switches
60471/I/GW/015	Typical Hookup - Open Channel Flow Instrument
60471/I/GW/016	Typical Hookup - Differential Level Transmitter
60471/I/GW/017	Typical Hookup Pressure Switches

### **C3.9.2 EWS STANDARD SPECIFICATIONS**

#### **NAME OF SPECIFICATION**

EWS Electrical Standard Specifications for Wastewater Pump Stations

EWS Control & Instrumentations Specification

EWS Network and SCADA Specifications



# **ELECTRICAL STANDARD SPECIFICATIONS FOR WASTEWATER PUMP STATIONS**

**DEPARTMENT: MECHANICAL AND ELECTRICAL BRANCH  
WATER AND SANITATION**

# **ELECTRICAL STANDARD SPECIFICATION**

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MC10	Generators

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## **STANDARD SPECIFICATION**

MC1

### **OVERVIEW**

This section specifies general requirements of electric equipment and the installation thereof. It is to be read in conjunction with the Project Specification which has precedence in the event of conflict.

MC2

### **COMPLIANCE WITH STANDARDS**

Equipment and methods of installation shall comply with the latest edition and/or amendment of:

Electrical Design Norms and Standards

a) All EWS Electrical Standards and Particular Specifications applicable to eThekweni Water and Sanitation Installations

b) OHS Act: Occupational Health and Safety Act.

c) SANS 10142-1: Code of practice for the wiring of premises – Low voltage installations.

d) VC8008: NRCS Compulsory safety specification.

e) SANS 61439 – 1: Low-voltage switchgear and control gear assemblies - General rules.

f) SANS 61439 – 2: Power switchgear and control gear assemblies.

g) SANS 61439 – 3: Distribution boards intended to be operated by ordinary persons (DBO).

h) SANS 1973 – 1: Type tested assemblies with stated deviations and a rated short circuit withstand strength above 10kA.

i) SANS 1973 – 3: Safety of assemblies with a rated prospective short circuit current of up to and including 10kA.

j) SANS 1973 – 8: Safety of minimally tested assemblies with a rated busbar current of up to and including 1600A AC

k) SANS 60947-1: Low-voltage switchgear and control gear. Part 1. General Rules.

l) SANS 60947-2: Low-voltage switchgear and control gear. Part 2. Circuit breakers.

m) SANS 60947-3: Low-voltage switchgear and control gear. Part 3. Switches, disconnectors, switch-disconnectors and fuse combination units.

n) SANS 60947-4: Low-voltage switchgear and control gear. Part 4. Contactors and motor starters.

o) SANS 60947-5: Low-voltage switchgear and control gear. Part 5. Control circuit devices and switching elements.

p) SANS 60947-6-1: Low-voltage switchgear and control gear Part 6-1: Multiple function equipment - Transfer switching equipment.

q) SANS 60947-7-1: Low-voltage switchgear and control gear Part 7-1: Ancillary equipment - Terminal blocks for copper conductors.

r) SANS 556-1: Low-voltage switchgear Part 1: Circuit-breakers.

s) SANS 1091: SA National Colour Standard for Paint.

t) SANS 1195: Standard Specification for Busbars.

u) SANS 1411: 1-2 Materials of insulated electric cables and cords.

v) SANS 1507: 1-4 Electric Cables (300/500V to 1,900/3,300V).

w) SANS 1574: Electric Cables: flexible cords and flexible cables.

x) SANS 60044-1: Instrument transformers Part 1: Current Transformers.

y) SANS 60044-2: Instrument transformers Part 2: Voltage Transformers.

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- z) SANS 60269: Low Voltage Fuses.
  - aa) SANS 60079-14: Explosive atmospheres: Electrical installations design, selection and erection.
  - bb) SANS 60529: Degrees of Protection.
  - cc) SANS 60614: Conduits for Electrical Installations.
  - dd) SANS 60695-2: Fire Hazard Testing – Part 2: Glowing / hotwire test methods. Glow wire flammability test method for end products.
  - ee) SANS 61000: Electromagnetic compatibility (EMC). Part 1. General.
  - ff) SANS 10292: Earthing of low voltage distribution systems.
  - gg) SANS 61213: Mechanical Glands.
  - hh) SANS 1274: Coatings applied by the powder coating process.
  - ii) IEC TR 61641: Enclosed low-voltage switchgear and control gear assemblies - Guide for testing under conditions of arcing due to internal fault.
  - jj) SANS 10131: Above-ground storage tanks for petroleum products.
  - kk) SANS 10108: The classification of hazardous locations and the selection of equipment for use in such locations.
  - ll) SANS 60079-10-1: Classification of areas — Explosive gas atmospheres.
  - mm) SANS 60439-1/IEC 60439-1, Low-voltage switchgear and controlgear assemblies – Part 1: Type-tested and partially type-tested assemblies

MC3

**QUALITY**

Material and equipment shall be new and unused and of the best quality available.

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## SYSTEMS AND OPERATING/ENVIRONMENTAL CONDITIONS

The Motor control centre is for in indoor installations which form part of eThekweni Water and Sanitation Low Voltage (400/440/230V) system and shall be designed to operate satisfactorily when subjected to the following operating conditions:

Description	Detail
Climate	humid and sub-tropical
Altitude	from sea-level to 1 000 m
Ambient temperature	from 0°C to 50°C
Maximum relative humidity	99 %
Highest system phase-to-phase voltage	440 V
System frequency	50 Hz
System neutral earthing	Solid
Fault level	TBA
Service configuration of switchboard	In-line extendable to form a continuous bank
Mean annual value of solar radiation	1.0 kW/m <sup>2</sup>
Average total annual rainfall figure	1 000 mm
Lightning level/lightning ground flash density	High/up to 5 flashes per km <sup>2</sup> per year
Line configuration	Triangular, horizontal and vertical
Number of phases Plus Neutral	3 + N



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MC4      **MOTOR CONTROL CENTRES**

MC4.1      **Overview**

The motor control centre (MCC) shall incorporate all equipment necessary for the control and protection of the electric motors.

Indoor panels shall be totally enclosed and flush fronted. Outdoor panels shall have an outer hinged door, free of equipment, providing a weatherproof enclosure for the inner door. All equipment shall be mounted within the panels and connections and terminals shall be easily accessible. Pilot lights, instrumentation, control switches etc. shall be mounted on a hinged door.

The incoming switch, control equipment, distribution equipment and starters shall be housed in separate metal enclosed panels.

With the starter main isolator in the OFF position there shall be no live wires entering the starter cubicle.

With the incoming main switch in the OFF position there shall be no live wiring entering the entire panel.

Live incoming cable terminals are to be located in separate panels to outgoing terminations and are to be effectively shrouded against inadvertent contact.

Equipment shall have adequate current carrying capacity and shall be labelled corresponding to line and schematic diagrams.

The form of internal separation (in accordance with SANS 60439-1 ) shall be as specified in the Project Specification. Form 4a as appropriate, shall be considered the minimum allowable internal separation for DBs and MCCs.

An earth bar shall be fitted, to which all non-current carrying metal parts are bonded. As a standard a separate earth bar shall be provided for connecting equipment requiring a clean earth or an intrinsically safe earth directly to the main incoming earth terminal. The earth bar shall be located through out the MCC.

Panels shall not be moved onto site until finishing trade work has been completed in the room where the panels are to be installed. The supplier shall allow in his pricing for storage under suitable conditions until delivery.

MC4.2      **Shop Drawings**

Three copies of shop drawings shall be submitted to the Engineer for approval, two weeks in advance of manufacture.

Shop drawings shall include at least:

- (a)            substantiation of the short circuit capabilities of the busbar support system in the form of authority test reports.
- (b)            substantiation of the full load rating of the busbars.
- (c)            time - current characteristics of the protective devices including, fuses, circuit breakers, and protective relays.
- (d)            front and side elevations of equipment and component layout.
- (e)            construction, dust proofing, vermin proofing, cable access and cable termination details.
- (f)            power single line diagrams drawn to the IEC system
- (g)            control schematic diagrams drawn to the IEC system
- (h)            cable termination diagrams
- (i)            component schedules cross referenced to drawings and equipment.
- (j)            component layout drawings showing the position and designation of all components.

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**MC4.3      Installation Drawings**

Three copies of installation drawings shall be submitted to the Engineer for approval two weeks in advance of manufacture. The drawings shall include at least :

- (a) adjacent trenches, penetrations, walls, cable trays and other equipment.
- (b) surrounding space available for access and maintenance
- (c) cable routing and cable entry details
- (d) details of supports required, other than those built into the control panel.
- (e) details of cable trench covers.
- (f) Drawings to be submitted in electronic format Autocad(.dwg)

**MC4.4      Enclosures**

Panels in existing installations shall match existing panels in general appearance.

3CR12 stainless steel shall be at least 1.5 mm thick for panels up to 0,75 m<sup>2</sup> and at least 2mm thick for larger panels.

There shall be no lap-welding of the steel frame or steel panels. Burrs, sharp edges, blemishes and welding slag shall be removed prior to painting. Construction shall be dust and vermin proof and suitable for ambient conditions.

Floor standing panels shall be provided with a removable steel channel base.

Panels in excess of 100 kg shall be provided with a removable steel channel base.

Panels in excess of 100 kg shall be provided with removable lifting eyes.

Covers and doors shall be hinged. Lift-out covers will not be accepted.

Panels shall be extensible in both directions.

The finished metal work is to be approved by the Engineer prior to painting.

**MC4.5      Ventilation**

All enclosures shall be ventilated without degrading dust and vermin proofing.

Location	Description	Minimum rating
Indoor	Clean, dry areas (e.g. inside substations or motor control rooms)	IP54 (doors closed)
		IP2X (inter-compartment & doors open)
Outdoor	Located outside buildings	IP65 (doors closed)
		IP2X (inter-compartment & doors open)

**Minimum levels of ingress protection**

Enclosures containing heat producing equipment shall be louvered such that adequate upward and cross ventilation is obtained.

Ventilation shall ensure that the temperature at any point within the enclosure does not exceed 40°C, irrespective of the ambient temperature, when the equipment is operating at full load.

Outdoor panels shall be fitted with heaters and thermostats to effectively prevent condensation within the panels.

**MC4.6      Vermin Proofing**

Panels shall be protected against the entry of vermin.

Non-hardening compound shall be supplied with the panels to permit sealing of entries after installation of cables.

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MC4.7     **Space Requirements**

The panel shall be sized to allow for the following clearances:

- |     |   |       |
|-----|---|-------|
| (a) | bare conductors or terminals to earth   | 45 mm |
| (b) | insulated busbars to earth  | 40 mm |
| (c) | equipment to metal work   | 50 mm |
| (d) | vertical distance between horizontal rows of equipment  | 75 mm |
| (e) | When installing equipment in the MCC the equipment shall be install as per the manufactures specifications. |       |

Cable entries and equipment shall be so disposed that the minimum bending radius of cables is not exceeded.

MC4.8     **General and Installation Arrangement Details**

Large circuit breakers and switch fuse units shall be positioned at low level.

Sufficient space shall be allowed between equipment for routing of conductors and expansion of ionised gas.

Flash barriers shall be installed between items of equipment where operation of one item is likely to cause an insulation breakdown in the other.

Control fuses shall be base mounted on busbars. Unprotected wiring may not be run to remote fuses or equipment.

All parts of the control panel metal work shall be electrically continuous and studs shall be provided for earthing the enclosure.

Flexible copper straps shall be used for earthing hinged doors carrying control equipment.

MC4.9     **Cable Gland Plate**

A removable cable gland plate shall be installed across the full width of the panel at a height appropriate to the bending radius of the cables and the manner of approach of the cables.

A channel iron cable support and saddles shall be provided to carry the mass of the cables and remove mechanical stress from the glands.

MC4.10    **Paint Finish**

An electrostatically applied powder coating is the preferred finish. Baked enamel finishes will not be accepted.

Care shall be taken that all edges and corners are properly covered.

Panels shall be electric orange device plates shall be white.

The painting process shall include at least the following steps:

- |     |  |
|-----|--|
| (a) | metal work is to be derusted by complete submersion in phosphoric acid.  |
| (b) | thorough rinsing   |
| (c) | metal work has to have an anti-corrosive coating applied by complete submersion in zinc phosphate followed by thorough rising. |
| (d) | metal work is to be passivated by submersion in chromic acid   |
| (e) | metal work is to be thoroughly dried   |
| (f) | metal work is to have a 10 micron primer coat applied  |
| (g) | primer coat is to be thoroughly rubbed down with fine abrasive paper and dusted off.   |
| (h) | polyurethane powder is to be applied to a thickness of 100 microns plus or minus 10 microns                                    |
| (i) | the metal work is to be baked at a temperature and for a duration recommended by the supplier of the paint                     |
| (j) | painted surfaces are to be cleaned and touched up to the above standard prior to handover.                                     |

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The contractor shall obtain written approval of the painting process from the paint manufacturer and submit this to the engineer.

**MC4.11 Accessories**

Door locks shall be of the Barker Nelson square key type. Hinges shall be of the D hinge type, permitting doors to be lifted off.

Hinges and door locks shall not be welded on.

Hinged doors shall not scratch painted surfaces during repeated opening and closing.

Sealing gaskets shall be of durable non-hardening synthetic rubber and shall be uniformly compressed along the entire length of the gasket without deflecting or buckling panels.

For applications outdoor, bolts, nuts, washers shall be of 316 L stainless steel.

Screws, bolts and nuts must not be in direct contact with paint work.

Self tapping screws shall not be used.

Tapped holes shall have a thread length equal to the diameter of the hole and shall be rust protected by TECTYL.

Busbar bolts shall be of mild steel and shall be fitted with lock nuts and lock washers.

**MC4.12 Wiring**

Wiring shall be arranged in horizontal and vertical rows and shall be bound with plastic straps or enclosed in wiring channels. PVC tape shall not be used for bunching or for colour identification.

Bunched conductors shall be uniform and neat and conductors shall enter and leave the harness adjacent to the chassis.

Conductors to hinged doors shall be secured at the door and the frame and the loop between the fixed points shall be covered in a flexible sleeve.

For wiring in trunking the summated cross sectional area of the conductors measured over the insulation shall not exceed 40% of the cross sectional area of the trunking.

Power and control wiring shall not be installed in the same channel.

Holes in metal work shall be fitted with rubber grommets.

Wiring shall not be subjected to pressure points.

Wiring and terminations shall be readily accessible and shall be installed away from terminals or other current carrying parts. Wiring shall not block access to equipment.

Conductors damaged during removal of insulation will be rejected as will insulation stripped beyond the leading edge of terminals.

No joints will be permitted in the run of conductors.

Not more than two conductors shall be connected to a single terminal.

Conductors shall be stranded annealed copper, PVC. Insulated, 600/1000 volt grade to SABS 150.

The minimum conductor size shall be 2,5 mm<sup>2</sup>

Screened cables shall enter panels through compression glands. Conductors shall remain within the screen at terminations for as great a distance as possible and shall leave the cable through the braid without damage to the braid. Screens shall be earthed in the control panel only.

Neutral conductors which are looped between terminals shall have the two ends crimped in a common terminal.

Conductors shall be derated and protected in accordance with the following table. It is to be noted that the maximum temperature within the panel shall not exceed 40°C.

NOMINAL SECTIONAL AREA (mm <sup>2</sup> )	CONDUCTOR RATING (AMPS)				
	NUMBER OF CONDUCTORS IN BUNCH				
	1	03-Feb	05-Apr	09-Jun	>10
1	13	12	10	9	8
1.5	17	15	14	12	10
2.5	23	21	18	16	14
4	31	28	25	22	19
6	40	36	32	28	24
10	55	50	44	39	33
16	72	65	58	50	43

#### MC4.13 **Busbars**

Busbars shall be installed along the full length of the control panels and shall be shrouded over that length by an enclosing chamber through which pass only connections to the busbars.

Busbars shall be insulated in heat shrink sleeving and the minimum clearance to earth or between live conductors shall be 40 mm. Breaks to the heat shrink sleeving shall be taped using two layers of self-adhesive PVC. tape over non-hardening compound.

Busbars and busbar supports shall be electrically and mechanically designed to withstand the dynamic and thermal short circuit stresses occurring at the specified fault level.

Busbars shall be rated for the full load current of the busbar protective device such that the internal temperature of the control panel remains below 40°C.

Busbars shall be of hard drawn, high conductivity copper and shall be of uniform cross section throughout the run.

Tufnol busbar supports may not be used above 10 kA.

Busbar support systems shall have been tested by a recognised authority and a certificate shall be submitted as evidence of the test. The test certificate and support system shall be identified and cross referenced.

Busbar support spacing shall not exceed the spacing used for the test.

#### MC4.14 **Colour Coding**

Busbar phase identification shall be red, white, blue from top to bottom, left to right and front to back when facing the panel.

Conductors shall be identified as follows:-

220/110 volt AC control	Orange
50 volt DC control	Purple (+) and Blue (-).
PLC wiring	Grey
Earth wires	Green/Yellow
Neutral wires	Black
Telemetry wiring	Yellow

#### MC4.15 **Equipment Identification**

All equipment and components used in the control panel shall be identified using the IEC system of identification.

Labels shall be black on white traffolyte and fixed to the panel by bolts and nuts in the close proximity of the component in a position where they may be easily read.

The size of the characters shall be such that they may be read from a distance of 1m by a person with normal eyesight.

#### MC4.16 **Wire Identification**

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All wire ends shall be identified using engraved interlocking ferrules which shall be cross referenced to schematic diagrams.

MC5      **CABLE LADDERS AND TRAYS**

Cable ladders, trays, hangers and fixings shall be of 3CR12 in both indoor and outdoor applications. Cable ladders, fittings and fixtures shall be the product of one manufacture.

Purpose made bends, tees, offsets and the like shall be used in preference to site manufacture. Cable ladders shall be earthed at a point closest to the source of supply and continuity shall be maintained across joints by means of jumpers. The minimum size of the earth continuity conductor shall be 16 mm<sup>2</sup>, the bonding conductor shall be 10 mm<sup>2</sup> and it shall be green PVC insulated. Cable ladders shall be run horizontally or vertically within tolerances that can be detected on a 1 metre spirit level.

MC6      **CABLE WORK**

MC6.1      **General**

Low voltage power and control cables shall be 600/1000 volt grade and shall have stranded copper cores, PVC insulation, PVC bedding, PVC sheath, galvanised steel wire armour, and a PVC outer serving.

Low voltage cables shall carry the SABS mark of approval.

MC6.2      **Cable Laying**

The contractor shall be equipped with the equipment recommended by the cable manufacturer for laying cables. This shall include at least a pulling sock, winch, pulling tension measuring device, cable rollers, corner skids and cable drum support with a means of braking.

Cables shall be laid straight. Power cables shall be spaced 100mm. Control cables may be close spaced. There shall be no cable to cable contact in crossing cables.

Cables which cross pipes shall do so below the pipes.

Signal cables shall be laid at a separation of at least 1000mm from power cables. Signal cables shall be run in PVC conduits below ground through drawboxes located above ground. Drawbox spacing shall not exceed 50m in straight runs and shall be located after every second bend. The conduit diameter shall be agreed with the engineer before installation. Conduit joints shall be well glued, taped with 2 layers of rubber tape, 1 layer of bitumen tape and shall be reinforced by being strapped to a 2 m length of 38 x 38 batten. Drawboxes shall be mounted above ground in a manner to be agreed with the Engineer and shall be watertight. A test for water tightness shall be conducted on each draw box with a fire hose.

MC6.3      **Cable Joints**

Cable joints will only be permitted in cables where the cable length exceeds a drum length.

The minimum drum lengths shall be 500 m for cable of 35 mm<sup>2</sup> and below and 300 m for larger cables.

All cable, irrespective of length, shall be delivered on drums. Cable delivered in coils will not be accepted irrespective of how short the length is.

Cables in excess of a drum length shall be jointed in a manner recommended by the manufacturer of the cable. This recommendation shall be documented.

Cores shall be ferruled and crimped. A sample crimp of each size core used shall be submitted to the engineer for approval. The sample shall be cut through and dressed after initial inspection.

MC6.4      **Cable Duct**

Cable ducts shall be laid under hardened surfaces which shall include tiled and/or loose paving.

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The cable duct diameters shall be appropriate to the cable diameters and are subject to the approval of the Engineer.

Cable pipes shall be of PVC and of a strength sufficient to withstand compaction. The integrity of cable pipes shall be examined after compaction and excavation on both sides of the pipes shall be allowed for in the tender price.

The number of ducts shall be sufficient for the cables to be installed plus twenty five percent.

MC6.5 **Sheath Integrity**

The integrity of the sheath is regarded as important.

The minimum acceptable insulation resistance between armouring and the general mass of the earth is 100 mega ohms. Cables which have insulation resistance below this value shall be replaced. The insulation resistance shall be measured with a hand cranked megger.

MC6.6 **Documentation**

As built drawings shall show:-

- (a) Cable routes fixed to permanent structures.
- (b) The disposition of each cable by cable identification number.

MC6.7 **Cables Within Buildings**

Cables run within buildings shall be run on cable ladders. Cable ladder routes shall be co-ordinated with other services by the contractor. There shall be easy and safe access to cable ladders after installation of all other services.

All accessories shall be the product of the ladder manufacturer and there shall be no site fabrication of bends, tees, fixings, fastenings and the like.

Cable ladder routes shall be agreed with the engineer before installation.

Cable ladders shall be sized to allow 50mm spacing between power cables, and for close spacing of control cables.

Power and instrument cables shall be run at the spacing recommended by the supplier of the instrument but with a minimum spacing of 500mm.

Cables shall be individually strapped to ladders using self locking, plastic straps. Cable routes shall be planned to obviate unnecessary cross over of cables.

Cables entering enclosures shall be straight for a minimum distance of 300mm above the point of entry.

MC6.8 **Terminations**

Only Pratley Enviroglands shall be used.

Compression lugs shall be embossed with the size of the compression die.

The compression tool design shall prevent release of the tool before the crimp is complete.

The compression equipment and method of use shall be recommended by the manufacturer of the lug.

Equipment shall be inspected by the engineer before use.

A sample lug shall be crimped and presented to the engineer for inspection. After inspection, the contractor shall cut through the sample at 45 degrees, dress the surface and present the sample for inspection.

MC7 **STATING DEVICES**

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## MC7.1 **VARIABLE SPEED DRIVES**

Standard Specification for Variable Frequency Drives (VFDs) to be used in eThekweni Water and Wastewater applications

This shall be used to specify the required features of VFDs that are designed for use with standard IEC and/or NEMA AC induction motors, synchronous reluctance motors (SynRM) and permanent magnet motors (PM) in Water and Wastewater applications.

Any deviations from this specification must be:

- A) LISTED and
- B) APPROVED

by the specifier PRIOR to the quotation.

### PART 1 - GENERAL

#### 1.01 DESCRIPTION

This specification is to cover a complete Variable Frequency Drive (VFD) consisting of a pulse width modulated (PWM) inverter designed for use with a standard AC induction motor, synchronous reluctance (SynRM) and permanent magnet (PM) motors in Water and Wastewater applications.

The VFD manufacturer shall supply the VFD and all necessary options as specified. VFDs that are manufactured by a third party and "brand labeled" shall not be acceptable. All VFDs installed on this project shall be from the same manufacturer.

#### 1.02 TERMINOLOGY USED

- A. Cabinet: Enclosure into which the VFD may be built
- B. Control panel: Device to be used in controlling and/or monitoring the VFD; normally attached on the VFD cover or on the cabinet door
- C. Motor: Induction motor (IM), Permanent magnet Motor (PM) or Synchronous reluctance motor (SynRM), typically IE2, IE3 or IE4 efficiency class
- D. THDi: Total Harmonic Distortion of current
- E. VFD: Variable Frequency Drive (aka: AFD, ASD, VSD, inverter, drive, etc)

#### 1.03 QUALITY ASSURANCE

- A. Referenced Standards and Guidelines:
  - 1. International Building Code (IBC)
    - a. IBC 2012 Seismic – referencing ASC 7-05 and ICC AC-156
  - 2. International Electro-technical Commission (IEC)
    - a. IEC/EN 61800-3, Adjustable speed electrical power drive systems
    - b. IEC/EN 60529:1992 + A2: 2013 (IP), Degrees of protection provided by enclosures
    - c. IEC 60664-1:2007, Insulation coordination for equipment within low voltage systems
    - d. 2014/35/EU Low voltage directive
    - e. 2014/30/EU Electromagnetic compatibility (EMC)
    - f. 2006/42/EC Machinery directive
  - 3. Institute of Electrical and Electronic Engineers (IEEE)
    - a. IEEE 519, Guide for harmonic content and control
  - 4. International Organization for Standardization (ISO)
    - a. ISO 9001:2015, Quality Management System



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- b. ISO 14001:2015, Environmental Management System
  - c. ISO 45001:2018, OHSMS Management System
  - 5. National Electric Code (NEC)
    - a. NEC 430.120, Adjustable-Speed Drive Systems
  - 6. National Electrical Manufacturer's Association (NEMA)
    - a. ICS 7.0, AC Adjustable Speed Drives
  - b. NEMA 250:2008, Enclosures for Electrical Equipment
  - 7. Underwriters Laboratories (UL)
    - a. UL508A, Industrial control panels
    - b. UL508C, Power conversion equipment
    - c. UL61800-5-1, Standard for adjustable speed electrical power drive systems
  - B. Qualifications:
    - 1. The VFD manufacturer shall:
      - a. have a minimum of 40 years of experience in VFD design and manufacturing and
      - b. have adequate business volume in order to provide credibility in its commitments and capability for long-term support,
      - b. be able to make identical products in more than one location, in order to ensure production capacity at all times,
      - c. have a Functional Safety Management system and valid IEC 61508-1 certificate available,
      - d. have a valid ISO 9001:2008 certification and an applicable quality assurance system and certificate available,
      - e. have a valid Environment Certification ISO 14001:2014 and certificate available,
      - f. have an Occupational Health and Safety Management system and valid OHSAS 45001 certificate available.
    - 2. The VFD shall comply with the technical requirements specified in IEC/EN 61800-5-1:2007 (Adjustable speed electrical power drive systems – Part 5-1: Safety requirements – Electrical, thermal and energy).
    - 3. The VFD shall with the technical requirements specified in EN 61800-3:2004 + A1:2012 (Adjustable speed electrical power drive systems – Part 3: EMC requirements and specific test methods).
    - 4. CE mark - The VFD shall comply with the following directives, required for the CE mark:
      - a. Low Voltage Directive 2014/35/EU of the European Parliament and of the Council of the European Union.
        - 1) The VFD shall have the manufacturers name and postal address printed on the VFDs type label and package label according to LVD 2014/35/EU.
        - 2) The contact details shall be clearly printed and not removable from the VFD.
        - 3) VFDs without the manufacturer's name and contact details are not acceptable.
      - b. Electromagnetic compatibility (EMC) Directive 2014/30/EU of the European Parliament and of the Council of the European Union.
      - c. Machinery Directive 2006/42/EC of the European Parliament and of the Council of the European Union.

A manufacturer's Declaration of Conformity to confirm compliance with mandatory directives shall be available for public access. The Declaration of Conformity of Machinery Directive shall specify the person authorized to compile the VFDs technical file for safety functions. Contact details shall be included in the Manufacturers Declarations.
    - 5. CULUS approval

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- a. The VFD shall comply with the technical requirements of UL according to UL61800-5-1. A UL listing document shall be available to confirm VFDs compliance with the requirements.
  - b. In lieu of UL61800-5-1 compliance, the VFD shall comply with the technical requirements of UL according to UL508C. A UL listing document shall be available to confirm VFDs compliance with the requirements.
  - c. Along with the declaration, there shall be the UL (Underwriters Laboratories) mark on the VFDs type label to identify the compliance.
  - d. Pending UL approval is not accepted.
  - e. The VFD shall be UL labeled 100 kA SCCR, RMS Symmetrical, 600V max.

6. Environmental Manufacturing

- a. The VFD shall comply with Restriction of Hazardous Substances in Electrical and Electronic Equipment directive 2011/65/EU requirements, so called RoHS II requirements.
- b. The VFD shall be easy to recycle. The manufacturer shall make recycling instructions publicly available. The recycling instructions shall provide recycling information in accordance to Waste Electrical and Electronic Equipment directive 2012/19/EU (WEEE).
- c. The VFD shall not contain toxic or hazardous substances or elements above the maximum concentration values as specified in the People's Republic Electronic Industry Standard (SJ/T 11364-2014). The EIP (Electronic Information Products) mark shall be on the VFDs type label to identify EIP compliance.

7. Functional Safety

- a. The VFDs shall support 'Safe Torque Off' (STO) function capable for safety related applications up to SIL 3, SILCL 3 and PL e.
- b. The VFD shall comply with the following standards
  - 1) IEC 61508:2010; SIL
  - 2) ISO 13849-1:2006; PL e
  - 3) IEC 62061:2005; SILCL 3
  - 4) IEC 61800-5-2:2007; SIL 3
- c. There shall be a 3rd party statement of compliance available to confirm the VFDs compliance. Manufacturer's statements are not accepted to confirm compliance

1.04 SUBMITTALS

- A. The Submittals shall include the following information:
  - 1. Product Overview
  - 2. Dimensional Drawings
  - 3. Control Circuit Drawings
  - 4. Engineering Data including rating tables and weight
  - 5. General Notes

PART 2 - VARIABLE FREQUENCY DRIVES (VFD)

2.01 GENERAL

- A. The VFD must be designed specifically for the Water and Wastewater market. General purpose products are not acceptable.
- B. The VFD shall have the same customer interface, including control panel, I/O connections and firmware, regardless of power, voltage rating or harmonic mitigation solution.
- C. The VFD shall be solid state, with a Pulse Width Modulated (PWM) output. The VFD shall

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be a Sensorless Vector AC to AC converter utilizing the latest Insulated Gate Bipolar Transistor (IGBT) technology. The VFD shall employ a Sensorless Vector inner loop torque control strategy that mathematically determines motor torque and flux. The VFD must also provide an optional operational mode for V/Hz operation.

D. Electrical network

1. The VFD shall be rated to operate from:
  - a. 3-phase, 380 to 480 VAC, +10%...-15%
2. The VFD shall operate with supply frequencies from a minimum range of 47.5 to 63Hz. Nominal power ratings shall be met in the allowed frequency range.
3. The VFD shall operate should a minimum +/- 3% of nominal phase to phase input voltage imbalance exist. Nominal power ratings shall be met at all times.
4. The VFD shall be allowed to be used on TN (grounded), IT (ungrounded) and corner grounded TN systems without options or hardware modifications.
5. The VFD shall employ a full wave rectifier to prevent input line notching and operate at a fundamental (displacement) input power factor of 0.98 at all speeds and nominal load.
6. The VFD shall be designed to be used in, and to meet the requirements of, public low voltage networks. VFDs designed only for industrial electrical networks are not accepted.
7. The VFD must comply with SEMI F47 – the semiconductor industry standard for voltage sag immunity. Compliance shall be verified by a third party.

E. EMC, Electromagnetic compatibility

1. The VFD shall have inbuilt EMC/RFI filters as standard.
  - a. It shall be possible to disconnect the EMC filters without specific tools (for IT and corner grounded TN electrical systems).
2. The VFD shall conform to the European Union Electro Magnetic Compatibility (EMC) Directive EMC 2014/30/EU, a requirement for CE marking.
3. The VFD shall comply with the EMC Product Standard for drives EN 61800-3 Class C3 (2nd environment, restricted distribution) as standard.
4. The manufacturer shall provide suitable cable glands for EMC compliant installation.

F. Harmonics

1. The VFD shall comply with mandatory Equipment Standard IEC/EN 61000-3-12:2007: Limits for harmonic currents produced by equipment connected to public low voltage systems.
2. The manufacturer shall provide a tool for calculating the current and voltage harmonics at the input terminals of the VFD.
3. The VFD shall not contribute any significant harmonics at the input terminals of the VFD and shall maintain harmonics levels at the VFDs input terminals to levels at or below

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those listed in “Harmonic Control in Electrical Power Systems, IEE Std. 519-1992” in the system that is already in compliance with the said standard.

4. The input current to the VFD shall have a total harmonic content less than 5% of full rated capability at the input terminals of the VFD on a power system sized according to IEEE 519-1992 at a line voltage unbalance up to 3% and under all motor load conditions.
5. The VFD design shall not compensate for existing harmonic content in the distribution system.
6. The VFD harmonic solution shall be contained within the VFD, not require external hardware (ie transformers, filters, etc) and not require additional wiring (ie 3 power wires in, 3 motor wires out).
7. Regenerative front end VFDs used as harmonic solutions are not acceptable, due to possible regeneration on to power distribution network. The VFD shall not interfere with the Emergency Back-up Generator’s voltage regulator.
8. VFD without DC Bus capacitors are not acceptable.
- G. Environmental conditions
  1. Temperature
    - a. The VFD shall have a minimum temperature range for transportation and storage from -40 to 70 °C.
    - b. The VFD shall operate without disturbances in continuous ambient temperatures with a minimum range from -15 to 50 °C (no frost allowed).
  2. Altitude
    - a. The VFD shall be suitable for safe operation up to a minimum of 4000 m (13,000 ft) altitude in neutral grounded TN electrical systems.
    - b. The VFD shall be suitable for safe operation up to a minimum of 2000 m (6,500 ft) altitude in corner grounded TN electrical systems or IT systems.
  3. Humidity
    - a. The VFD shall be designed to operate in ambient conditions of relative humidity with a minimum range from 5 to 95% (without condensation).
    - b. A motor heater function shall be supported to prevent condensation and corrosion of the motor.
  4. Vibration
    - a. The VFD shall be designed to operate in vibrating environments with vibration limits allowed per IEC 60068-2 (modules) or IEC 60721-3-3 (cabinets).
  5. Contamination
    - a. The VFD shall operate in contamination levels according to IEC 60721-3-1, IEC 60721-3-2 and IEC 60721-3-3; Chemical gases min. class 3C2, Solid particles class 3S2.
    - b. All printed circuit boards (PCB) shall be conformal coated to extend the electronics lifetime in harsher environments.

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- H. The protection class of the VFD (class defined by IEC/EN 60529:1989 + A1:1999 + A2:2013) shall not reduce the output current rating nor any environmental condition ranges.
  - I. The VFD output frequency shall be adjustable between 0 to 500Hz, forward or reversing. Operation above motor nameplate shall require programming changes to prevent inadvertent high-speed operation.
  - J. Maintenance
    - 1. The VFD shall have cooling fans that are designed for easy replacement. The fans shall be designed for replacement without removing the VFD from the wall or removal of circuit boards.
    - 2. The VFDs main cooling fans for the power electronics shall be speed controlled based on the cooling need. Fan speed should be controlled to extend the fan and fan bearing operating lifetime.
    - 3. The VFD shall record a) VFD on-time, b) VFD run-time and c) cooling fan on-time for maintenance logging purposes.
    - 4. The VFDs cooling fans shall have a minimum expected lifetime of 6 years.
    - 5. Any battery used in the VFD shall have a minimum expected lifetime of 6 years.
    - 6. For cabinet-built VFDs, all heavy components shall have a service position for safe maintenance operation.

## 2.02 MOTOR CONTROL

- A. The VFD shall be capable of controlling an induction motor, permanent magnet motor and synchronous reluctance motors as standard.
- B. It shall be possible to commission an induction motor, permanent magnet motor and synchronous reluctance motor with the motor nameplate values only, without the need to get the motor values from other sources.
- C. The VFD shall include scalar and vector control modes with independent control chains and parameters for each control mode.
- D. The overload rating of the VFD shall be 110 % of its rated normal duty current for 1 minute every 10 minutes and with a minimum of 130 % for 2 seconds every 1 minute. Overload ability shall be available at all times - not only at start.
- E. The VFD shall be capable of sensing the loss of load (broken belt / broken coupling / dry pump) and signal the loss of load condition. The VFD shall be possible to be programmed to signal this condition via a control panel warning, relay output and/or over the serial communications.
  - 1. Relay outputs shall include programmable time delays that will allow for VFD acceleration from zero speed without signaling a false underload condition. Underload and overload curves shall be user-definable.

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- F. It shall be possible to disconnect a motor running full speed by opening an optional contactor between motor and VFD without causing any damage to the VFD.
  - G. The VFD shall include a standard embedded functional safety feature Safe Torque Off, (STO), to make the motor mechanically safe.
  - H. The VFD shall include an energy optimization circuit (flux optimization) that will automatically reduce applied motor voltage to the motor to reduce energy consumption by up to 10% and lower audible motor noise.
  - I. The VFD shall be capable of starting into a spinning load (forward or reverse) up to full speed and accelerate or decelerate to a set-point (flying start) without tripping or component damage.
  - J. The VFD shall restart after a power loss without the need to resend the start command. This feature shall be there regardless of the control source, control panel, I/O or fieldbus.
  - K. Flux braking shall be available, where the VFD controls the motor to dissipate the extra rotary energy as heat whenever braking is required. It shall be possible to use this flux braking feature to decelerate the motor from one speed to another – not only for stopping the motor.
  - L. Power Loss Ride-Through shall be programmable. If the incoming supply voltage is cut off, the VFD continues to operate using the kinetic energy of the rotating motor. The VFD continues to be operational as long as the motor rotates and generates energy.
  - M. The VFD shall include a switching frequency control function. This adjusts the switching or carrier frequency, based on actual VFD temperature and allows the highest carrier frequency without de-rating the VFD or operating at high carrier frequency only at low speeds (temperature fold-back). It shall be possible to set a minimum and a reference switching frequency.
  - N. The VFD shall include a noise smoothing function, which distributes the acoustic motor noise over a range of frequencies instead of a single tonal frequency resulting in lower peak noise intensity.
  - O. The VFD shall have three programmable critical frequency or critical speed lockout ranges to prevent the VFD from operating the load continuously on an undesirable speed range (skip frequencies)

## 2.03 STANDARD CONTROL HARDWARE FEATURES - ADJUSTABLE BY THE USER

### A. General I/O

- 1. All I/O terminals shall be color coded to simplify wiring and troubleshooting.
- 2. All I/O shall be accessible (monitor and control) for fieldbus protocols (pass-through I/O).
- 3. It shall be possible to monitor status of the I/O from the control panel.
- 4. The VFD shall have a special mode for testing the I/O and VFD configuration without requiring external equipment connected.

### B. Analog I/O

- 1. The VFD shall have at least two programmable analog inputs. Both inputs shall accept

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current (0 to 20 mA or 4 to 20mA) or voltage (0 to 10 VDC) signals. The signal type selection, current or voltage, shall be made via the VFD user interface; DIP-switches or jumpers are not allowed.

2. The analog inputs shall be freely programmable to be used e.g. as speed reference, frequency reference, pressure monitor or PID loop controller's setpoint reference or feedback signal.
3. The VFD shall have at least two programmable analog outputs (0 to 20 mA or 4 to 20 mA); out of which one shall be configurable to be either a current or voltage (0 to 10 VDC). The signal type selection, current or voltage, shall be made via the VFD user interface; DIP-switches or jumpers are not allowed.
4. The analog outputs shall be freely programmable to give an output signal proportional to any data available via the VFD user interface (including, but not limited to: frequency, motor speed, output voltage, output current, motor torque, motor power, DC bus voltage, active reference and other data).
5. Analog I/O signals shall have an accuracy of > 99% of full scale in both current and voltage modes.
6. If the input reference (4 to 20 mA or 2 to 10 VDC) is lost, The VFD shall give the user the option of: (1) stopping and displaying a fault; (2) running at a programmable preset speed and displaying an alarm; (3) hold the VFD speed based on the last good reference received and displaying an alarm. It shall be possible to program the VFD to signal this condition via the control panel, relay output and/or over the serial communication bus.

C. Digital I/O

1. The VFD shall have at least six programmable digital inputs (24 VAC and 12 to 24 VDC, PNP or 5 pcs NPN) to connect to external devices, as follows:
  - a. All inputs can be configurable for PTC sensors.
  - b. There shall be a programmable run permissive circuit.
  - c. Up to four programmable free text interlock inputs shall be available.
  - d. The VFD shall have at least one digital input which can be configured to receive a pulse signal up to 16 kHz.

D. Relay I/O

1. The VFD shall have at least three programmable digital Form-C relay (changeover) outputs. The relays shall include programmable on and off delay times.

E. I/O Optional Extension Modules

1. The following I/O option modules shall be available:
  - a. A module with two relay outputs and one digital output.
  - b. A reinforced insulated PTC input module for up to six PTC sensors with the capability to trigger the STO circuitry of the VFD.
  - c. A module to provide an additional six digital inputs which can be operated with 115 VAC or 230 VAC voltage.
  - d. An ATEX (EU directive 2014/34/EU) certified Ex II (2) GD PTC input module for up to 6 PTC sensors with the capability to trigger the STO circuitry of the VFD.

## 2.04 SOFTWARE FEATURES

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- A. Water specific features:
1. The VFD shall have specific pump control functionality to control up to six pumps with one VFD to allow distribution of pump usage in a multiple pump system.
  2. The VFD shall have multipump functionality with an intelligent master/follower configuration for controlling up to eight parallel pumps equipped with own VFD without additional devices:
    - a. The VFD shall have a parameter synchronization feature to broadcast PID, Multipump and Analog Input parameters to ensure system parametrization is equal in the parallel VFDs
    - b. The VFD shall have specific functionality to start and stop the pumps based on the required pumping capacity. In order to balance the operating time of the pumps, the VFD shall have the capability to change the order in which the pumps are started and stopped.
    - c. The VFD shall have the capability to give priorities for parallel pumps in the system to enable the most efficient pumps to be operated the most.
    - d. The VFD shall have the capability to set a maximum stationary time to ensure all pumps get exercised regularly, regardless of their priorities.
    - e. The VFD shall have the capability to control across-the-line pumps instead of parallel VFDs, in order to resolve the system demand.
  3. The VFD shall have a level control function with operation modes for optimal tank filling or emptying supporting up to eight parallel pumps.
    - a. User-programmable start level shall indicate the point at which the pump will start.
    - b. The pump(s) shall operate in user-programmable “efficient speed”.
    - c. If the level keeps raising, more pumps will be started based on unique start levels.
    - d. There shall be a possibility to connect high- and low-level limit switches, which will trigger either full speed pumping or pump stop, depending if the application is for filling or emptying a tank
  4. The VFD shall have the ability to calculate the flow based on the measured pressure difference (using pressure sensors) or the power curve of the pump (sensorless).
    - a. There shall be a multiplier parameter to enable correction for the calculation.
    - b. There shall be a specific energy parameter to measure actual flow per input power ratio. The motor speed can be adjusted to locate the most economical pumping point.
  5. The VFD shall have two additional ramps for quick acceleration and two additional for deceleration in order to reduce wear of the mechanical parts in submersible pumps.
  6. The VFD shall have soft pipe filling function with flexible user parameter settings to protect the system. There shall be a configurable pipe fill time to ensure the setpoint is reached within a desired time.
  7. The VFD shall have a specific “Pump cleaning” functionality, based on a series of rapid reverse and forward rotation of the impeller, to prevent pump and pipe clogging.
    - a. The VFD shall have the cleaning cycle counter and user-programmable cleaning count time to give a warning and indicate the need for manual inspection.
    - b. The cleaning function shall consist of forced stopping, reverse and forward rotations to allow debris to be removed from the impeller.
    - c. There shall be a cleaning cycle status visible on the control panel screen when the cleaning function is active for monitoring the cleaning progress.
    - d. The VFD shall resume normal operation after the cleaning cycle is complete.



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8. The VFD shall have a programmable Sleep functionality for PID control in pumping systems to stop the pump during low demand.
  - a. The VFD shall have a specific "Sleep Boost" functionality to minimize the amount of unnecessary pump starts and stops during periods of low demand. The sleep boost function is used to boost the pressure or water level up before the pump shuts down in order to extend the pumps sleeping time.
  9. The VFD shall support a torque boost function for applications where boosting of the torque is required for initial starting of the pump.
- B. PID control
1. The VFD shall have a minimum of two independent process PID controllers as standard, allowing pressure or flow signals to be connected to the VFD, using the microprocessor in the VFD for the closed loop control.
  - a. The VFD shall have 250 mA of 24 VDC auxiliary power and be capable of loop powering a transmitter supplied by other suppliers.
  - b. The loop controller setpoint shall be adjustable from the VFDs control panel, analog inputs, or over the serial communications bus.
  - c. The VFD shall have a minimum of four constant setpoints available for each loop controller.
  - d. The setpoint shall be possible to be set and displayed in engineering units. Using only percentage as setting and display unit is not acceptable.
  - e. There shall be two parameter sets for the first PID loop controller. Switching between the sets shall be possible via digital inputs, timed function, and serial communications or from the control panel.
  2. All setpoints, process variables, etc. shall be accessible from the serial communication bus.
  3. The VFD shall have the ability to calculate air or water flow from pressure difference. There shall be the possibility to use a differential pressure transducer or two separate pressure transducers. The control panel shall be able to display the flow in engineering units.
  4. PID controller shall be standard in the VFD, allowing an analog input signals to be connected to the VFD for the closed loop control. The VFD shall have 250 mA of 24 VDC power to power an external transmitter supplied by others. The loop controller set-point shall be adjustable from the VFD control panel, analog inputs, or over field bus. The set-point shall be set and displayed in engineering units.
- C. Function block programming
1. The VFD shall provide a PLC-like programming capability as standard.
  2. It shall be possible to use different kinds of arithmetic, logical, selection, comparison and operation function blocks to monitor and control the VFD, functions, inputs, outputs and variables.
  3. There shall be a possibility to run different kinds of function block programs in different states and to set the criteria, when to change the state.
- D. Timed functions
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1. A real-time clock and calendar shall be available as standard for giving true time and date information to fault event history. The real-time clock shall have a minimum of 10 years power-off back-up without optional components. Back-up battery shall be replaceable without opening the VFD enclosure
  2. A real-time clock shall be possible to use with timed functions, which shall allow controlling the VFD and its functions based on: time of the day, day of the week, seasons of the year, holiday periods and holiday dates and special working periods and working days
  3. Timed functions shall be possible to use for: starting and stopping the VFD, for selecting the speed reference, for selecting the PID loop controller's set-point, for controlling the relay outputs, for selection the control location, for giving the run permissive or interlock signal to the VFD, etc.
  4. There shall be the ability to temporarily override the time controlled start and start the and/or its functions regardless of: the time of the day, day of the week, season of the year, holiday, or workday.
  - E. Fault Logger: A fault logger shall accommodate seven diagnostic values together with a date and time stamp.
  - F. Built in Energy Calculators: There shall be built-in counters for calculating energy savings achieved with the VFD.
    1. Used and saved energy
    2. CO2 reduction
    3. Saved money
    4. Programmable kW rate
  - G. Pre-Set Speeds: There shall be a minimum of seven programmable pre-set speeds or frequencies.
  - H. Operating Values: All applicable operating values shall be capable of being displayed in engineering (user) units. A minimum of three operating values from the list below shall be capable of being displayed at all times. Engineering units shall be freely configurable for the user to display.
    1. Output frequency
    2. Motor speed (RPM, %, or engineering units)
    3. Motor current
    4. Calculated motor torque
    5. Calculated motor power (kW)
    6. DC bus voltage
    7. Output voltage
    8. Energy Consumption
  - I. Underload and overload curves shall be user-definable.
  - J. Independently adjustable acceleration and deceleration ramps with 1 to 1800 seconds adjustable time ramps. There shall be a possibility to use start delay before acceleration to ensure that all start conditions have been fulfilled.

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- K. Changed parameters list shall be available in order to assist commissioning and troubleshooting.
  - L. The VFD shall include pass code protection against unauthorized parameter changes. The pass code and the protection level shall possible to be defined by the user.
  - M. The VFD shall have ability to use any internal parameter value as input for any other parameter.
  - N. The VFD shall have the capability to fault or to show warning when triggered from external sources.

#### 2.05 PROTECTIONS

- A. The following protection functions shall be available:
  - 1. Dry pump Protection: (Prevent the pump from running dry. Protects the pumps bearings and shaft seal from damage when there is no water in the pump)
  - 2. Overvoltage and under-voltage controller
  - 3. Ground Fault (Earth-leakage) supervision
  - 4. Motor short-circuit protection
  - 5. Output and input switch supervision
  - 6. Overcurrent protection
  - 7. Phase-loss detection (both motor & line)
  - 8. Underload and overload supervision
  - 9. Freely configurable supervisions for any parameter or signal to trigger an action.
  - 10. Communication loss functionality to ensure uninterrupted operation.
    - a. The VFD shall have the capability to change the control location from PLC to another external location identified by user, e.g. VFDs embedded PID/loop controller and change back when communication is recovered.
  - 11. The VFD shall have pump protection functions for flow and pressure to avoid damages of the pump and for leakage detection.
    - a. Inlet protection for avoid dry run, cavitation and blocked pipe.
    - b. Outlet protection for avoid high pressure and leakages.
    - c. Stall protection for avoid running locked pump.

#### 2.06 USER INTERFACES

- A. Detachable control panel
  - 1. The control panel shall be detachable in all types of VFD protection classes and/or enclosures, without tools to allow easy commissioning and programming of multiple VFDs.
  - 2. The control panel shall include a backlit LCD.
  - 3. The control panel shall have a real-time clock with battery backup for adding time stamps

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to events, as well as for use with timer functions.

4. The control panel shall provide a clear, interactive, context sensitive menu based user interface to make it easy to adjust the settings of the VFD.
5. The display shall be in complete words, in a language selectable by the user, for programming and fault diagnostics (alphanumeric fault codes are not acceptable).
6. The control panel shall provide interactive assistants (wizards) to help to commission and use the VFD.
7. A dedicated "Help" button shall be available on the control panel. The Help button shall provide context sensitive assistance for programming and troubleshooting.
8. The control panel shall provide an easy to use I/O menu, where the user can see the status and function of all the analog and digital inputs and outputs.
9. The control panel shall have a menu, which contains diagnostic data about the VFD operation. The data shall include data about active faults, warnings and events. In addition the data shall contain a summary of VFD active control sources.
10. There shall be an editable home-view in the control panel to allow different customer specific configurations.
  - a. A minimum of three operating values shall be capable of being displayed at all times.
    - i. All applicable operating values shall be capable of being displayed in engineering (user) units.
    - ii. Engineering units shall be freely configurable for the user to display.
11. The control panel shall include Hand-Off-Auto selections and manual speed control.
  - a. The VFD shall incorporate "bump-less transfer" of speed reference when switching between "Auto" and "Hand" modes.
  - b. It shall be possible to disable the Hand and Off buttons of the control panel.
  - c. As a safety feature, the control panel's Hand and Off buttons shall have clear symbols to allow non-English speaking people to understand the meaning of the buttons. English text only is not acceptable in the Hand and Off button marking.
12. There shall be a possibility to reset the VFD from the control panel.
13. The VFD shall have the capability to change the output phase rotation sequence by use of a parameter. This parameter must be independent from, and not affecting, any speed reference or direction input to the VFD.
14. The VFD shall have the capability to run the motor in either direction, forward or reverse. Additionally, the VFD shall allow for forcing the direction in a given direction, regardless of the speed reference or direction input to the VFD.
15. A listing of changed parameters shall be readily available in order to assist with commissioning and troubleshooting.
16. The VFD shall have flexible selections within a parameter. Not only shall the parameter have a list for easy selection, when applicable, but also the ability to choose any other signal/parameter that may not be within the list.
17. The VFD shall include pass code protection against unauthorized parameter changes. The pass code and the protection level shall possible to be defined by the user.

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18. The control panel shall contain at least one back-up of the VFD settings. Back-up information shall be possible to be saved on the control panel both manually and automatically.
  19. The control panel shall have the capability to copy VFD settings from one VFD to another VFD, regardless of the VFD power, voltage or enclosure rating.
  20. The control panel shall have an editable "Contact info" that shows up in case of a fault.
  21. The user shall be able to take a screen capture snapshot of the display with the control panel and be able to download the screen capture for user's computer for further purposes.
  22. The user shall be able to connect a PC tool with a standard USB cable to the control panel in order to set up and control the VFD. It shall be possible to connect the USB cable without using any tools.
  23. The VFD shall provide a possibility for wireless communication to allow working outside the arc flash boundary area and/or when there is no easy or safe access to the VFD. Wi-Fi connection is not acceptable because of its cyber security limitations.
    - a. For safety reasons, the VFD supplied with wireless communications shall have a local control panel with control buttons regardless of the wireless connection possibility.
    - B. Serial communications
      1. The VFD shall have an EIA-485 (RS-485) port for serial communications as standard.
      2. The VFD shall be equipped with built-in fieldbus communication of type Modbus RTU
      3. There shall be following optional protocols available as plug-in and inbuilt options:
        - a. EtherNet/IP, Modbus/TCP, CANopen, DeviceNet, PROFIBUS-DP, PROFINET.
        - b. Protocols that have a governing authority shall be certified. Use of non-certified protocols is not allowed.
        - c. The use of third party gateways or multiplexers is not acceptable and all communication modules shall fit inside the enclosure of the VFD.
        - d. Serial communication capabilities shall include, but not be limited to: run-stop control, speed set adjustment, proportional/integral/derivative (PID) control adjustments, loop controllers' set-point adjustment, current limit, acceleration/deceleration time adjustments and lock and unlock the control panel.

### PART 3 - EXECUTION

#### 3.01 DOCUMENTATION

- A. Documents to be delivered with the VFD:
  1. Multi-lingual quick installation and start up guide.
  2. Mounting template in case of wall mountable VFD.
  3. Hardware and firmware manuals on request, describing step-by-step how to install, start-up, trouble-shoot and maintain the VFD.
- B. Documents to be delivered per request
  1. Dimensional drawings (dwg and pdf formats).
  2. Dimensional drawings 3D (stp format).
  3. Customer connections and power wiring diagrams (dwg and pdf formats).

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4. Cooling air requirement (xls and pdf formats).
  5. Manufacturer's statement on output currents available continuously in different ambient temperatures up to 40 °C. Type of product needed at 50 °C continuous (24/7/365) operation must be clearly listed.
  6. Environmental information / Recycling instructions of the VFD.
  7. Semi F47 statement.
  8. Harmonics statement EN61800-3-12.
  9. Routine test reports.

C. ePlan macros shall be available for all the wall mountable frames and modules.

#### A.02 INSTALLATION

- A. Installation shall be the responsibility of the installation contractor. The contractor shall install the VFD in accordance with the recommendations of the VFD manufacturer as outlined in the VFD installation manual.
- B. Power wiring shall be completed by the electrical contractor, adhering to local electrical codes, wiring requirements based on the VFD input current. The contractor shall complete all wiring in accordance with the recommendations of the VFD manufacturer as outlined in the installation manual.

#### 3.03 START-UP

- A. A factory-authorized service technician shall perform start-up on each VFD.

#### 3.04 PRODUCT SUPPORT

- A. The VFD manufacturer shall have an international sales, service, training and support network. These services shall be available in the local language.
  1. The VFD manufacturer shall supply 24/7/365 technical phone support at no additional expense.
  2. Training shall include installation, programming and operation of the VFD, and serial communication. Factory authorized start up and owner training to be provided locally upon request.
- B. The VFD manufacturer shall be capable to offer spare parts support the product.
- C. The VFD manufacturer shall have an analysis laboratory to evaluate the failure of any component within the VFD.

#### 3.05 WARRANTY (SELECTION REQUIRED)

- A. The VFD shall be covered with a worldwide warranty of a minimum of 36 months from the date of delivery.  
An optional extension of warranty of up to 60 months shall be available.

**COMPULSORY: WHEN SELECTING VSD'S, CABLING AND ANCILLARY EQUIPMENT, TENDERERS MUST TAKE COGNISANCE OF THE POINTS BELOW**

1. High performance VSD cables with significant excesses of ground potential copper must be chosen.
2. In noise sensitive environments strong consideration must be given to the selection of a foil braid construction with enhanced common mode current control.

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3. The cable voltage rating must be high enough to support voltages generated by the VSD.
  4. A round cable should be selected to provide a good seal as the cable passes through circular openings and connection glands.
  5. Consult the drive manufacturer who will provide the specific information needed to make decisions about gauge size and cable run length. Note: if a cable length is too long, it will act like a large capacitor that must be charged up when the system is turned on. After that initial phase, electrical energy continually pumped into the cable from the drive can surge into the motor.
  6. Provide an effective earthing system to guard against stray currents affecting the bearings/ motor.
  7. The tenderer shall choose a well-designed, robust VSD cable which must ensure motor uptime and reliability of the VSD system and also provide protection for any sensitive instrumentation and adjacent control systems.
  8. The tenderer in his design shall choose the appropriate filter if the VSD is mounted a significant distance away from the motor.
  9. Defects which can be proved from an independent report that the bearing/motor failure is the result of stray currents, the remedial cost thereof shall be paid by the tenderer for not providing an effective design solution.
  10. A separate instrument earth bar must be provided.
  11. All VSD must be wall mounted and rated accordingly.

## MC7.2

### SOFT STARTER

Conformity of standards

#### IEC

The soft starter shall be constructed and tested in accordance with the international IEC standards EN 60947-1 and EN 60947-4-2 and respect the following EC directives:

- “Low voltage Equipment” No. 2006/95/EC
- “Electromagnetic compatibility Directive” (EMC) No.2004/108/EC

#### UL

The soft starter shall be constructed and tested in accordance with UL 508.

#### Product features

The soft starter shall comply with the following technical requirements:

#### General specification

- Three phase control with operation voltage: 208 - 600VAC or 208 - 690VAC, 50/60 Hz
- Wide rated control supply voltage: 100 - 250VAC 50/60 Hz
- Built-in bypass to reduce energy consumption at full speed and increase the life time of soft starter.
- Possibility for both in-line and inside-delta connection of the motor
- The soft starter shall have built-in Modbus RTU for communication. Support for other protocols shall be an option.
- The soft starter shall be equipped with one analog output
- The soft starter shall have a minimum of 3 signal Relays Output for Run, Bypass (Top of Ramp) and Event signal.

#### User interface

- The soft starter shall support multiple languages in both the manual and HMI, including: English, Swedish, German, French, Italian, Spanish, Portuguese, Dutch, Polish, Russian, Finish, Turkish, Czech, Chinese and Arabic.
- The soft starter shall have a detachable keypad with graphical LCD display. The keypad shall have start and stop buttons, information button for access to a built-in manual and an USB-port for connection to a PC.

#### Environmental conditions

- The soft starter shall have coated PCBAs to withstand harsh environments
- The soft starter shall support operational temperature of -25 to +60°C with de-rating of maximum 0.8% per °C above 40°C
- The soft starter shall be able to operate on up to 4000 meters above sea level with de-rating of maximum 0.67% per meter above 1000 meters

#### Motor starting, stopping and operation

- The soft starter shall have pre-start functions:
  - o Stand still brake, to keep the load still before start
  - o Motor heating, to keep the motor well-tempered before start
- The soft starter shall have the following start ramps available:
  - o Voltage start ramp
  - o Torque start ramp
  - o Full voltage start
- The soft starter shall have possibility for slow speed forward and backward operation for positioning of a motor load.
- The soft starter shall have Torque Control and pump cleaning feature, to eliminate water hammering and prolong lifetime of the pump system.
- The soft starter shall include a kick start feature to be able to start heavy loads.
- The soft starter shall have the following three types of current Limit:
  - o Current Limit
  - o Dual Current Limit
  - o Current Ramp
- The soft starter shall have a limp mode feature to allow the soft starter to operate even with shorted thyristors in one phase.
- The soft starter shall have possibility for sequence start of up to 3 different motors.

#### Built-in motor protections

The soft starter shall integrate motor and load protections, which shall under no circumstances be disabled when the integrated bypass is used. The soft starter shall also be able to present a warning before tripping for each protection.

The soft starter shall have the following motor protections available

- Electronic Overload Protection, class 10A, 10, 20, 30
- Locked Rotor Protection
- Motor Underload Protection
- Current Imbalance Protection
- Voltage Imbalance Protection
- Overvoltage and Under Voltage Protection
- Phase Reversal Protection
- Earth-fault Protection

It shall also have input for PTC and PT100.

#### Built-in diagnostics

The soft starter shall have the following diagnostics features:

- THD(U)-Total Harmonic Distortion
- Counted number of start sequences
- Motor runtime measurement
- Thyristor runtime measurement
- Auto phase sequence detection
- Electricity metering
- Voltage sags detection
- Time to trip estimation
- Time to cool estimation

#### Fault detection

The soft starter shall provide following fault detection, to protect both the starting equipment, the load and the soft starter itself

- Phase loss
- High current
- Low control supply voltage
- Fault connection
- Bad network quality



- Thyristor overload

#### **MC8. MOTOR STARTER CONTACTORS , INTELLIGENT MOTOR CONTROL UNITS .**

Motor starter contactors, short circuit protective devices, electronic and thermal overloads shall be selected so as to provide Type 2 Co-ordination in accordance with SANS 60439-4-1. The minimum starter contactor utilisation category shall be AC3.

Intelligent Motor Control units shall only be used for starters irrespective of Killowatt Rating where it is critical to the process for feedback otherwise the motor shall be protected by an electronic or thermal overloads.

#### **MC8.1 CCTV AND FIRE PROTECTION EQUIPMENT**

CCTV and Fire protection equipment such as automated fire suppression systems shall only be incorporated into a design upon the outcome of a HAZOP, Risk Assessment and Hazardous Areas study. This shall be confirmed with the responsible EWS Electrical Engineer before such decision is made

#### **LABELLING**

MC9

- a The text of every label, excluding individual internal component identification labels, shall be as agreed with the Engineer.
- b Every Assembly shall be provided with a name plate detailing the following:

#### **NAME PLATE DETAILS**

The main name plate should be riveted on to the main incomer door. The name plate shall be made of stainless steel plate one mm thick and the descriptions etched on the plate in Black. It shall have the following details on it where applicable.

Description	Details
Name Of Pump Station	TBA
Year Of Manufacture	TBA
Manufacturers Name	TBA
Manufacturers Drawing No:	TBA
Standards Manufactured	SANS 60439-1
Current	TBA
Frequency	50Hz
Operational Voltage	400V
Rate Insulated Voltage	TBA
Rated Impulse Withstand Voltage	TBA
Short Circuit With Stand Strength (KA)	TBA
Service Condition	TBA
Pollution Degree	3 or 4 when used outdoors
Type Of System Earthing	TN-S
Dimension Of Switchgear	
Weight	
Form Of Separation	4b
Environment	IP 54.
EWS Electrical Engineers Name	

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MC10      **STANDARD SPECIFICATION- GENERATOR**

1.1      **GENERAL**

2.1      **OVERVIEW**

This section specifies general requirements of electric equipment and the installation thereof. It is to be read in conjunction with the Project Specification which has precedence in the event of conflict.

2.2      **COMPLIANCE WITH STANDARDS**

Equipment and methods of installation shall comply with the latest edition and/or amendment of:

- (a)      Act No. 85 of 1993 Occupational Health and Safety Act.
- (b)      SANS 0142 Code of Practice for the Wiring of Premises
- (c)      Relevant SABS specifications and Codes of Practice
- (d)      Relevant BSI Specifications and Codes of Practice in the absence of published SABS documents.
- (e)      Relevant IEC Specifications and Codes of Practice in the absence of published SABS and BSI documents.
- (f)      Comply with SANS 1473-1 LV Switchgear and Control Gear.
- (g)      Comply with SANS 10131

2.3      **QUALITY**

Material and equipment shall be new and unused and of the best quality available.

2.4      **DIESEL CONTROL AND CHANGEOVER PANEL**

2.4.1      **Overview**

The diesel control and changeover panel equipment necessary for the control and protection of the diesel generator

Indoor panels shall be totally enclosed and flush fronted. Outdoor panels shall have an outer hinged door, free of equipment, providing a weatherproof enclosure for the inner door. All equipment shall be mounted within the panels and connections and terminals shall be easily accessible. Pilot lights, instrumentation, control switches etc. shall be mounted on a hinged door.

The incoming switch, control equipment, distribution equipment and starters shall be housed in separate metal enclosed panels.

With the starter main isolator in the OFF position there shall be no live wires entering the starter cubicle.

With the incoming main switch in the OFF position there shall be no live wiring entering the entire panel.

Live incoming cable terminals are to be located in separate panels to outgoing terminations and are to be effectively shrouded against inadvertent contact.

Equipment shall have adequate current carrying capacity and shall be labelled corresponding to line and schematic diagrams.

An earth bar shall be fitted, to which all non-current carrying metal parts are bonded.

Panels shall not be moved onto site until finishing trade work has been completed in the room where the panels are to be installed. The supplier shall allow in his pricing for storage under suitable conditions until delivery.

All incoming live sections of fuse switches, circuit breaks and isolators shall have perspex barriers installed to limit expose. This barrier should have a danger live label attached to it.

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- 2.4.2      **Shop Drawings**  
As per MCC requirements
- 2.4.3      **Installation Drawings**  
As per MCC requirements
- 2.4.4      **Enclosures**  
As per MCC requirements
- 2.4.5      **Ventilation**  
As per MCC requirements
- 2.4.6      **Vermin Proofing**  
As per MCC requirements
- 2.4.7      **Space Requirements**  
As per MCC requirements
- 2.4.8      **General and Installation Arrangement Details**  
As per MCC requirements
- 2.4.8.1    **General Installation Arrangement Details**  
As per MCC requirements
- 2.4.9      **Cable Gland Plate**  
As per MCC requirements
- 2.4.10     **Paint Finish**  
(a) The colour of LV switchboards and equipment enclosures in buildings shall be "Electric ORANGE", colour of SABS 1091 as recommended in SABS 0140.  
(b) The standby power section of LV switchboards in buildings shall be coloured "SIGNAL RED", colour of SABS 1091. as recommended in SABS 0140.
- The contractor shall obtain written approval of the painting process from the paint manufacturer and submit this to the engineer.
- 2.4.11     **Accessories**  
As per MCC requirements
- 2.4.12     **Wiring**  
As per MCC requirements
- 2.4.13     **Busbars**  
As per MCC requirements
- 2.4.14     **Colour Coding**
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As per MCC requirements

2.4.15     **Equipment Identification**  
As per MCC requirements

2.4.15     **Wire Identification**  
As per MCC requirements

2.5         **CABLE LADDERS AND TRAYS**  
As per MCC requirements

2.6         **CABLE WORK**

2.6.1       **General**  
As per MCC requirements

2.6.2       **Cable Laying**  
As per MCC requirements

2.6.3       **Cable Joints**  
As per MCC requirements

2.6.4       **Cable Duct**  
As per MCC requirements

2.6.5       **Sheath Integrity**  
As per MCC requirements

2.6.6       **Documentation**  
As per MCC requirements

2.6.7       **Cables Within Buildings**  
As per MCC requirements

2.7         **TERMINATIONS**

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As per MCC requirements

## 2.8 **AUTOMATIC TRANSFER SWITCH**

Automatic Transfer Switch (ATS) 4 Pole to incorporate Switch and Controller in one unit and in accordance to IEC 60947-6-1, which will allow for emergency manual operation under load for immediate power restoration in the event of an equipment malfunction without opening the panel door. Should also provide predictive maintenance and modular components to reduce down time and service costs. The ATS Switch should come with detachable HMI, so there is no need for connecting dangerous line voltages to the door and the risk of operator injury due to equipment malfunction is reduced.

ATS to guarantee safe and reliable operation during variations in temperature (-25–+70°C) and voltage (200–480 VAC with +/-20% tolerance), and it's tolerant of vibrations (acc. IEC 60068-2-6) and shocks (acc. IEC 60068-2-27). To also have true short-circuit resilience, and able to take the hit and remain fully operational after exposure to even the most dangerous phenomena.

- Auto config (voltage, frequency, phase system)
- In-phase monitor (synchro check)
- In-built power meter module
- Load shedding
- Real time clock (48h back-up after power outage)
- Event log
- Predictive maintenance
- Harmonics measuring (Voltage, current)
- Padlocking the automatic transfer switch to prevent automatic and manual operation

## 2.9 **CIRCUIT BREAKERS**

### 2.9.1 Metal Clad Air Circuit Breakers (ACBs)

ACBs shall be of the withdrawable type and shall be suitable for use in power distribution systems up to 660V, 50Hz.

The circuit breakers shall comply with IEC 157 and shall have a P2-performance rating.

The ACBs shall be self-contained units of the dead front type, with the necessary mechanical interlocks to prevent: -

Access to "LIVE" terminals when the circuit breaker is withdrawn.

The withdrawal or insertion of the ACB, when the unit is in the closed position.

Closing of the circuit breaker without resetting after a manual trip.

The circuit breaker shall be of the quick-make and quick-break type with a stored-energy spring assisted operating mechanism provided with:

A trip free mechanical hand operated closing mechanism.

A manual operated mechanical trip mechanism suitably protected to prevent inadvertent tripping.

A positively driven mechanical device to provide ON-OFF-TRIP indication.

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All non-current carrying metal parts of the ACB shall be solidly interconnected and connected to an earthing contact on the truck that shall engage with a mating contact on the cradle. The cradle itself shall be connected with a solid earthing bar to the protective earth of the control board. The contacts for earthing shall be made in the "racked in" as well in the test position.

The cradle shall be of a sturdy construction and shall incorporate safety shutters.

The "RACKED IN", "TEST" AND "RACKED OUT" positions shall be clearly marked and visible.

The ACBs shall be designed in such a way, that the direction of the energy flow does not affect the performance of the breaker.

Adjustable thermal overload releases shall be provided to suit the required current range.

In addition, a magnetic short circuit release shall be fitted. This release shall have an adjustable current release value as well as an adjustable time – lag. A minimum of four, time lag settings shall be available.

Care shall be taken to ensure that the magnetic release is set low enough, where required, to operate under the lowest fault level condition (e.g. if ever the plant is supplied from a temporary alternator set).

Each ACB shall be equipped with the following accessories:

- Two normally open aux. contacts - Two normally closed aux. contacts - One alarm contact - One shunt release - Padlocking facility in the "TEST" position and pad lockable shutter gear.

Each ACB shall allow for the fitting of the following options:

- Motor drive for spring charge mechanism - Closing release complete with "ANTI PUMPING CIRCUIT" - Key interlock facility (equal to "Castell") - Adjustable time delayed under voltage release - Carriage switches for "RACKED-IN" and "TEST" position - Mechanical interlock facility of the Bowden type

Minimum distances between enclosure and arc chutes shall be strictly observed. Full technical information of the ACB's offered, shall be supplied with the tender.

#### 2.9.1 Moulded Case Circuit – Breakers (Switchboards)

Switchboards shall be suitable for use in power distribution systems up to 660V – 50Hz and for panel mounting. They shall comply with SANS 156:2007. Switchboards of the same frame size and the same fault level shall be of the same manufacturer.

An adjustable release shall be provided where deemed necessary.

Switchboards employed for motor starting circuits shall be rated in such a way that the expected transient currents will not cause any "nuisance tripping".

Feeder breakers to motor control centres shall be equipped with a thermal release and a time and value adjustable magnetic release. These Switchboards shall be selective towards the upstream and downstream circuit breakers.

Switchboards of the same frame size, where in one application an instantaneous magnetic release is used and in another application a time lagged release is used, shall have plug-in type trip units.

The operating handles of Switchboards shall give a positive indication of the ON/TRIP/OFF status.

Switchboards shall be installed vertically. Horizontally mounting is not acceptable.

Minimum distances from enclosure to arc chutes as required by the manufacturer shall be strictly observed.

Where indicated, circuit breakers shall be of the adjustable type.

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The main circuit breaker and generator circuit breakers within XXXX Pump Stations, together with the two-generator standby auxiliary supplies, shall be of the motorized type.

Circuit breakers will be fitted with rated extended tinned copper terminals where necessary, to accommodate multi single core terminations.

Where cascading of circuit breakers is allowed, all equipment shall be coordinated, and discrimination shall be taken into account.

All equipment shall be approved by the Employer in writing and shall bear the SANS mark.

Circuit breakers shall be from the same supplier in one application. Circuit breakers shall be equipped with an instantaneous magnetic release and a thermal release. Circuit breakers for motor circuits shall be suitably rated. Circuit breakers handles shall provide a clear indication of "ON", "OFF" and "TRIP" status. Circuit breakers shall be installed vertically with the upstream terminal on top. Minimum clearances shall be maintained.

All circuit breakers shall be pad lockable in the "off" position or be supplied with means that will enable pad locking.

The Contractor shall supply and install all necessary circuit breakers and equipment required to form a complete functional protection system within each Switchboard complete.

### 3

#### ISOLATORS

Isolators shall not be provided in this project. Circuit breakers shall be used instead.

#### 4 ASSEMBLY Construction Drawings – Standard Requirements

All Construction Drawings for ASSEMBLIES (SWITCHBOARDS, DB's, and Instrumentation Panels, etc.) shall contain the following information:

- Project Name and Contract Number
- Manufacturer/Supplier
- EWS Engineer and contact details
- Client details
- Drawing Number and Revision
- Drawing to be Signed
- Source of Supply – SWITCHBOARDS or transformer name etc
- Switchboard General Description
- Fault level (kA and time rating)
- Form factor/Sectioning
- Busbar Details (cross-section, material type, tinned etc)
- Busbar Support Details – type, manufacturer
- Required VFC cooling fan – type, manufacturer
- Earth bar details (cross-section, full-length, front or rear etc) □
- Switchboard Material type, grade, thickness etc.
- Gland Plate details – material type, thickness, mounting etc
- Colour – internal and external
- Switchboard Dimensions
- Base Dimensions and bolting arrangements
- Front door details – hinge and padlock requirements
- Rear door details – hinge and padlock requirements
- End panel details – removable cover details
- Door details - Stiffeners and restrainers installed etc.
- Hinge Details
- Locking Details
- Handle Details
- Cable Entry Details
- All bolts, nuts, screws material type (i.e. 316 Stainless Steel)
- Equipment details – CB ratings, fault levels, type, manufacturer etc

- Equipment Layout details – Cubicle name, function, equipment function etc.
- Section to be provided through switchboard

## 5. ASSEMBLY Schematic drawings– Standard Requirements

All Schematic Drawings for ASSEMBLIES shall contain the following information:

- Project Name and Contract Number
- Manufacturer/Supplier
- EWS Engineer and contact details
- Client details
- Drawing Number and Revision
- Revision details to be listed
- Drawing Page Number
- Drawing to be Signed
- Reference Grid required on each schematic page
- Source of Supply – Switchboard or transformer name etc.
- Fault level (kA and time rating)
- Voltages for all circuit to be clearly indicated
- All devices to have reference number i.e. relays
- Equipment ratings to be given i.e. motor ratings
- All indication lamps to be labeled including required lamp colour
- Legend to be provided
- Equipment Tag Numbers as per P&ID and Water and Sanitation Plant Numbering System to be provided.

## 6. STANDARD COLOURS – INDICATION LAMPS AND BUTTONS

The suitability of colours employed is generally based on IEC 60073 (No SANS version/ To be updated with latest Standard).

Due to colour schemes on existing plant and user/operator familiarity, the application of certain colours differs from IEC 60073 (To be updated with latest standard). For clarification, the lamp colours are a reflection of the status of the particular control system (front of panel towards equipment to be controlled).

The following colours shall in general be employed on switchboards for indication lamps, push buttons and selector switches:

COLOUR	Condition / Meaning / Application
RED	System stopped/not running or CLOSED
AMBER/YELLOW/ORANGE	Any warning/trip/abnormal condition
GREEN	System running/healthy/normal/ SAFE Condition or OPEN
BLUE	Step/Process change condition
WHITE	

Specifically, the application of colours shall be as follows:



INDICATION	LAMP	COLOURS	Examples/Specifics
Local/Auto/SCADA Mode	Indication Lamp	WHITE	
Bus Bar Alive	Indication Lamp	WHITE	
Capacitor Bank Discharged	Indication Lamp	GREEN	Power Factor Equipment
Closed	Indication Lamp	RED	Valves, penstocks
Differential Pressure – HIGH	Indication Lamp	AMBER	
Differential Pressure – NORMAL	Indication Lamp	GREEN	
Earth Fault	Indication Lamp	AMBER	MV
Equipment Emergency Stop	Indication Lamp	AMBER	
Mechanical Seal Failure Warning	Indication Lamp	AMBER	Sub / Immersible Pumps
Moisture in Coolant	Indication Lamp	AMBER	Sub / Immersible Pumps
Moisture/Water Ingress	Indication Lamp	AMBER	Motor
Winding Over Temperature	Indication Lamp	AMBER	May be flashing AMBER
Open Indication Lamp GREEN	Indication Lamp		Valves
Overload	Indication Lamp	AMBER	
PFC Fault	Indication Lamp	AMBER	Power Factor Equipment
Running	Indication Lamp	GREEN	
Starter Alive (Circuit Healthy)	Indication Lamp	GREEN	
Stepped Function	Indication Lamp	BLUE	Power Factor Equipment
Stopped & Power Available	Indication Lamp	RED	
Tripped	Indication Lamp	AMBER	

PUSH BUTTON/SELECTOR SWITCH COLOURS		Examples/Specifics Emergency	
Stop	Push Button	RED	With yellow backing
Lamp Test Reset Push Button BLUE	Push Button	BLACK	
Start	Push Button	GREEN	
Stop	Push Button	RED	
Up/Down/Left/Right/Forward/Reverse	Push Button	BLACK on WHITE	
Selector Switches/Knobs	Push Button	BLACK	with Black back plates with white lettering

Note: AMBER=YELLOW=ORANGE

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For existing plant, lamp/pushbutton colours to be matched accordingly All indication lamps to be accompanied with engraved backing plates

The Engineer shall provide the final confirmation/approval of ALL colours to be employed on all new

## 7 Labelling

### 7.1 Labels

- a) Labels shall be in English and isZulu
- b) Labels shall be indelibly and permanently marked, and shall be securely attached to the equipment.
- c) A label indicating the grade of oil shall be attached to the diesel engine.
- d) All printed-circuit cards shall be clearly identified.
- e) All instruments shall be clearly labelled to indicate their function, and all alarm indicators shall be clearly labelled to indicate the alarm they represent.
- f) Statutory labels required to be attached to building doors, etc. shall be provided and fitted when applicable.
- g) Labels that have red letters on a white background, the lettering being of height at least 10 mm, shall be affixed to all places where danger can exist owing to automatic start-up. The text on these labels shall be as below:

#### **DANGER**

**THIS MACHINE SHALL START WITHOUT NOTICE. BEFORE WORKING ON THE MACHINE, LOCK THE CONTROL SWITCH ON THE CONTROL PANEL IN THE OFF POSITION**

- h) A label shall be attached adjacent to each terminal to indicate its function and designation in accordance with the relevant circuit diagram.
- i) A graphic diagram with an electric flash in accordance with type designation WW7 of [7] SANS 1186, and a label indicating the voltage shall be placed near all mains terminals.
- j) Labels may be engraved on sandwich plastic material that is suitable for tropical outdoor use.

## **STANDARD SPECIFICATION**

### **AA7 DIESEL GENERATOR SET**

#### **AA7.1 Scope**

This specification covers the design, engineering, manufacture, installation, testing and commissioning and maintain of both mobile and stationery standby generators rated for prime power for eThekweni Municipality to maintain its existing infrastructure with emergency electrical supply where required. The equipment must be capable of providing power in the event of a mains failure for lighting and power as well. The set shall be fully automatic, that is, it shall start when any one phase of the main supply fails, **AND** when the pumps is required to start and shall shut down when the normal supply is re-established **OR** after pumps have stopped.

The scope of works is as follows:

- Supply, installation, testing and commissioning of emergency generators for each identified site, according to specification
- Delivery of each generator to the specified site, including all necessary rigging, craneage and transportation means
- Delivery of each mobile generator to the specified site, including all necessary rigging, craneage and transportation means
- Construction of a concrete plinth in a location agreed with the Employer, and according to the generator OEM specifications

- Supply, installation, testing and commission change-over panel which shall incorporate all equipment necessary for the control and protection of the generator
- Supply and installation of all necessary cables, cable trays, conduit, glands as required, including trenching in soft/hard soil
- Tie-in to existing MCC, including panel modification, if required
- Liaison with eThekweni Electricity regarding the necessary isolations
- Preparation and submission of O&M Manuals and drawings
- Training of eThekweni Municipality staff at each specific site
- Submission of an Electrical Certificate of Compliance
- Submission of all associated test certificates for the generator manufacturing and testing process
- Supply of diesel for testing purposes for the Factory acceptance test
- Supply full tank of diesel after the commissioning on site.

#### AA7.2 **Site and Climatic Conditions**

The Tenderer shall establish site conditions at the site visits.

No.	Description	Detail
4.1.1	Climate	humid and sub-tropical
4.1.2	Altitude	from sea-level to 1 000 m
4.1.3	Ambient temperature	from 0°C to 50°C
4.1.4	Maximum relative humidity	99 %
4.1.5	Highest system phase-to-phase voltage	440 v
4.1.6	System frequency	50 Hz
4.1.7	Earthing System	TNCS

#### AA7.3 **Maintenance of Equipment**

Equipment offered shall be currently in production and capable of being properly maintained and serviced without the necessity for carrying large stocks of spare parts. All spare parts required shall be available in Durban.

A written guarantee and commitment from the tenderer concerning the availability of spare parts for the full-service life of the equipment must be submitted and will be taken into consideration in adjudication of this tender. Tenderers shall submit a list of recommended spare parts which should be held by EWS, together with a current price list.

Tenderers shall specify the name, address, telephone and facsimile numbers of local agents or the nearest location of spare parts depot from which components may be obtained, in necessary quantities, and without prior warning, at any time, day or night, in order to ensure the minimum outage time of the equipment.

- a) The Diesel Generator System shall be designed to minimize the need for maintenance.

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- b) Whether preventative or predictive, where maintenance is required, the design shall provide for good ergonomics in order to make it as easy as possible, with due consideration given to personnel safety.
  - c) The design shall allow for modular replacement of assemblies and components to a level as low as possible.
  - d) The time to isolate a faulty component shall be reduced by making extensive use of built-in test facilities.
  - e) Component conditions that may lead to a failure shall be monitored, and an alarm condition generated.
  - f) Spares and parts availability shall be guaranteed for the designed life of the DG.
  - g) Warranty on any part of the system shall be at least two years unless specified differently.
  - h) Tenders shall also price to Maintain, service and do regular start-ups of generator sets as required by acceptable maintenance practices and standards during the latent defect period

#### **AA7.4 STATIONARY GENERATOR CONTAINER/ENCLOSURES**

Canopies shall be constructed from 1.6mm 3CR12 sheet metal for coastal conditions. Canopies shall be sized to allow recommended maintenance to take place through lockable hinged doors.

Doors shall be secured by double expanding locks and all fittings shall be stainless steel. The canopy shall protect the set-in locations fully exposed to the weather.

The canopy shall be fixed to the plinth.

The plinth shall be in a position to be agreed with the engineer, and shall be shown on site. It shall have a bund wall as per SANS 10131-2004.

Canopies shall be vermin proof.

Ventilations openings shall be fitted with Trox AWG type louvers.

The enclosure shall be cleaned, degreased and painted with strontium chromate primer and finished with 2 coats of twin pack epoxy paint – color Grey C631.

##### **General for each ISO Container where required**

One standard modified ISO containers or similar robust steel enclosures will be manufactured, with sound attenuation and suitable doors for ease of maintenance purposes, as is required, complete for this Project. The doors are to be so positioned as to avoid the necessity for removal of major items of equipment in order to affect maintenance. The doors shall be provided to open outward of the container. These doors shall be lockable doors with a suitable door catch arrangement including a padlock cover for anti-vandalism.

The ISO containers shall be cleaned, degreased and painted with strontium chromate primer and finished with 2 coats of twin pack epoxy paint – color Grey C631.

##### **AA7.4.2 Sound Attenuation for each Container/Enclosure**

The prime-mover and alternator-combined noise level, when installed within the container, shall not exceed 70 dBA measured at a distance of 7m from the container in open field, at full load.

The Tenderer shall submit detailed drawings with his Tender Offer.

The sound attenuation louvers will be manufactured from 304 stainless steel and shall be painted with suitable paint that will bond onto the 304 stainless steel.

The Engineer, shall approve each Container/Enclosure prior to the Contractor delivering it to site.

##### **AA7.4.3 Signage for each Container/Enclosure**

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The Contractor shall fix the following notices (signage) to the inside wall of the Generator Enclosure in four of the official languages, viz English, Afrikaans, Xhosa and Zulu:

- Fire extinguisher location (red and white).
- Danger of electrical shock (yellow and black).
- Hearing protection (blue and white).
- In the event of electrical shock – first aid steps for resuscitation of electrical shock victim.
- First aid steps for burn victims.

Operating signs that are not safety related need only be in English.

The contractor shall supply and mount a suitably rated fire extinguisher for each stationary and mobile generator set.

#### AA7.6 **Electrical Equipment**

Alternators shall have rated Prime Power outputs, 1500rpm, at 0,8 lagging power factor. The machines shall deliver a three-phase, four-wire 50Hz supply at 400 Volt and shall be suitable for powering Variable Frequency Controller equipment. The alternator output voltage shall not drop by more than 15% under worst-case step loading.

##### AA7.6.1 Licenses

The Contractor shall supply to the eThekweni Municipality, Sanitation Mechanical and Electrical Branch, all original software licenses for any equipment installed and used for the control of each alternator.

##### AA7.6.2 Over current and short circuit protection

Alternators shall each have one suitably rated main circuit breaker for alternator main output circuit protection. This main circuit breaker shall be mounted within 300mm (max) of the alternators output terminals and shall supply the new alternator change over switches installed within each new switchboard within each ISO container or enclosure.

Each alternator main circuit breaker shall be of such a design so as to allow for shunt tripping from any emergency stop switches, or the emergency stop situated in the alternator control panel.

##### AA7.6.3 Alternators shall meet the following requirements

The following requirements shall be met for each alternator.

1. Synchronous.
2. Operating at a speed of 1500 rpm.
3. Each alternator shall be capable of delivering 115% of its continuously rated power output, on the site, for a minimum of 15 minutes at the rated voltage, without damaging the alternator or shortening the life span.
4. Seals shall be provided to prevent the lubricating grease from migrating along the shaft to the rotor windings.

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5. Grease cups shall be provided for each bearing in readily accessible positions, even if this means remotely mounting the cups.
  6. The shaft-mounted fan shall be fitted at the air intake end of the machine and preferably this shall be the non-drive end.
  7. The exciter shall be of the brushless construction, inboard of the bearings, of three-phase full wave rectification design with silicon rectifying diodes.
  8. Insulation shall be non-hygroscopic, non-nutrient Class B on the exciter, Class F on the stator and Class H on the rotating pole pieces.
  9. Each alternator shaft shall be rolled steel. The rotating field pole shall be bolted to the shaft with all other rotating electrical components. This means that the shaft shall be free from electrical grounds on the shaft.
  10. Each alternator shall be 4-wire Y connected with all cable ends brought out to the terminal blocks in the alternator cable end box.
  11. The feet shall have machined surfaces at the mounting rail positions for good axial parallelism and shall be designed to minimise noise and vibration transmitted to the bedplate.
  12. Each alternator shaft with its rotating equipment shall be dynamically balanced up to 25% over speed condition.
  13. A heater shall be provided in the alternator, which shall be arranged to keep the machine warm, to prevent the ingress of moisture. The heater shall be energised whilst the machine is stationary and de-energised when the machine is operating.
  14. Measures shall be taken to limit noise emission to an absolute minimum and to achieve this, use of a high efficiency-cooling fan may be necessary.
  15. It should be noted that the electric load of each alternator will include harmonic loads (i.e. between 40 kVA and 2 000kVA Prime Power harmonic loading) which will be developed by variable frequency controllers that are employed in the eThekweni Municipality's existing infrastructure irrespective of individual sites starting methods.
  16. Each alternator shall have a suitably rated circuit breaker installed in a 3CR12 sheet steel enclosure situated within 300 mm of the alternator output terminals.
  17. The components of the voltage regulator shall consist of semi-conductors, completely static and containing no electromechanical relays or fuses. The regulator shall be of the solid-state electronic type. A circuit breaker for protection of the power circuit shall be provided with the voltage regulator.
  18. Each alternator windings shall incorporate temperature sensors for temperature monitoring.
  19. Response time to changes in load shall be less than 10 milliseconds and shall maintain voltage regulation at 1% R.M.S., when:
    - Load varies between no load and full load
    - The power factor varies between 0,8 and unity
    - A speed change of up to 5% occurs
  20. Each alternator shall be designed **without the use of "dummy loads"** to operate supplying load/s that are less than 40% of the alternator's rated kVA rating, without any long-term damage to the alternator.

#### AA.8 **CHANGEOVER PANEL**

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A change over panel shall be supplied in a location to be indicated at the site visit.

Automatic Transfer Switch (ATS) 4 Pole to incorporate Switch and Controller in one unit and in accordance to IEC 60947-6-1, which will allow for emergency manual operation under load for immediate power restoration in the event of an equipment malfunction without opening the panel door. Should also provide predictive maintenance and modular components to reduce down time and service costs. The ATS Switch should come with detachable HMI, so there is no need for connecting dangerous line voltages to the door and the risk of operator injury due to equipment malfunction is reduced.

ATS to guarantee safe and reliable operation during variations in temperature (-25–+70°C) and voltage (200–480 VAC with +/-20% tolerance), and it's tolerant of vibrations (acc. IEC 60068-2-6) and shocks (acc. IEC 60068-2-27). To also have true short-circuit resilience, and able to take the hit and remain fully operational after exposure to even the most dangerous phenomena.

- Auto config (voltage, frequency, phase system)
- In-phase monitor (synchro check)
- In-built power meter module
- Load shedding
- Real time clock (48h back-up after power outage)
- Event log
- Predictive maintenance
- Harmonics measuring (Voltage, current)
- Padlocking the automatic transfer switch to prevent automatic and manual operation

The changeover panel shall include metering CT's and isolating links all to the approval of eThekweni Electricity Department. The tenderer shall carry out all liaison with eThekweni Electricity Department including supply of metering CT's, submission for approval and testing.

#### **AA.9 DIESEL CONTROL PANEL**

The diesel control panel shall be integral with the enclosure. A "Deepsea Controller (latest) or equivalent controller shall be installed for generator supervision and control, within each generator set. The control equipment shall be so designed as to protect the standby generator set against damage due to failure of any of the sub-systems comprising the set. The control system shall allow for automatic starting and stopping.

Each distribution panel shall be suitably divided into two sections, one for " Deepsea Controller (latest) or equivalent controller, selector switches and indication and the other section for the distribution equipment and load circuit breakers.

The Alternator Control Panel shall include the following:

- A "Deepsea (latest) or equivalent controller for the supervision and control, accessed and operated from the interior of the canopy.
- Emergency stop.
- Battery charger.
- Monitoring System
- Immersion heater control equipment
- Alternator temperature display

The following facilities, components and constructional items shall be supplied: but not limited to it

1. Current transformers suitably rated.

- 
2. Line, neutral and earth busbars.
  3. Automatic constant voltage battery charger.
  4. Control circuit breakers for instruments, etc.
  5. 24 Volt fuel/crank relays.
  6. Terminal strips.
  7. Signals required for control of the changeover panel.

#### Door Mounted Components

The following constructional items shall be supplied/used:

1. 3 off flush mounted M.D.I. 76mm x 76mm dial ammeters suitably scaled.
2. 1 off flush mounted 76mm x 76mm dial voltmeter, 0 to 500V AC.
3. 1 off flush mounted voltage selector switch with off, phase to phase and phase to neutral positions.
4. 1 off flush mounted 76mm x 76mm dial vibrating reed frequency meter, scaled 47 to 53 Hz.
5. 1 off flush mounted voltmeter, 0 to 30 V DC - Battery volts.
6. 1 off alternator "Heater on" indicator.
7. 1 off flush mounted running hour meter.
8. 1 off manual "start" push button.
9. 1 off manual "stop" button.
10. 1 off emergency "stop" button : "latching type".
11. 1 off engine alternator charge indication.
12. 1 off Automatic mains failure engine protection microprocessor control unit.
13. 1 off Engine temperature gauge.
14. 1 off lubricating oil pressure gauge.

An external power source shall be used for the battery charger, when the generator is in storage and unattended.

Where it is required to synchronize sets Deep Sea Electronic latest or equivalent controllers shall be used to facilitate load sharing.

#### **AA.9.2 Control Equipment Requirements**

##### **AA.9.2.1 INTRODUCTION**

Control systems may not consist of the electromagnetic relay type. Only the Deepsea(latest) or equivalent solid-state programmable systems complying with the following specification will be accepted.



The solid-state control systems shall be available “off the shelf” and shall have a proven local operating history of at least five years. The control systems shall consist of a single unit including all indicators/switches and allow for quick installation using locking connectors.

Imported or specially made solid state control systems or engine control and/or management systems will not be acceptable under any circumstances. The control systems shall consist of a single unit including all indicators/switches and allow for quick installation using locking connectors. The solid-state controller and associated systems wiring shall be to the control system manufacturer’s guidelines and shall be adequately protected against transient over voltages arising from lightning effects, switching surges, power system surges or mains and alternator borne noise/interference. Full details of the suppression systems are to be provided at tender. Wiring to and from the solid-state programmable controller is to be screened as necessary to prevent electrostatic and magnetic interference from adjacent wiring/systems. The solid-state controller must be able to communicate via ethernet, mod bus TCP/IP as minimum protocol.

#### AA.9.2.2 **SPECIFICATION**

##### a. Front Panel Indicators

***These indicators are not limited to the table below***

CONDITION	ALARM	SHUTDOWN
High Temperature	X	X
Low Oil Pressure	X	X
Overspeed	X	X
Under speed	X	X
Manual/Test Mode		
Heater Fault	X	
Low Fuel	X	
No Fuel	X	X
Low Water	X	X
Low Bulk Tank/Spare 2	X	
Start Fail	X	X
Manual Stop		
Emergency Stop	X	X
Mains Phase Fault		
High Mains Volts		
Low Mains Volts		
Mains On		
Mains on Load		
Coolant Level		
Alternator On		
Alternator Phase Rotation Fault	X	X
High Alternator Volts	X	X
Low Alternator Volts	X	X
Battery Volts Fault	X	
Alternator Charge Fault	X	
Control System On		
Excess electrical load on alternator.	X	X
Battery voltage low at starter motor cranking speed.		
Failure of supply to engine immersion element.		
Start system inhibited (excessive start attempts).		
Alternator output under frequency.		
Alternator output over frequency.	X	X
Alternator temperature (with temperature display on control panel)		

**All trip conditions shall not be resettable unless the fault has been cleared.**

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b. Front Panel Switches

The following switches shall be included on the control system front panel:

Lamp test push-button  
Alarm mute push-button  
Four position mode selector switches: "off/reset, auto, manual, test"

c. Plant Operation

The mode selector switch functions shall be as follows: -

OFF/RESET	Control System off and alarm condition reset.
AUTO	Automatic starting and stopping of the set dependant on the mains supply.
MANUAL	Starting and stopping activated manually (two panel mount pushbuttons) for maintenance purposes. In this mode the load will not be transferred in the event of a mains failure.
TEST	The set will start automatically in this position. The load will be taken by the alternator in the event of a mains failure.

d. Logging Events

All events relating to the status generator set shall be logged with date and time in a non-volatile memory (which can retain information for a period of 6 months in the absence of power to the controller)

g. Control System DC Supply Voltage

The control system must be able to operate with a minimum DC supply voltage of 4 volts (without making use of either an internal or an external auxiliary battery) to allow cranking and starting under conditions of low battery capacity.

h. RS-232 Serial Port

The control unit shall have an RS-232/RS-485 serial port allowing various options to be added as listed below.

Equipment connected at each end of the RS-232/RS-485 cable shall be adequately protected against transient over-voltages, lightning effects (particularly if the set and remote alarms are in separate buildings), switching surges, power system surges or mains and alternator borne noise/interference.

### AA.9. 3 TELEMETRY

The following signals wired via potential free contacts must be taken to the telemetry unit for all stationary generators

- Intrusion alarm
- Low battery voltage
- Engine failure
- Fuel level (40 %) requires refueling
- Diesel Generator on Manual

- 
- No Fuel
  - Manual Stop
  - Emergency Stop
  - Mains Phase Fault

#### AA.9.4 **Earthing**

The successful tenderer shall ensure that provision is made for the satisfactory earthing of the machine which shall be bonded to the earthing system of the electrical installations of the building. The control panel shall also be earthed.

#### AA.10 **PRIME- MOVER FOR THE STATIONARY GENERATOR SETS**

- The prime mover shall be a diesel engine specifically designed for the purpose of driving an alternator at a class AO governed speed of 1500 revolutions per minute.
- The derating of the engine for site conditions shall be strictly in accordance with BS 5514 as amended.
- The engine shall be freely available in the Republic of South Africa, including spares, servicing and workshop facilities.
- The engine of the standby generator set as supplied and installed shall be suitably rated to meet the requirements of this specification.
- The exhaust gas temperature, measured in or on the manifold, shall not exceed the manufacturer's stated limit, and in any case shall not exceed 500°C at 100% of the specified generator rating.
- Turbo-charged engines will only be accepted provided the engine is designed and manufactured as such. The turbo-charger shall be fitted with a heat shield if near any combustible material. Turbocharged engines shall be suitably sized to meet the step load performance specified. Reaction time of the turbo-charger shall not exceed the time specified in BS 5514, for class AO governing.
- The Contractor shall ensure that the manufacturer of the prime-mover shall provide the prime-mover intake and exhaust silencing, to ensure compliance with standards and specifications pertaining to the prime-mover considered. Should 'add on' silencing equipment be necessary for sound attenuation, then the 'add on' shall be to the approval of the manufacturer of the prime-mover.

##### AA.10.1 Engine

The engine shall comply with the requirements laid down in BS 5514 and shall be a multi-cylinder diesel fueled engine of the direct injection, compression ignition type, running at a speed not exceeding 1 500 rpm. The engine shall be amply rated, to start and supply the load. The engine shall have a one-step loading acceptance of at least 60% from cold start. The delay between of mains supply and the diesel alternator accepting full load shall not exceed 30 seconds. The net power rating of the engine at 1500rpm with all driven accessories connected shall be at least 15% greater than the full alternator power output (in kilowatts).

Preferred diesel engine suppliers are :Caterpillar, Cummins and Perkins.

The engine shall be provided with the following:

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- An enclosed flow, force feed lubrication system by a positive displacement type oil pump fed from engine oil sump.
  - A low oil pressure protection alarm.
  - Fuel and lubricating oil filters with replaceable elements and pressure by-pass.
  - An air-inlet manifold filter of the dry element type.
  - A fuel injection pump with a suitable governor, capable of controlling the engine speed in accordance with BS 5514 class AO.
  - A continuously rated fuel solenoid required for engine cut out. The control arm shall have only one knuckle joint and should an external spring be required it shall be anchored to a purpose made bracket.
  - A heavy-duty 26-volt charging alternator, regulator and batteries for engine starting. Batteries shall be capable of at least 6 consecutive start attempts, each attempt at cranking calculate for duration of 10 seconds.
  - Provision shall be made to adequately protect the engine against failure of the cooling system (i.e. high temperature protection and alarm).
  - "EMERGENCY STOP" push button shall be fitted within the alternator/generator control panel, affording maximum safety to the operators of the standby generator set.
  - A rotary pump, with pipe, for the removal of the crankcase oil where oil is difficult to drain.
  - An acceptable over speed sensing device.
  - The engine shall be supported at the front by mounting brackets. An acceptable method of supporting the back of the engine in the event of alternator removal shall be supplied, such as loose mounting brackets.
  - The flywheel shall have a moment of inertia, which shall allow the cyclic irregularity of the set to fall within the limits specified by BS 5514 as amended and meet the specified performance. The flywheel shall be both statically and dynamically balanced.
  - The engine shall be fitted with the necessary devices to automatically protect the engine against low oil pressure, excessive temperature rise, etc. Further, suitable gauges shall be mounted on a suitable purpose made bracket, mounted within the prime-mover area, to afford visual inspection of the state of the standby generator set, operating parameters.

#### AA.10.2 Exhaust and Silencing System

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All piping required for the exhaust system, silencers and all pipe support brackets shall be grade 304 stainless steel.

The exhaust system, including silencers, shall be acoustically insulated with a preformed mineral wool inner layer sealed with asbestos free finishing plaster in order to satisfy the OHS act requirements.

The silencer will be mounted within the ISO container and the exhaust outlet shall exit the trailer on the side and shall be fully protected against the ingress of rain.

The silencing system shall include a reactive silencer and an absorptive type silencer, and all support brackets and a flexible connection of the bellows type shall be installed as close to the manifold(s) as possible to limit vibration transfer and to allow expansion under heating. The standard reactive (i.e. pulsation damper type) silencer shall be installed downstream of the flexible connection. The distance between the engine and the reactive silencer shall be designed to avoid resonance and additional absorptive silencer, burgess or equivalent, shall be installed downstream of the reactive silencer. The tail pipe shall have a length of at least 15 times the pipe diameter, measured downstream of the absorptive silencer.

#### AA.10.3 Starting and Stopping

The engines shall be easily started from cold, without the use of any special ignition devices, under summer as well as winter conditions, against full load. To ensure easy starting in cold weather the engines shall each be provided with a thermostatically controlled 230-250-volt AC. electric immersion heater fitted to the water jacket. The electric circuits for these heaters shall be taken from the respective battery charger control board and shall be de-energized once the alternator has reached a 'steady state' output. Circuit-breaker protection (with earth-leakage) is required for each immersion heater circuit. The starting control for the prime mover shall make provision for three consecutive start attempts of 10 seconds duration, each with 10 seconds rest periods in between. After a 3-minute rest period provision shall be made for a further three start attempts also of 10 seconds duration. If the prime mover fails to start after these six attempts, the control circuit shall inhibit further start attempts until the reason for the failure to start has been traced and rectified, whereupon it shall be possible to reset the inhibiting device. When the set fails to start a visual alarm shall indicate the fault.

#### AA.10.4 Prime-Mover Batteries

The prime-mover batteries shall be deep charging lead acid type batteries. The Contractor shall ensure that the batteries are rated for the application intended in this specification.

The battery stand shall incorporate a protective cover to prevent accidental contact with the battery terminals. The batter stand shall be lockable to prevent theft of the batteries and supplied with a lock and keys (3).

#### AA.10.5 Battery Charger

Automatic battery charging equipment of the constant current, voltage, monitoring type, shall be provided in a compartment, within the control panel. The battery charging equipment shall be isolated, with sheet steel barriers, from the remainder of the equipment in the control board. When the battery voltage reaches a predetermined high level, the charger shall be switched off, thus enabling the battery to discharge to a predetermined lower point, whereupon the charger shall again be switched on.

The battery charger circuit shall incorporate a "boost charge" with a lock out key switch, thus ensuring only authorized persons have access to the "boost" facility.

In the event of a mains failure, the supply to the battery charger shall be arranged to change over to the standby power output when the diesel engine driven alternator set is switched to its load, thus obviating the necessity for a separate charging device mounted on the engine.

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#### AA.10.6 Cooling Systems

The prime-mover shall be of the water-cooled type and shall incorporate a built-on, heavy duty pattern, pressurised radiator, suitable for ambient temperatures up to 450°C. The cooling system shall be arranged to draw the air over the prime-mover and to force the cooling air through the radiator and into the duct which shall direct the air to the outside of the container. Temperature sensing devices shall be provided which shall monitor temperatures in both the engine cooling and exhaust systems. The temperature monitors shall be provided with alarm and "shut down" features. The temperatures at which the alarms are set shall be adjustable within the range 85% to 98% of the value set for the temperature at which "shut down" occurs. The temperature at which "shut down" occurs shall be similarly adjustable but shall be set and sealed by the manufacturer. Should a high temperature be monitored, an alarm shall be provided. If the temperature continues to rise the alternator set shall automatically shut down when the "shut down" temperature setting is attained. Audible and visual alarms shall be indicated and enunciated when "shut down" occurs. The audible alarms, at all levels, shall be provided with accept facilities but the visual alarms shall remain displayed until the cause is removed. All alarms and settings shall be provided on the control board. (The visual and audible alarm will be transmitted to a central control as described elsewhere)

#### AA.10.7 Lubrication

Each lubrication system shall comprise: -

- a self-lubricated, positive displacement gear driven oil pump with a pressure relief valve
- full flow engine mounted oil filter of the replaceable element type equipped with an manual by-pass valve (direct engine mounted no exposed oil lines)
- full flow oil cooler with an automatic by-pass valve
- pressure lubricated main, connecting rod, gudgeon pin, camshaft and rocker arm bearings
- Spray oil cooled piston under crowns
- Positive crankcase ventilation.
- Low engine oil level sensor

Protection shall be provided against low oil system pressure. This protective device shall shut down the engine and give a visual and audible indication on the control board. The detection system shall be manually reset before the engine may be re-started.

The Contractor shall provide details of the recommended lubricants specified by the manufacturer in the installation, operation and maintenance manual.

#### AA.10.8 Fuel System

The fuel system shall comprise:

- One base tank consisting of a 304 stainless steel inner fuel tank and a 304 stainless steel bund. The safety tank shall have a stop-cock for draining any diesel or oil leakages.
- Manual, self-lubricated, positive displacement, gear driven fuel transfer pump requiring no adjustment where applicable.
- One primary and one secondary fuel filter of the replacement element type, and a water trap of the "Automatic" type or equivalent.

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- An approved water trap / trap.
  - An indicating fuel level gauge.
  - A fuel sensor which shall provide the following indications:
    - a) A low fuel level (when level reaches 10% capacity) alarm giving an audible and visual signal. The diesel generator must be inhibited to start unless the tank is full. A cancel device for the audible alarm is required once the above condition is met. The low-level alarm must be sent to the telemetry unit as an alarm requiring action.
    - b) An alarm signal stating the tank is at 50% capacity, this signal must be a visual signal as well as signal sent to the telemetry. This alarm condition can only be reset when the tank is a 100% full.
  - A drain cock shall be provided on the fuel tank to permit the tank to be drained and cleaned. The drain cock shall be fitted with a padlocking facility.
  - A visual fuel level indication (non- electric or electronic).

#### AA. 10.9 Base Fuel Tank

The fuel tank requirement is:

- The tank capacity should be designed for 12 hours standby
- The fuel tank shall be designed, constructed and installed in accordance with SANS 10131:2004. "The Storage and Handling of liquid Fuel, Part II – 1979 Large Consumer Installations".
- Manufactured from 304 stainless steel plate.
- Exterior of the tank to be painted with a suitable diesel resistant paint.
- Tank will be mounted within a "bundling" type tank, manufactured from 304 stainless steel plate (complete with drain plug).
- Pad lockable arrangement for fuel cap (Contractor to furnish details for approval).
- All fuel lines to be mechanically protected to prevent damage and breakage.
- An analogue fuel level indication transducer shall be installed in the proposed fuel tank and shall be compatible for use with the proposed controller. It is preferable that actual fuel in liters be indicated and not as percentage of the tank volume.
- The capacity of the fuel tanks shall be stenciled on the outside of the tanks.
- The fuel tank shall be supplied with fuel for four hours of commissioning.
- For mobile generators the fuel tank shall be installed in a suitable position on the trailer and be easily removable. The position shall be compliant with all Road Traffic Regulations.

#### AA.10.10 Spare Parts

The Contractor shall ensure that the supplier of the prime mover considered for the alternator shall be able to supply any spare parts within 24 hours of placing an order for spare parts should the need arise at a later date after the defect's notification period has expired.

#### AA. 10.11 Water Heater

The Contractor shall manufacture a heater reservoir from 304L stainless steel. The water heater reservoir shall have a 3kW dry element installed into a suitable heater pocket within or under the water volume to be heated.

The water heater reservoir shall have all hose connecting attachments match the existing water-cooling system hoses. The water inlet must be at the lowest point of the reservoir and the outlet

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at the highest point, ensuring proper heat transfer. The design must ensure that no air is captured inside the reservoir.

AA.10.12 Load Banks

NO LOAD BANKS WILL BE USED

AA.10.12 **Test Data**

The tenderer shall provide the manufacturer's test certificate with all relevant information for performance including all curves, etc., relative to the engine supplied.

AA.11 **PLINTHS FOR THE STATIONARY GENERATOR SET**

Appropriately sized concrete plinth slabs required for each Stationery Generator Set shall be designed and constructed as per the OEM of the generator set. Unless otherwise stated/approved, excavations for the plinth slabs shall be carried out to a depth of 150mm below natural ground level or as otherwise indicated. A 150mm compacted thickness gravel base layer shall be constructed using G5 quality processed crushed stone and compacted to 95% Mod AASHTO. A Damp-Proof Membrane (DPM), 250 microns thick, is to be laid on the gravel base layer prior to casting of concrete. All seams in the DPM shall be sealed with pressure sensitive tape that is suitable for this type of application. The concrete plinth slab shall be constructed with a suitable MPa concrete and mild steel mesh reinforcing, all in accordance with good engineering practices.

It's compulsory that all plinths shall have bund walls as per SANS 10131-1

AA.11.1 Power Connectors and connection panels for each Mobile Generator Set

The single pole power "Panel Mounted Source" connectors and "Line Drain" connectors shall conform to the following:

400A/800A capacity at 600V

IP67

Secondary locking

Dead front contacts

High impact insulation

Multi-point contacts

Integral location keys

Waterproof when coupled

Colour coded

AA.12 **Wiring, Cable Terminations and Glanding**

AA.12.1 Mobile Standby Generator Sets

The Contractor shall make up sets of **20-meter-long** H07RN-F single core Cu trailing cable leads, run in parallel for each red, blue, white phase, neutral and earthing cable. The cable leads shall be fitted with correctly selected colour coded "Powersafe Phase 3" (or equivalent), "Line Drain Connectors" (on both ends), with dead end contacts and current carrying contacts of between 400A and 800A capacity. There will be colour coded "Powersafe Phase 3" (or equivalent), "Panel Mounted Source" connectors on both the generator load panel and the generator connection box.



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All wiring within panels may be enclosed in PVC slotted ducting. The exception is signal and instrumentation cabling passing through power compartments or cubicles, which shall be in galvanised screwed conduit. Wiring outside of panels and switchboards shall be run within galvanized ducting or conduit.

Alternatively, signal and instrumentation wiring may be run in a channel at either the front or the rear of the busbar chamber, accessible from that respective side of the switchboard within the busbar chamber. The channel shall be manufactured of 304 stainless steel and shall be welded into position. The channel shall contain a cover that is screwed into position.

All wiring and terminations shall be labelled with identification tags corresponding to the wiring diagrams. Cable terminations shall be marked with an identification label externally to the switchboard indicating the source of supply as well as the equipment being fed for feeder cables.

For example: "FED FROM SWITCHBOARDS A" and "SUPPLY TO LINE FEEDERS".

All glands for cable shall be nickel-plated brass and fitted with waterproof neoprene shrouds.

#### AA.14 **ENVIRONMENTAL REQUIREMENTS**

The equipment, comprising diesel engine, alternator and ancillary equipment, shall be fixed to a base frame and placed on anti-vibration pads of the Teeco type.

The engine and alternator shall be directly coupled, by means of a flexible coupling, via the engine flywheel.

The equipment assembly shall be so designed that no harmful vibrations are transmitted to other equipment which may be mounted on the equipment, or the building.

The engine/alternator base shall be shot blasted and etch primed and coated with a twin pack epoxy paint, colour grey.

#### AA.15 **INSPECTION AND TEST**

The successful tenderer shall arrange, at his own expense, for **THREE** representatives of eThekweni Water and Sanitation to carry out a pre-delivery inspection, at the manufacturer's factory. At this time the complete set must be load tested to 100% of its rated capacity for a period of at least 1 hour. The Contractor shall carry out any tests, which, in the opinion of the Engineer, are necessary to determine that the electrical work complies with the Drawings, the Specification and SANS 10142-1.

The Contractor shall notify the Engineer at least 2 weeks in advance, for inspections or witnessing of tests.

Continuity, phase rotation and pressure testing shall be undertaken by the Contractor, to the Engineer's specifications, prior to energising any equipment.

Works acceptance (function) tests shall be performed, which shall be witnessed by the Engineer. In the event that tests fail, the Contractor shall be required to perform such tests again. Should these tests require the Engineer to be present again, the Engineer's cost for time and travel shall be recovered from the Contractor at rates as set out by the Engineering Council of South Africa (ECSA).

The fact that the plant and equipment has satisfactorily passed any test made at the Contractor's works shall in no way lessen the responsibility of the Contractor to obtain the same results after it has been delivered and erected permanently on site.

All test certificates required in terms of the current SANS regulations shall be furnished before the project can be completed. These shall also be bound into the installation, operating and maintenance manuals.

#### AA.16 **CERTIFICATE OF COMPLIANCE**

A certificate of compliance is required for the Installation. Due allowances in the tender price shall therefore be made for testing.

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AA.17     **TECHNICAL DOCUMENTATION**

Tenderers are required to provide full details of the electrical and mechanical equipment proposed for installation in the project.

Tenderers shall also state the names of suppliers and manufacturers of switchboard, instrumentation equipment, etc.

The Engineer reserves the right to accept or reject any equipment offer made and, if equipment is rejected, to call upon the Tenderer to submit further details of similar or more suitable equipment, without affecting the tender price.

Furthermore, as the work proceeds the Contractor shall submit samples or technical literature, of all equipment, for approval, prior to purchase and installation.

The Contractor shall submit detailed working drawings of all cubicles, boxes, boards, panels, brackets, trays, etc. to the Engineer for approval prior to manufacture. The drawings shall be not less than A2 in format and shall clearly indicate the principal dimensions. At least two cross sections shall be provided on the drawings. Door and cover plate details shall be given, together with hinges and catches.

The work may not proceed until the drawings have been properly scrutinised.

The lead-time for approval of drawings shall not be more than 21 (twenty one) days from the date of receipt. The Contractor shall make the necessary allowance for this in his work program.

AA 18     **SCHEDULE OF EQUIPMENT**

A complete list of fittings and other equipment intended for use on this Contract is to be submitted with the Tender. This list shall contain manufacturers' names, catalogue numbers, etc. Where any item offered is not to specification, prior approval shall be obtained in writing from the Engineer prior to acceptance.

Should any item supplied after acceptance of this tender not comply with the specification, an alternative which meets the specification is to be approved by the Engineer and provided at no additional cost.

AA 19     **EVERYTHING NECESSARY**

The Contractor will be deemed to have visited the site and to have satisfied himself as to the nature of the work, to have acquainted himself with any limitations which may be imposed upon him and to have provided for any additional costs which he may consider necessary for the proper completion of the work. No claim will be recognised or considered after submission of price on the grounds of lack of knowledge of site conditions or limitations.

The installation shall include everything necessary whether specified in detail or not and shall be carried out in the best possible way to ensure a complete and first-class installation to the approval of the Engineer.

AA 20     **UNIFORMITY**

All items of the same type of equipment shall where at all possible, be of the same make and type for each item throughout the installation, to ensure interchange ability and ease of maintenance.

AA 21     **DELIVERY**

The Contractor must co-ordinate the delivery dates for all items of equipment supplied by him to allow adequate time for installation, commissioning and testing prior to the issue of the Completion Certificate. To this end, the Contractor must ensure that shop drawings are presented to the Engineer for comment timeously, and a programme of submission of such drawings must be commented on by the Engineer as specified in the Scope of Work. Documentary proof is to be supplied of the placing of all orders for equipment having a protracted

delivery period. No substitution of specified items will be allowed due to the late placing of orders, and no delay claims in this regard will be entertained.

The Manual shall comply with the following:

- (a) A Manual for the complete Works (covered by this specification) is required.
- (b) Three draft copies of the Installation, Operation and Maintenance Manual shall be provided prior to commissioning of the Works. Two copies shall be submitted for acceptance by the Engineer and will be returned to the Contractor. The third copy will be used by the operational staff on Site during commissioning. Unless otherwise specified, six copies of the final version of the Installation, Operation and Maintenance Manuals shall be provided prior to the issuing of the Taking-Over Certificate and the commencement of the Defects Notification Period. All information shall also be recorded on compact disk of which two copies shall be provided.
- (c) The Manuals shall be of a standard acceptable to the Engineer. At least one set shall contain original copies and this set shall be marked "Original". The other sets shall be marked "Copies 2 to 6".
- (d) Binders shall have hard, plastic protected covers utilizing four- ring, spring- clip holders. Sufficient binders shall be used to make each volume easy to use. One spare, empty binder shall be provided for every three used. A title label shall be affixed to the spine of all binders. This shall indicate contract number, title and location, Contractor's name and, where required, plant description, volume number and contents.
- (e) Labelled separator sheets shall be provided between each section and sub-section and also wherever volume or complexity makes this advisable.
- (f) The Manual shall be in English, shall be easy to use, practically and neatly presented, clearly sectionalised and titled, provided with a Contents List and shall be specifically applicable to the system as installed.
- (g) Where standard equipment manuals are used in any sections, these shall be marked up to be unambiguously applicable to the equipment installed and marking up shall be done in a manner which will be transmitted to photocopies.
- (h) All sections and sub-sections shall be numbered. Numbering of the Contents List shall be sequenced so that no two sections have the same number.
- (i) Drawings shall be to a scale, which makes all details clear. Drawings shall be held in plastic envelopes in the Manual. Drawings shall also be provided on CD disk in AutoCAD format.
- (j) Where practical, each section shall form a separate volume

The Manual shall be divided into sections and shall include the information described below.

Section 1 – General

The following shall be provided:

- (a) Contents List for the complete Manual. This shall consist of:
  - An overall contents list.
  - Detailed contents list in front of each section and/or sub-section.
  - A comprehensive list of all drawings.
  - The Contents Lists shall be structured so as not to be affected if volumes are added or subtracted from the Manual.
- (b) Equipment List for all individual items of mechanical, electrical, instrumentation and control equipment. The Equipment list shall include the description, make, model, serial number,

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batch number, size, range, performance data, motor and drive details, supplier's name, address and phone numbers, all as applicable. The design duty, the position of the unit's installation and its design purpose in the system shall be given. A schedule of corrosion protection systems used shall be provided for fabrications such as tanks, supporting structures, clarifier bridges, etc.

(c) Drawing list of all Contractor's and Tender drawings.

(d) Cable schedule for power and instrumentation cables. This shall include the cable type, start and finish points, route length, duty, load, size, voltage drop, number of cores, number of cores used and gland size. For cable voltages above 400 Volts, the schedule shall also include the purchase details, specification and date of manufacture.

(e) Drawings:

✧ Cable routes.

## Section 2 – Process, Operation and Control

The following shall be provided:

- (a) Description of plant and process design and including all design parameters.
- (b) A description of each system supported by drawings, process flow or circuit diagrams and explanatory sketches to assist operating staff.
- (c) Description of control system, including control panels, as applicable and including controls, Instruments, settings, indications, alarms, trips, etc. Functional Specification. List of protections, including description, sensor, operating limits, settings, etc.
- (d) Straight forward, step by step, initial startup instructions for commissioning. These shall include Operating steps, precautions, settings, adjustments, observations, etc.
- (e) Normal start up, adjustment, operating and shut down procedures for the system as installed and Including settings, adjustments, observations, etc. The procedures shall highlight any safety precautions to be observed.
- (f) An Instrument List giving a description of the duty as well as the serial number, normal operating Reading, maximum or minimum permissible readings, set-points (activation, warning and trip), etc.
- (g) Trouble-shooting guide, including symptoms, causes and solutions.
- (h) Drawings:
  - ✧ As-built system, layout and GA drawings.
  - ✧ Plant circuit or flow diagrams and P&IDs.
  - ✧ Control panel layouts.
  - ✧ System control diagram and logic sequence chart, as applicable.

## Section 3 - Maintenance Schedules

*The following shall be provided for all mechanical, electrical, instrumentation and control equipment:*

- (a) A comprehensive lubrication schedule of recommended and initial lubricants, capacity, lubrication periods, etc., for all items.
- (b) A comprehensive maintenance schedule of routine maintenance by time period for the new installation and including information for individual items.

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These schedules may cross-refer to supplier's standard Manual

#### Section 4 - Mechanical Equipment

*The following shall be provided for each item of mechanical equipment:*

- (a) A copy of the information applicable to the item and appearing in the Equipment List.
- (b) A separate table containing the unit's nameplate information; or, a photograph of the nameplate.
- (c) Technical and descriptive literature, including principle of operation and construction.
- (d) Installation instructions. (e) Detailed operating instructions.
- (f) Control and electrical details, including logic sequence, circuit diagrams and software, as applicable.
  
- (g) Full technical and maintenance information including instructions for assembly, disassembly, lubrication, adjustment, calibration, reconditioning, repair, etc.
- (h) A spares list giving the item number, part number, description, quantity and materials. A list of recommended spares. Tenderers must submit a written assurance that spare parts for the plant offered by them as a whole are readily available within the Republic of South Africa and state from where these are available.
- (i) Factory and Site test results.
- (j) Corrosion protection systems used, coating supplier's data sheets and coating repair procedures.
- (k) Drawings:
  - Performance curves.
  - Layout drawings.
  - large scale, dimensioned, cross sectional and arrangement drawings of the item for assembly and spares recognition purposes, cross-referenced to the spares list.
  - Dimensioned drawings of fabricated equipment.
  - Circuit layout of any auxiliary systems.

#### Section 5 - Electrical Equipment

*The following shall be provided for each item of electrical equipment:*

- (a) A copy of the information applicable to the item and appearing in the Equipment List.
- (b) A separate table containing the unit's nameplate information; or, a photograph of the nameplate.
- (c) Technical and descriptive literature, including principle of operation and construction.
- (d) Control and electrical details, including logic sequence, circuit diagrams and software, as applicable.
- (e) Installation instructions.
- (f) Detailed operating instructions.
- (g) Full technical and maintenance information including instructions for assembly, disassembly, lubrication, adjustment, calibration, reconditioning, repair, etc.
- (h) A spares list giving the item number, part number, description, quantity and materials. A list of recommended spares.

- 
- (i) Factory and Site test results.
  - (j) Drawings:
    - ✧ Equipment overall dimensions.
    - ✧ Circuit diagrams.
    - ✧ Switchboard layout drawings and SLDs.
    - ✧ Electrical panel construction drawings.
    - ✧

#### Section 6 - Instrumentation Equipment

*The following information shall be provided for each item of instrumentation equipment:*

- (a) A copy of the information applicable to the item and appearing in the Equipment List.
- (b) A copy of the relevant information in the table of instrumentation in the sub-clause "Operation Section" and including all settings.
- (c) Installation instructions.
- (d) Descriptive and technical literature giving full details of performance, operation, calibration, setting, service, maintenance and spares including suitable assembly drawings
- (e) Technical and descriptive literature, including principle of operation and construction.
- (f) Control and electrical details, including logic sequence, circuit diagrams and software, as applicable.
- (g) Factory test results.
- (h) Full technical and maintenance information including instructions for assembly, disassembly, lubrication, adjustment, calibration, reconditioning, repair, etc.
- (i) Drawings:
  - ✧ Circuit diagrams of both instrumentation systems and individual instruments.
  - ✧ Overall dimension and installation drawings.

#### Section 7 - Control Equipment, Network and Software

*The following shall be provided:*

- (a) A copy of the information applicable to the item and appearing in the Equipment List.
- (b) Cross-referenced listing of all I/O used.
- (c) An annotated program listing.
- (d) Loop drawings showing field terminal numbers, marshalling terminal numbers and PLC rack/slot/terminal numbers.

#### Section 8 - Drawings

All drawings not filed elsewhere shall be filed in this section.

#### AA 23 **TRAINING**

After the three draft copies of the Installation, Operation and Maintenance Manual have been received prior to the commissioning of the Works, the Contractor shall train Employer's staff in the operating and maintenance

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departments of the plants in the day to day operation as well as the maintenance of the newly installed equipment. This training shall be done during the Trial Operation Period.

**AA.24 GUARANTEE AND MAINTENANCE**

**AA.24.1 General**

The tenderer shall guarantee and maintain the complete installation, i.e. as defined within the scope of this contract, for a period of twelve months after commissioning and acceptance of the plant by eThekweni Water and Sanitation. During the maintenance period the installation shall be maintained as specified by the tenderer and any defective material, equipment or workmanship (excepting proven, wilful or accidental damage, or fair wear and tear) shall be made good with all possible speed at the tenderer's expense and to the satisfaction of the Engineer.

**AA.24.2 Making Good**

When called upon by the Purchaser, the tenderer shall make good on site and shall bear all expense incidental thereto including making good of work by others, arising out of removal or re-installation of equipment. All work arising from the implementation of the guarantee or maintenance of equipment shall be carried out at times which will not result in any undue inconvenience to users of the equipment, or occupants of the premises.

If any defects are not remedied within a reasonable time, the Engineer may proceed to do the work at the tenderer's risk and expense, but without prejudice to any other rights which the Engineer may have against the tenderer.

**AA.24.3 Latent Defects and Failure to Comply with Specification**

The Purchaser reserves the right to demand the replacement or making good, by the tenderer at his own expense, of any part of the installation, including the diesel alternator, which is shown to have any latent defects or not to have complied what the Specification, notwithstanding that such work has been taken over or that the guarantee period has expired.

**AA.25 Maintenance**

The Tenderer shall maintain the supplied range of standby generator sets during the ***LATENT DEFECT PERIOD, STARTING A MONTH AFTER THE SET HAS BEEN COMMISSIONED.*** The required maintenance shall include the following:

**(1) THREE MONTHLY INSPECTION**

**UNIT STATIONARY:**

- 1) Check the oil level.
- 2) Check the radiator water level.
- 3) Check battery water and specific gravity or indicator in case of sealed maintenance free batteries.
- 4) Check operation of automatic battery charger.
- 5) Check operation of jacket water heater.
- 6) Check condition of jacket water heater hoses.
- 7) Check radiator core for cleanliness.
- 8) Check tension and condition of fan belts.
- 9) Check diesel fuel level.
- 10) Check tightness and condition of battery terminals, clean and seal.

- 
- 11) Check for presence of water in primary fuel/water separator filter.

#### UNIT RUNNING (MANUAL START)

- 1) Check oil pressure.
- 2) Check water temperature.
- 3) Check engine speed.
- 4) Check AC voltage.
- 5) Check for exhaust gas leakage.
- 6) Check operation of set mounted DC charging system.
- 7) Test operation of engine safety systems.
- 8) Check for visible oil, water and fuel leaks.
- 9) Return generator selector switch to auto function.

#### LOAD TEST (AUTOMATIC FUNCTION)

A: Isolate incoming mains supply and witness the following:

- 1) Start delay.
- 2) On load timing.
- 3) Load acceptance of connected load.
- 4) AC voltage.
- 5) Engine speed in Hz.
- 6) Record amperage drawn per phase.
- 7) Run unit for 1 hour checking water temperature and oil pressure.

B: Re-instate incoming mains supply and witness the following:

- 1) On load run times.
- 2) Cool down times.
- 3) Engine shut down.

#### (2) ANNUAL SERVICE OR AFTER 250 RUNNING HOURS

- 1) Proceed as per monthly service procedure.
- 2) Drain lubricating oil.
- 3) Replace oil and fuel filters.
- 4) Refill lubricating oil.
- 5) Check and clean primary fuel/water separator filter. Replace if necessary.
- 6) Remove clean and check air filter element. Replace oil in oil bath type air cleaners.
- 7) Drain coolant refill and add coolant conditioner.
- 8) Check for perished or damaged radiator hoses.
- 9) Tighten all jubilee clamps on radiator and intake systems.



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- 10) Remove access covers and check for litter in air cooled engines.
  - 11) Check for perished or damaged fuel lines and tighten jubilee clamps.
  - 12) Check engine wiring looms for chafing and loose connections.
  - 13) Check AC alternator for cleanliness and loose connections.
  - 14) Check automatic mains failure panel for loose or hot connections.
  - 15) Grease service points as required.
  - 16) Check fuel tank level and dip to check for presence of water. Drain off water if necessary.
  - 17) Clean unit and plant room

***The cost of such inspections, maintenance, adjustments, repairs, etc., shall be included in the tender price, but the cost of renewing any part which may become worn through fair wear and tear, or damage beyond the control of the tenderer or not a latent defect (provided this is not due to unsuitable design), shall be excluded.***

## **GENERAL QUALITY ASSURANCE REQUIREMENTS**

The appointed contractor shall provide the following .

TABLE OF CONTENTS		
TASK	DESCRIPTION	WHEN REQUIRED
Drawings and design ,3 Sets Each	Design Calculations	
	General Assemenbly	3 Weeks after kick off
	Detail Drawings	
	AS Built Drawings	
	Technical Brochures	
	Sketches	
	Schematics	3 Weeks after kick off
	Risk Assessemnet	
Quality Control Documents , 3 Sets	Quality Control Plan	3 Weeks after kick off
	Manufacturing Program	3 Weeks after kick off
	Procurement Program	3 Weeks after kick off
Material Certificates		At Factory Inspection
Certificates of Inspection , Testing and Acceptance	Presure Test Certicate	Three Weeks before Hot comissioning
	Electrical Hazardous Certificate	Three Weeks before Hot comissioning
	Electrical Test Certificate	Three Weeks before Hot comissioning
	Instrumentation Calibration Certificates	Three Weeks before Hot comissioning
	Vendor Certificate of conformance	Three Weeks before Hot comissioning
	Non Conformity/Concession Reports	Three Weeks before Hot comissioning
	All electronic Programming , VSD, Soft Starters , Instruments etc	Three Weeks before Hot comissioning
	PLC ,SCADA , Software and hardcopies of programming	Three Weeks before Hot comissioning

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Manuals 5 set each	Operating Manual	Three Weeks before Hot comissioning
	Maintenance Manual	Three Weeks before Hot comissioning
	Training Manual	Three Weeks before actual training
	Schematics	Three Weeks before Hot comissioning

# ETHEKWINI MUNICIPALITY

## WATER & SANITATION

### SANITATION OPERATION

#### Control & Instrumentations Specification

Rev 4

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## **SECTION A**

### **GPIS: GENERAL PROCESS INSTRUMENTATION SPECIFICATION**

#### **GPIS 1: DESIGN BASIS**

##### **GPIS 1.1 General**

- 1.1.2 All panel mounted instrumentation and control equipment shall be capable of operating at the required capacity in ambient temperatures not exceeding 50°C and an average, over a period of 24 hours, not exceeding 40°C. The field mounted instruments and control equipment shall however, be suitable for operation under ambient temperatures not more than 55°C unless higher ambient temperatures are specifically stated in the Technical Specification.
- 1.1.3 All equipment and accessories shall be designed to withstand the environment and operational conditions within the plant.
- 1.1.4 Instrumentation sensing system shall be pneumatic or electronic. Electric signal transmission shall be of common standard and level or converted, where required to the common standard.
- 1.1.5 Special care shall be taken to make the equipment enclosures proof against entry of vermin and insects (IP rating).
- 1.1.6 The design shall include all reasonable precautions and provisions for the safety of operating and maintenance personnel as well as for their accessibility.

##### **GPIS 1.2 Panel Instruments**

- 1.2.1 It should be endeavoured not to have any panel instruments, but rather to make use of the PLC / SCADA. Where panel instruments are required for instance at a T/A set the following shall apply.
- 1.2.2 Standard size instruments shall be used on the control panels to indicate, record and control the major portion of the process variables.
- 1.2.3 Factory assembled panels or field assembled panels shall be furnished in accordance with Item 4.1 of this specification.

- 1.2.4 Process fluids shall not be piped directly to instruments in the control room.
- 1.2.5 Where separate electric power supplies are required for critical electronic instrumentation systems, it shall be taken off the UPS supplying that area Instrumentation.

### **GPIS 1.3 Field Instruments**

- 1.3.1 All field mounted instruments shall be weather-proof and dust-tight, suitable for use under ambient conditions prevalent in a specific plant area with a minimum of IP rating of 65.
- 1.3.2 In plant areas giving rise to corrosive atmospheres, field mounted instruments such as transmitters, I/P converters, solenoid valves, pressure switches etc. shall be housed in steel boxes with IP65 rating. Piping and cable entries shall be made at the bottom of the box.
- 1.3.3 All field boxes will be fitted with canopies.
- 1.3.4 All valves and drives shall be correctly sized with a 50% turn down ratio.

### **GPIS 1.4 Control Performance**

- 1.4.1 Automated production is performed by a distributed process control and information management system comprising supervisory computers and controllers linked to a distributed real-time network.
- 1.4.2 Automatic control systems shall, in general, be of feedback type, however, feed-forward control shall be used when process time-lag conditions that exist in a feed-back system are not tolerable. Modes of control shall, in general, be proportional (P), proportional plus automatic reset (I), or proportional plus reset plus rate (D).
- 1.4.3 All control loops shall be stable for all process conditions. Cyclic stability will not be accepted. Final value error shall be minimised whenever practical.

### **GPIS 1.5 Metering Base and PCS Units**

Pressure above 1 bar - kPa

Pressure below 1 bar	- Pa
Draft	- mm H <sub>2</sub> O
Vacuum	- kPa (abs)
Temperatures	- °C
Flow (all gases)	- m <sup>3</sup> /hr
Flow (steam and condensate)	- kg/hr tonne/hr
Flow (liquids)	- m <sup>3</sup> /h lt/sec
Flow base	- based at 760mm Hg and 0°C
Level	- % or m
Density	- kg/m <sup>3</sup>

## **GPIS 1.6 Utilities**

1.6.1 Electrical power, available from the plant system is 3 phase 400 V and 1 phase 240 V, 50Hz. If the equipment is required to operate at any other voltage level, the necessary transformer and/or conversion units shall be included in the scope of supply by the Contractor.

1.6.2 A power supply calculation shall be performed to determine the capacity of:

- UPS capacity including battery.

1.6.3 Standard voltage:

Main power supply	- 3 x 400/220 V 50 Hz
UPS Supply	- 1 x 220 V ± 5%, 50 Hz
Instrument Control Voltage	- 1 x 220 V ± 5%, 50 Hz
	- 24 V ±5%, DC
Digital Signals	- 24 V ±5%, DC
Analogue Signals	- 4 to 20 mA DC

1.6.4 Clean instrument compressed air will generally be available, however where specific instruments may require air quality above the normal quality of plant instrument air or at a lower pressure than the plant instrument air the contractor is to ensure that all necessary regulators, dryers, separators and lubricators are allowed for.

## **GPIS 2 PANEL INSTRUMENT DESIGN**

### **GPIS 2.1 Recorders**

Recorders are not preferred, SCADA trends, i.e. Real Time and History trends should be available for all measured variables.

## **GPIS 2.2     Controllers**

2.2.1         Stand-Alone controllers, (panel mount controllers), are not preferred.

## **GPIS 2.3     Indicators**

2.3.1         Stand-Alone indicators, (panel mount electronic indicators), are not preferred.

## **GPIS 2.4     Alarm Annunciator**

2.4.1         Alarm display window shall be LED side lighted name plate type.

Each alarm system shall be equipped with flasher and horn and shall have provision for push-buttons to acknowledge, reset and test the system.

Visual alarms shall be located in the vicinity of monitored process conditions on graphics panels. Miscellaneous alarms shall be grouped into a common bank whenever practical.

Alarm initiating contacts shall be normally open, either fleeting or permanent type. For the case of power failure or wire break, closed safety circuit operation shall be applied wherever practical.

The response for alarm systems shall be less than 20 milliseconds.

Alarm annunciation systems shall be energised from a secure 24V DC or 220 V AC power supply source or UPS.

Client Preferences:

All alarm annunciation will take place on the PLC/SCADA, or HIM.

## **GPIS 3         FIELD INSTRUMENT DESIGN - TRANSMITTER DESIGN**

### **GPIS 3.1       Magnetic Flow Meter**

3.1.1         Transmitter shall be indicating, electronic type based on law of induction.

3.1.2         Transmitter shall meet the following minimum requirements:

Accuracy:	0,5% of span or better
Repeatability:	0,2% of span
Output:	Linear
Ambient temperature effect:	Not to exceed 0,5% of maximum span per 10°C change.
Material:	
- Tube:	Stainless Steel
- Liner:	Teflon (depending on application)
- Electrode:	Hastalloy Tantalum

### **GPIS 3.2 Vortex Shedding Meter**

3.2.1 Transmitter shall be indicating, electronic type based on the Vortex shedding measuring principle.

3.2.2 Transmitter shall meet the following minimum requirements:

Accuracy:	0,2% of span or better
Repeatability:	0,2% of span
Output:	Linear
Ambient temperature effect:	Not to exceed 0,5% of maximum span per 10°C change.
Material:	
- Tube:	Stainless Steel
Vortex shedder:	Stainless Steel

### **GPIS 3.3 Pressure Transmitter**

3.3.1 Transmitter shall be indicating, electronic type based on force balance principle.

3.3.2 Transmitter shall meet the following minimum requirements:

Accuracy:	0,2% of span or better
Repeatability:	0,1% of span
Dead band:	Not to exceed 0,1% of span
Ambient temperature effect:	Not to exceed 0,5% of maximum span per 10°C change.
Proof Pressure:	200% of max. process static pressure.
Mounting:	Universal bracket type
Material:	Case, primary element and wetted parts shall be made of material that is

corrosion resistant to process fluid and ambient atmosphere.

Adjustment: Independent for span and zero. (Adjustment may be via bus or hand held calibrator)

#### **GPIS 3.4 Temperature Transmitter**

Transmitter shall be electronic type for thermocouple or RTD connection.

Transmitter shall meet the following minimum requirements:

Accuracy:	0, 5% of span or better
Repeatability:	0,1% of span
Dead band:	Not to exceed 0,1% of span
Ambient temperature effect:	Not to exceed 0,5% of maximum span per 10°C change
Proof Pressure:	200% of max. process static pressure
Mounting:	Head mounted unless specifically stated otherwise in instrument specification
Material:	Case, primary element and wetted parts shall be made of material that is corrosion resistant to process fluid and ambient atmosphere.
Adjustment: Independent for span and zero. (Adjustment may be via bus or hand held calibrator)	

#### **GPIS 3.5 Capacitance Level Transmitter**

Transmitter shall be indicating, two-wire electronic type for rod – or rope-probe connection.

Transmitter shall meet the following minimum requirements:

Accuracy:	1% of span or better
Repeatability:	0,2% of span
Dead band:	Not to exceed 0,2% of span

Ambient temperature effect:	Not to exceed 0,5% of maximum span per 10°C change.
Material:	Standard materials that are suitable for process and ambient conditions shall be used.
Probes:	Shall generally be stainless steel / Teflon coated.
Adjustment:	Independent for span and zero.

### **GPIS 3.6 Ultrasonic Level Transmitter**

Ultrasonic level measuring device shall have facilities to compensate echo changes due to temperature changes and to ignore periodically recurring false echo due to agitators.

Evaluating device shall be indicating, two-wire electronic type.

Transmitter shall meet the following minimum requirements:

Accuracy:	1% of span or better
Repeatability:	0,2% of span
Dead band:	Not to exceed 0,2% of span
Ambient temperature effect:	Not to exceed 0,5% of maximum span per 10°C change.
Material:	Standard materials that are suitable for process and ambient conditions shall be used.
Adjustment:	Independent for span and zero. (Adjustment may be via bus or hand held calibrator)

### **GPIS 3.7 Radar Level**

Microwave level measurement. Measures the transit time of a radar signal that is reflected from the surface of a liquid.

Transmitter shall meet the following minimum requirements:

Accuracy:	1% of span or better
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Repeatability:	0.2% of span
Temperature Drift:	<100ppm / °K
Material:	wetted parts stainless steel

Device shall be 2 wire, with a local indication.

### **GPIS 3.8 Guided Radar Level**

Guided radar (TOR) level transmitter. Guided radar is based on time domain reflectometry principle. Low power microwaves are sent along conductors and at the point where the waves meet the product surface the waves are reflected.

Transmitter shall meet the following minimum requirements:

Accuracy:	1% of span or better
Repeatability:	0.2% of span
Temperature Drift:	<100ppm / °K
Material:	rod or cable – stainless steel

Device shall be 2 wire, with local indication.

### **GPIS 3.9 Weight Transmitter**

Weight transmitters shall be selected in conjunction with load cells, shall have high immunity to plant vibration, allow long distances to load cells and shall be designed to compensate for temperature effects.

Transmitter shall meet the following minimum requirements:

Accuracy:	0,5% of span or better
Dead band:	Not to exceed 0,1% of span
Ambient temperature effect:	Not to exceed 0,5% of maximum span per 10°C change.
Material:	Case, primary element and wetted parts shall be made of material that is corrosion resistant to process fluid and ambient atmosphere.
Adjustment: Independent for span and zero.	(Adjustment may be via bus or hand held calibrator)



### **GPIS 3.10 Open Channel Flow Transmitter**

Open Channel Flow ultrasonic measuring device shall have facilities to compensate echo changes due to temperature changes and to ignore periodically recurring false echoes due to agitator.

Evaluating device shall be indicating, two-wire electronic type.

Transmitter shall meet the following minimum requirements:

Accuracy:	1% of span or better
Repeatability:	0,2% of span
Dead band:	Not to exceed 0,2% of span
Ambient temperature effect:	Not to exceed 0,5% of maximum span per 10°C change.
Material:	Case, primary element and wetted parts shall be made of material that is corrosion resistant to process fluid and ambient atmosphere.
Adjustment: Independent for span and zero.	(Adjustment may be via bus or hand held calibrator)

## **GPIS 4 CONVERTER DESIGN**

### **GPIS 4.1 Electric-Pneumatic Converter (I/P)**

Electric to pneumatic converters are intended primarily for use in conjunction with controllers having electrical output or with electrical transmitter where the final control element is actuated from pneumatic actuator or controller.

Pneumatic-electric converter shall be of force balance type and shall convert the direct current input into a standard pneumatic output signal.

Converter shall be provided with a 1:1 relay wherever required in order to provide large volume of air required for rapid operation at long distance.

Transmitter shall meet the following minimum requirements:

Accuracy:	0,5% of span or better
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Linearity:	0,1% of span
Hysteresis:	0.2% of span
Ambient temperature effect:	Not to exceed 0,5% of maximum span per 10°C change.
Adjustment:	Independent for span and zero.
Mounting:	Universal bracket suitable for horizontal or vertical support
Case:	Dust-tight for general application

## **GPIS 5      PRIMARY ELEMENT DESIGN**

### **GPIS 5.1      Orifice Plate Design**

Orifice plates shall be made of suitable grade stainless steel, unless process conditions require some other material.

In general, orifice plates shall be designed for flange taps, however, Venacontracta taps may be substituted when designated by good engineering practice.

Concentric type orifices are preferential.

Eccentric or segmented types shall be used for measurement of dirty gases or fluids carrying suspended matter which might tend to cause build-up.

The orifice ratio (orifice inside diameter to process pipe line internal diameter) shall, in general, be between 0,3 and 0,7 for metering accuracy.

### **GPIS 5.2      Annubar Design**

Annubar material shall be made of suitable grade stainless steel, unless process conditions require some other material.

In general, Annubars shall be designed for single support and on-line vertical, or horizontal taps.

Opposite side support are to be used only in extreme diameter and high flow cases.

On-line steam purge accessories are to be included for measurement of dirty gases or

fluids carrying suspended matter which might tend to cause build-up.

Flow turndown of 10:1 is acceptable.

Annubar element shall meet the following minimum requirements:

Accuracy:	1,0% of actual value
Repeatability:	0,1% of actual value
Mounting:	Universal bracket suitable for horizontal or vertical support

### **GPIS 5.3 Pressure Elements**

Directly connected instruments shall be diaphragm, Borden or bellows type elements depending upon the service requirements.

In general, diaphragm elements shall be used in the range of 0 to 100kPa vacuum or pressure, bellows type element for range of 0 to 1000 kPa and Borden tube element for range higher than 1000 kPa.

Primary element material shall be corrosion resistant to process fluid or chemical seals must be provided for protection.

Primary element material shall provide good creep and fatigue resistance, and low hysteresis.

Proof pressure shall be at least twice the maximum system pressure.

### **GPIS 5.4 Temperature Elements**

The primary elements for temperature services shall consist of resistance thermometers or thermocouples or radiation pyrometers, depending upon the range of measurement.

The following types of elements shall be used for stated ranges:

Type	Temperature Range °C
Pt-Rh (10%) Pt	0 - 1500 Type S
Chromel – Alumel	0 – 1100 type K
Copper resistance Element	-50 to +100
Platinum resistance Element Pt100	0 to +600

Whenever specified, duplex thermocouple shall be provided.

Thermocouple/emf calibration shall conform to the International Practical Temperature Scale of 1968 (ITS).

Gas-tight mineral insulated type, reinforced with stainless steel protective tubes shall be used for thermocouples. Preferred outside diameter shall be 6mm. Lengths to fit standardised thermo-wells shall be used.

Resistance thermometer shall be of three lead connection system to the instrument and shall be gas-tight internal insulated type, reinforced with stainless steel protective tubes shall be used for thermocouples. Preferred outside diameter shall be 6mm. Lengths to fit standardised thermo-wells shall be used.

The resistance/temperature relationship shall conform to British Standard 1904 Table 1, 1979 revision or with DIN 43760.

Thermo-wells shall be used for all temperature elements under pressure application. Construction material for thermo-wells shall be suitable stainless steel, unless some other material is required due to process conditions.

#### **GPIS 5.5 Radiation Pyrometers**

Radiation pyrometers shall be used when:

- Temperatures are above practical operating range of thermocouple.
- Environment will contaminate or seriously limit the life of thermocouples.
- The target is not easily accessible.
- Where plant requirements make them impractical.

Radiation pyrometers shall be of solid state circuitry type and shall, for standard application, respond to 98% of target temperature changes within 2 seconds.

The burner flame detector applications, radiation pyrometers shall be designed for use with self-checking flame self-guard controls.

#### **GPIS 5.6 Filled Systems**

Filled systems shall not be used unless otherwise specified.

## **GPIS 6      INDICATOR DESIGN**

### **GPIS 6.1      Flow Indicators**

Flow indicator shall be rotameter or differential pressure type.

Rotameters, when used, shall preferably be of metal type with magnetic indicator extension. Glass type rotameters shall be used for purge or auxiliary services.

Differential pressure type, when used, shall in general be of dry type complete with equalising valve manifold.

Indicators shall have suitable body material and packing of process fluid being monitored.

Scales shall be linear or square root direct reading.

Accuracy shall be 1% of full scale or better and repeatability at least 0,255 of full scale range.

Proof pressure shall be at least 200% of maximum static process pressure at maximum process fluid temperature.

### **GPIS 6.2      Pressure Indicators**

Pressure gauges shall generally be 150mm diameter. Case and movement – stainless steel.

Scales shall be white with black lettering. Accuracy shall be 1% of full scale range or better.

Scale ranges shall be selected so that normal process pressure is approximately 50% of full scale.

Rotary geared stainless steel movements shall be used.

Gauges for steam service shall be connected with pigtail siphon. Dampers shall be provided for all pulsating fluids.

Draft gauges shall be diaphragm type or fluid filled manometers.

### **GPIS 6.3     Temperature Indicators**

Temperature indicators shall generally be 100mm dial, bi-metallic or fluid type with thermo-well suitable for application.

Material of construction for thermo-well shall be suitable stainless steel, unless some other material is required due to process conditions.

Fluid filled type indicators, when used, shall be either rigid stem or capillary tubing type.

Capillary tubing shall be armour protected.

Stem or bulb shall be suitable stainless steel with welded joints.

Indicator shall be provided with automatic ambient temperature compensation.

Accuracy shall be 1% of full scale range or better.

### **GPIS 6.4     Level Indicators**

6.4.1     Sight level glasses or dial type or float type level indicators shall be used.

6.4.2     Each sight glass shall be complete with a pair of offset valves, valves shall have union level connection, flanged tank connection, vent and drain plugs.

If float type indicators are used, cable must be made of braided stainless steel.

Dial type indicator shall be of differential pressure type having accuracy of 1% of full scale or better.

## **GPIS 7        SWITCHES AND CONTROLLERS**

### **GPIS 7.1     Mechanical Switches**

Pressure, flow level, temperature etc. type switches shall be provided with enclosures of a type to suit individual area environment.

Actuating switches shall be either hermetically sealed mercury type or snap action micro-switches. Contacts shall have a minimum rating of 3A inductive braking at 220V AC.

All switches shall have two parallel contacts normally open/closed and the on-off

differential switches shall be adjustable. Adjustable range shall be suitable for switch application, actuation set point shall be adjustable over full scale range.

All switches shall have an accuracy of 1% or better of full scale range.

Level switches shall be in general resonating or displacer type. Standard material shall be suitable for process and ambient conditions. Material of the displacer shall be stainless steel.

Conductivity level switches shall be either single or double type with contacts changeable to minimum/maximum closed safety circuit. Electrodes shall be heavy version, either single or three rod types, material shall be preferable of special steel.

Position switches shall be of inductance or capacitance proximity sensors with single or dual potential free contacts.

## **GPIS 8      ACTUATORS**

### **GPIS 8.1    General**

Actuators shall be either pneumatic diaphragm or pneumatic piston type.

All actuators shall have a stall torque rating of at least 150% of maximum required torque for the driven element.

All actuators shall have a minimum repeatability of 0,5% of full travel. Hysteresis effect shall not exceed 1,0% of full scale travel.

Manual over-ride facilities shall be provided.

A mechanical shaft position indicator shall be standard on all actuators.

Actuators shall have a totally enclosed housing to provide complete protection for all moving, pneumatic and electronic parts. Construction material shall be suitable for ambient and process conditions.

Unless specified otherwise, actuators be of spring return type for fail-safe operation.

### **GPIS 8.2    Pneumatic Actuators**

Actuators shall be of diaphragm or cylinder type for either rotary or linear version depending upon specific application and shall be reversible for air-to-open or air-to-close action.

Actuator shall operate on 600 kPa, cylinder shall be able to withstand a line pressure of 1500kPa. Positioner shall operate on 20 to 100 kPa.

Corrosion, endangered parts such as cylinder wall, piston rod, torque plug, etc. shall be manufactured of hard wearing and rustless metal, with high lubricity.

Actuators shall be provided complete with line filter, lubricator, positioner, manual operating handle and air lock-up system, unless otherwise specified.

For actuator position remote indication the provision for two limit switches attachment shall be provided.

### **GPIS 8.3    Electric Actuators**

Actuators shall be fitted with a 3 phase 400 squirrel-cage motor.

If two speeds are required a pole-changeable motor may be used.

Output force of the motor shall be transmitted through a stage of spur gears, a spring-balanced worm with axial bearings, a worm wheel, and a clutch stage to the output shaft.

All actuators shall be fitted with a double torque-dependent switch.

For remote position indication of actuators fitted to modulating valves, provision for an analogue 4-20 mA attachment shall be provided. For isolation valves two limit switches shall be provided. All actuators must be able to communicate via Modbus TCP/IP

Provision for manual operation shall be made by means of a hand wheel – the mechanically independent hand-wheel shall be engaged by means of a clutch, which also de-clutches the motor drive from the output shaft.

Actuators shall be fitted with a mechanical position indicator.

#### **Technical specifications:**

Torque and travel dependent switches:



No, NC or change-over:	10A at 30V AC, 5A at 250V AC 5A at 30V DC, 0,4V at 250V DC
Mechanical life time:	± 106 cycles
Suitable for ambient temperature	-20 to +80°C
Electronic position indicator:	
Supply voltage:	15 to 30V smoothed
Output:	4-20 mA load R: 500 ohm at 15V, 1250 ohm max. at 30V
Current consumption:	Max. 40 mA at 20 mA output signal
Linearity deviation:	±1% from 5 to 95% of measuring range
Suitable for ambient temperature	-25 to +90°C
Adjustment:	Independent for span or better
Linearity:	0,1% of span
Hysteresis:	0,2% of span
Accuracy:	0,5% of span or better
Case:	Dust-tight for general application

#### **GPIS 8.4 Control Valves – General**

Control valves for modulation services shall be pneumatically operated.

Flange facing and drilling shall be according to either BS or equivalent DIN standard.

Control valves of size 40mm and above shall have flanged end connections.

In general control valves of size 40mm and below shall have screwed connection.

Valve size shall be based on specified allowable pressure drop at 130% of normal process design flow conditions.

Valve top-works shall be sized so that the valve will operate properly when upstream pressure is 10% above maximum inlet pressure and downstream pressure is atmospheric.

Isolating valves and by-pass valves shall in general be provided for each control valve application. Isolating valves shall be of line size whereas by-pass valves shall be of control valve size.

Seals and liner material used for valves in boiler gas lines shall be made of VITON.

Nylon shall not be used unless otherwise specified.

Close attention shall be given to the selection of valve body, line and diaphragm material depending upon specific application, however, Engineer approval is required prior to order.

#### **GPIS 8.5 Diaphragm Valves**

Diaphragm valves shall be used where process control quality requirements are comparatively poor and a low pressure drop across the valve is required or where the valve function is restricted to on-off control

Diaphragm valves shall be used for aggressive fluids such as weak sulphuric acid, corrosive, slurry and sludge which contain solids in suspension.

For application with high control frequency another valve type shall be considered.

Material construction:

Body:	Cast Iron
Liner:	Hard rubber, Soft rubber, Butyl
Diaphragm:	Depending on application.

#### **GPIS 8.6 Globe Valves**

Globe valves shall be used in the majority for conventional control application.

For water, steam, gas and air control applications, a cast steel valve body with stainless steel trim shall be provided.

In case of special treated water, selection of stainless steel body may become necessary.

For oxygen control application, a bronze valve body with monel-metal trim and a PTFE Chevron packing shall be provided.

Trim material shall normally be of 316 stainless steel, for special applications stellite shall be used.

Extended bonnets and graphite laminate/filament packing shall be used for operating temperature higher than 200°C up to 530°C.

## **GPIS 8.7     Butterfly Valves**

Butterfly valves may be used for modulating service but shall not be used for shut-off service if the maximum differential pressure across the valve exceed 500 kPa.

Butterfly valves shall be used for high control performance and where low process pressure loss with high recovery is required.

For water, gas and air application, a cast steel valve body with stainless steel disk shall be provided. Packing shall be of PTFE Chevron up to 100°C and graphite laminate/filament packing for high temperatures. In case of special treated water, selection of a stainless steel body may become necessary.

For acid application polypropylene valves shall be provided.

Close attention shall be paid to the selection of valve body, disk and packing material depending upon specific application; however, Engineer approval is required prior to order.

## **GPIS 8.8     Ball Valves**

Ball valves shall be used for modulating and shut-off service where high control performance with low process loss and high recovery as well as tight shut-off function is required.

For water, gas and air application, a stainless steel valve body with stainless steel disk shall be provided. Packing shall be of PTFE Chevron up to 100°C and graphite laminate/filament packing for higher temperatures.

## **GPIS 9       ANALYTICAL INSTRUMENTS**

### **GPIS 9.1     General**

Instruments measuring pH-value, Dissolved Oxygen, Conductivity, Concentration or other properties of process streams shall consist of a suitable design primary element to convert or transform the measured variable into an electrical signal which shall be fed to a control system.

Analyser shall be capable of operating under the ambient conditions prevalent in the specific plant area and to maintain calibration within 0,5% during a 24-hour period while

subject to temperature variations between 10°C and 50°C.

Analysis time shall not exceed 30 seconds.

Reproducibility of analysers shall be 1% of span or better and sensitivity shall be 0,5% of full span.

For calibration purposes, analysers shall be provided with one year supply of a certified calibration sample as well as calibration curves.

All necessary accessories including nozzles, valves and fittings shall be provided. For high temperature applications, sample coolers shall be provided. Sampling accessories shall be of material suitable for each specific application.

## **GPIS 9.2    pH Measurement**

For pH-measurement, reference electrode shall be of rugged and sealed construction moulded in glass coupled polypropylene. Electrical connection shall be made directly onto the outer end of the element ensuring first class electrical performance of the electrode.

Measuring pH-electrode shall be of toughened all purpose glass type giving accurate Ph reading with long electrode life.

In applications where variations in sample temperature may occur, automatic temperature compensation device shall be provided.

The reference and glass electrode including the automatic temperature compensator shall be housed in a compact sensor holder assembly provided with terminal block, cable glands, silica-gel desiccator and screened top cap to prevent against spurious pick-up.

Electrodes assembly materials shall be of glass couples polypropylene and the assembly shall be provided with either flow through type or immersion type, depending upon specific application, complete with all associated accessories and mounting bracket.

pH-transmitter shall be electronic two wire type, with alphanumeric operator interface, manual and automatic calibration facilities, and shall meet the following minimum requirements:

Accuracy:	0,5% of span or better
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Measuring range:	0-14 pH
Temperature Compensation:	Glass electrode 0° to 130°C
Cycle:	max. 1,5 seconds
Output:	Preferable 4 to 20 mA DC
Relay Output:	Alarm contact 220 V AC 5A NC
Mounting:	Universal type bracket

### **GPIS 9.3 Conductivity Measurement**

Cell electrode material shall be carbide lined high grade steel or platinum black coated nickel and the cell range shall be selected to suit the required measurement.

Cell shall be equipped with semiconductor temperature sensor for temperature compensation.

Cell shall be either of flow through type or immersion type, depending upon specific application, complete with all associated accessories and mounting bracket.

Conductivity transmitter shall be electronic two wire type, with alphanumeric operator interface, manual and automatic calibration facilities, and shall meet the following minimum requirements;

Accuracy:	2% of span or better
Measuring range:	0,1 to 100 µS/cm depending on used cell type
Reproducibility:	1% within range or better
Temperature Compensation:	Semi conductor 0° to 130°C
Cycle:	max. 1,5 seconds
Output:	Preferable 4 to 20 mA DC
Relay Output:	Alarm contact 220 V AC 5A NC
Mounting:	Universal type bracket

### **GPIS 9.4 Oxygen in Combustion Measurement**

Cell electrode material shall be of Zirconia.

Cell shall be equipped with semiconductor temperature sensor for temperature compensation.

Cell shall be direct insertion type, complete with all associated accessories and mounting brackets.

Oxygen analyser transmitter shall be electronic four wire type, with alphanumeric operator interface, manual and automatic calibration facilities, and shall meet the following minimum requirement:

Accuracy:	1,0% of span or better
Measuring range:	0 to 5, 0 to 10 or 0 to 20 vol % O <sub>2</sub>
Reproducibility:	1% within range or better
Temperature Compensation:	0° to 1400°C
Response rate:	90% response within 5 sec when gas introduced from calibration gas inlet
Warm up time:	max. 15 minutes
Output:	Preferable 4 to 20 mA DC
Relay Output:	Alarm contact 220 V AC 5A NC
Mounting:	Universal type bracket
Calibration:	One-touch calibration using calibrated memory

#### **GPIS 9.5 Dissolved Oxygen Measurement**

The measuring sensor shall be of the Luminescent type – LDO technology.

The sensor shall be equipped with a hermetically sealed cable suitable for direct immersion. The cable end shall be fitted with a quick disconnect plug.

The sensor shall be mounted on a manufactured extension bracket for immersion in an open tank application to allow easy access for cleaning purposes.

The DO transmitter shall be electronic four wire type, with alphanumeric operator interface, manual and automatic calibration facilities, and shall meet the following minimum requirements:

Accuracy:	0,2% of span or better
Measuring range:	0-20.0 ppm or 0-20 mg/L
Temperature Range	0 to 50°C
Response time:	90% in less than 40 sec.
Power Supply:	220 V AC
Output:	4 to 20 mA DC
Mounting:	Universal type bracket

**GPIS 9.6     Turbidity Measurement**

The measuring sensor shall be of the self cleaning type with wiper blade

The sensor shall be equipped with a hermetically sealed cable suitable for direct immersion.

The cable end shall be fitted with a quick disconnect plug.

The sensor shall be mounted on a manufactured extension bracket for immersion in an open tank application for ease of maintenance.

The Turbidity transmitter shall be electronic four wire type, with alphanumeric operator interface, manual and automatic calibration facilities, and shall meet the following minimum requirements:

Accuracy:	0.001 NTU
Measuring range:	0.001 – 4000 NTU
Temperature Range	0 to 50°C
Power Supply:	220 V AC
Output:	4 to 20 mA DC
Mounting:	Universal type bracket

**GPIS 9.6     Suspended Solids Measurement**

The measuring sensor shall be of the self cleaning type with wiper blade

The sensor shall be equipped with a hermetically sealed cable suitable for direct immersion.

The cable end shall be fitted with a quick disconnect plug.

The sensor shall be mounted on a manufactured extension bracket for immersion in an open tank application for ease of maintenance.

The Suspended Solids transmitter shall be electronic four wire type, with alphanumeric operator interface, manual and automatic calibration facilities, and shall meet the following minimum requirements:

Accuracy:	< 5% of reading
Measuring range:	0.001 – 50 mg/l
Temperature Range	0 to 50°C
Power Supply:	220 V AC
Output:	4 to 20 mA DC
Mounting:	Universal type bracket

## **GPIS 9.7 Tank or Hopper Mass Measurement**

If mass content measurement of a vessel is required, the vessel shall be supported on load cells.

The mechanical design shall make provision for load cell protection against overload, shock load and plant vibration. It shall also take into consideration the prevention of excessive shear loads being transmitted to the load cell without affecting the accuracy of the scale.

Jacking facilities shall be provided to enable the load cell to be removed without taking the vessel out of service.

Copper braiding shall be connected across load cells to protect them against welding currents.

Continuous weight monitoring shall be achieved by the load cells weight detectors, weight transmitters and suitable indicators. An electrical signal, preferable 4 to 20 mA, shall be provided to be fed to a control system.

Load cells shall be of robust hermetically sealed stainless steel construction and shall meet the following minimum requirements:

Temperature Compensation:	0 to 55°C
Temperature Effect:	Not to exceed 0,5% of maximum span per 10°C change
Accuracy:	0,5% or better
Overload:	200% of nominal load
Rated Output:	1mV/V

Load cell cable joints are to be soldered according to manufacturer's instruction.



## **GPIS 10      INSTRUMENT PANELS AND CABINETS**

### **GPIS 10.1    Construction**

Panels shall be free standing type and shall be fabricated from cold rolled sheet steel of thickness not less than 2mm with welded construction throughout. All welds shall be ground smooth, all corners to be ground and all weld spatters shall be cleaned.

Surface of panels shall be painted and free from all marks and defects.

Mounting angle, flush with bottom of panel, shall be provided. All panels shall be supported on suitable sized vibration isolators, designed for bolting to panel frame and flooring.

Accessories such as swing rack mounting frames, circuit breaker panels and covers, base gland plates, etc, shall be standardised.

Front doors shall be fitted with suitable armoured glass cut-out and rubber gasket and shall be hinged door lockable. Rear doors shall be of solid construction and lockable.

All instrument cut-outs and drillings shall be straight and true. If provisions are to be made for further instrument installation, cut-outs shall be made and suitable blanks shall be provided. Blanks shall be painted with same colour as panel and a minimum of four anchors shall be used to attach them to panel board.

Instruments mounted on panels shall be spaced to provide access for adjustment and removal of equipment.

Removable eye bolt lifting lugs shall be furnished and installed on all panels.

### **GPIS 10.2    Field Junction Boxes**

Boxes shall be constructed of 304SS and painted with hinged and lockable door. Mounting plate and bottom gland plate suitable for electric and pneumatic process connection shall be standardised.

All instrument cut outs and drillings shall be straight and true. If provisions are to be made for further instrument installation, cut outs shall be made and suitable blanks shall be provided.

Instruments mounted on boxes shall be spaced to provide access for adjustments and

removal of equipment.

The degree of protection shall comply with IP 65. Construction material shall be suitable to resist the conditions prevalent in the specific plant area.

Field boxes are to be fitted with knife type termination, indicating fuse holders are to be used where power is supplied to solenoids or any other secondary field instrument.

All cables should be properly glanded and all cores will be terminated PLC connections are to be terminated at the left and field connections terminated at right.

All terminals to display an identification number according to the numbering standard as applied.

**GPIS 10.3 The panel wires should be as per table below**

Wire	Colours
220/110 volt AC control : Orange	Orange
AC neutral wires : Black	Black
24-50 volt AC control : Red	Red
24-50 volt AC neutral : Pink	Pink
24-50 volt DC control : Purple	Purple
Zero volts DC : Blue	Blue
PLC wiring : Gray	Gray
Telemetry wiring : Yellow	Yellow
Earth wires : Green yellow	Green Yellow
CT's to ammeters : White	White

## **SECTION B**

### **PIIS: PROCESS INSTRUMENTATION INSTALLATION SPECIFICATION**

#### **PIIS 1 INTRODUCTION**

This standard specification furnishes information and sets out requirements for the installation of instrumentation equipment.

All equipment and material shall be of a quality and type approved by the Engineer.

No equipment or material shall be installed unless it complies with the requirements of this specification.

All equipment and material shall be checked for suitability, quality and adherence to this specification. Every approval must be obtained by the Contractor prior to installation.

Any installation or installation procedure which is in contravention to this specification shall be made good or replaced, to the satisfaction of the Engineer, and all costs for making good or replacement shall be for the contractors account.

Failure to adhere to the requirements of this specification may result in the equipment or material being rejected by the Engineer.

#### **PIIS 2 STANDARD OF WORK**

The complete instrumentation installation shall be carried out by skilled, competent and qualified operatives to the highest standard of safety and workmanship, using the correct tools for the operations and best quality materials.

A clean, orderly and safe environment shall be maintained in the Instrumentation Contractor's workshop, the stores and offices and in the construction areas.

Cabling and wiring shall form a neat and functional appearance.

Work shall be planned such that access to equipment for the current installation or future maintenance shall not be obstructed.

The completed installation including supports, brackets, wiring, cabling and piping shall present a clean, tidy appearance and shall conform to good engineering practice.

The contractor shall install instruments and other equipment in accordance with the manufacturers instructions, and the project drawings, taking due cognisance of the Standards and Codes listed in this Specification.

The standards and codes which shall apply to this project are those issued by the following organisations:

- British Standard Institution (BSI)
- Deutsche Industrie Normen (DIN)
- American National Standards Institute (ANSI)
- The Instrumentation, Systems and Automation Society (ISA)
- South African Bureau of Standards (SABS)

### **PIIS 3      INSTRUMENT LOCATIONS**

General locations of the instruments are shown on the instrument location drawing. It may however be necessary to make minor changes on site. In the interests of the prevention of rework, confirmation of the exact location shall be obtained by the contractor from the site representative before the work is carried out.

Where no instrument location drawing is available the instrument shall be positioned as close as possible to the process monitoring point.

The instrument shall be mounted in an easily accessible position to facilitate maintenance and removal.

The contractor shall avoid, where possible, locating instruments in locations subject to leaks and spills. Where an instrument is unavoidably located where exposure to the above mentioned is likely, a splash guard shall be provided over or around the instrument.

Field mounted instruments, excluding in-line and close-coupled devices shall be mounted so that the centre line of the housing, chart or scale is approximately 1,400mm above grade, floor or platform, unless otherwise specified on an installation drawing.

Instruments must not be mounted where there is excessive vibration.

Instruments must be mounted away from steam lines and other sources of heat.

Instruments are not to be mounted on hand rails or process parts of the plant (e.g. pipe lines).

Transmitters or local controllers shall be located as close to the primary process connection as possible but instrument accessibility must be maintained.

Instruments shall be installed so as not to cause any obstruction to walkways, headroom or access to other plant items.

Instruments are not to be mounted near or in the way of sections of the plant that are regularly removed.

Direct mounted dial thermometers, pressure switches, pressure gauges and thermo wells shall be plainly visible and accessible from floor or adjacent platform.

#### **PIIS 4      SUPPORTING BRACKETING AND FIXING**

The drilling of holes in structural steelwork is not permitted except with the prior written approval of the engineer.

The drilling of holes in vessels or pipe work is expressly prohibited.

Explosive type fixing devices shall not be used.

Instrument pipe stands where required are to be manufactured according to the drawings. All stands should be floor mounted unless otherwise stated. Fixing bolts, nuts and washers must not be cadmium plated. They shall be hot dipped galvanised or stainless steel.

Mounting brackets must be hot dipped galvanised.

Instrument supports and mounting brackets shall be of a suitable strength and rigidity to ensure proper operation of the instrument. Careful attention shall be given to ensure that instruments are not mounted on or attached to equipment or structures which are subject to vibration. All proposed locations must be approved by the Engineer before installation.

Brackets shall in general, be made of mild steel flat bar, angle or channel. All brackets shall be hot dipped galvanised.

## **PIIS 5      INSTRUMENT PIPING AND TUBING**

The instrument primary process connection is defined as the connection after the first isolation valve on the process pipeline, duct, vessel, or tank. The isolation valve will be supplied and installed by others unless specifically stated otherwise in the instrument installation/wiring diagram.

Piping from the primary process connection to the instrument shall be as short as possible and shall be installed so that no pockets or traps can occur. Where such pockets are unavoidable, drain valves and pots shall be provided at the lowest points. All such piping shall be properly supported to relieve all connections points of strain, and where expansion is likely, suitable offsets should be incorporated.

Instrument piping impulse lines shall be 12mm seamless stainless steel, except in specific high pressure temperature applications where the process conditions will dictate the material. Process connection tubing shall be 12mm seamless stainless steel and 10mm or 6mm seamless stainless steel for signal lines, depending on application.

Air supply manifolds are to be made of stainless steel. Drain valves must be fitted to the lowest point of the manifold. Each take-off point must have an isolation ball valve. Each take-off point shall be labelled with the instrument reference number. An allowance must be made for 20% spare take-off points. All take-off points not utilised must be plugged after the isolation valve.

Air supply tubing from manifolds to air regulators or solenoid operated valves shall be 12mm seamless stainless steel.

Air supply tubing from regulators and solenoid operated valves to actuators, positioners, etc. shall be 10mm seamless stainless steel.

All tubing fittings shall be Gyrolok, or an approved equivalent.

Isolation valves, other than those intended for use with an orifice carrier, are not normally the responsibility of the instrument section, but are supplied as part of the plant pipe work.

Valves shall be accessible for operation from floor and operating platforms unless otherwise approved by the Employer. Valves or equipment shall not obstruct passageways.

All instrument piping entering or leaving a control cubicle, box or panel shall do so via a bulkhead coupling.

In cases where pipe penetration openings are not provided in gratings which are installed by others, openings shall be field cut and the grating banded. The contractor shall then paint the cuts and welds according to the paint specification. This must be avoided at all times where possible.

Capillary tubing for filled system temperature instruments, diaphragm level transmitters and the like, shall be supported and protected by running the tubing in angle iron or 'Unistrut' channel for the entire exposed length of the capillary. Excess capillary tube shall be neatly coiled and secured. Minimum bend radius for capillary tube shall be 75mm.

Piping within plant building shall be carried on overhead racks attached to the building frame or other supports. Piping racks shall be separate from cable racks. Existing piping racks may be used after permission is obtained from the Engineer.

Every pipe installed on racking in a building or on a supporting structure shall be supported in such a manner that there is no undue mechanical strain on any termination.

## **PIIS 6 CABLE RACKS AND SUPPORT**

Cable rack/tray shall follow the building or mechanical construction line to which they are attached, with as few direction changes as possible.

Cable racks shall be mounted in the vertical plane and shall be positioned so as to avoid obstruction to walkways and access routes. Racks shall not be mounted in the horizontal position without the prior written permission of the Engineer.

Cable rack/tray bends and tees will be constructed as to allow all cables within trays to have a bending radii of not more than the manufacturer's specifications. No right angle jointing of rack/tray will be allowed.

Cable rack/trays shall be properly aligned and supported and the completed installation should have no visible deflection and be devoid of any distortion, kinks or sags.

The maximum distance between centres of adjacent supports shall be 2 metres. Additional supports shall be located at the joints of straight tray lengths and at every change in direction.

Supports shall be attached to permanent members of the building.

Cable racks to be fabricated mild steel and hot dipped galvanised similar or equal to the 'O' line support system unless specified otherwise in the document

Touching up after fabrication shall be by cold galvanising.

Single angle cable supports may be used under the following conditions:

- Up to no more than 3 cables may be run on an angle iron support
- The size of the angle iron shall be such that in cross section, no part of any cable shall project beyond the square of which the angle iron forms two sides
- The minimum size angle iron to be used shall be 25 x 25 x 5mm and maximum size 40 x 40 x 6mm

Where required, any cable in danger of mechanical damage will be protected by using galvanised pipe or channel.

Cable rack/trays shall be installed in accordance with the route diagram. Minor deviations in routing to avoid interference may be allowed subject to the approval of the Engineer. Where no cable routing drawing is available the cable routes shall be "site" determined in conjunction with the Engineer.

All cables run on racking or angle iron supports shall be fully supported to within 150mm from the gland entry on the equipment serviced or as cable size dictates.

## **PIIS 7      CABLING AND WIRING**

Cable sizes, number of cores and cable number shall be as indicated on the cable schedules.



Cables shall be tested per drum length on delivery to site prior to installation. Results shall be documented.

Cable drums shall be rolled in the proper direction to prevent loosening of the cable. Cable shall be drawn into position using a sufficiency of rollers and cornering apparatus to avoid damaging the cable by excessive bending or dragging.

Cable shall be stored in dry areas.

Where cables pass through a floor, they shall be protected by a metal pipe or suitable mechanical protection, extending from 50mm to 350mm above floor or ground level.

The contractor shall observe the manufacturer's recommendations for minimum bending radius but shall never use less than the following radii:

- Unarmoured cables: 5 times the overall outside diameter of the cable
- Armoured cables: 10 times the overall outside diameter of the cable

Clips, saddles or clamps for securing of cables shall have smooth and rounded edges and shall not damage the cable sheath or serving. The type of saddle or clamps shall be approved by the Engineer before installation commences.

Instrument signal and electric power may not run bunched in the same rack/tray. A minimum distance of 300mm shall separate such racks/trays. If instrument cables are required to run on the same cable rack as electrical cables, then there must be at least a 300mm gap between the electric and instrument cables.

To avoid interference arising from electrical power supply voltage dips or spikes, instrument signals and electrical power cables shall only cross at right angle to each other.

On no account will instrument signal and electrical power wiring be transmitted in the same multi-core cable. Solenoid coils of 24V or less may be run with instrument switching signals.

Instrumentation cables may only be installed a maximum of 2 deep on racks if approved by the Engineer.

Joints in cables are permitted only where the length of the run exceeds the standard manufactured length of cable available on a drum. In these cases, the joints will be made

in a junction box. No through jointing of cables will be permitted on cable racks/trays or in any cable way.

Coaxial cable for data highways shall be run individually in 20mm conduit as per 7.16. Conduits used for this purpose shall be installed a minimum of 300mm from electrical cables.

All cables shall be labelled at each end and at 10m intervals along its length with a strap on plastic marker tags bearing the cable number as shown on the cable schedule. (Black letters on a yellow background).

All cables shall be mechanically anchored at the position of termination by the use of flanges of the correct size, as follows:

- Where equipment supplied is provided with cable entries having DIN, NPT, etc., threads, the contractor shall provide all necessary adapters to permit the use of standard ISO Metric thread cable glands.
- Where glands are to be used with non-threaded clearance holes, a heavy duty lock-but, together with suitable weatherproofing gaskets shall be provided. Holes with a tolerance greater than 1.5mm larger than the gland size will not be accepted.
- Cables shall always be made off according to the gland manufacturers recommendations.
- When glanding off SWA cables in non-conducting enclosures the gland shall be provided with an internal earthing washer and connected to a suitable earth connection.

Where wiring is specified to be run in conduit, the following shall be observed:

- The conduit used shall be heavy gauge seamless metal conduit with galvanised finish. Flexible conduit shall be of the PVC sheathed variety.
- The conduit shall have a smooth bore. The smallest size to be used shall be 20mm and the largest 50mm nominal diameter.
- All conduit joints and entries shall be screwed a minimum of 20mm and made tight and weatherproof. Conduit threads shall be protected from corrosion by the application of an approved cold galvanising paint.

- Draw-in boxes shall be installed after every second bend or a combination of sets and bends which equal 180 deg. or after every 7,5m of straight run. All boxes shall be supplied with gaskets for weatherproofing.
- Where the possibility of condensation exists, the conduit shall be installed with a slope of approximately 3 in 100 and a 3mm diameter drain hole shall be drilled at the lowest point.
- Metal conduits shall be bonded and earthed. Conduit bends, boxes, flexible conduits, etc., shall not interrupt the earth continuity.
- Conduit must not be used as an earth continuity conductor.
- The minimum bending radius of conduit shall be 6 times the conduit diameter.
- Conduit shall be fixed with clips or saddles at a pitch not exceeding 1,5m.

## **PIIS 8 CABLE AND WIRE TERMINATIONS AND CONNECTIONS**

All instruments, control panels, junction boxes, etc., shall be wired in accordance with the relevant project drawings.

Each conductor shall be fitted with an insulated double crimp lug of the correct size. Pin lugs shall be used for pressure type terminals. Ring or spade lugs shall be used for post type terminals.

A proprietary type of wire stripper must always be used. The stripping tool must be checked regularly and is subject to inspection by the Engineer. The termination of stranded conductors where one or more strands have been damaged or broken is expressly prohibited.

The crimping tool used for attaching termination lugs shall be of the ratchet type which requires a specific amount of pressure prior to release, recommended by the manufacture of the crimp lugs.

All wires are to be terminated. Spare terminals shall be provided for unused pairs or cores. All spare terminals of field multi-cores shall be connected together and bonded to instrument earth.

Terminated wires shall be arranged neatly and loomed where necessary using cable ties. Spiral lacing shall be used for flexible or semi flexible looms.

Each wire shall be numbered with the respective terminal number by means of interlocking slip-on plastic ferrules of the correct size. Split or clip on ferrules are not acceptable. The ferrules shall be a tight or interference fit on the wire.

Cable colours:

- Normal signal cables - black outer sheath
- Earth cables - green

Conductors to be 0,5mm flexible stranded twisted copper wire for normal instrument signals and 1,5mm to solenoid valves.

Nylon washers shall be put on all cable glands and cable gland adapters on weatherproof boxes.

Cables must not be trapped in lagging.

Cables to field instruments must have at least 30cm slack which should be neatly looped before the instrument.

Cables incorporating shields or screens shall have the shield or screen isolated for electrical earth throughout its length and it shall be earthed only at the point indicated on the drawing.

Only cable in the following standard sizes shall be used:

- |            |          |
|------------|----------|
| • 1 pair   | 1 triad  |
| • 2 pairs  | 2 triad  |
| • 4 pairs  | 4 triad  |
| • 8 pairs  | 8 triad  |
| • 12 pairs | 12 triad |
| • 16 pairs | 16 triad |
| • 24 pairs | 24 triad |
| • 36 pairs |          |
| • 50 pairs |          |

For field instrumentation power supply only 3 core S.W.A. or Dekobon cable shall be used.

The approved cable is Dekobon type M855 single pair, M877 multi pairs and M865, M887 respectively for triads. The conductor size shall be 0,5mm<sup>2</sup> for instrumentation signals unless specified otherwise in the instrument cable schedule.

A variation from this type of cable must have the permission of the engineer.

Instrument cabling identification

Cables are to be labelled according to the cable schedule. The numbering will be made up as follows:

Field instrument to JB or marshalling:

- analogue = IA + instrument tag number
- digital = ID + instrument tag number
- power = IP + instrument tag number

JB to marshalling:

- marshalling terminal strip number

## **PIIS 9      JUNCTION BOXES**

Junction boxes must be numbered on the door or lid with an engraved plastic type label having numbers at least 5mm in height. (Refer section 12 Instrument Labels).

Terminal rails and individual terminals shall be numbered.

An earth plate or rings for the cable glands shall be put in the bottom of each junction box, where required.

Cables must enter from the bottom of the junction box.

Spare holes for cable glands must be plugged with the approved type of plugs.

Boxes with pneumatics inside must have a vent at the bottom of the box and shall be fitted with a port protector/silencer.

Shield wires must be strapped together.

The box must be classified IP65 or better.

The box must be mounted securely.

Junction boxes shall be polycarbonate. Painting or other colouring is not required.

## **PIIS 10 INSTRUMENT INSTALLATION – SPECIFIC REQUIREMENTS**

### **PIIS 10.1 Flow Meters**

The in-line element of the flow meter will be installed by others. It is the responsibility of the instrumentation contractor to check that the correct element is installed and that it is correctly installed and is undamaged before accepting the installation for his part of the work.

The flowmeter/d.p. cell shall be installed and piped up according to the instrument installation diagram.

Orifice plates shall be clearly stamped with the orifice diameter, direction of flow and tag number.

The minimum slope of lines to instruments situated above or below the primary element shall be 25mm per metre.

If seal-pots are used, they shall be located as close as possible to the orifice taps and shall be installed so that both seal-pots are the same elevation.

DP cells must not be mounted where there is excessive vibration. On steam applications, the measuring element and isolation valves must be below the orifice tapping points.

Magnetic flow meters shall be installed such that the product lines remain full when flow occurs and when flow is zero.

Magnetic flow meters mounted on lined pipes shall have earthing rings mounted on the upstream and downstream flanges. Earth bonding trays shall be installed as per manufactures instructions and/or the instrument installation diagrams.

## **PIIS 10.2 Control Valves**

Control valves shall be mounted by others so that the direction of flow indicator (if any) on the valve body is compatible with the direction of flow of process fluid in the pipe. It is the responsibility of the instrumentation contractor to check that the correct valve is installed and that it is correctly installed and there is no damage visible before accepting the valve for hooking up to pneumatics or electrics.

The control valve shall be installed and piped up according to the instrument installation diagram.

A bulkhead plate will be provided where stainless steel/dekabon lines end and flexible lines start.

Flexible lines are to be tidy and are not to be in contact with any hot surface.

The position of the limit switches on a valve should be made adjustable.

## **PIIS 10.3 Level Measuring Instruments**

Ultrasonic transducers shall be mounted in such a way that any vibration present at the site of installation cannot be mechanically transmitted to the transducer housing. In this respect, the manufacturer's instructions must be strictly adhered to.

Flange mounted ultrasonic transducers must be mounted on a thick gasket of soft resilient material and lightly secured with PVC or nylon nuts and bolts. Under no circumstances shall the bolts be over tightened, finger tightening is sufficient.

Differential pressure type level transmitters shall be installed onto instrument stands unless they are of the flange mounted type. Connections shall be as per hook-up drawings.

## **PIIS 10.4 Temperature Elements**

A thermo well must be inserted first to protect sensor against damage from corrosion, erosion, abrasion and high pressure processes.

The elements used to measure temperatures will be either thermocouples, platinum resistance temperature bulb (R.T.D.) or capillary filled local indicators.

The element must be installed in such a way that it is easily accessible for inspection and

replacement.

The tip of the measuring element must reach and be in contact with the end of the thermo well.

Positions of detecting elements shall be such to facilitate easy removal without fouling.

Capillary lines are to be protected.

#### **PIIS 10.5      Pressure**

All pressure points shall be fitted with ½ inch N.P.T. isolation cocks unless flush mounted diaphragms are used.

If the fluid to be measured is toxic or corrosive, a drain or vent shall be provided to discharge the fluid to a safe location.

Where the pressure pulsates heavily, suitable damping shall be fitted.

Gauges more than 3m from their impulse points shall have an additional isolation valve at the gauge.

If the unit is not flange mounted and the process fluid is dangerous, a valve must be fitted for releasing the pressure in the impulse line.

Gauges shall be mounted in a vertical position.

#### **PIIS 11      INSTRUMENT LABELS**

Each instrument shall be fitted with a label giving the function and tag number as detailed in the label schedule. Field mounted instruments including final control elements shall have labels mounted on a bracket which is fixed independent of the instrument and stays in position if the instrument is removed. The label must be in a clearly visible location.

Labels shall be made of laminated trafolite and have black letters on a white background.

The size of the labels shall be:

Type 1	Field Instruments/ Transmitters/ Control Valves	80mmW x 30mmH
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Type 2	Cabinets/ Field Junction Boxes	200mmW x 30mmH
Type 3	Terminal Rails	39mmW x 18mmH
Type 4	Power Supplies	70mmW x 20mmH
Type 5	Power Rails	15mmW x 10mmH
Type 6	Marshalling Cubicles	150mmW x 50mmH
Type 7	Distribution Boards	150mmW x 50mmH

Type number will be included in the label schedule with the letter size.

## **PIIS 12 INSTRUMENT NUMBERING**

The instrumentation shall be tagged according to the following system:

Prefix :	MCC area code
Instrument type :	Modified ISA abbreviation
Instrument number :	Sequential number

e.g. 02-LT-02

MCC 2, level transmitter, 2<sup>nd</sup> instrument in that area.

## **PIIS 13 ACCEPTANCE OF INSTRUMENTATION**

**When all the testing and flushing on an instrument loop has been completed the contractor shall notify the Engineer in writing and request inspection. Defects attributable to the contractor shall be punch listed and shall be rectified at the contractor expense. The Engineer shall accept equipment in a particular area on a loop by loop basis in writing, but the contractor shall retain responsibility for the loop until the complete area is handed over and accepted in writing by the Engineer.**

## **SECTION C**

### **INDUSTRIAL AUTOMATION AND NETWORK SPECIFICATION**

#### **IAN 1 PROGRAMMABLE LOGIC CONTROLLERS (PLCS)**

##### **IAN 1.1 PLC HARDWARE & ENGINEERING**

New Modicon M580 PLC's shall be supplied, installed, programmed, tested and commissioned for the complete control and operation of the respective existing and new plant installed. The PLC's and the required components shall be supplied as specified in the EWS standardised preferred equipment list.

The Contractor's engineering design shall include for all cubicles and hardware required for PLC control, and shall include comprehensive equipment lists, cubicle GA drawings and Control Centre drawings, I/O schedules and functional descriptions.

Provision shall be made for PLC control of all items require, plus allowance for expansion.

The Contractor shall furthermore ensure that the complete design, installation, commissioning shall include all necessary cabling, interfacing, connections, mountings etc. to ensure that the final product is complete, functional and to a good engineering standard.

The Contractor shall provide the following documentation to the integrator to enable the integrator to complete his scope. Documentation shall be at "For Construction" revision.

- Plant P&ID's
- IO Lists including:
  - instrument ranges;
  - alarm setpoints;
  - IO allocations per PLC system/rack/card;
- Plant network layout
- SCADA Hardware specifications

On completion of electrical and control panel manufacture, the contractor shall complete a Factory Acceptance Test (FAT) of all panels at his premises before delivery to site. The contractor shall inform the engineer that panels are ready for FAT and a team including the employer, the engineer, and the integrator shall attend and witness the FAT.

Acceptance of the FAT shall require acceptance by the employer, the engineer and the integrator.

The integrator has then accepted the panels for site tests and commissioning.

## **IANS 1.2 SOFTWARE ENGINEERING**

### **IANS 1.2.1 PLC Software**

The integrator shall utilise the latest revision Unity Pro Software Program for the programming of the PLCs. The integrator shall provide their own computer for the programming and software engineering and on completion of the project the engineered software shall be transferred to the Employer. The software shall remain the property of the Employer with all copies kept by the Integrator during the course of the contract transferred to the Employer on completion of the Contract. No password protected codes will be accepted.

The integrator shall use information provided by the contractor and the EWS representative to develop the Function Design Specification (FDS) for approval by the EWS representative, prior to detailed software development.

Additional information shall be provided to the integrator in the form of the Process and Control Description which will assist with the FDS development.

The software engineering shall be developed in accordance with the final design P&ID and the FDS, which will include information from the Process and Control Description and sample FDS.

All control loops in the software engineering shall be based on an island control basis for the various process sections.

Software engineering shall be done using a structure format of function blocks to facilitate program simplicity and fault finding.

Certain standard programming function blocks might be provided by EWS to the successful tenderer to facilitate standardisation and shall be incorporated when programming the PLC and HMI for each section.

The integrator shall however be required to develop new function blocks in consultation with the Employer and the Engineer for approval prior to implementing the program.

The integrator shall allow for a minimum of three reiterations of the PLC program for changes as may be requested by the Employer and EWS representative without their pricing for this work.

### **IAN 1.3 I/O LIST**

The Process and Control Description is to be read in conjunction with the P&ID drawings and single line schematic diagrams.

The Contractor, on completion of design, shall submit to the EWS representative comprehensive I/O lists for the new PLC in the form of a I/O list. This list shall be the expansion of the instrumentation index supplied at tender stage and shall include information listed in section 1.2 above.

The resultant I/O's shall be forwarded to, and used by the integrator for configuration of the respective process PLC's and to provide the necessary input to the overall HMI system to be installed under this Contract.

## **IAN 2 HUMAN MACHINE INTERFACES (HMI'S)**

### **IAN 2.1 HARDWARE**

For the local interaction and control of the respective plant areas the contractor shall supply and install Schneider Magelis 15" Graphic Terminal (HMI) (model number) units.

Each MCC shall be fitted with an HMI.

### **IAN 2.2 SOFTWARE**

#### Integrator Scope

The integrator shall use the latest revision Vijeo Designer Software Program for programming the HMIs. The integrator shall provide his own computer for the programming and on completion of the project transfer the software and licence to the Employer.

The software engineering shall be developed in accordance with the final design P&ID, the Process and Control Description and sample Process Control Philosophy. All control loops in the software engineering shall be based on an island control basis for the various process sections.

Software engineering shall be done using a structure format of function blocks to facilitate program simplicity and fault finding.

Certain standard programming function blocks and graphics might be provided by EWS to the successful tenderer to facilitate standardisation and shall be incorporated when programming the PLC and HMI for each section.

The integrator shall however be required to develop new function blocks in consultation with the Employer and the Engineer for approval prior to implementing the program. The new developed software shall however be required to follow the standard EWS display format.

The integrator shall allow for a minimum of three reiterations of the HMI program and display graphics and trending for changes as may be requested by the Employer and Engineer without their pricing for this work.

### **IAN 3      CONTROL NETWORK**

The network design provides for a Modbus on Ethernet communication backbone which has been designed to support two systems namely:

- eThekweni Electrical MV Gear and Standby generator on site.
- eThekweni Water and Sanitation, PLC and SCADA data and control communications.

#### **IAN 3.1    NETWORK HARDWARE**

The Contractor shall supply and install ethernet switches, which shall be high quality industrial grade.

Network switches utilised in the design shall be the standard preferred model managed switches as specified in the Schedule of Quantities.

The switches shall have the option to accept both fibre and copper cable in order to reduce the number of media convertors required. Configurable ports are preferred for flexibility.

The manufacturing details in respect of the panels to house the network switches is covered under the Motor Control Centres.

## **IANS 3.2 NETWORK CONFIGURATION**

### Integrator Scope

The integrator shall configure each switch for maximum efficiency of the data transfer between his configured PLC's and SCADA systems.

### **IANS 3.2.1 Documentation**

The integrator shall include design drawings & documentation to the SCADA system and allow for retrieval of documentation or drawings from the operator accessible system help screens.

Available documentation shall include:

- Process & Control Description
- Functional Design Specification

Available drawings shall include:

- Control Network Overview Layout
- Power Distribution Schematics & Drawings
- PLC Card Wiring Diagrams
- Loop Sheets
- MCC Schematics
- Instrument Data Sheets



# **NETWORK AND SCADA SPECIFICATIONS**

**DEPARTMENT: MECHANICAL AND ELECTRICAL BRANCH  
WATER AND SANITATION**

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## **1. PROGRAMMABLE LOGIC CONTROLLERS (PLCS)**

### **1.1 PLC HARDWARE & ENGINEERING**

New Modicon M580 PLC's shall be supplied, installed, programmed, tested and commissioned for the complete control and operation of the respective existing and new plant installed. The PLC's and the required components shall be supplied as specified in the EWS standardised preferred equipment list.

The Contractor's engineering design shall include for all cubicles and hardware required for PLC control, and shall include comprehensive equipment lists, cubicle GA drawings and Control Centre drawings, I/O schedules and functional descriptions.

Provision shall be made for PLC control of all items require, plus allowance for expansion.

The Contractor shall furthermore ensure that the complete design, installation, commissioning shall include all necessary cabling, interfacing, connections, mountings etc. to ensure that the final product is complete, functional and to a good engineering standard.

The Contractor shall provide the following documentation to the integrator to enable the integrator to complete his scope. Documentation shall be at "For Construction" revision.

- Plant P&ID's
- IO Lists including:

- instrument ranges;
  - alarm setpoints;
  - IO allocations per PLC system/rack/card;
- Plant network layout
- SCADA Hardware specifications

On completion of electrical and control panel manufacture, the contractor shall complete a Factory Acceptance Test (FAT) of all panels at his premises before delivery to site. The contractor shall inform the engineer that panels are ready for FAT and a team including the employer, the engineer, and the integrator shall attend and witness the FAT.

Acceptance of the FAT shall require acceptance by the employer, the engineer and the integrator.

The integrator has then accepted the panels for site tests and commissioning.

## **1.2 SOFTWARE ENGINEERING:**

### **1.2.1 PLC Software**

#### Integrator Scope

The integrator shall utilise the latest revision Unity Pro Software Program for the programming of the PLCs. The integrator shall provide their own computer for the programming and software engineering and on completion of the project the engineered software shall be transferred to the Employer. The software shall remain the property of

the Employer with all copies kept by the Integrator during the course of the contract transferred to the Employer on completion of the Contract. No password protected codes will be accepted.

The integrator shall use information provided by the contractor and the EWS representative to develop the Function Design Specification (FDS) for approval by the EWS representative, prior to detailed software development.

Additional information shall be provided to the integrator in the form of the Process and Control Description which will assist with the FDS development.

The software engineering shall be developed in accordance with the final design P&ID and the FDS, which will include information from the Process and Control Description and sample FDS.

All control loops in the software engineering shall be based on an island control basis for the various process sections.

Software engineering shall be done using a structure format of function blocks to facilitate program simplicity and fault finding.

Certain standard programming function blocks might be provided by EWS to the successful tenderer to facilitate standardisation and shall be incorporated when programming the PLC and HMI for each section.

The integrator shall however be required to develop new function blocks in consultation with the Employer and the Engineer for approval prior to implementing the program.

The integrator shall allow for a minimum of three reiterations of the PLC program for changes as may be requested by the Employer and EWS representative without their pricing for this work.

## **2. I/O LIST:**

The Process and Control Description is to be read in conjunction with the P&ID drawings and single line schematic diagrams.

The Contractor, on completion of design, shall submit to the EWS representative comprehensive I/O lists for the new PLC in the form of a I/O list. This list shall be the expansion of the instrumentation index supplied at tender stage and shall include information listed in section 1.2 above.

The resultant I/O's shall be forwarded to, and used by the integrator for configuration of the respective process PLC's and to provide the necessary input to the overall HMI system to be installed under this Contract.

## **3. HUMAN MACHINE INTERFACES (HMI'S)**

### **3.1        HARDWARE**

For the local interaction and control of the respective plant areas the contractor shall supply and install Schneider Magelis 15" Graphic Terminal (HMI) (model number) units.

Each MCC shall be fitted with an HMI.

### **3.2        SOFTWARE**

#### Integrator Scope

The integrator shall use the latest revision Vijeo Designer Software Program for programming the HMIs. The integrator shall provide his own computer for the programming and on completion of the project transfer the software and licence to the Employer.

The software engineering shall be developed in accordance with the final design P&ID, the Process and Control Description and sample Process Control Philosophy. All control loops in the software engineering shall be based on an island control basis for the various process sections.

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The integrator shall however be required to develop new function blocks in consultation with the Employer and the Engineer for approval prior to implementing the program. The new developed software shall however be required to follow the standard EWS display format.

The integrator shall allow for a minimum of three reiterations of the HMI program and display graphics and trending for changes as may be requested by the Employer and Engineer without their pricing for this work.

#### **4. CONTROL NETWORK**

The network design provides for a Modbus on Ethernet communication backbone which has been designed to support two systems namely:

- eThekweni Electrical MV Gear and Standby generator on site.
- eThekweni Water and Sanitation, PLC and SCADA data and control communications.

##### **4.1 NETWORK HARDWARE**

The Contractor shall supply and install ethernet switches, which shall be high quality industrial grade.

Network switches utilised in the design shall be the standard preferred model managed switches as specified in the Schedule of Quantities.

The switches shall have the option to accept both fibre and copper cable in order to reduce the number of media convertors required. Configurable ports are preferred for flexibility.

The manufacturing details in respect of the panels to house the network switches is covered under the Motor Control Centres.

## **4.2 NETWORK CONFIGURATION**

### Integrator Scope

The integrator shall configure each switch for maximum efficiency of the data transfer between his configured PLC's and SCADA systems.

#### **4.2.1 Documentation**

The integrator shall include design drawings & documentation to the SCADA system and allow for retrieval of documentation or drawings from the operator accessible system help screens.

Available documentation shall include:

- Process & Control Description
- Functional Design Specification

Available drawings shall include:

- Control Network Overview Layout
- Power Distribution Schematics & Drawings
- PLC Card Wiring Diagrams
- Loop Sheets
- MCC Schematics
- Instrument Data Sheets



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**C3.9.3 ZUTARI SPECIFICATIONS****NAME OF SPECIFICATION**

1002680-ZUT-SCH-EE-001	Biofilter MCC Schedule
1002680-ZUT-SCH-EE-002	Inlet Works MCC Schedule
1002680-ZUT-SCH-EE-003	Second Class Water MCC Schedule
1002680-ZUT-SCH-EE-004	Admin DB Schedule
SPE-EE-0002	Training, Testing and Commissioning

# ISIPINGO WWTW UPGRADE

MCC: MCC01  
Biofilter MCC Schedule

**eThekwini Municipality: Water & Sanitation Unit**

Reference: 31300-5W  
Revision: A

Description	Item No	Tag Number	Service Description	Starter	V	Ph	Absorbed Equipment Rating	Unit	Eff class	Duty	Back-up Supply	Rated Equipment Rating	Unit	Load PF	Load Efficiency	Absorbed Load Current	Absorbed kVA	Rated Current (FLC)	Supply Efficiency
MCC	1	S 85-03-F-01	Incomer	Incomer	400	3	784.6	kW		1		1245.7	kW			1372.3	950.7	1372.3	
MCC	2	S 85-03-F-03	Generator Incomer 1	Incomer	400	3	784.6	kW		1		1245.7	kW			1372.3	950.7	1019.0	
MCC	3	S 85-03-F-04	Generator Incomer 2 (Provisional Future Spare)	Incomer	400	3		kW		0			kW					0.0	
MCC	4	S 85-03-F-05	PFC Feeder (Provisional Estimate)	FDR	400	3	145.9	kVA		1	Generator	150.1	kVA	1.00	94.7%	210.5	145.9	228.8	94.7%
MCC	5	S 85-01-VFD-01	MCC01 - External VFC01	FDR	400	3	72.9	kW	IE3	1	Generator	75.0	kW	0.90	94.7%	116.9	81.0	127.0	94.7%
MCC	6	S 85-01-PMP-01	VFC01 - Bio Filter pump 1	VFC	400	3	0.0	kW	IE3	0	Generator	75.0	kW	0.90	94.7%	0.0	0.0	127.0	94.7%
MCC	7	S 85-01-VFD-02	MCC02 - External VFC02	FDR	400	3	72.9	kW	IE3	1	Generator	75.0	kW	0.90	94.7%	116.9	81.0	127.0	94.7%
MCC	8	S 85-01-PMP-02	VFC02 - Bio Filter pump 2	VFC	400	3	0.0	kW	IE3	0	Generator	75.0	kW	0.90	94.7%	0.0	0.0	127.0	94.7%
MCC	9	S 85-01-VFD-03	MCC03 - External VFC03	FDR	400	3	72.9	kW	IE3	1	Generator	75.0	kW	0.90	94.7%	116.9	81.0	127.0	94.7%
MCC	10	S 85-01-PMP-03	VFC03 - Bio Filter pump 3	VFC	400	3	0.0	kW	IE3	0	Generator	75.0	kW	0.90	94.7%	0.0	0.0	127.0	94.7%
MCC	11	S 85-01-VFD-04	MCC04 - External VFC04	FDR	400	3	0.0	kW	IE3	0	Generator	75.0	kW	0.90	94.7%	0.0	0.0	127.0	94.7%
MCC	12	S 85-01-PMP-04	VFC01 - Bio Filter pump 4	VFC	400	3	0.0	kW	IE3	0	Generator	75.0	kW	0.90	94.7%	0.0	0.0	127.0	94.7%
MCC	13	S 85-01-PMP-05	Humus pump 1 (Existing) - DOL	DOL	400	3	0.0	kW	IE3	0	Generator	7.5	kW	0.80	90.8%	0.0	0.0	14.9	90.8%
MCC	14	S 85-01-PMP-06	Humus pump 2 (Existing) - DOL	DOL	400	3	7.6	kW	IE3	1	Generator	7.5	kW	0.80	90.8%	13.7	9.5	14.9	90.8%
MCC	15	S 85-01-PMP-07	Main house sump pump (Existing) - DOL	DOL	400	3	7.6	kW	IE3	1	Generator	7.5	kW	0.80	90.8%	13.7	9.5	14.9	90.8%
MCC	16	S 85-01-PMP-08	Small house sump pump (Existing) - DOL	DOL	400	3	7.6	kW	IE3	1	Generator	7.5	kW	0.80	90.8%	13.7	9.5	14.9	90.8%
MCC	17	S 85-01-PMP-09	Digester pump 1 (Existing) - SS	SS	400	3	29.5	kW	IE3	1	Generator	30.0	kW	0.75	93.6%	56.7	39.3	61.7	93.6%
MCC	18	S 85-01-PMP-10	Digester pump 2 (Existing) - SS	SS	400	3	0.0	kW	IE3	0	Generator	30.0	kW	0.75	93.6%	0.0	0.0	61.7	93.6%
MCC	19	S 85-01-PMP-11	Digester gland seal pump 1 (Existing) - DOL	DOL	400	3	0.2	kW	IE3	1	Generator	0.2	kW	0.63	67.0%	0.6	0.4	0.6	67.0%
MCC	20	S 85-01-PMP-12	Digester gland seal pump 2 (Existing) - DOL	DOL	400	3	0.0	kW	IE3	0	Generator	0.2	kW	0.63	67.0%	0.0	0.0	0.6	67.0%
MCC	21	S 85-01-FAN-01	MCC Building Fan 1 - DOL	DOL	400	3	0.6	kW	IE3	1	Generator	0.55	kW	0.74	79.0%	1.2	0.9	1.4	79.0%
MCC	22	S 85-01-FAN-02	MCC Building Fan 2 - DOL	DOL	400	3	0.0	kW	IE3	0	Generator	0.55	kW	0.74	79.0%	0.0	0.0	1.4	79.0%
Feeders	28	MCC01-Q-01	Chlorine Disinfection - DB/1 (Existing) (100A TP)	FDR	400	3	20.0	kW		1	Generator	20.0	kW	0.78	100.0%	37.0	25.6	37.0	100.0%
Feeders	29	MCC01-Q-02	Admin DB	FDR	400	3	43.7	kW		1	Generator	43.7	kW	0.95	100.0%	66.6	46.2	66.6	100.0%
Feeders	30	MCC01-Q-03	Inlet Works MCC02 Feeder	FDR	400	3	56.6	kW		1	Generator	56.6	kW	0.78	100.0%	104.7	72.6	104.7	100.0%
Feeders	31	MCC01-Q-04	Second Class Water MCC03 Feeder	FDR	400	3	80.0	kW		1	Generator	80.0	kW	0.86	100.0%	133.6	92.6	133.6	100.0%
Feeders	32	MCC01-Q-05	Future Digester Equipment (6x50kW + ancillaries )	VFC	400	3	300.0	kW		1	None	300	kW	0.78	94.7%	557.6	386.3	588.8	94.7%
Local Distribution	40	MCC01-Q-06	Local Distribution Section	FDR	400	3	12.58	kW		1	Generator	53.98	kW	0.81	100.0%	22.4	15.5	96.2	100.0%
Local Distribution	41	MCC01-Q-07	Area Lighting 1	FDR	230	1	2.00	kW		1	Generator	2	kW	0.81	100.0%	10.7	2.5	10.7	100.0%
Local Distribution	42	MCC01-Q-08	Area Lighting 2	FDR	230	1	2.00	kW		1	Generator	2	kW	0.81	100.0%	10.7	2.5	10.7	100.0%
Local Distribution	43	MCC01-Q-15	Area Lighting 3	FDR	230	1	2.00	kW		1	Generator	2	kW	0.81	100.0%	10.7	2.5	10.7	100.0%
Local Distribution	44	MCC01-Q-09	Area Lighting Contactor	FDR	230	1	0.00	kW		1	Generator	0	kW	0.81	100.0%	0.0	0.0	0.0	100.0%
Local Distribution	45	MCC01-Q-10	Area Lighting Contactor Bypass	FDR	230	1	0.00	kW		1	Generator	0	kW	0.81	100.0%	0.0	0.0	0.0	100.0%
Local Distribution	46	MCC01-Q-11	MCC Plug Circuit	FDR	230	1	0.30	kW		0.1	Generator	3	kW	0.81	100.0%	1.6	0.4	16.1	100.0%
Local Distribution	47	MCC01-Q-12	Single Phase Welding Plug	FDR	230	1	0.50	kW		0.1	Generator	5	kW	0.81	100.0%	2.7	0.6	26.8	100.0%
Local Distribution	48	MCC01-Q-13	3 Phase Welding Plug	FDR	400	3	1.50	kW		0.1	Generator	15	kW	0.81	94.7%	2.7	1.9	28.2	94.7%
Local Distribution	49	MCC01-Q-14	Overhead crane feeder	FDR	400	3	0.52	kW		0.1	Generator	5.2	kW	0.81	100.0%	0.9	0.6	9.3	100.0%
Local Distribution	50	MCC01-Q-18	Dig 1 (Existing) (20SP)	FDR	230	1	0.10	kW		0.1	Generator	1	kW	0.81	100.0%	0.5	0.1	5.4	100.0%
Local Distribution	51	MCC01-Q-19	Dig 2 (Existing) (20SP)	FDR	230	1	0.10	kW		0.1	Generator	1	kW	0.81	100.0%	0.5	0.1	5.4	100.0%
Local Distribution	52	MCC01-Q-20	Dig 3 (Existing) (20SP)	FDR	230	1	0.10	kW		0.1	Generator	1	kW	0.81	100.0%	0.5	0.1	5.4	100.0%
Local Distribution	53	MCC01-Q-21	Canal Shed (Existing) (16SP)	FDR	230	1	0.10	kW		0.1	Generator	1	kW	0.81	100.0%	0.5	0.1	5.4	100.0%
Local Distribution	54	MCC01-Q-22	Control - PLC and Instrumentation Feeder	FDR	230	1	1.00	kW		1	Generator	1	kW	0.81	100.0%	5.4	1.2	5.4	100.0%
Local Distribution	55	MCC01-Q-23	Local Building DB Feeder	FDR	400	1	2.36	kW		1	Generator	14.78	kW	0.81	100.0%	7.3	2.9	45.6	100.0%
Local Building DB	63	MCC03-DB1-1	L1	FDR	230	1	0.56	kW		1	Generator	0.56	kW	0.81	94.7%	3.0	0.7	3.2	94.7%
Local Building DB	64	MCC03-LDB1-2	L2	FDR	230	1	0.32	kW		1	Generator	0.32	kW	0.81	94.7%	1.7	0.4	1.8	94.7%
Local Building DB	65	MCC03-LDB1-3	L3	FDR	230	1	0.10	kW		1	Generator	0.1	kW	0.81	94.7%	0.5	0.1	0.6	94.7%
Local Building DB	66	MCC03-LDB1-4	External Lighting XL1	FDR	230	1	0.08	kW		0.1	Generator	0.8	kW	0.81	94.7%	0.4	0.1	4.5	94.7%
Local Building DB	67	MCC03-LDB1-5	Single Phase Power P1	FDR	230	1	0.50	kW		0.1	Generator	5	kW	0.81	94.7%	2.7	0.6	28.3	94.7%
Local Building DB	68	MCC03-LDB1-6	Single Phase Power P2	FDR	230	1	0.50	kW		0.1	Generator	5	kW	0.81	94.7%	2.7	0.6	28.3	94.7%
Local Building DB	69	MCC03-LDB1-7	Heat Pump - Ablution Geyser	FDR	230	1	0.30	kW		0.1	Generator	3	kW	0.81	94.7%	1.6	0.4	17.0	94.7%



Description	Item No	Tag Number	Service Description	Starter	V	Ph	Absorbed Equipment Rating	Unit	Eff class	Duty	Back-up Supply	Rated Equipment Rating	Unit	Load PF	Load Efficiency	Absorbed Load Current	Absorbed kVA	Rated Current (FLC)	Supply Efficiency
Control	76	S 85-01-HS-001	Bio Filter pump 1 Field Control Station / E-stop	Other	230	1													
Control	77	S 85-01-HS-002	Bio Filter pump 2 Field Control Station / E-stop	Other	230	1													
Control	78	S 85-01-HS-003	Bio Filter pump 3 Field Control Station / E-stop	Other	230	1													
Control	79	S 85-01-HS-004	Bio Filter pump 4 Field Control Station / E-stop	Other	230	1													
Control	80	S 85-01-HS-005	Humus pump 1 (Existing) Field Control Station / E-stop	Other	230	1													
Control	81	S 85-01-HS-006	Humus pump 2 (Existing) Field Control Station / E-stop	Other	230	1													
Control	82	S 85-01-HS-007	Main house sump pump (Existing) Field Control Station / E-stop	Other	230	1													
Control	83	S 85-01-HS-008	Small house sump pump (Existing) Field Control Station / E-stop	Other	230	1													
Control	84	S 85-01-HS-009	Digester pump 1 (Existing) Field Control Station / E-stop	Other	230	1													
Control	85	S 85-01-HS-010	Digester pump 2 (Existing) Field Control Station / E-stop	Other	230	1													
Control	86	S 85-01-HS-011	Digester gland seal pump 1 (Existing) Field Control Station / E-stop	Other	230	1													
Control	87	S 85-01-HS-012	Digester gland seal pump 2 (Existing) Field Control Station / E-stop	Other	230	1													
Instrumentation	99	S 85-01-FIT-001	Common discharge flow meter	Other	24	1													
Instrumentation	100	S 85-01-LIT-001	Settled Effluent Sump Level Transmitter 1	Other	24	1													
Instrumentation	101	S 85-01-LIT-002	Settled Effluent Sump Level Transmitter 2	Other	24	1													
Instrumentation	102	S 85-01-LIT-003	Humus PS Level Effluent Sump Level Transmitter (Existing)	Other	24	1													
Instrumentation	103	S 85-01-PIT-001	Pump no.1 discharge pressure transmitter	Other	24	1													
Instrumentation	104	S 85-01-PIT-002	Pump no.1 suction pressure transmitter	Other	24	1													
Instrumentation	105	S 85-01-VT-001	Bio Filter pump 1 Motor DE Vibration transmitter XYZ	Other	24	1													
Instrumentation	106	S 85-01-VT-002	Bio Filter pump 1 Motor NDE Vibration transmitter XYZ	Other	24	1													
Instrumentation	107	S 85-01-VT-003	Bio Filter pump 1 DE Vibration transmitter XYZ	Other	24	1													
Instrumentation	108	S 85-01-VT-004	Bio Filter pump 1 NDE Vibration transmitter XYZ	Other	24	1													
Instrumentation	109	S 85-01-TS-001	Bio Filter pump 1 motor temperature thermistors	Other	24	1													
Instrumentation	110	S 85-01-TT-001	Bio Filter pump 1 Motor DE Temperature transmitter	Other	24	1													
Instrumentation	111	S 85-01-TT-002	Bio Filter pump 1 Motor NDE Temperature transmitter	Other	24	1													
Instrumentation	112	S 85-01-TT-003	Bio Filter pump 1 DE Temperature transmitter	Other	24	1													
Instrumentation	113	S 85-01-TT-004	Bio Filter pump 1 NDE Temperature transmitter	Other	24	1													
Instrumentation	114	S 85-01-PIT-003	Pump no.2 discharge pressure transmitter	Other	24	1													
Instrumentation	115	S 85-01-PIT-004	Pump no.2 suction pressure transmitter	Other	24	1													
Instrumentation	116	S 85-01-VT-005	Bio Filter pump 2 Motor DE Vibration transmitter XYZ	Other	24	1													
Instrumentation	117	S 85-01-VT-006	Bio Filter pump 2 Motor NDE Vibration transmitter XYZ	Other	24	1													
Instrumentation	118	S 85-01-VT-007	Bio Filter pump 2 DE Vibration transmitter XYZ	Other	24	1													
Instrumentation	119	S 85-01-VT-008	Bio Filter pump 2 NDE Vibration transmitter XYZ	Other	24	1													
Instrumentation	120	S 85-01-TS-002	Bio Filter pump 2 motor temperature thermistors	Other	24	1													
Instrumentation	121	S 85-01-TT-005	Bio Filter pump 2 Motor DE Temperature transmitter	Other	24	1													
Instrumentation	122	S 85-01-TT-006	Bio Filter pump 2 Motor NDE Temperature transmitter	Other	24	1													
Instrumentation	123	S 85-01-TT-007	Bio Filter pump 2 DE Temperature transmitter	Other	24	1													
Instrumentation	124	S 85-01-TT-008	Bio Filter pump 2 NDE Temperature transmitter	Other	24	1													
Instrumentation	125	S 85-01-PIT-005	Pump no.3 discharge pressure transmitter	Other	24	1													
Instrumentation	126	S 85-01-PIT-006	Pump no.3 suction pressure transmitter	Other	24	1													
Instrumentation	127	S 85-01-VT-009	Bio Filter pump 3 Motor DE Vibration transmitter XYZ	Other	24	1													
Instrumentation	128	S 85-01-VT-010	Bio Filter pump 3 Motor NDE Vibration transmitter XYZ	Other	24	1													
Instrumentation	129	S 85-01-VT-011	Bio Filter pump 3 DE Vibration transmitter XYZ	Other	24	1													
Instrumentation	130	S 85-01-VT-012	Bio Filter pump 3 NDE Vibration transmitter XYZ	Other	24	1													
Instrumentation	131	S 85-01-TS-003	Bio Filter pump 3 motor temperature thermistors	Other	24	1													
Instrumentation	132	S 85-01-TT-009	Bio Filter pump 3 Motor DE Temperature transmitter	Other	24	1													
Instrumentation	133	S 85-01-TT-010	Bio Filter pump 3 Motor NDE Temperature transmitter	Other	24	1													
Instrumentation	134	S 85-01-TT-011	Bio Filter pump 3 DE Temperature transmitter	Other	24	1													
Instrumentation	135	S 85-01-TT-012	Bio Filter pump 3 NDE Temperature transmitter	Other	24	1													
Instrumentation	136	S 85-01-PIT-007	Pump no.4 discharge pressure transmitter	Other	24	1													
Instrumentation	137	S 85-01-PIT-008	Pump no.4 suction pressure transmitter	Other	24	1													
Instrumentation	138	S 85-01-VT-013	Bio Filter pump 4 Motor DE Vibration transmitter XYZ	Other	24	1													
Instrumentation	139	S 85-01-VT-014	Bio Filter pump 4 Motor NDE Vibration transmitter XYZ	Other	24	1													
Instrumentation	140	S 85-01-VT-015	Bio Filter pump 4 DE Vibration transmitter XYZ	Other	24	1													
Instrumentation	141	S 85-01-VT-016	Bio Filter pump 4 NDE Vibration transmitter XYZ	Other	24	1													
Instrumentation	142	S 85-01-TS-004	Bio Filter pump 4 motor temperature thermistors	Other	24	1													
Instrumentation	143	S 85-01-TT-013	Bio Filter pump 4 Motor DE Temperature transmitter	Other	24	1													
Instrumentation	144	S 85-01-TT-014	Bio Filter pump 4 Motor NDE Temperature transmitter	Other	24	1													
Instrumentation	145	S 85-01-TT-015	Bio Filter pump 4 DE Temperature transmitter	Other	24	1													



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Item No	Service Description	Tag Number	Installed Equipment Rating	Unit	FLC	Nom %Vd	St %Vd	Estimated CB size
1	Incomer	S 85-03-F-01	1245.7	kW	1372.3	1.5%	5%	2000
2	Generator Incomer 1	S 85-03-F-03	1245.7	kW	1019.0	1.5%	5%	1250
3	Generator Incomer 2 (Provisional Future Spare)	S 85-03-F-04						
4	PFC Feeder (Provisional Estimate)	S 85-03-F-05	150.1	kVA	228.8	3.5%	5%	320
5	MCC01 - External VFC01	S 85-01-VFD-01	75.0	kW	127.0	3.5%	5%	160
6	VFC01 - Bio Filter pump 1	S 85-01-PMP-01	75.0	kW	127.0	3.5%	15%	160
7	MCC02 - External VFC02	S 85-01-VFD-02	75.0	kW	127.0	3.5%	5%	160
8	VFC02 - Bio Filter pump 2	S 85-01-PMP-02	75.0	kW	127.0	3.5%	15%	160
9	MCC03 - External VFC03	S 85-01-VFD-03	75.0	kW	127.0	3.5%	5%	160
10	VFC03 - Bio Filter pump 3	S 85-01-PMP-03	75.0	kW	127.0	3.5%	15%	160
11	MCC04 - External VFC04	S 85-01-VFD-04	75.0	kW	127.0	3.5%	5%	160
12	VFC01 - Bio Filter pump 4	S 85-01-PMP-04	75.0	kW	127.0	3.5%	15%	160
13	Humus pump 1 (Existing) - DOL	S 85-01-PMP-05	7.5	kW	14.9	3.5%	15%	20
14	Humus pump 2 (Existing) - DOL	S 85-01-PMP-06	7.5	kW	14.9	3.5%	15%	20
15	Main house sump pump (Existing) - DOL	S 85-01-PMP-07	7.5	kW	14.9	3.5%	15%	20
16	Small house sump pump (Existing) - DOL	S 85-01-PMP-08	7.5	kW	14.9	3.5%	15%	20
17	Digester pump 1 (Existing) - SS	S 85-01-PMP-09	30.0	kW	61.7	3.5%	8%	80
18	Digester pump 2 (Existing) - SS	S 85-01-PMP-10	30.0	kW	61.7	3.5%	8%	80
19	Digester gland seal pump 1 (Existing) - DOL	S 85-01-PMP-11	0.2	kW	0.6	3.5%	15%	6.3
20	Digester gland seal pump 2 (Existing) - DOL	S 85-01-PMP-12	0.2	kW	0.6	3.5%	15%	6.3
21	MCC Building Fan 1 - DOL	S 85-01-FAN-01	0.6	kW	1.4	3.5%	15%	6.3
22	MCC Building Fan 2 - DOL	S 85-01-FAN-02	0.6	kW	1.4	3.5%	15%	6.3
28	Chlorine Disinfection - DB/1 (Existing) (100A TP)	MCC01-Q-01	20.0	kW	37.0	3.5%	5%	100
29	Admin DB	MCC01-Q-02	43.7	kW	66.6	1.5%	10%	125
30	Inlet Works MCC02 Feeder	MCC01-Q-03	56.6	kW	104.7	2.5%	5%	125
31	Second Class Water MCC03 Feeder	MCC01-Q-04	80.0	kW	133.6	2.7%	5%	160
32	Future Digester Equipment (6x50kW + ancillaries )	MCC01-Q-05	300.0	kW	588.8	3.5%	15%	800
40	Local Distribution Section	MCC01-Q-06	54.0	kW	96.2	3.5%	5%	125
41	Area Lighting 1	MCC01-Q-07	2.0	kW	10.7	3.5%	5%	20
42	Area Lighting 2	MCC01-Q-08	2.0	kW	10.7	3.5%	5%	20
43	Area Lighting 3	MCC01-Q-15	2.0	kW	10.7	3.5%	5%	20
44	Area Lighting Contactor	MCC01-Q-09		kW		3.5%	5%	10
45	Area Lighting Contactor Bypass	MCC01-Q-10		kW		3.5%	5%	10
46	MCC Plug Circuit	MCC01-Q-11	3.0	kW	16.1	2.0%	5%	20
47	Single Phase Welding Plug	MCC01-Q-12	5.0	kW	26.8	2.0%	5%	32
48	3 Phase Welding Plug	MCC01-Q-13	15.0	kW	28.2	3.5%	5%	32
49	Overhead crane feeder	MCC01-Q-14	5.2	kW	9.3	3.5%	5%	20
50	Dig 1 (Existing) (20SP)	MCC01-Q-18	1.0	kW	5.4	3.5%	5%	20
51	Dig 2 (Existing) (20SP)	MCC01-Q-19	1.0	kW	5.4	3.5%	5%	20
52	Dig 3 (Existing) (20SP)	MCC01-Q-20	1.0	kW	5.4	3.5%	5%	20
53	Canal Shed (Existing) (16SP)	MCC01-Q-21	1.0	kW	5.4	3.5%	5%	20
54	Control - PLC and Instrumentation Feeder	MCC01-Q-22	1.0	kW	5.4	3.5%	5%	10
55	Local Building DB Feeder	MCC01-Q-23	14.8	kW	45.6	3.5%	5%	63



MCC Item No	Cable Tag	Cable Source	Cable Destination	Destination Description	Installation Method	Estimate Length	Current	Armour	Number of cables	Instl Cores	Area mm <sup>2</sup>	% Volt Drop Nominal	% Volt Drop Start-up	Cu Earth Qty	Cu Earth Size
2	GEN01-P//S 85-03-F-03	GEN01	S 85-03-F-03	Generator Incomer 1	Air	85	255	SWA	4	4	185	1.4%	1.4%	4	95
5	MCC01-P//S 85-01-VFD-01	MCC01	S 85-01-VFD-01	MCC01 - External VFC01	Air	10	127	SWA	1	4	50	0.3%	0.4%		4th core
6	MCC01-P//S 85-01-PMP-01	MCC01	S 85-01-PMP-01	VFC01 - Bio Filter pump 1	Air	15	127	SCREENED	1	4	50	0.5%	0.6%		4th core
7	MCC01-P//S 85-01-VFD-02	MCC01	S 85-01-VFD-02	MCC02 - External VFC02	Air	10	127	SWA	1	4	50	0.3%	0.4%		4th core
8	MCC01-P//S 85-01-PMP-02	MCC01	S 85-01-PMP-02	VFC02 - Bio Filter pump 2	Air	15	127	SCREENED	1	4	50	0.5%	0.6%		4th core
9	MCC01-P//S 85-01-VFD-03	MCC01	S 85-01-VFD-03	MCC03 - External VFC03	Air	10	127	SWA	1	4	50	0.3%	0.4%		4th core
10	MCC01-P//S 85-01-PMP-03	MCC01	S 85-01-PMP-03	VFC03 - Bio Filter pump 3	Air	15	127	SCREENED	1	4	50	0.5%	0.6%		4th core
11	MCC01-P//S 85-01-VFD-04	MCC01	S 85-01-VFD-04	MCC04 - External VFC04	Air	10	127	SWA	1	4	50	0.3%	0.4%		4th core
12	MCC01-P//S 85-01-PMP-04	MCC01	S 85-01-PMP-04	VFC01 - Bio Filter pump 4	Air	15	127	SCREENED	1	4	50	0.5%	0.6%		4th core
13	MCC01-P//S 85-01-PMP-05	MCC01	S 85-01-PMP-05	Humus pump 1 (Existing) - DOL	Ground	180	15	SWA	1	4	Existing - Size TBC	TBC	TBC	Existing	Existing
14	MCC01-P//S 85-01-PMP-06	MCC01	S 85-01-PMP-06	Humus pump 2 (Existing) - DOL	Ground	180	15	SWA	1	4	Existing - Size TBC	TBC	TBC	Existing	Existing
15	MCC01-P//S 85-01-PMP-07	MCC01	S 85-01-PMP-07	Main house sump pump (Existing) - DOL	Air	10	15	SWA	1	4	Existing - Size TBC	TBC	TBC	Existing	Existing
16	MCC01-P//S 85-01-PMP-08	MCC01	S 85-01-PMP-08	Small house sump pump (Existing) - DOL	Ground	180	15	SWA	1	4	Existing - Size TBC	TBC	TBC	Existing	Existing
17	MCC01-P//S 85-01-PMP-09	MCC01	S 85-01-PMP-09	Digester pump 1 (Existing) - SS	Air	10	62	SWA	1	4	Existing - Size TBC	TBC	TBC	Existing	Existing
18	MCC01-P//S 85-01-PMP-10	MCC01	S 85-01-PMP-10	Digester pump 2 (Existing) - SS	Air	10	62	SWA	1	4	Existing - Size TBC	TBC	TBC	Existing	Existing
19	MCC01-P//S 85-01-PMP-11	MCC01	S 85-01-PMP-11	Digester gland seal pump 1 (Existing) - DOL	Air	10	1	SWA	1	4	Existing - Size TBC	TBC	TBC	Existing	Existing
20	MCC01-P//S 85-01-PMP-12	MCC01	S 85-01-PMP-12	Digester gland seal pump 2 (Existing) - DOL	Air	10	1	SWA	1	4	Existing - Size TBC	TBC	TBC	Existing	Existing
21	MCC01-P//S 85-01-FAN-01	MCC01	S 85-01-FAN-01	MCC Building Fan 1 - DOL	Air	10	1	SWA	1	4	2.5	0.1%	0.3%		4th core
22	MCC01-P//S 85-01-FAN-02	MCC01	S 85-01-FAN-02	MCC Building Fan 2 - DOL	Air	10	1	SWA	1	4	2.5	0.1%	0.3%		4th core
28	MCC01-P//MCC04	MCC01	MCC04	Chlorine Disinfection - DB/1 (Existing) (100A TP)	Ground	495	100	SWA	1	4	Existing - Size TBC	TBC	TBC	Existing	Existing
29	MCC01-P//DB ADMIN	MCC01	DB ADMIN	Admin DB	Ducts	40	100	SWA	1	4	35	1.1%	1.1%	1	16
30	MCC01-P//MCC02	MCC01	MCC02	Inlet Works MCC02 Feeder	Ground	250	63	SWA	2	4	70	2.2%	2.2%	1	70
31	MCC01-P//MCC03	MCC01	MCC03	Second Class Water MCC03 Feeder	Ground	460	53	SWA	3	4	95	2.1%	2.1%	3	50
41	MCC01-P//MCC01-Q-07	MCC01	MCC01-Q-07	Area Lighting 1	Ground	150	11	UA	1	3	16	3.1%	3.1%		3rd core
42	MCC01-P//MCC01-Q-08	MCC01	MCC01-Q-08	Area Lighting 2	Ground	150	11	UA	1	3	16	3.1%	3.1%		3rd core
43	MCC01-P//MCC01-Q-15	MCC01	MCC01-Q-15	Area Lighting 3	Ground	200	11	UA	1	3	16	2.6%	2.6%		3rd core
46	MCC01-P//MCC01-Q-11	MCC01	MCC01-Q-11	MCC Plug Circuit	Air	5	16	UA	1	3	2.5	0.6%	0.6%		3rd core
47	MCC01-P//MCC01-Q-12	MCC01	MCC01-Q-12	Single Phase Welding Plug	Ducts	15	27	UA	1	3	6	1.3%	1.3%		3rd core
48	MCC01-P//MCC01-Q-13	MCC01	MCC01-Q-13	3 Phase Welding Plug	Ducts	15	28	UA	1	4	6	1.0%	1.0%	1	6
49	MCC01-P//MCC01-Q-14	MCC01	MCC01-Q-14	Overhead crane feeder	Ducts	30	9	SWA	1	4	4	1.1%	1.1%	1	4
50	MCC01-P//MCC01-Q-18	MCC01	MCC01-Q-18	Dig 1 (Existing) (20SP)	Ground	150	5	SWA	1	4	Existing - Size TBC	TBC	TBC	Existing	Existing
51	MCC01-P//MCC01-Q-19	MCC01	MCC01-Q-19	Dig 2 (Existing) (20SP)	Ground	150	5	SWA	1	4	Existing - Size TBC	TBC	TBC	Existing	Existing
52	MCC01-P//MCC01-Q-20	MCC01	MCC01-Q-20	Dig 3 (Existing) (20SP)	Ground	150	5	SWA	1	4	Existing - Size TBC	TBC	TBC	Existing	Existing
53	MCC01-P//MCC01-Q-21	MCC01	MCC01-Q-21	Canal Shed (Existing) (16SP)	Ground	185	5	SWA	1	4	Existing - Size TBC	TBC	TBC	Existing	Existing
55	MCC01-P//MCC01-Q-23	MCC01	MCC01-Q-23	Local Building DB Feeder	Air	10	63	SWA	1	4	16	0.4%	0.4%	1	16



Item No	Tag Number	Service Description	Volt	Starter in cubicle	Forced Ventilation	Selector Switches	Push Buttons								Indicators												Metering				Protection			Field Control					Comments
						Manual/ Off/ Auto	Start / Forward	Start / Reverse	Stop	Open	Close	Reset/Overload	Lamp Test	Other	Running / Forward	Running / Reverse	Stopped	Opened	Closed	Healthy	E-Stop	No Flow	Over Torque	Seal Failure	Overheat	Over vibration	Other	kWh	Amp	Volt	Run Hours	Overload	Earth Leakage	Surge Protection	Start	E-Stop	Open/Stop/Close Forward/Stop/Reverse	Other	
1	S 85-03-F-01	Incomer	400	Incomer		0																			1		Power meter			1		1							Alarms for reverse phase, over/under voltage, phase unbalanced
2	S 85-03-F-03	Generator Incomer 1	400	Incomer		1	1		1			1	1		1		1	1								1	1	1	1	1							DSE8610 controller for generator field control - Refer to specification for additional generator panel requirements	DSE8660 for Main Panel control and to allow for future additional generator synchronization	
3	S 85-03-F-04	Generator Incomer 2 (Provisional Future Spare)	400	Incomer																																			
4	S 85-03-F-05	PFC Feeder (Provisional Estimate)	400	FDR	1													1	1																				
6	S 85-01-PMP-01	VFC01 - Bio Filter pump 1	400	VFC		1	1		1			1	1		1		1	1			1	1	1				1		1	1				1					Remote Display/Controller
8	S 85-01-PMP-02	VFC02 - Bio Filter pump 2	400	VFC		1	1		1			1	1		1		1	1			1	1	1				1		1	1				1					Remote Display/Controller
10	S 85-01-PMP-03	VFC03 - Bio Filter pump 3	400	VFC	1	1	1		1			1	1		1		1	1			1	1	1				1		1	1				1					Remote Display/Controller
12	S 85-01-PMP-04	VFC01 - Bio Filter pump 4	400	VFC	1	1	1		1			1	1		1		1	1			1	1	1				1		1	1				1					Remote Display/Controller
13	S 85-01-PMP-05	Humus pump 1 (Existing) - DOL	400	DOL		1	1		1			1	1		1		1	1									1		1	1				1					
14	S 85-01-PMP-06	Humus pump 2 (Existing) - DOL	400	DOL		1	1		1			1	1		1		1	1									1		1	1				1					
15	S 85-01-PMP-07	Main house sump pump (Existing) - DOL	400	DOL		1	1		1			1	1		1		1	1									1		1	1				1					
16	S 85-01-PMP-08	Small house sump pump (Existing) - DOL	400	DOL		1	1		1			1	1		1		1	1									1		1	1				1					
17	S 85-01-PMP-09	Digester pump 1 (Existing) - SS	400	SS		1	1		1			1	1		1		1	1									1		1	1				1					Remote Display/Controller
18	S 85-01-PMP-10	Digester pump 2 (Existing) - SS	400	SS		1	1		1			1	1		1		1	1									1		1	1				1					Remote Display/Controller





Item No	Tag Number	Service Description	Digital Input												Digital Output				Analog Input					Analog		Comments
			Healthy	Fault	E-stop	Running / Forward	Running / Reverse	Opened	Closed	Auto/ Man/ Off	Overheat	Seal Failure	Other	Stop	Open/ Forward Start	Start	Other	Measured Value	Amps	Volt	kW	kWh	Set Point	Other		
1	S 85-03-F-01	Incomer	1																						Alarms for: - Reverse phase - Over/under voltage - Phase unbalanced	
2	S 85-03-F-03	Generator Incomer 1	1	2	1	1				1	2			2	1			2	1	1	1	1			The following signals wired via potential free contacts must be taken to SCADA via MODBUS TCP - Intrusion alarm (DI) - Low battery voltage - Engine failure (DI) - Fuel level (40 %) requires refueling - Diesel Generator on Manual (DI) - No Fuel - Manual Stop - Emergency Stop - Mains Phase Fault	
3	S 85-03-F-04	Generator Incomer 2 (Provisional Future Spare)																								
4	S 85-03-F-05	PFC Feeder (Provisional Estimate)	1																							
6	S 85-01-PMP-01	VFC01 - Bio Filter pump 1	1	1	1	1					2	1	1	8	1	1									PUMP PROTECTION 1. MOISTURE INGRESS/SEAL FAILURE 2. BEARING TEMPERATURE 3. VIBRATION	
8	S 85-01-PMP-02	VFC02 - Bio Filter pump 2	1	1	1	1					2	1	1	8	1	1									MOTOR PROTECTION 1. WINDING TEMPERATURE 2. BEARING PROTECTION 3. VIBRATION	
10	S 85-01-PMP-03	VFC03 - Bio Filter pump 3	1	1	1	1					2				1											
12	S 85-01-PMP-04	VFC01 - Bio Filter pump 4	1	1	1	1					2				1											
13	S 85-01-PMP-05	Humus pump 1 (Existing) - DOL	1	1	1	1					2				1											
14	S 85-01-PMP-06	Humus pump 2 (Existing) - DOL	1	1	1	1					2				1											
15	S 85-01-PMP-07	Main house sump pump (Existing) - DOL	1	1	1	1					2				1											
16	S 85-01-PMP-08	Small house sump pump (Existing) - DOL	1	1	1	1					2				1											
17	S 85-01-PMP-09	Digester pump 1 (Existing) - SS	1	1		1					2															
18	S 85-01-PMP-10	Digester pump 2 (Existing) - SS	1	1		1					2															
99	S 85-01-FIT-001	Common discharge flow meter															1	1								
100	S 85-01-LIT-001	Settled Effluent Sump Level Transmitter 1																1								
101	S 85-01-LIT-002	Settled Effluent Sump Level Transmitter 2																1								
102	S 85-01-LIT-003	Humus PS Level Effluent Sump Level Transmitter (Existing)																1								
103	S 85-01-PIT-001	Pump no.1 discharge pressure transmitter																1								
104	S 85-01-PIT-002	Pump no.1 suction pressure transmitter																1								
105	S 85-01-VT-001	Bio Filter pump 1 Motor DE Vibration transmitter XYZ																3								
106	S 85-01-VT-002	Bio Filter pump 1 Motor NDE Vibration transmitter XYZ																3								
107	S 85-01-VT-003	Bio Filter pump 1 DE Vibration transmitter XYZ																3								
108	S 85-01-VT-004	Bio Filter pump 1 NDE Vibration transmitter XYZ																3								
109	S 85-01-TS-001	Bio Filter pump 1 motor temperature thermistors									1															
110	S 85-01-TT-001	Bio Filter pump 1 Motor DE Temperature transmitter																1								
111	S 85-01-TT-002	Bio Filter pump 1 Motor NDE Temperature transmitter																1								
112	S 85-01-TT-003	Bio Filter pump 1 DE Temperature transmitter																1								
113	S 85-01-TT-004	Bio Filter pump 1 NDE Temperature transmitter																1								
114	S 85-01-PIT-003	Pump no.2 discharge pressure transmitter																1								
115	S 85-01-PIT-004	Pump no.2 suction pressure transmitter																1								
116	S 85-01-VT-005	Bio Filter pump 2 Motor DE Vibration transmitter XYZ																3								
117	S 85-01-VT-006	Bio Filter pump 2 Motor NDE Vibration transmitter XYZ																3								
118	S 85-01-VT-007	Bio Filter pump 2 DE Vibration transmitter XYZ																3								
119	S 85-01-VT-008	Bio Filter pump 2 NDE Vibration transmitter XYZ																3								
120	S 85-01-TS-002	Bio Filter pump 2 motor temperature thermistors									1															
121	S 85-01-TT-005	Bio Filter pump 2 Motor DE Temperature transmitter																1								



Item No	Tag Number	Service Description	Healthy	Fault	E-stop	Running / Forward	Running / Reverse	Opened	Closed	Auto/ Man/ Off	Overheat	Seal Failure	Other	Stop	Open/ Forward Start	Start	Other	Measured Value	Amps	Volt	kW	kWh	Set Point	Other	Comments
122	S 85-01-TT-006	Bio Filter pump 2 Motor NDE Temperature transmitter																1							
123	S 85-01-TT-007	Bio Filter pump 2 DE Temperature transmitter																1							
124	S 85-01-TT-008	Bio Filter pump 2 NDE Temperature transmitter																1							
125	S 85-01-PIT-005	Pump no.3 discharge pressure transmitter																1							
126	S 85-01-PIT-006	Pump no.3 suction pressure transmitter																1							
127	S 85-01-VT-009	Bio Filter pump 3 Motor DE Vibration transmitter XYZ																3							
128	S 85-01-VT-010	Bio Filter pump 3 Motor NDE Vibration transmitter XYZ																3							
129	S 85-01-VT-011	Bio Filter pump 3 DE Vibration transmitter XYZ																3							
130	S 85-01-VT-012	Bio Filter pump 3 NDE Vibration transmitter XYZ																3							
131	S 85-01-TS-003	Bio Filter pump 3 motor temperature thermistors									1														
132	S 85-01-TT-009	Bio Filter pump 3 Motor DE Temperature transmitter																1							
133	S 85-01-TT-010	Bio Filter pump 3 Motor NDE Temperature transmitter																1							
134	S 85-01-TT-011	Bio Filter pump 3 DE Temperature transmitter																1							
135	S 85-01-TT-012	Bio Filter pump 3 NDE Temperature transmitter																1							
136	S 85-01-PIT-007	Pump no.4 discharge pressure transmitter																1							
137	S 85-01-PIT-008	Pump no.4 suction pressure transmitter																1							
138	S 85-01-VT-013	Bio Filter pump 4 Motor DE Vibration transmitter XYZ																3							
139	S 85-01-VT-014	Bio Filter pump 4 Motor NDE Vibration transmitter XYZ																3							
140	S 85-01-VT-015	Bio Filter pump 4 DE Vibration transmitter XYZ																3							
141	S 85-01-VT-016	Bio Filter pump 4 NDE Vibration transmitter XYZ																3							
142	S 85-01-TS-004	Bio Filter pump 4 motor temperature thermistors									1														
143	S 85-01-TT-013	Bio Filter pump 4 Motor DE Temperature transmitter																1							
144	S 85-01-TT-014	Bio Filter pump 4 Motor NDE Temperature transmitter																1							
145	S 85-01-TT-015	Bio Filter pump 4 DE Temperature transmitter																1							
146	S 85-01-TT-016	Bio Filter pump 4 NDE Temperature transmitter																1							
147	S 85-01-TS-005	Humus pump 1 (Existing) thermistors									1														
148	S 85-01-TS-006	Humus pump 2 (Existing) thermistors									1														
149	S 85-01-TS-007	Main house sump pump (Existing) thermistors									1														
150	S 85-01-TS-008	Small house sump pump (Existing) thermistors									1														
151	S 85-01-TS-009	Digester pump 1 (Existing) thermistors									1														
152	S 85-01-TS-010	Digester pump 2 (Existing) thermistors									1														
		Total	122											12				82							



MCC Item No	Service Description	Instrument Tag	Instrument Cable	Estimate Length	JB	JB to Marshalling Cable	Estimate Length
2	Generator Incomer 1 - Control Panel	S 85-03-F-03	Modbus TCP - CAT6e	85			
5	MCC01 - External VFC01	S 85-01-VFD-01	Modbus TCP - CAT6e	10			
7	MCC02 - External VFC02	S 85-01-VFD-02	Modbus TCP - CAT6e	10			
9	MCC03 - External VFC03	S 85-01-VFD-03	Modbus TCP - CAT6e	10			
11	MCC04 - External VFC04	S 85-01-VFD-04	Modbus TCP - CAT6e	10			
76	Bio Filter pump 1 Field Control Station / E-stop	S 85-01-HS-001	Dekobon type M855 1 pair 1.5mm2	15			
77	Bio Filter pump 2 Field Control Station / E-stop	S 85-01-HS-002	Dekobon type M855 1 pair 1.5mm2	15			
78	Bio Filter pump 3 Field Control Station / E-stop	S 85-01-HS-003	Dekobon type M855 1 pair 1.5mm2	15			
79	Bio Filter pump 4 Field Control Station / E-stop	S 85-01-HS-004	Dekobon type M855 1 pair 1.5mm2	15			
80	Humus pump 1 (Existing) Field Control Station / E-stop	S 85-01-HS-005	Existing: to be re-routed to new MCC	existing			
81	Humus pump 2 (Existing) Field Control Station / E-stop	S 85-01-HS-006	Existing: to be re-routed to new MCC	existing			
82	Main house sump pump (Existing) Field Control Station / E-stop	S 85-01-HS-007	Existing: to be re-routed to new MCC	existing			
83	Small house sump pump (Existing) Field Control Station / E-stop	S 85-01-HS-008	Existing: to be re-routed to new MCC	existing			
84	Digester pump 1 (Existing) Field Control Station / E-stop	S 85-01-HS-009	Existing: to be re-routed to new MCC	existing			
85	Digester pump 2 (Existing) Field Control Station / E-stop	S 85-01-HS-010	Existing: to be re-routed to new MCC	existing			
86	Digester gland seal pump 1 (Existing) Field Control Station / E-stop	S 85-01-HS-011	Existing: to be re-routed to new MCC	existing			
87	Digester gland seal pump 2 (Existing) Field Control Station / E-stop	S 85-01-HS-012	Existing: to be re-routed to new MCC	existing			
112	Bio Filter pump 1 DE Temperature transmitter	S 85-01-TT-003	Integral to the immersible pump set	8	Pump Termination	Dekobon type M877 24 pair 0.5mm2	30
107	Bio Filter pump 1 DE Vibration transmitter XYZ	S 85-01-VT-003					
153	Bio Filter pump 1 Moisture Ingress Sensor	S 85-01-MI-001					
110	Bio Filter pump 1 Motor DE Temperature transmitter	S 85-01-TT-001					
105	Bio Filter pump 1 Motor DE Vibration transmitter XYZ	S 85-01-VT-001					
111	Bio Filter pump 1 Motor NDE Temperature transmitter	S 85-01-TT-002					
106	Bio Filter pump 1 Motor NDE Vibration transmitter XYZ	S 85-01-VT-002					
109	Bio Filter pump 1 motor temperature thermistors	S 85-01-TS-001					
113	Bio Filter pump 1 NDE Temperature transmitter	S 85-01-TT-004	Integral to the immersible pump set	8	Pump Termination	Dekobon type M877 24 pair 0.5mm2	30
108	Bio Filter pump 1 NDE Vibration transmitter XYZ	S 85-01-VT-004					
123	Bio Filter pump 2 DE Temperature transmitter	S 85-01-TT-007					
118	Bio Filter pump 2 DE Vibration transmitter XYZ	S 85-01-VT-007					
154	Bio Filter pump 2 Moisture Ingress Sensor	S 85-01-MI-002					
121	Bio Filter pump 2 Motor DE Temperature transmitter	S 85-01-TT-005					
116	Bio Filter pump 2 Motor DE Vibration transmitter XYZ	S 85-01-VT-005					
122	Bio Filter pump 2 Motor NDE Temperature transmitter	S 85-01-TT-006					
117	Bio Filter pump 2 Motor NDE Vibration transmitter XYZ	S 85-01-VT-006	Integral to the immersible pump set	8	Pump Termination	Dekobon type M877 24 pair 0.5mm2	30
120	Bio Filter pump 2 motor temperature thermistors	S 85-01-TS-002					
124	Bio Filter pump 2 NDE Temperature transmitter	S 85-01-TT-008					
119	Bio Filter pump 2 NDE Vibration transmitter XYZ	S 85-01-VT-008					
134	Bio Filter pump 3 DE Temperature transmitter	S 85-01-TT-011					
129	Bio Filter pump 3 DE Vibration transmitter XYZ	S 85-01-VT-011					
155	Bio Filter pump 3 Moisture Ingress Sensor	S 85-01-MI-003					
132	Bio Filter pump 3 Motor DE Temperature transmitter	S 85-01-TT-009					
127	Bio Filter pump 3 Motor DE Vibration transmitter XYZ	S 85-01-VT-009	Integral to the immersible pump set	8	Pump Termination	Dekobon type M877 24 pair 0.5mm2	30
133	Bio Filter pump 3 Motor NDE Temperature transmitter	S 85-01-TT-010					
128	Bio Filter pump 3 Motor NDE Vibration transmitter XYZ	S 85-01-VT-010					
131	Bio Filter pump 3 motor temperature thermistors	S 85-01-TS-003					
135	Bio Filter pump 3 NDE Temperature transmitter	S 85-01-TT-012					
130	Bio Filter pump 3 NDE Vibration transmitter XYZ	S 85-01-VT-012					
145	Bio Filter pump 4 DE Temperature transmitter	S 85-01-TT-015					
140	Bio Filter pump 4 DE Vibration transmitter XYZ	S 85-01-VT-015	Integral to the immersible pump set	8	Pump Termination	Dekobon type M877 24 pair 0.5mm2	30
156	Bio Filter pump 4 Moisture Ingress Sensor	S 85-01-MI-004					
143	Bio Filter pump 4 Motor DE Temperature transmitter	S 85-01-TT-013					
138	Bio Filter pump 4 Motor DE Vibration transmitter XYZ	S 85-01-VT-013					
144	Bio Filter pump 4 Motor NDE Temperature transmitter	S 85-01-TT-014					
139	Bio Filter pump 4 Motor NDE Vibration transmitter XYZ	S 85-01-VT-014					
142	Bio Filter pump 4 motor temperature thermistors	S 85-01-TS-004					
146	Bio Filter pump 4 NDE Temperature transmitter	S 85-01-TT-016					
141	Bio Filter pump 4 NDE Vibration transmitter XYZ	S 85-01-VT-016					
99	Common discharge flow meter	S 85-01-FIT-001	Dekobon type M855 1 pair 0.5mm2	8			
151	Digester pump 1 (Existing) thermistors	S 85-01-TS-009	existing	existing			
151	Digester pump 1 (Existing) thermistors	S 85-01-TS-009	existing	existing			
152	Digester pump 2 (Existing) thermistors	S 85-01-TS-010	existing	existing			
152	Digester pump 2 (Existing) thermistors	S 85-01-TS-010	existing	existing			
102	Humus PS Level Effluent Sump Level Transmitter (Existing)	S 85-01-LIT-003	existing	existing			
147	Humus pump 1 (Existing) thermistors	S 85-01-TS-005	existing	existing			
148	Humus pump 2 (Existing) thermistors	S 85-01-TS-006	existing	existing			
149	Main house sump pump (Existing) thermistors	S 85-01-TS-007	existing	existing			
149	Main house sump pump (Existing) thermistors	S 85-01-TS-007	existing	existing			
103	Pump no.1 discharge pressure transmitter	S 85-01-PIT-001	Dekobon type M855 1 pair 0.5mm2	8	JB01	Dekobon type M877 4 pair 0.5mm2	15
104	Pump no.1 suction pressure transmitter	S 85-01-PIT-002	Dekobon type M855 1 pair 0.5mm2				
114	Pump no.2 discharge pressure transmitter	S 85-01-PIT-003	Dekobon type M855 1 pair 0.5mm2	8	JB02	Dekobon type M877 4 pair 0.5mm2	15
115	Pump no.2 suction pressure transmitter	S 85-01-PIT-004	Dekobon type M855 1 pair 0.5mm2				
125	Pump no.3 discharge pressure transmitter	S 85-01-PIT-005	Dekobon type M855 1 pair 0.5mm2	8	JB03	Dekobon type M877 4 pair 0.5mm2	15
126	Pump no.3 suction pressure transmitter	S 85-01-PIT-006	Dekobon type M855 1 pair 0.5mm2				
136	Pump no.4 discharge pressure transmitter	S 85-01-PIT-007	Dekobon type M855 1 pair 0.5mm2	8	JB04	Dekobon type M877 4 pair 0.5mm2	15
137	Pump no.4 suction pressure transmitter	S 85-01-PIT-008	Dekobon type M855 1 pair 0.5mm2				
100	Settled Effluent Sump Level Transmitter 1	S 85-01-LIT-001	existing	existing			
101	Settled Effluent Sump Level Transmitter 2	S 85-01-LIT-002	existing	existing			
150	Small house sump pump (Existing) thermistors	S 85-01-TS-008	existing	existing			
150	Small house sump pump (Existing) thermistors	S 85-01-TS-008	existing	existing			



# ISIPINGO WWTW UPGRADE

MCC: MCC02  
Inlet Works MCC Schedule

**eThekwini Municipality: Water & Sanitation Unit**

Reference: 31300-5W  
Revision: A



Description	Item No	Tag Number	Service Description	Starter	V	Ph	Absorbed Equipment Rating	Unit	Duty Factor	Back-up Supply	Rated Equipment Rating	Unit	Load PF	Load Efficiency	Absorbed Load Current	Absorbed kVA
MCC	1	S 85-02-F01	Incomer	Incomer	400	3	59.70	kW	1		77.96	kW	0.78		110.8	76.76
MCC	2	S 85-02-MSR-01	Mechanical Trash Rack Screen	DOL	400	3	1.58	kW	1	Generator	1.5	kW	0.72	86.0%	3.2	2.2
MCC	3	S 85-02-MSR-02	Mechanical Front Rake Screen 01	DOL	400	3	1.58	kW	1	Generator	1.5	kW	0.72	86.0%	3.2	2.2
MCC	4	S 85-02-MSR-03	Mechanical Front Rake Screen 02	DOL	400	3	1.58	kW	1	Generator	1.5	kW	0.72	86.0%	3.2	2.2
MCC	5	S 85-02-SCC-01	Wash Compactor 01 Screw Conveyor	DOL	400	3	2.28	kW	1	Generator	2.2	kW	0.73	87.0%	4.5	3.1
MCC	6	S 85-02-SCC-02	Wash Compactor 02 Screw Conveyor	DOL	400	3	2.28	kW	1	Generator	2.2	kW	0.73	87.0%	4.5	3.1
MCC	7	S 85-02-MIX-01	Wash Compactor 01 Agitator	DOL	400	3	7.45	kW	1	Generator	7.5	kW	0.80	90.8%	13.4	9.3
MCC	8	S 85-02-MIX-02	Wash Compactor 02 Agitator	DOL	400	3	7.45	kW	1	Generator	7.5	kW	0.80	90.8%	13.4	9.3
MCC	9	S 86-02-PMP-03	Sludge Stockpile Sump Pump 01	DOL	400	3	3.07	kW	1	Generator	3	kW	0.73	88.0%	6.1	4.2
MCC	10	S 86-02-PMP-04	Sludge Stockpile Sump Pump 02	DOL	400	3	0.00	kW	0	Generator	3	kW	0.73	88.0%	0.0	0.0
MCC	11	S 85-02-MIX-03	Vortex Degritter 01 Paddle Drive	DOL	400	3	1.17	kW	1	Generator	1.1	kW	0.72	84.5%	2.3	1.6
MCC	12	S 85-02-MIX-04	Vortex Degritter 02 Paddle Drive	DOL	400	3	1.17	kW	1	Generator	1.1	kW	0.72	84.5%	2.3	1.6
MCC	13	S 86-02-PMP-01	Vortex Grit Self Priming Grit Pump 01	DOL	400	3	7.45	kW	1	Generator	7.5	kW	0.80	90.8%	13.4	9.3
MCC	14	S 86-02-PMP-02	Vortex Grit Self Priming Grit Pump 02	DOL	400	3	7.45	kW	1	Generator	7.5	kW	0.80	90.8%	13.4	9.3
MCC	15	S 85-02-SCC-03	Grit Classifier 01 Screw	DOL	400	3	1.17	kW	1	Generator	1.1	kW	0.72	84.5%	2.3	1.6
MCC	16	S 85-02-SCC-04	Grit Classifier 02 Screw	DOL	400	3	1.17	kW	1	Generator	1.1	kW	0.72	84.5%	2.3	1.6
MCC	17	S 86-02-MTR-01	Skip Dolly 01: Screenings	DOL	400	3	0.43	kW	1	Generator	0.37	kW	0.62	75.0%	1.0	0.7
MCC	18	S 86-02-MTR-02	Skip Dolly 02: Grit	DOL	400	3	0.43	kW	1	Generator	0.37	kW	0.62	75.0%	1.0	0.7
MCC	19	S 86-02-FAN-01	MCC Room Extraction Fan 1	DOL	400	3	0.61	kW	1	Generator	0.55	kW	0.74	79.0%	1.2	0.8
MCC	20	S 86-02-FAN-02	MCC Room Extraction Fan 2	DOL	400	3	0.00	kW	0	Generator	0.55	kW	0.74	79.0%	0.0	0.0
Local Distribution	21	MCC02-Q-01	Local Distribution Section Incomer	FDR	400	3	11.15	kW	1	Generator	25.56	kW	0.81	100%	19.9	13.8
Local Distribution	22	MCC02-Q-02	Light Circuit - Indoor	FDR	230	1	0.08	kW	1	Generator	0.08	kW	0.81	100%	0.4	0.1
Local Distribution	23	MCC02-Q-03	Light Circuit - External XL1	FDR	230	1	0.50	kW	1	Generator	0.5	kW	0.81	100%	2.7	0.6
Local Distribution	24	MCC02-Q-04	Light Circuit - External XL2	FDR	230	1	0.90	kW	1	Generator	0.9	kW	0.81	100%	4.8	1.1
Local Distribution	25	MCC02-Q-05	Light Circuit - External XL3	FDR	230	1	0.10	kW	1	Generator	0.1	kW	0.81	100%	0.5	0.1
Local Distribution	26	MCC02-Q-06	Area Lighting 1	FDR	230	1	1.00	kW	1	Generator	1	kW	0.81	100%	5.4	1.2
Local Distribution	27	MCC02-Q-07	Area Lighting 2	FDR	230	1	1.00	kW	1	Generator	1	kW	0.81	100%	5.4	1.2
Local Distribution	28	MCC02-Q-08	Area Lighting Contactor	FDR	230	1	0.00	kW	1	Generator		kW	0.81	100%	0.0	0.0
Local Distribution	29	MCC02-Q-09	Area Lighting Contactor Bypass	FDR	230	1	0.00	kW	1	Generator		kW	0.81	100%	0.0	0.0
Local Distribution	30	MCC02-Q-10	Plug Circuit 1	FDR	230	1	0.74	kW	0.2	Generator	3.7	kW	0.81	100%	4.0	0.9
Local Distribution	31	MCC02-Q-11	Plug Circuit - Spare	FDR	230	1	0.00	kW	0	Generator		kW	0.81	100%	0.0	0.0
Local Distribution	32	MCC02-Q-12	Single Phase Welding Plug	FDR	230	1	1.00	kW	0.2	Generator	5	kW	0.81	100%	5.4	1.2
Local Distribution	33	MCC02-Q-13	3 Phase Welding Plug	FDR	400	1	1.60	kW	0.2	Generator	8	kW	0.81	100%	4.9	2.0
Local Distribution	34	MCC02-CRN-001	Overhead Crane	FDR	400	1	3.00	kW	1	Generator	3	kW	0.81	100%	9.3	3.7
Local Distribution	35	MCC02-Q-14	Control - UPS, PLC and Instrumentation Feeder	FDR	230	1	1.00	kW	1	Generator	1	kW	0.81	100%	5.4	1.2
Local Distribution	36	MCC02-Q-15	Actuated Valves Distribution Feeder	FDR	400	3	0.23	kW	0.2	Generator	1.26	kW	0.81	100%	0.4	0.3
Actuated Valves Distr	35	S 85-02-F03	Actuated Valves Distribution Incomer	FDR	400	3	0.23	kW	0.2	Generator	1.26	kW	0.81	100%	0.4	0.3
Actuated Valves Distr	36	S 86-02-XV-003	Water launder diverter Valve	FDR	400	3	0.0324	kW	0.2	Generator	0.18	kW	0.81	100%	0.1	0.0
Actuated Valves Distr	37	S 86-02-XV-005	Wash Compactor 01 outlet valve actuator	FDR	400	3	0.0324	kW	0.2	Generator	0.18	kW	0.81	100%	0.1	0.0
Actuated Valves Distr	38	S 86-02-XV-006	Wash Compactor 02 outlet valve actuator	FDR	400	3	0.0324	kW	0.2	Generator	0.18	kW	0.81	100%	0.1	0.0
Actuated Valves Distr	39	S 86-02-XV-009	Grit Classifier 01 Inlet valve actuator	FDR	400	3	0.0324	kW	0.2	Generator	0.18	kW	0.81	100%	0.1	0.0
Actuated Valves Distr	40	S 86-02-XV-010	Grit Classifier 02 Inlet valve actuator	FDR	400	3	0.0324	kW	0.2	Generator	0.18	kW	0.81	100%	0.1	0.0
Actuated Valves Distr	41	S 86-02-XV-011	Grit Classifier 01 Outlet valve actuator	FDR	400	3	0.0324	kW	0.2	Generator	0.18	kW	0.81	100%	0.1	0.0
Actuated Valves Distr	42	S 86-02-XV-012	Grit Classifier 02 Outlet valve actuator	FDR	400	3	0.0324	kW	0.2	Generator	0.18	kW	0.81	100%	0.1	0.0
Control	42	S 85-02-HS-001	Mechanical Trash Rack Screen - Field Control Station / Estop	Other	230											
Control	43	S 85-02-HS-002	Mechanical Front Rake Screen 01 Field - Control Station / Estop	Other	230											
Control	44	S 85-02-HS-003	Mechanical Front Rake Screen 02 Field - Control Station / Estop	Other	230											
Control	45	S 85-02-HS-004	Wash Compactor 01 - Control Station / Estop	Other	230											
Control	46	S 85-02-HS-005	Water launder diverter Control Station / Estop	Other	230											
Control	47	S 85-02-HS-006	Wash Compactor 02 - Control Station / Estop	Other	230											
Control	48	S 85-02-HS-008	Vortex Degritter 01 Paddle Drive Field Control Station / Estop	Other	230											
Control	49	S 85-02-HS-009	Vortex Grit Self Priming Grit Pump 01 Field Control Station / Estop	Other	230											
Control	50	S 85-02-HS-010	Vortex Degritter 02 Paddle Drive Field Control Station / Estop	Other	230											
Control	51	S 85-02-HS-011	Vortex Grit Self Priming Grit Pump 02 Field Control Station / Estop	Other	230											

Description	Item No	Tag Number	Service Description	Starter	V	Ph	Absorbed Equipment Rating	Unit	Duty Factor	Back-up Supply	Rated Equipment Rating	Unit	Load PF	Load Efficiency	Absorbed Load Current	Absorbed kVA
Control	52	S 85-02-HS-012	Grit Classifier 01 Screw Motor Field Control Station / Estop	Other	230											
Control	53	S 85-02-HS-013	Grit Classifier 02 Screw Motor Field Control Station / Estop	Other	230											



Description	Item No	Tag Number	Service Description	Starter	V	Ph	Absorbed Equipment Rating	Unit	Duty Factor	Back-up Supply	Rated Equipment Rating	Unit	Load PF	Load Efficiency	Absorbed Load Current	Absorbed kVA
Control	54	S 85-02-HS-007	Skip Dolly 01: Screenings Field Control Station / Estop	Other	230											
Control	55	S 85-02-HS-014	Skip Dolly 02: Grit Field Control Station / Estop	Other	230											
Control	56	S 85-02-HS-015	Sludge Stockpile Sump Pump 01 Control Station / Estop	Other	230											
Control	57	S 85-02-HS-016	Sludge Stockpile Sump Pump 02 Control Station / Estop	Other	230											
Instrumentation	58	S 85-02-LIT-001	Mechanical Trash Rack Screen Front level transmitter	Other	24											
Instrumentation	59	S 85-02-LIT-002	Mechanical Front Rake Screens differential level transmitter	Other	24											
Instrumentation	60	S 85-02-LIT-003	Wash Compactor 01 feed trough level transmitter	Other	24											
Instrumentation	61	S 85-02-LIT-004	Wash Compactor 02 feed trough level transmitter	Other	24											
Instrumentation	62	S 85-02-ZS-001	Water launder diverter position switch 1	Other	24											
Instrumentation	63	S 85-02-ZS-002	Water launder diverter position switch 2	Other	24											
Instrumentation	64	S 85-02-ZS-003	Water launder diverter position switch 3	Other	24											
Instrumentation	65	S 85-02-ZS-004	Skip Dolly 01: Screenings Limit Switch forward	Other	24											
Instrumentation	66	S 85-02-ZS-005	Skip Dolly 01: Screenings Limit Switch reverse	Other	24											
Instrumentation	67	S 85-02-ZS-006	Skip Dolly 02: Grit Limit Switch forward	Other	24											
Instrumentation	68	S 85-02-ZS-007	Skip Dolly 02: Grit Limit Switch reverse	Other	24											
Instrumentation	69	S 85-02-PT-001	Vortex Degritter 01 grit pressure transmitter	Other	24											
Instrumentation	70	S 85-02-PT-002	Vortex Degritter 02 grit pressure transmitter	Other	24											
Instrumentation	71	S 85-02-LT-004	Grit Classifier 01 grit level transmitter	Other	24											
Instrumentation	72	S 85-02-LT-005	Grit Classifier 02 grit level transmitter	Other	24											
Instrumentation	73	S 85-02-FIT-001	Overflow Channel flow transmitter	Other	24											
Instrumentation	74	S 85-02-FIT-002	Existing Main Channel flow transmitter	Other	24											
Instrumentation	75	S 85-02-FSL-001	Vortex Grit Self Priming Grit Pump 01 flow switch	Other	24											
Instrumentation	76	S 85-02-FSL-002	Vortex Grit Self Priming Grit Pump 02 flow switch	Other	24											
Instrumentation	77	S 85-02-NS-001	Mechanical Trash Rack Screen overtorque switch	Other	24											
Instrumentation	78	S 85-02-NS-002	Mechanical Front Rake Screen 01 overtorque switch	Other	24											
Instrumentation	79	S 85-02-NS-003	Mechanical Front Rake Screen 02 overtorque switch	Other	24											
Instrumentation	80	S 85-02-NS-004	Wash Compactor 01 overtorque switch	Other	24											
Instrumentation	81	S 85-02-NS-005	Wash Compactor 02 overtorque switch	Other	24											
Instrumentation	82	S 85-02-NS-006	Grit Classifier 01 overtorque switch	Other	24											
Instrumentation	83	S 85-02-NS-007	Grit Classifier 02 overtorque switch	Other	24											
Instrumentation	82	S 85-02-TE-001	Second Class Water MCC Room Temperature Element	Other	24											
Instrumentation	83	S 85-02-LIT-005	Sludge Stockpile Sump level transmitter	Other	24											
Solenoid Valves	84	S 86-02-XV-001	Water Launder Wash Water - Solenoid Valve	Other	24											
Solenoid Valves	85	S 86-02-XV-002	Wash Compactor 01 Wash Water - Solenoid Valve	Other	24											
Solenoid Valves	86	S 86-02-XV-004	Wash Compactor 02 Wash Water - Solenoid Valve	Other	24											
Solenoid Valves	87	S 86-02-XV-007	Vortex Degritter 01 Wash Water - Solenoid Valve	Other	24											
Solenoid Valves	88	S 86-02-XV-008	Vortex Degritter 02 Wash Water - Solenoid Valve	Other	24											



<b>Service Description</b>	<b>Tag Number</b>	<b>FLC</b>	<b>Nom %Vd</b>	<b>St %Vd</b>	<b>Estimated CB size</b>
Incomer	S 85-02-F01	110.8	2.5%	5%	125
Mechanical Trash Rack Screen	S 85-02-MSR-01	3.5	2.0%	15%	6.3
Mechanical Front Rake Screen 01	S 85-02-MSR-02	3.5	2.0%	15%	6.3
Mechanical Front Rake Screen 02	S 85-02-MSR-03	3.5	2.0%	15%	6.3
Wash Compactor 01 Screw Conveyor	S 85-02-SCC-01	5.0	2.0%	15%	6.3
Wash Compactor 02 Screw Conveyor	S 85-02-SCC-02	5.0	2.0%	15%	6.3
Wash Compactor 01 Agitator	S 85-02-MIX-01	14.9	2.0%	15%	20
Wash Compactor 02 Agitator	S 85-02-MIX-02	14.9	2.0%	15%	20
Sludge Stockpile Sump Pump 01	S 86-02-PMP-03	6.7	2.0%	15%	10
Sludge Stockpile Sump Pump 02	S 86-02-PMP-04	6.7	2.0%	15%	10
Vortex Degritter 01 Paddle Drive	S 85-02-MIX-03	2.6	2.0%	15%	6.3
Vortex Degritter 02 Paddle Drive	S 85-02-MIX-04	2.6	2.0%	15%	6.3
Vortex Grit Self Priming Grit Pump 01	S 86-02-PMP-01	14.9	2.0%	15%	20
Vortex Grit Self Priming Grit Pump 02	S 86-02-PMP-02	14.9	2.0%	15%	20
Grit Classifier 01 Screw	S 85-02-SCC-03	2.6	2.0%	15%	6.3
Grit Classifier 02 Screw	S 85-02-SCC-04	2.6	2.0%	15%	6.3
Skip Dolly 01: Screenings	S 86-02-MTR-01	1.1	2.0%	15%	6.3
Skip Dolly 02: Grit	S 86-02-MTR-02	1.1	2.0%	15%	6.3
MCC Room Extraction Fan 1	S 86-02-FAN-01	1.4	2.0%	15%	6.3
MCC Room Extraction Fan 2	S 86-02-FAN-02	1.4	2.0%	15%	6.3
Local Distribution Section Incomer	MCC02-Q-01	45.5	2.0%	5%	63
Light Circuit - Indoor	MCC02-Q-02	0.4	2.0%	5%	10
Light Circuit - External XL1	MCC02-Q-03	2.7	2.0%	5%	10
Light Circuit - External XL2	MCC02-Q-04	4.8	3.0%	5%	10
Light Circuit - External XL3	MCC02-Q-05	0.5	3.0%	5%	10
Area Lighting 1	MCC02-Q-06	5.4	2.0%	5%	10
Area Lighting 2	MCC02-Q-07	5.4	2.0%	5%	10
Area Lighting Contactor	MCC02-Q-08	0.0	2.0%	5%	10
Area Lighting Contactor Bypass	MCC02-Q-09	0.0	2.0%	5%	10
Plug Circuit 1	MCC02-Q-10	20.0	2.0%	5%	20
Plug Circuit - Spare	MCC02-Q-11	0.0	2.0%	5%	20
Single Phase Welding Plug	MCC02-Q-12	26.8	2.0%	5%	32
3 Phase Welding Plug	MCC02-Q-13	24.7	3.0%	5%	32
Overhead Crane	MCC02-CRN-001	9.3	3.0%	5%	20
Control - UPS, PLC and Instrumentation Feeder	MCC02-Q-14	5.4	2.0%	5%	10
Actuated Valves Distribution Feeder	MCC02-Q-15	2.2	2.0%	5%	20
Actuated Valves Distribution Incomer	S 85-02-F03	2.2	2.0%	5%	20
Water launder diverter Valve	S 86-02-XV-003	0.3	2.0%	5%	6.3
Wash Compactor 01 outlet valve actuator	S 86-02-XV-005	0.3	2.0%	5%	6.3
Wash Compactor 02 outlet valve actuator	S 86-02-XV-006	0.3	2.0%	5%	6.3
Grit Classifier 01 Inlet valve actuator	S 86-02-XV-009	0.3	2.0%	5%	6.3
Grit Classifier 02 Inlet valve actuator	S 86-02-XV-010	0.3	2.0%	5%	6.3
Grit Classifier 01 Outlet valve actuator	S 86-02-XV-011	0.3	2.0%	5%	6.3
Grit Classifier 02 Outlet valve actuator	S 86-02-XV-012	0.3	2.0%	5%	6.3



Cable Tag	Cable Source	Cable Destination	Destination Description	Installation Method	Estimated Length	Current	Armour	Number of cables	Cores	Area mm <sup>2</sup>	% Volt Drop Nominal	% Volt Drop Start-up	Cu Earth Size
MCC01-P//S 85-02-F01	MCC01	S 85-02-F01	Incomer	Ground	250	63	SWA	2	4	70	2.2%	2.2%	70
MCC02-P//S 85-02-MSR-01	MCC02	S 85-02-MSR-01	Mechanical Trash Rack Screen	Ducts	35	6	SWA	1	4	2.5	0.8%	6.3%	4th core
MCC02-P//S 85-02-MSR-02	MCC02	S 85-02-MSR-02	Mechanical Front Rake Screen 01	Ducts	50	6	SWA	1	4	2.5	1.2%	9.0%	4th core
MCC02-P//S 85-02-MSR-03	MCC02	S 85-02-MSR-03	Mechanical Front Rake Screen 02	Ducts	50	6	SWA	1	4	2.5	1.2%	9.0%	4th core
MCC02-P//S 85-02-SCC-01	MCC02	S 85-02-SCC-01	Wash Compactor 01 Screw Conveyor	Ducts	40	6	SWA	1	4	2.5	1.0%	7.2%	4th core
MCC02-P//S 85-02-SCC-02	MCC02	S 85-02-SCC-02	Wash Compactor 02 Screw Conveyor	Ducts	40	6	SWA	1	4	2.5	1.0%	7.2%	4th core
MCC02-P//S 85-02-MIX-01	MCC02	S 85-02-MIX-01	Wash Compactor 01 Agitator	Ducts	55	20	SWA	1	4	6	1.8%	14.6%	4th core
MCC02-P//S 85-02-MIX-02	MCC02	S 85-02-MIX-02	Wash Compactor 02 Agitator	Ducts	55	20	SWA	1	4	6	1.8%	14.6%	4th core
MCC02-P//S 86-02-PMP-03	MCC02	S 86-02-PMP-03	Sludge Stockpile Sump Pump 01	Ducts	200	10	SWA	1	4	10	1.9%	14.8%	4th core
MCC02-P//S 86-02-PMP-04	MCC02	S 86-02-PMP-04	Sludge Stockpile Sump Pump 02	Ducts	200	10	SWA	1	4	10	1.9%	14.8%	4th core
MCC02-P//S 85-02-MIX-03	MCC02	S 85-02-MIX-03	Vortex Degritter 01 Paddle Drive	Ducts	65	6	SWA	1	4	2.5	1.6%	12.0%	4th core
MCC02-P//S 85-02-MIX-04	MCC02	S 85-02-MIX-04	Vortex Degritter 02 Paddle Drive	Ducts	65	6	SWA	1	4	2.5	1.6%	12.0%	4th core
MCC02-P//S 86-02-PMP-01	MCC02	S 86-02-PMP-01	Vortex Grit Self Priming Grit Pump 01	Ducts	70	20	SWA	1	4	10	1.3%	11.0%	4th core
MCC02-P//S 86-02-PMP-02	MCC02	S 86-02-PMP-02	Vortex Grit Self Priming Grit Pump 02	Ducts	70	20	SWA	1	4	10	1.3%	11.0%	4th core
MCC02-P//S 85-02-SCC-03	MCC02	S 85-02-SCC-03	Grit Classifier 01 Screw	Ducts	50	6	SWA	1	4	2.5	1.2%	9.2%	4th core
MCC02-P//S 85-02-SCC-04	MCC02	S 85-02-SCC-04	Grit Classifier 02 Screw	Ducts	50	6	SWA	1	4	2.5	1.2%	9.2%	4th core
MCC02-P//S 86-02-MTR-01	MCC02	S 86-02-MTR-01	Skip Dolly 01: Screenings	Ducts	8	6	SWA	1	4	2.5	0.2%	0.9%	4th core
MCC02-P//S 86-02-MTR-02	MCC02	S 86-02-MTR-02	Skip Dolly 02: Grit	Ducts	8	6	SWA	1	4	2.5	0.2%	0.9%	4th core
MCC02-P//S 86-02-FAN-01	MCC02	S 86-02-FAN-01	MCC Room Extraction Fan 1	Ducts	10	6	SWA	1	4	2.5	0.2%	1.6%	4th core
MCC02-P//S 86-02-FAN-02	MCC02	S 86-02-FAN-02	MCC Room Extraction Fan 2	Ducts	10	6	SWA	1	4	2.5	0.2%	1.6%	4th core
MCC02-P//MCC02-Q-02	MCC02	MCC02-Q-02	Light Circuit - Indoor	Ducts	20	10	UA	1	2	2.5	1.5%	1.5%	3rd core
MCC02-P//MCC02-Q-03	MCC02	MCC02-Q-03	Light Circuit - External XL1	Ducts	20	10	UA	1	2	2.5	1.5%	1.5%	3rd core
MCC02-P//MCC02-Q-04	MCC02	MCC02-Q-04	Light Circuit - External XL2	Ducts	60	10	UA	1	4	4	2.9%	2.9%	4th core
MCC02-P//MCC02-Q-05	MCC02	MCC02-Q-05	Light Circuit - External XL3	Ducts	60	10	UA	1	4	4	2.9%	2.9%	4th core
MCC02-P//MCC02-Q-06	MCC02	MCC02-Q-06	Area Lighting 1	Ground	150	10	SWA	1	3	16	1.8%	1.8%	3rd core
MCC02-P//MCC02-Q-07	MCC02	MCC02-Q-07	Area Lighting 2	Ground	150	10	SWA	1	3	16	1.8%	1.8%	3rd core
MCC02-P//MCC02-Q-10	MCC02	MCC02-Q-10	Plug Circuit 1	Ducts	10	20	UA	1	3	4	1.0%	1.0%	3rd core
MCC02-P//MCC02-Q-12	MCC02	MCC02-Q-12	Single Phase Welding Plug	Ducts	10	32	UA	1	3	10	0.6%	0.6%	3rd core
MCC02-P//MCC02-Q-13	MCC02	MCC02-Q-13	3 Phase Welding Plug	Ducts	10	32	UA	1	4	10	0.4%	0.4%	10
MCC02-P//MCC02-CRN-001	MCC02	MCC02-CRN-001	Overhead Crane	Ducts	65	20	SWA	1	4	6	2.4%	2.4%	6



Tag Number	Service Description	V	Starter in cubicle	Selector Switches	Push Buttons								Indicators												Metering			Protection			Field Control						Comments
				Manual/ Off/ Auto	Start / Forward	Start / Reverse	Stop	Open	Close	Reset/Overload	Lamp Test	Other	Running /	Running /	Stopped	Opened	Closed	Healthy	E-Stop	No Flow	Over Torque	Seal Failure	Overheat	Over vibration	Other	kWh	Amp	Volt	Run Hours	Overload	Earth Leakage	Surge Protection	Start	E-Stop	Open/ Stop/ Close	Forward/ Stop/ Reverse	
S 85-02-F01	Incomer	400	Incomer												1						1		Power meter				1		1							Alarms for reverse phase, over/under voltage, phase unbalanced	
S 85-02-MSR-01	Mechanical Trash Rack Screen	400	DOL	1	1	1	1			1	1		1	1	1		1	1		1				1		1	1				1		2				
S 85-02-MSR-02	Mechanical Front Rake Screen 01	400	DOL	1	1	1	1			1	1		1	1	1		1	1		1				1		1	1				1		2				
S 85-02-MSR-03	Mechanical Front Rake Screen 02	400	DOL	1	1	1	1			1	1		1	1	1		1	1		1				1		1	1				1		2				
S 85-02-SCC-01	Wash Compactor 01 Screw Conveyor	400	DOL	1	1	1	1			1	1		1	1	1		1	1		1				1		1	1				1		2				
S 85-02-SCC-02	Wash Compactor 02 Screw Conveyor	400	DOL	1	1	1	1			1	1		1	1	1		1	1		1				1		1	1				1		2				
S 85-02-MIX-01	Wash Compactor 01 Agitator	400	DOL	1	1		1			1	1		1		1		1	1						1		1	1			1	1						
S 85-02-MIX-02	Wash Compactor 02 Agitator	400	DOL	1	1		1			1	1		1		1		1	1						1		1	1			1	1						
S 86-02-PMP-03	Sludge Stockpile Sump Pump 01	400	DOL	1	1		1			1	1		1		1		1	1						1		1	1			1	1						
S 86-02-PMP-04	Sludge Stockpile Sump Pump 02	400	DOL	1	1		1			1	1		1		1		1	1						1		1	1			1	1						
S 85-02-MIX-03	Vortex Degritter 01 Paddle Drive	400	DOL	1	1		1			1	1		1		1		1	1						1		1	1			1	1						
S 85-02-MIX-04	Vortex Degritter 02 Paddle Drive	400	DOL	1	1		1			1	1		1		1		1	1						1		1	1			1	1						
S 86-02-PMP-01	Vortex Grit Self Priming Grit Pump 01	400	DOL	1	1		1			1	1		1		1		1	1	1					1		1	1			1	1						
S 86-02-PMP-02	Vortex Grit Self Priming Grit Pump 02	400	DOL	1	1		1			1	1		1		1		1	1	1					1		1	1			1	1						
S 85-02-SCC-03	Grit Classifier 01 Screw	400	DOL	1	1	1	1			1	1		1	1	1		1	1		1				1		1	1				1		2				
S 85-02-SCC-04	Grit Classifier 02 Screw	400	DOL	1	1	1	1			1	1		1	1	1		1	1		1				1		1	1				1		2				
S 86-02-MTR-01	Skip Dolly 01: Screenings	400	DOL							1	1		1	1	1		1	1						1		1	1				1		2		Field control only for safety reasons		
S 86-02-MTR-02	Skip Dolly 02: Grit	400	DOL							1	1		1	1	1		1	1						1		1	1				1		2		Field control only for safety reasons		
S 86-02-FAN-01	MCC Room Extraction Fan 1	400	DOL													1										1	1										
S 86-02-FAN-02	MCC Room Extraction Fan 2	400	DOL													1										1	1										




Tag Number	Service Description	Digital Input										Digital Output				Analog Input					Analog		Comments
		Healthy	Fault	E-stop	Running Forward	Running Reverse	Opened	Closed	Auto/ Man/ Off	Overheat	Seal Failure	Other	Stop	Open/ Forward Start	Close/ Reverse Start	Other	Measured Value	Amps	Volt	kW	kWh	Set Point	
		1															1	1	1	1			Alarms for: - Reverse phase - Over/under voltage - Phase unbalanced
S 85-02-F01	Incomer																						
S 85-02-MSR-01	Mechanical Trash Rack Screen	1	1	1	1	1			2				1	1	1								
S 85-02-MSR-02	Mechanical Front Rake Screen 01	1	1	1	1	1			2				1	1	1								
S 85-02-MSR-03	Mechanical Front Rake Screen 02	1	1	1	1	1			2				1	1	1								
S 85-02-SCC-01	Wash Compactor 01 Screw Conveyor	1	1		1	1			2			1	1	1	1								Over Torque
S 85-02-SCC-02	Wash Compactor 02 Screw Conveyor	1	1		1	1			2			1	1	1	1								Over Torque
S 85-02-MIX-01	Wash Compactor 01 Agitator	1	1	1	1				2				1	1									
S 85-02-MIX-02	Wash Compactor 02 Agitator	1	1	1	1				2				1	1									
S 86-02-PMP-03	Sludge Stockpile Sump Pump 01	1	1	1	1				2				1	1									
S 86-02-PMP-04	Sludge Stockpile Sump Pump 02	1	1	1	1				2				1	1									
S 85-02-MIX-03	Vortex Degritter 01 Paddle Drive	1	1	1	1				2				1	1									
S 85-02-MIX-04	Vortex Degritter 02 Paddle Drive	1	1	1	1				2				1	1									
S 86-02-PMP-01	Vortex Grit Self Priming Grit Pump 01	1	1		1				2				1	1									
S 86-02-PMP-02	Vortex Grit Self Priming Grit Pump 02	1	1		1				2				1	1									
S 85-02-SCC-03	Grit Classifier 01 Screw	1	1		1	1			2			1	1	1	1								Over Torque
S 85-02-SCC-04	Grit Classifier 02 Screw	1	1		1	1			2			1	1	1	1								Over Torque
S 86-02-MTR-01	Skip Dolly 01: Screenings	1		1	1	1							1	1	1								
S 86-02-MTR-02	Skip Dolly 02: Grit	1		1	1	1							1	1	1								
S 86-02-FAN-01	MCC Room Extraction Fan 1	1	1		1	1			2				1	1									
S 86-02-FAN-02	MCC Room Extraction Fan 2	1	1		1	1			2				1	1									
MCC02-Q-01	Local Distribution Section Incomer	1																					
MCC02-Q-14	Control - UPS, PLC and Instrumentation Feeder	1																					
S 85-02-F03	Actuated Valves Distribution Incomer	1																					
S 86-02-XV-003	Water launder diverter Valve	1	1	1	1	1	1	1	2	1			1	1	1								
S 86-02-XV-005	Wash Compactor 01 outlet valve actuator	1	1	1	1	1	1	1	2	1			1	1	1								
S 86-02-XV-006	Wash Compactor 02 outlet valve actuator	1	1	1	1	1	1	1	2	1			1	1	1								
S 86-02-XV-009	Grit Classifier 01 Inlet valve actuator	1	1	1	1	1	1	1	2	1			1	1	1								
S 86-02-XV-010	Grit Classifier 02 Inlet valve actuator	1	1	1	1	1	1	1	2	1			1	1	1								
S 86-02-XV-011	Grit Classifier 01 Outlet valve actuator	1	1	1	1	1	1	1	2	1			1	1	1								
S 86-02-XV-012	Grit Classifier 02 Outlet valve actuator	1	1	1	1	1	1	1	2	1			1	1	1								
S 85-02-LIT-001	Mechanical Trash Rack Screen Front level transmitter																1						
S 85-02-LIT-002	Mechanical Front Rake Screens differential level transmit																1						
S 85-02-LIT-003	Wash Compactor 01 feed trough level transmitter																1						
S 85-02-LIT-004	Wash Compactor 02 feed trough level transmitter																1						
S 85-02-LIT-005	Sludge Stockpile Sump level transmitter																1						
S 85-02-ZS-001	Water launder diverter position switch 1											1											Open
S 85-02-ZS-002	Water launder diverter position switch 2											1											Open
S 85-02-ZS-003	Water launder diverter position switch 3											1											Open
S 85-02-ZS-004	Skip Dolly 01: Screenings Limit Switch forward											1											Open
S 85-02-ZS-005	Skip Dolly 01: Screenings Limit Switch reverse											1											Open
S 85-02-ZS-006	Skip Dolly 02: Grit Limit Switch forward											1											Open
S 85-02-ZS-007	Skip Dolly 02: Grit Limit Switch reverse											1											Open
S 85-02-PT-001	Vortex Degritter 01 grit pressure transmitter																1						
S 85-02-PT-002	Vortex Degritter 02 grit pressure transmitter																1						



Tag Number	Service Description	Healthy	Fault	E-stop	Running Forward	Running Reverse	Opened	Closed	Auto/ Man/ Off	Overheat	Seal Failure	Other	Stop	Open/ Forward Start	Close/ Reverse Start	Other	Measured Value	Amps	Volt	kW	kWh	Set Point	Other	Comments
S 85-02-LT-004	Grit Classifier 01 grit level transmitter																1							
S 85-02-LT-005	Grit Classifier 02 grit level transmitter																1							
S 85-02-FIT-001	Overflow Channel flow transmitter															1	1							Instantaneous flow and flow totaliser pulse
S 85-02-FIT-002	Existing Main Channel flow transmitter															1	1							Instantaneous flow and flow totaliser pulse
S 85-02-FSL-001	Vortex Grit Self Priming Grit Pump 01 flow switch							1																
S 85-02-FSL-002	Vortex Grit Self Priming Grit Pump 02 flow switch							1																
S 85-02-NS-001	Mechanical Trash Rack Screen overtorque switch							1																
S 85-02-NS-002	Mechanical Front Rake Screen 01 overtorque switch							1																
S 85-02-NS-003	Mechanical Front Rake Screen 02 overtorque switch							1																
S 85-02-NS-004	Wash Compactor 01 overtorque switch							1																
S 85-02-NS-005	Wash Compactor 02 overtorque switch							1																
S 85-02-NS-006	Grit Classifier 01 overtorque switch							1																
S 85-02-NS-007	Grit Classifier 02 overtorque switch							1																
S 85-02-TE-001	Second Class Water MCC Room Temperature Element																1							
S 86-02-XV-001	Water Launder Wash Water - Solenoid Valve	1					1							1										Normally Closed
S 86-02-XV-002	Wash Compactor 01 Wash Water - Solenoid Valve	1					1							1										Normally Closed
S 86-02-XV-004	Wash Compactor 02 Wash Water - Solenoid Valve	1					1							1										Normally Closed
S 86-02-XV-007	Vortex Degritter 01 Wash Water - Solenoid Valve	1					1							1										Normally Closed
S 86-02-XV-008	Vortex Degritter 02 Wash Water - Solenoid Valve	1					1							1										Normally Closed
	Totals						215							75				16				0		



			<div>ISIPINGO WWTW UPGRADE</div> <div>Motor Control Centre MCC02</div> <div>Control and Instrumentation Cable Schedule</div>			Revision A
Service Description	Instrument Tag	Instrument Cable	Estimate Length	JB	JB to Marshalling Cable	Estimate Length m
Incomer	S 85-02-F01	Modbus TCP - CAT6e				
Existing Main Channel flow transmitter	S 85-02-FIT-002	Dekobon type M855 1 pair 0.5mm2	90			
Grit Classifier 01 grit level transmitter	S 85-02-LT-004	Dekobon type M855 1 pair 0.5mm2	8	JB01	Dekobon type M877 4 pair 0.5mm2	70
Grit Classifier 02 grit level transmitter	S 85-02-LT-005	Dekobon type M855 1 pair 0.5mm2	8			
Overflow Channel flow transmitter	S 85-02-FIT-001	Dekobon type M855 1 pair 0.5mm2	8	JB02	Dekobon type M877 4 pair 0.5mm2	50
Mechanical Front Rake Screens differential level transmitter	S 85-02-LIT-002	Dekobon type M855 1 pair 0.5mm2	8			
Mechanical Trash Rack Screen Front level transmitter	S 85-02-LIT-001	Dekobon type M855 1 pair 0.5mm2	8	JB03	Dekobon type M877 4 pair 0.5mm2	70
Vortex Degritter 01 grit pressure transmitter	S 85-02-PT-001	Dekobon type M855 1 pair 0.5mm2	8			
Vortex Degritter 02 grit pressure transmitter	S 85-02-PT-002	Dekobon type M855 1 pair 0.5mm2	8	JB04	Dekobon type M877 4 pair 0.5mm2	50
Wash Compactor 01 feed trough level transmitter	S 85-02-LIT-003	Dekobon type M855 1 pair 0.5mm2	8			
Wash Compactor 02 feed trough level transmitter	S 85-02-LIT-004	Dekobon type M855 1 pair 0.5mm2	8	JB05	Dekobon type M877 12 pair 0.5mm2	70
Grit Classifier 01 Inlet valve actuator	S 86-02-XV-009	Dekobon type M877 4 pair 0.5mm2	8			
Grit Classifier 01 Outlet valve actuator	S 86-02-XV-011	Dekobon type M877 4 pair 0.5mm2	8	JB06	Dekobon type M877 12 pair 0.5mm2	70
Grit Classifier 01 overtorque switch	S 85-02-NS-006	Dekobon type M855 1 pair 0.5mm2	8			
Grit Classifier 02 Inlet valve actuator	S 86-02-XV-010	Dekobon type M877 4 pair 0.5mm2	8	JB07	Dekobon type M877 8 pair 0.5mm2	50
Grit Classifier 02 Outlet valve actuator	S 86-02-XV-012	Dekobon type M877 4 pair 0.5mm2	8			
Grit Classifier 02 overtorque switch	S 85-02-NS-007	Dekobon type M855 1 pair 0.5mm2	8	JB08	Dekobon type M877 4 pair 0.5mm2	50
Mechanical Front Rake Screen 01 overtorque switch	S 85-02-NS-002	Dekobon type M855 1 pair 0.5mm2	8			
Mechanical Front Rake Screen 02 overtorque switch	S 85-02-NS-003	Dekobon type M855 1 pair 0.5mm2	8	JB09	Dekobon type M877 4 pair 0.5mm2	70
Mechanical Trash Rack Screen overtorque switch	S 85-02-NS-001	Dekobon type M855 1 pair 0.5mm2	8			
Skip Dolly 01: Screenings Limit Switch forward	S 85-02-ZS-004	Dekobon type M855 1 pair 0.5mm2	8	JB10	Dekobon type M877 4 pair 0.5mm2	70
Skip Dolly 01: Screenings Limit Switch reverse	S 85-02-ZS-005	Dekobon type M855 1 pair 0.5mm2	8			
Skip Dolly 02: Grit Limit Switch forward	S 85-02-ZS-006	Dekobon type M855 1 pair 0.5mm2	8	JB11	Dekobon type M877 8 pair 0.5mm2	50
Skip Dolly 02: Grit Limit Switch reverse	S 85-02-ZS-007	Dekobon type M855 1 pair 0.5mm2	8			
Vortex Grit Self Priming Grit Pump 01 flow switch	S 85-02-FSL-001	Dekobon type M855 1 pair 0.5mm2	8	JB12	Dekobon type M877 8 pair 0.5mm2	50
Vortex Grit Self Priming Grit Pump 02 flow switch	S 85-02-FSL-002	Dekobon type M855 1 pair 0.5mm2	8			
Wash Compactor 01 outlet valve actuator	S 86-02-XV-005	Dekobon type M877 4 pair 0.5mm2	8	JB13	Dekobon type M877 8 pair 1.5mm2	50
Wash Compactor 01 overtorque switch	S 85-02-NS-004	Dekobon type M855 1 pair 0.5mm2	8			
Wash Compactor 02 outlet valve actuator	S 86-02-XV-006	Dekobon type M877 4 pair 0.5mm2	8	JB14	Dekobon type M877 8 pair 1.5mm2	70
Wash Compactor 02 overtorque switch	S 85-02-NS-005	Dekobon type M855 1 pair 0.5mm2	8			
Water launder diverter position switch 1	S 85-02-ZS-001	Dekobon type M855 1 pair 0.5mm2	8	JB15		
Water launder diverter position switch 2	S 85-02-ZS-002	Dekobon type M855 1 pair 0.5mm2	8			
Water launder diverter position switch 3	S 85-02-ZS-003	Dekobon type M855 1 pair 0.5mm2	8			
Water Launder Wash Water - Solenoid Valve	S 86-02-XV-001	Dekobon type M877 2 pair 1.5mm2	8			
Wash Compactor 01 Wash Water - Solenoid Valve	S 86-02-XV-002	Dekobon type M877 2 pair 1.5mm2	8			
Wash Compactor 02 Wash Water - Solenoid Valve	S 86-02-XV-004	Dekobon type M877 2 pair 1.5mm2	8			
Vortex Degritter 01 Wash Water - Solenoid Valve	S 86-02-XV-007	Dekobon type M877 2 pair 1.5mm2	8			
Vortex Degritter 02 Wash Water - Solenoid Valve	S 86-02-XV-008	Dekobon type M877 2 pair 1.5mm2	8			
Mechanical Trash Rack Screen - Field Control Station / Estop	S 85-02-HS-001	Dekobon type M877 4 pair 1.5mm2	60			
Mechanical Front Rake Screen 01 Field - Control Station / Estop	S 85-02-HS-002	Dekobon type M877 4 pair 1.5mm2	60			
Mechanical Front Rake Screen 02 Field - Control Station / Estop	S 85-02-HS-003	Dekobon type M877 4 pair 1.5mm2	60			
Wash Compactor 01 - Control Station / Estop	S 85-02-HS-004	Dekobon type M877 8 pair 1.5mm2	60			
Water launder diverter Control Station / Estop	S 85-02-HS-005	Dekobon type M877 4 pair 1.5mm2	60			
Wash Compactor 02 - Control Station / Estop	S 85-02-HS-006	Dekobon type M877 8 pair 1.5mm2	60			
Vortex Degritter 01 Paddle Drive Field Control Station / Estop	S 85-02-HS-008	Dekobon type M877 2 pair 1.5mm2	60			
Vortex Grit Self Priming Grit Pump 01 Field Control Station / Estop	S 85-02-HS-009	Dekobon type M877 2 pair 1.5mm2	60			
Vortex Degritter 02 Paddle Drive Field Control Station / Estop	S 85-02-HS-010	Dekobon type M877 2 pair 1.5mm2	60			
Vortex Grit Self Priming Grit Pump 02 Field Control Station / Estop	S 85-02-HS-011	Dekobon type M877 2 pair 1.5mm2	60			
Grit Classifier 01 Screw Motor Field Control Station / Estop	S 85-02-HS-012	Dekobon type M877 4 pair 1.5mm2	60			
Grit Classifier 02 Screw Motor Field Control Station / Estop	S 85-02-HS-013	Dekobon type M877 4 pair 1.5mm2	60			
Skip Dolly 01: Screenings Field Control Station / Estop	S 85-02-HS-007	Dekobon type M877 4 pair 1.5mm2	60			
Skip Dolly 02: Grit Field Control Station / Estop	S 85-02-HS-014	Dekobon type M877 4 pair 1.5mm2	60			
Sludge Stockpile Sump Pump 01 Control Station / Estop	S 85-02-HS-015	Dekobon type M877 4 pair 1.5mm2	200			
Sludge Stockpile Sump Pump 02 Control Station / Estop	S 85-02-HS-016	Dekobon type M877 4 pair 1.5mm2	200			
Sludge Stockpile Sump level transmitter	S 85-02-LIT-005	Dekobon type M855 1 pair 0.5mm2	200			



# ISIPINGO WWTW UPGRADE

MCC: MCC03  
Second Class Water MCC Schedule  
1002680-ZUT-SCH-EE-003

**eThekwini Municipality: Water & Sanitation Unit**

Reference: 31300-5W  
Revision: A

Description	Item No	Tag Number	Service Description	Starter in MCC bucket	V	Ph	Absorbed Equipment Rating	Unit	Efficiency class	Duty Factor	Back-up Supply	Rated Equipment Rating	Unit	Load PF	Load Efficiency	Absorbed Load Current	Absorbed kVA	Rated Current (FLC)
MCC	1	S 85-03-F01	Incomer	Incomer	400	3	79.95	kW		1		125.69	kW	0.86		133.6	92.58	133.6
MCC	2	S 85-03-PMP-01	Second Class Water Booster Pumpset - Feeder	FDR	400	3	52.27	kW	IE3	1	Generator	55	kW	0.90	94.7%	83.8	58.1	93.1
MCC	3	S 85-03-PMP-05	Raw Water Pump 1 - DOL	DOL	400	3	5.52	kW	IE3	1	Generator	5.5	kW	0.80	89.6%	10.0	6.9	11.1
MCC	4	S 85-03-PMP-06	Raw Water Pump 2 - DOL	DOL	400	3	0.00	kW	IE3	0	Generator	5.5	kW	0.80	89.6%	0.0	0.0	11.1
MCC	5	S 85-03-CMP-01	Air Compressor 1 - Feeder	FDR	400	3	5.52	kW	IE3	1	Generator	5.5	kW	0.80	89.6%	10.0	6.9	11.1
MCC	6	S 85-03-CMP-02	Air Compressor 2 - Feeder	FDR	400	3	5.52	kW	IE3	1	Generator	5.5	kW	0.80	89.6%	10.0	6.9	11.1
MCC	7	S 85-03-XV-05	Second Class Water Reservoir Valve Actuator	FDR	400	3	0.33	kW	IE3	1	Generator	0.37	kW	0.81	90.0%	0.6	0.4	0.7
MCC	8	S 85-03-FAN-01	MCC Building Fan 1 - DOL	DOL	400	3	0.61	kW	IE3	1	Generator	0.55	kW	0.74	79.0%	1.2	0.8	1.4
MCC	9	S 85-03-FAN-02	MCC Building Fan 2 - DOL	DOL	400	3	0.00	kW	IE3	0	Generator	0.55	kW	0.74	79.0%	0.0	0.0	1.4
Local Distribution	10	MCC03-Q-01	Local Distribution Section	FDR	400	3	10.18	kW		1	Generator	47.22	kW	0.81	100%	18.1	12.6	84.1
Local Distribution	11	MCC03-Q-02	Light Circuit - Indoor	FDR	230	1	0.08	kW		1	Generator	0.08	kW	0.81	95%	0.5	0.1	0.5
Local Distribution	12	MCC03-Q-03	Light Circuit - External	FDR	230	1	0.08	kW		1	Generator	0.08	kW	0.81	95%	0.5	0.1	0.5
Local Distribution	13	MCC03-Q-04	Area Lighting 1	FDR	230	1	1.58	kW		1	Generator	1.5	kW	0.81	95%	8.5	1.9	8.5
Local Distribution	14	MCC03-Q-05	Area Lighting 2	FDR	230	1	1.58	kW		1	Generator	1.5	kW	0.81	95%	8.5	1.9	8.5
Local Distribution	15	MCC03-Q-06	Area Lighting Contactor	FDR	230	1	0.00	kW		1	Generator	0	kW	0.81	95%	0.0	0.0	0.0
Local Distribution	16	MCC03-Q-07	Area Lighting Contactor Bypass	FDR	230	1	0.00	kW		1	Generator	0	kW	0.81	95%	0.0	0.0	0.0
Local Distribution	17	MCC03-Q-08	Plug Circuit 1	FDR	230	1	0.74	kW		0.2	Generator	3.5	kW	0.81	95%	4.0	0.9	19.9
Local Distribution	18	MCC03-Q-09	Plug Circuit - Spare	FDR	230	1	0.74	kW		0.2	Generator	3.5	kW	0.81	95%	4.0	0.9	19.9
Local Distribution	19	MCC03-Q-10	Raw Water PS DB Feeder	FDR	400	3	1.68	kW		0.1	Generator	16	kW	0.81	95%	3.0	2.1	30.0
Local Distribution	20	MCC03-Q-11	Single Phase Welding Plug	FDR	230	1	1.05	kW		0.2	Generator	5	kW	0.81	95%	5.7	1.3	28.3
Local Distribution	21	MCC03-Q-12	3 Phase Welding Plug	FDR	400	3	1.58	kW		0.1	Generator	15	kW	0.81	95%	2.8	1.9	28.1
Local Distribution	22	MCC03-Q-13	Control - PLC and Instrumentation Feeder	FDR	230	1	1.05	kW		1	Generator	1	kW	0.81	95%	5.7	1.3	5.7
Control	23	S 85-03-HS-001	Air Compressor 1 Estop	Other	230													
Control	24	S 85-03-HS-002	Air Compressor 2 Estop	Other	230													
Control	25	S 85-03-HS-003	Raw Water Pump 1 Start/Estop	Other	230													
Control	26	S 85-03-HS-004	Raw Water Pump 2 Start/Estop	Other	230													
Control	27	S 85-03-HS-005	Booster Pump Set Estop	Other	230													
Instrumentation	28	S 85-03-FIT-001	Second Class Water Booster Pump Flow Transmitter Signal	Other	24													
Instrumentation	29	S 85-03-FIT-001P	Second Class Water Booster Pump Flow Transmitter Power	Other	24													
Instrumentation	30	S 85-03-LIT-001	Second Class Water Raw Water Pump Inlet Level Transmitter (Loop Powered)	Other	24													
Instrumentation	31	S 85-03-LS-002	Second Class Water Reservoir Level Switch	Other	24													
Instrumentation	32	S 85-03-LIT-002	Second Class Water Reservoir Level Transmitter (Loop Powered)	Other	24													
Instrumentation	33	S 85-03-PIT-001	Second Class Water Filter 1 Pressure Transmitter	Other	24													
Instrumentation	34	S 85-03-PIT-002	Second Class Water Filter 2 Pressure Transmitter	Other	24													
Instrumentation	35	S 85-03-PIT-003	Second Class Water Filter 3 Pressure Transmitter	Other	24													
Instrumentation	36	S 85-03-PIT-004	Second Class Water Filter 4 Pressure Transmitter	Other	24													
Instrumentation	37	S 85-03-PT-005	Second Class Water Reservoir Delivery Line Pressure Transmitter	Other	24													
Instrumentation	38	S 85-03-PT-006	Booster Pump 1 Delivery Line Pressure Transmitter	Other	24													
Instrumentation	39	S 85-03-PT-007	Booster Pump 2 Delivery Line Pressure Transmitter	Other	24													
Instrumentation	40	S 85-03-PT-008	Booster Pump 3 Delivery Line Pressure Transmitter	Other	24													
Instrumentation	41	S 85-03-PT-009	Booster Pump 4 Delivery Line Pressure Transmitter	Other	24													
Instrumentation	42	S 85-03-PT-010	Booster Pump Common Delivery Line Pressure Transmitter	Other	24													
Instrumentation	43	S 85-03-FSL-001	Raw Water Pump 1 Delivery Line Flow Switch	Other	24													
Instrumentation	44	S 85-03-FSL-002	Raw Water Pump 2 Delivery Line Flow Switch	Other	24													
Instrumentation	45	S 85-03-FSL-003	Booster Pump 1 Delivery Line Flow Switch	Other	24													
Instrumentation	46	S 85-03-FSL-004	Booster Pump 2 Delivery Line Flow Switch	Other	24													
Instrumentation	47	S 85-03-FSL-005	Booster Pump 3 Delivery Line Flow Switch	Other	24													
Instrumentation	48	S 85-03-FSL-006	Booster Pump 4 Delivery Line Flow Switch	Other	24													
Instrumentation	49	S 85-03-VT-001	Second Class Water Booster Pump 1 DE Vibration Transmitter XYZ	Other	24													
Instrumentation	50	S 85-03-VT-002	Second Class Water Booster Pump 1 NDE Vibration Transmitter XYZ	Other	24													
Instrumentation	51	S 85-03-VT-003	Second Class Water Booster Pump 1 Motor DE Vibration transmitter XYZ	Other	24													
Instrumentation	52	S 85-03-VT-004	Second Class Water Booster Pump 1 Motor NDE Vibration transmitter XYZ	Other	24													
Instrumentation	53	S 85-03-VT-005	Second Class Water Booster Pump 2 DE Vibration Transmitter XYZ	Other	24													
Instrumentation	54	S 85-03-VT-006	Second Class Water Booster Pump 2 NDE Vibration Transmitter XYZ	Other	24													
Instrumentation	55	S 85-03-VT-007	Second Class Water Booster Pump 2 Motor DE Vibration transmitter XYZ	Other	24													
Instrumentation	56	S 85-03-VT-008	Second Class Water Booster Pump 2 Motor NDE Vibration transmitter XYZ	Other	24													
Instrumentation	57	S 85-03-VT-009	Second Class Water Booster Pump 3 DE Vibration Transmitter XYZ	Other	24													

Description	Item No	Tag Number	Service Description	Starter in MCC bucket	V	Ph	Absorbed Equipment Rating	Unit	Efficiency class	Duty Factor	Back-up Supply	Rated Equipment Rating	Unit	Load PF	Load Efficiency	Absorbed Load Current	Absorbed kVA	Rated Current (FLC)
Instrumentation	58	S 85-03-VT-010	Second Class Water Booster Pump 3 NDE Vibration Transmitter XYZ	Other	24													
Instrumentation	59	S 85-03-VT-011	Second Class Water Booster Pump 3 Motor DE Vibration transmitter XYZ	Other	24													
Instrumentation	60	S 85-03-VT-012	Second Class Water Booster Pump 3 Motor NDE Vibration transmitter XYZ	Other	24													
Instrumentation	61	S 85-03-VT-013	Second Class Water Booster Pump 4 DE Vibration Transmitter XYZ	Other	24													
Instrumentation	62	S 85-03-VT-014	Second Class Water Booster Pump 4 NDE Vibration Transmitter XYZ	Other	24													
Instrumentation	63	S 85-03-VT-015	Second Class Water Booster Pump 4 Motor DE Vibration transmitter XYZ	Other	24													
Instrumentation	64	S 85-03-VT-016	Second Class Water Booster Pump 4 Motor NDE Vibration transmitter XYZ	Other	24													
Instrumentation	65	S 85-03-TS-001	Second Class Water Booster Pump 1 Motor Temperature Thermistors	Other	24													
Instrumentation	66	S 85-03-TS-002	Second Class Water Booster Pump 2 Motor Temperature Thermistors	Other	24													
Instrumentation	67	S 85-03-TS-003	Second Class Water Booster Pump 3 Motor Temperature Thermistors	Other	24													
Instrumentation	68	S 85-03-TS-004	Second Class Water Booster Pump 4 Motor Temperature Thermistors	Other	24													
Instrumentation	69	S 85-03-TE-001	Second Class Water MCC Room Temperature Element	FDR	24													
Solenoid Valves	70	S 85-03-XV-001a	Second Class Water Filter 1 Solenoid Valve 1	Other	24													
Solenoid Valves	71	S 85-03-XV-001b	Second Class Water Filter 1 Solenoid Valve 2	Other	24													
Solenoid Valves	72	S 85-03-XV-001c	Second Class Water Filter 1 Solenoid Valve 3	Other	24													
Solenoid Valves	73	S 85-03-XV-001d	Second Class Water Filter 1 Solenoid Valve Master	Other	24													
Solenoid Valves	74	S 85-03-XV-002a	Second Class Water Filter 2 Solenoid Valve 1	Other	24													
Solenoid Valves	75	S 85-03-XV-002b	Second Class Water Filter 2 Solenoid Valve 2	Other	24													
Solenoid Valves	76	S 85-03-XV-002c	Second Class Water Filter 2 Solenoid Valve 3	Other	24													
Solenoid Valves	77	S 85-03-XV-002d	Second Class Water Filter 2 Solenoid Valve Master	Other	24													
Solenoid Valves	78	S 85-03-XV-003a	Second Class Water Filter 3 Solenoid Valve 1	Other	24													
Solenoid Valves	79	S 85-03-XV-003b	Second Class Water Filter 3 Solenoid Valve 2	Other	24													
Solenoid Valves	80	S 85-03-XV-003c	Second Class Water Filter 3 Solenoid Valve 3	Other	24													
Solenoid Valves	81	S 85-03-XV-003d	Second Class Water Filter 3 Solenoid Valve Master	Other	24													
Solenoid Valves	82	S 85-03-XV-004a	Second Class Water Filter 4 Solenoid Valve 1	Other	24													
Solenoid Valves	83	S 85-03-XV-004b	Second Class Water Filter 4 Solenoid Valve 2	Other	24													
Solenoid Valves	84	S 85-03-XV-004c	Second Class Water Filter 4 Solenoid Valve 3	Other	24													
Solenoid Valves	85	S 85-03-XV-004d	Second Class Water Filter 4 Solenoid Valve Master	Other	24													





Item No	Service Description	Tag Number	Installed Equipment Rating	Unit	FLC	Nom %Vd	St %Vd	Estimated CB size	Loading factor on current CB selection
1	Incomer	S 85-03-F01	125.69	kW	133.6	2.7%	5%	160	84%
2	Second Class Water Booster Pumpset - Feeder	S 85-03-PMP-01	55	kW	93.1	2.0%	15%	125	
3	Raw Water Pump 1 - DOL	S 85-03-PMP-05	5.5	kW	11.1	2.0%	15%	16	
4	Raw Water Pump 2 - DOL	S 85-03-PMP-06	5.5	kW	11.1	2.0%	15%	16	
5	Air Compressor 1 - Feeder	S 85-03-CMP-01	5.5	kW	11.1	2.0%	15%	16	
6	Air Compressor 2 - Feeder	S 85-03-CMP-02	5.5	kW	11.1	2.0%	15%	16	
7	Second Class Water Reservoir Valve Actuator	S 85-03-XV-05	0.37	kW	0.7	2.0%	5%	6.3	
8	MCC Building Fan 1 - DOL	S 85-03-FAN-01	0.55	kW	1.4	2.0%	15%	6.3	
9	MCC Building Fan 2 - DOL	S 85-03-FAN-02	0.55	kW	1.4	2.0%	15%	6.3	
10	Local Distribution Section	MCC03-Q-01	47.22	kW	84.1	2.0%	5%	100	
11	Light Circuit - Indoor	MCC03-Q-02	0.08	kW	0.5	2.0%	5%	10	
12	Light Circuit - External	MCC03-Q-03	0.08	kW	0.5	2.0%	5%	10	
13	Area Lighting 1	MCC03-Q-04	1.5	kW	8.5	2.0%	5%	10	
14	Area Lighting 2	MCC03-Q-05	1.5	kW	8.5	2.0%	5%	10	
15	Area Lighting Contactor	MCC03-Q-06	0	kW	0.0	2.0%	5%	10	
16	Area Lighting Contactor Bypass	MCC03-Q-07	0	kW	0.0	2.0%	5%	10	
17	Plug Circuit 1	MCC03-Q-08	3.53	kW	19.9	2.0%	5%	20	
18	Plug Circuit - Spare	MCC03-Q-09	3.53	kW	19.9	2.0%	5%	20	
19	Raw Water PS DB Feeder	MCC03-Q-10	16	kW	30.0	2.0%	5%	32	
20	Single Phase Welding Plug	MCC03-Q-11	5	kW	28.3	2.0%	5%	32	
21	3 Phase Welding Plug	MCC03-Q-12	15	kW	28.1	4.0%	5%	32	
22	Control - PLC and Instrumentation Feeder	MCC03-Q-13	1	kW	5.7	2.0%	5%	10	

MCC Item No	Cable Tag	Cable Source	Cable Destination	Destination Description	Installation Method	Estimate Length	Current	Armour	Number of cables	Instl Cores	Area mm <sup>2</sup>	% Volt Drop Nominal	% Volt Drop Start-up	Cu Earth Qty	Cu Earth Size
1	MCC01-P//S 85-03-F01	MCC01	S 85-03-F01	Incomer	Ground	460	53	SWA	3	4	95	2.6%	2.6%	3	50
2	MCC03-P//S 85-03-PMP-01	MCC03	S 85-03-PMP-01	Second Class Water Booster Pumpset - Feeder	Air	8	93	SWA	1	4	35	0.2%	0.2%	1	16
3	MCC03-P//S 85-03-PMP-05	MCC03	S 85-03-PMP-05	Raw Water Pump 1 - DOL	Ground	85	11	SWA	1	4	6	1.5%	12.5%		4th core
4	MCC03-P//S 85-03-PMP-06	MCC03	S 85-03-PMP-06	Raw Water Pump 2 - DOL	Ground	85	11	SWA	1	4	6	1.5%	12.5%		4th core
5	MCC03-P//S 85-03-CMP-01	MCC03	S 85-03-CMP-01	Air Compressor 1 - Feeder	Air	8	11	SWA	1	4	2.5	0.3%	2.8%	1	2.5
6	MCC03-P//S 85-03-CMP-02	MCC03	S 85-03-CMP-02	Air Compressor 2 - Feeder	Air	8	11	SWA	1	4	2.5	0.3%	2.8%	1	2.5
7	MCC03-P//S 85-03-XV-05	MCC03	S 85-03-XV-05	Second Class Water Reservoir Valve Actuator	Ducts	30	1	SWA	1	4	2.5	0.1%	0.1%		4th core
8	MCC03-P//S 85-03-FAN-01	MCC03	S 85-03-FAN-01	MCC Building Fan 1 - DOL	Ducts	8	1	SWA	1	4	2.5	0.0%	0.3%		4th core
9	MCC03-P//S 85-03-FAN-02	MCC03	S 85-03-FAN-02	MCC Building Fan 2 - DOL	Ducts	8	1	SWA	1	4	2.5	0.0%	0.3%		4th core
11	MCC03-P//MCC03-Q-02	MCC03	MCC03-Q-02	Light Circuit - Indoor	Ducts	8	0	UA	1	4	2.5	0.0%	0.0%		3rd core
12	MCC03-P//MCC03-Q-03	MCC03	MCC03-Q-03	Light Circuit - External	Ducts	8	0	UA	1	4	2.5	0.0%	0.0%		3rd core
13	MCC03-P//MCC03-Q-04	MCC03	MCC03-Q-04	Area Lighting 1	Ground	150	8	SWA	1	3	16	1.5%	1.5%		3rd core
14	MCC03-P//MCC03-Q-05	MCC03	MCC03-Q-05	Area Lighting 2	Ground	150	8	SWA	1	3	16	1.5%	1.5%		3rd core
17	MCC03-P//MCC03-Q-08	MCC03	MCC03-Q-08	Plug Circuit 1	Ducts	8	20	UA	1	3	4	0.8%	0.8%		3rd core
19	MCC03-P//MCC03-Q-10	MCC03	MCC03-Q-10	Raw Water PS DB Feeder	Ground	8	32	SWA	1	4	4	0.6%	0.6%	1	4
20	MCC03-P//MCC03-Q-11	MCC03	MCC03-Q-11	Single Phase Welding Plug	Ground	25	28	UA	1	3	6	2.3%	2.3%		3rd core
21	MCC03-P//MCC03-Q-12	MCC03	MCC03-Q-12	3 Phase Welding Plug	Ground	85	28	SWA	1	4	6	3.8%	3.8%	1	6



Rev	Item No	Tag Number	Service Description	Volt	Starter in cubicle	Selector Switches	Push Buttons							Indicators										Metering				Protection				Field Control						Comments
						Manual/ Off/ Auto	Start	Stop	Open	Close	Reset/Overload	Lamp Test	Other	Running	Stopped	Opened	Closed	Healthy	E-Stop	No Flow	Over Torque	Seal Failure	Overheat	Over vibration	Other	kWh	Amp	Volt	Run Hours	Overload	Earth Leakage	Surge Protection	Start	E-Stop	Open/Stop/Close	Local/Off/Remote Forward	Reverse	
A	1	S 85-03-F01	Incomer	400	Incomer															1		Power meter				1		1									Alarms for reverse phase, over/under voltage, phase unbalanced	
A	2	S 85-03-PMP-01	Second Class Water Booster Pumpset - Feeder	400	FDR	1	1	1			1	1		1	1			1	1	1			1			1				1	1		1					
A	3	S 85-03-PMP-05	Raw Water Pump 1 - DOL	400	DOL	1	1	1			1	1		1	1			1	1			1			1				1	1		1	1					
A	4	S 85-03-PMP-06	Raw Water Pump 2 - DOL	400	DOL	1	1	1			1	1		1	1			1	1			1			1				1	1		1	1					
A	5	S 85-03-CMP-01	Air Compressor 1 - Feeder	400	FDR						1	1		1	1			1	1			1	1		1		1	1			1							
A	6	S 85-03-CMP-02	Air Compressor 2 - Feeder	400	FDR						1	1		1	1			1	1			1	1		1		1	1			1							
A	7	S 85-03-XV-05	Second Class Water Reservoir Valve Actuator	400	FDR													1																				
A	8	S 85-03-FAN-01	MCC Building Fan 1 - DOL	400	DOL	1	1	1			1	1		1	1			1					1	1														
A	9	S 85-03-FAN-02	MCC Building Fan 2 - DOL	400	DOL	1	1	1			1	1		1	1			1					1	1														



Item No	Tag Number	Service Description	Digital Input										Digital Output					Analog Input					Analog Output		Comments
			Healthy	Fault	E-stop	Running Forward	Running Reverse	Opened	Closed	Auto/ Man/ Off	Overheat	Seal Failure	Other	Stop	Open/ Forward Start	Close/ Reverse Start	Other	Measured Value	Amps	Volt	kW	kWh	Set Point	Other	
1	S 85-03-F01	Incomer	1											1			1		1	1	1	1			Alarms for: - Reverse phase - Over/under voltage - Phase unbalanced
2	S 85-03-PMP-01	Second Class Water Booster Pumpset - Feeder	1	1		1				2				1	1										
3	S 85-03-PMP-05	Raw Water Pump 1 - DOL	1	1		1				2				1	1										
4	S 85-03-PMP-06	Raw Water Pump 2 - DOL	1	1		1				2				1	1										
5	S 85-03-CMP-01	Air Compressor 1 - Feeder	1		1					2				1	1										
6	S 85-03-CMP-02	Air Compressor 2 - Feeder	1		1					2				1	1										
7	S 85-03-XV-05	Second Class Water Reservoir Valve Actuator	1	1	1	1	1	1	1	2	1			1	1	1									
8	S 85-03-FAN-01	MCC Building Fan 1 - DOL	1	1		1	1			2				1	1										
9	S 85-03-FAN-02	MCC Building Fan 2 - DOL	1	1		1	1			2				1	1										
28	S 85-03-FIT-001	Second Class Water Booster Pump Flow Transmitter Signal															1	1							Instantaneous flow and flow totaliser pulse
32	S 85-03-LIT-002	Second Class Water Reservoir Level Transmitter (Loop Powered)																1							
33	S 85-03-PIT-001	Second Class Water Filter 1 Pressure Transmitter																1							
34	S 85-03-PIT-002	Second Class Water Filter 2 Pressure Transmitter																1							
35	S 85-03-PIT-003	Second Class Water Filter 3 Pressure Transmitter																1							
36	S 85-03-PIT-004	Second Class Water Filter 4 Pressure Transmitter																1							
37	S 85-03-PT-005	Second Class Water Reservoir Delivery Line Pressure Transmitter																1							
38	S 85-03-PT-006	Booster Pump 1 Delivery Line Pressure Transmitter																1							
39	S 85-03-PT-007	Booster Pump 2 Delivery Line Pressure Transmitter																1							
40	S 85-03-PT-008	Booster Pump 3 Delivery Line Pressure Transmitter																1							
41	S 85-03-PT-009	Booster Pump 4 Delivery Line Pressure Transmitter																1							
42	S 85-03-PT-010	Booster Pump Common Delivery Line Pressure Transmitter																1							
43	S 85-03-FSL-001	Raw Water Pump 1 Delivery Line Flow Switch								1															
44	S 85-03-FSL-002	Raw Water Pump 2 Delivery Line Flow Switch								1															
45	S 85-03-FSL-003	Booster Pump 1 Delivery Line Flow Switch								1															
46	S 85-03-FSL-004	Booster Pump 2 Delivery Line Flow Switch								1															
47	S 85-03-FSL-005	Booster Pump 3 Delivery Line Flow Switch								1															
48	S 85-03-FSL-006	Booster Pump 4 Delivery Line Flow Switch								1															
49	S 85-03-VT-001	Second Class Water Booster Pump 1 DE Vibration Transmitter XYZ																3							
50	S 85-03-VT-002	Second Class Water Booster Pump 1 NDE Vibration Transmitter XYZ																3							
51	S 85-03-VT-003	Second Class Water Booster Pump 1 Motor DE Vibration transmitter XYZ																3							
52	S 85-03-VT-004	Second Class Water Booster Pump 1 Motor NDE Vibration transmitter XYZ																3							
53	S 85-03-VT-005	Second Class Water Booster Pump 2 DE Vibration Transmitter XYZ																3							
54	S 85-03-VT-006	Second Class Water Booster Pump 2 NDE Vibration Transmitter XYZ																3							
55	S 85-03-VT-007	Second Class Water Booster Pump 2 Motor DE Vibration transmitter XYZ																3							
56	S 85-03-VT-008	Second Class Water Booster Pump 2 Motor NDE Vibration transmitter XYZ																3							
57	S 85-03-VT-009	Second Class Water Booster Pump 3 DE Vibration Transmitter XYZ																3							
58	S 85-03-VT-010	Second Class Water Booster Pump 3 NDE Vibration Transmitter XYZ																3							
59	S 85-03-VT-011	Second Class Water Booster Pump 3 Motor DE Vibration transmitter XYZ																3							
60	S 85-03-VT-012	Second Class Water Booster Pump 3 Motor NDE Vibration transmitter XYZ																3							
61	S 85-03-VT-013	Second Class Water Booster Pump 4 DE Vibration Transmitter XYZ																3							
62	S 85-03-VT-014	Second Class Water Booster Pump 4 NDE Vibration Transmitter XYZ																3							
63	S 85-03-VT-015	Second Class Water Booster Pump 4 Motor DE Vibration transmitter XYZ																3							
64	S 85-03-VT-016	Second Class Water Booster Pump 4 Motor NDE Vibration transmitter XYZ																3							



Item No	Tag Number	Service Description	Healthy	Fault	E-stop	Running Forward	Running Reverse	Opened	Closed	Auto/ Man/ Off	Overheat	Seal Failure	Other	Stop	Open/ Forward Start	Close/ Reverse Start	Other	Measured Value	Amps	Volt	kW	kWh	Set Point	Other	Comments
65	S 85-03-TS-001	Second Class Water Booster Pump 1 Motor Temperature Thermistors									1														
66	S 85-03-TS-002	Second Class Water Booster Pump 2 Motor Temperature Thermistors									1														
67	S 85-03-TS-003	Second Class Water Booster Pump 3 Motor Temperature Thermistors									1														
68	S 85-03-TS-004	Second Class Water Booster Pump 4 Motor Temperature Thermistors									1														
69	S 85-03-TE-001	Second Class Water MCC Room Temperature Element																1							
70	S 85-03-XV-001a	Second Class Water Filter 1 Solenoid Valve 1	1					1							1										Normally Closed
71	S 85-03-XV-001b	Second Class Water Filter 1 Solenoid Valve 2	1					1							1										Normally Closed
72	S 85-03-XV-001c	Second Class Water Filter 1 Solenoid Valve 3	1					1							1										Normally Closed
73	S 85-03-XV-001d	Second Class Water Filter 1 Solenoid Valve Master	1					1							1										Normally Closed
74	S 85-03-XV-002a	Second Class Water Filter 2 Solenoid Valve 1	1					1							1										Normally Closed
75	S 85-03-XV-002b	Second Class Water Filter 2 Solenoid Valve 2	1					1							1										Normally Closed
76	S 85-03-XV-002c	Second Class Water Filter 2 Solenoid Valve 3	1					1							1										Normally Closed
77	S 85-03-XV-002d	Second Class Water Filter 2 Solenoid Valve Master	1					1							1										Normally Closed
78	S 85-03-XV-003a	Second Class Water Filter 3 Solenoid Valve 1	1					1							1										Normally Closed
79	S 85-03-XV-003b	Second Class Water Filter 3 Solenoid Valve 2	1					1							1										Normally Closed
80	S 85-03-XV-003c	Second Class Water Filter 3 Solenoid Valve 3	1					1							1										Normally Closed
81	S 85-03-XV-003d	Second Class Water Filter 3 Solenoid Valve Master	1					1							1										Normally Closed
82	S 85-03-XV-004a	Second Class Water Filter 4 Solenoid Valve 1	1					1							1										Normally Closed
83	S 85-03-XV-004b	Second Class Water Filter 4 Solenoid Valve 2	1					1							1										Normally Closed
84	S 85-03-XV-004c	Second Class Water Filter 4 Solenoid Valve 3	1					1							1										Normally Closed
85	S 85-03-XV-004d	Second Class Water Filter 4 Solenoid Valve Master	1					1							1										Normally Closed
		Totals						88							36				65				0		







# ISIPINGO WWTW UPGRADE

Admin DB Schedule  
1002680-ZUT-SCH-EE-004

**eThekweni Municipality: Water & Sanitation Unit**

Reference: 31300-5W



Revision: A

Item No	Tag Number	Service Description	V	Ph	Absorbed Equipment Rating	Unit	Div Factor	Back-up Supply	Rated Equipment Rating	Unit	Load PF	Absorbed Load Current	Absorbed kVA	Rated Current (FLC)
<b>Equipment Schedule</b>														
1	S 85-ADM-INC-01	Incomer	400	3	43.67	kW	1	Generator	43.67	kW	0.95	66.6	46.2	67.0
2	S 85-ADM-DIS-01	Lighting L1	230	1	0.9	kW	1	Generator	0.9	kW	0.90	4.3	1.1	4.8
3	S 85-ADM-DIS-02	Lighting L2	230	1	0.9	kW	1	Generator	0.9	kW	0.90	4.3	1.1	4.8
4	S 85-ADM-DIS-03	Lighting L3	230	1	0.9	kW	1	Generator	0.9	kW	0.90	4.3	1.1	4.8
5	S 85-ADM-DIS-05	Lighting L4	230	1	0.9	kW	1	Generator	0.9	kW	0.90	4.3	1.1	4.8
6	S 85-ADM-DIS-07	External Lighting XL1	230	1	0.9	kW	1	Generator	0.9	kW	0.90	4.3	1.1	4.8
7	S 85-ADM-DIS-08	External Lighting XL2	230	1	1.6	kW	1	Generator	1.6	kW	0.90	7.7	2.0	8.6
9	S 85-ADM-DIS-10	Single Phase Power P1	230	1	1	kW	0.5	Generator	2	kW	0.85	5.1	0.7	10.7
10	S 85-ADM-DIS-11	Single Phase Power P2	230	1	1	kW	0.5	Generator	2	kW	0.85	5.1	0.7	10.7
11	S 85-ADM-DIS-12	Single Phase Power P3	230	1	1	kW	0.5	Generator	2	kW	0.85	5.1	0.7	10.7
12	S 85-ADM-DIS-13	Single Phase Power P4	230	1	1	kW	0.5	Generator	2	kW	0.85	5.1	0.7	10.7
13	S 85-ADM-DIS-14	Single Phase Power P5	230	1	1	kW	0.5	Generator	2	kW	0.85	5.1	0.7	10.7
14	S 85-ADM-DIS-15	Single Phase Power P6	230	1	1	kW	0.5	Generator	2	kW	0.85	5.1	0.7	10.7
12	S 85-ADM-DIS-13	Single Phase Power P7	230	1	1	kW	0.5	Generator	2	kW	0.85	5.1	0.7	10.7
13	S 85-ADM-DIS-14	Single Phase Power P8	230	1	1	kW	0.5	Generator	2	kW	0.85	5.1	0.7	10.7
14	S 85-ADM-DIS-15	Single Phase Power P9	230	1	1	kW	0.5	Generator	2	kW	0.85	5.1	0.7	10.7
15	S 85-ADM-DIS-16	Hydroboil 1	230	1	1	kW	0.5	Generator	2	kW	1.00	4.3	0.5	10.7
15	S 85-ADM-DIS-16	Hydroboil 2	230	1	1	kW	0.5	Generator	2	kW	1.00	4.3	0.5	10.7
16	S 85-ADM-DIS-17	Hand Dryer HD1	230	1	1.15	kW	0.5	Generator	2.3	kW	1.00	5.0	0.6	12.3
17	S 85-ADM-DIS-18	Hand Dryer HD2	230	1	1.15	kW	0.5	Generator	2.3	kW	1.00	5.0	0.6	12.3
19	S 85-ADM-DIS-20	Dedicated Plug - Fire Panel	230	1	0.1	kW	1	Generator	0.1	kW	0.90	0.5	0.1	0.5
20	S 85-ADM-DIS-21	UPS Dedicated Power SCADA Server	230	1	2	kW	1	Generator	2	kW	0.90	9.7	2.5	10.7
21	S 85-ADM-DIS-22	Airconditioning Unit AC1 Server Room 1	230	1	1.45	kW	1	Generator	1.45	kW	0.90	7.0	1.8	7.8
21	S 85-ADM-DIS-22	Airconditioning Unit AC2 Server Room 2 (Standby)	230	1	0	kW	0	Generator	1.45	kW	0.90	0.0	0.0	7.8
22	S 85-ADM-DIS-23	Airconditioning Unit AC3 Senior Operator	230	1	3.51	kW	1	Generator	3.51	kW	0.90	17.0	4.3	18.8
23	S 85-ADM-DIS-24	Airconditioning Unit AC4 Supervisors Works Assistant	230	1	1.45	kW	1	Generator	1.45	kW	0.90	7.0	1.8	7.8
24	S 85-ADM-DIS-25	Airconditioning Unit AC5 Works Manager	230	1	3.51	kW	1	Generator	3.51	kW	0.90	17.0	4.3	18.8
25	S 85-ADM-DIS-26	Airconditioning Unit AC6 Laboratory	230	1	1.45	kW	1	Generator	1.45	kW	0.90	7.0	1.8	7.8
26	S 85-ADM-DIS-27	Airconditioning Unit AC7 Superintendent	230	1	1.45	kW	1	Generator	1.45	kW	0.90	7.0	1.8	7.8
27	S 85-ADM-DIS-28	Airconditioning Unit AC8 Entrance Foyer	230	1	3.95	kW	1	Generator	3.95	kW	0.90	19.1	4.9	21.2
28	S 85-ADM-DIS-29	Airconditioning Unit AC9 Reception	230	1	0.65	kW	1	Generator	0.65	kW	0.90	3.1	0.8	3.5
29	S 85-ADM-DIS-30	Airconditioning Unit AC10 Board Room 1	230	1	0.65	kW	1	Generator	0.65	kW	0.90	3.1	0.8	3.5
29	S 85-ADM-DIS-30	Airconditioning Unit AC11 Board Room 2	230	1	0.65	kW	1	Generator	0.65	kW	0.90	3.1	0.8	3.5
30	S 85-ADM-DIS-31	Airconditioning Unit AC12 Technicians	230	1	1.45	kW	1	Generator	1.45	kW	0.90	7.0	1.8	7.8
30	S 85-ADM-DIS-32	Outbuilding OUTB	230	1	2	kW	1	Generator	2	kW	0.85	10.2	2.8	10.7



## General Specification

# Training, Testing and Commissioning Specification number: SPE-EE-0002

Document control					
Specification no.		SPE-EE-0002			
Rev	Date	Revision details / status	Author	Reviewer	Approver
0	2015/06/25	First Issue	E Biesenbach	K Adu Asomaning	A Zwiegers
Signature					

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# 1 Scope

## 1.1 Application

This Standard Specification covers the general requirements for the factory and on site testing and commissioning requirements for all equipment supplied and installed under this contract. The procedures described are the minimum required and additional tests/requirements are specified in the relevant standard and detail specifications.

This Specification identifies the standard procedures and requirements for factory inspection tests, site testing, commissioning and training. The detailed requirements for each portion of equipment shall be found in the testing and commissioning subsection of the relevant equipment's standard specification. Further detailed requirements of the project or site specific requirements shall be found in the Particular Specification and its accompanying Data Sheets, which shall be read in conjunction with this Specification.

# 2 Factory Inspections

## 2.1 General

The Contractor shall provide Works, factory and manufacturers test information, including certificates of conformity to the Engineer. They shall be complete, accurate, in accordance with the specifications and approved by the Engineer prior to the equipment leaving the factory.

These tests include all the inspections required by the Engineer, or Manufacturer (with associated testing results/reports to prove it) during the Factory Construction process.

The Contractor (and relevant manufacturers) shall operate an auditable quality assurance procedure covering the design, construction, inspection and testing of the industrial information and communications network.

The design, construction, inspection, testing and commissioning of the equipment shall comply with all relevant Statutory Regulations, and the latest editions (current at the time of Tender) of all relevant South African National Standards.

# 3 Site Testing and Commissioning

## 3.1 General

The full system testing of the electrical, instrumentation and control works are critical to the success of the project, therefore the Contractor shall execute it with the necessary diligence.

All new, refurbished or modified plant and equipment shall be thoroughly tested and commissioned prior to the handing over. Only plant and equipment that can be demonstrated to conform to the project specifications, relevant codes of practice and legislation, SANS, British, and IEC standards shall be handed over to the Employer.

During testing and commissioning the Contractor shall be responsible for providing all labour and materials (including testing equipment) and shall carry out all the servicing and any adjustment of the plant required for ensuring that it operates as specified.

Valid calibration certificates shall be available for all testing equipment on site during the commissioning and testing period.

Testing and commissioning activities shall be carefully planned, documented, and managed by the Contractor.

For details on the tests and inspections required for equipment refer to the relevant sub sections of the different equipment standard specifications.

All costs for equipment, labour and other expenses for the on-site testing and commissioning of equipment shall be included in the tendered rates for testing and commissioning as set out in the measurement and payment clauses of each piece of equipment and in the schedule of quantities. Any additional tests specified in the standard and detail specifications shall also be included in the tendered rates.

The Contractor shall:

- (a) Demonstrate the functionality of the plant and all operator interfaces. This shall include demonstration that the control system can perform as intended by the designer, over the full range of foreseeable operating conditions.
- (b) Carry out full site tests on completion of installation work, irrespective of the extent of any previous partial or sectional tests or works tests that is specified in other standard specifications.
- (c) Provide method statements for tests and commissioning activities, together with the range of values and settings that are in accordance with the detailed design and demonstrate compliance with the specifications, for inclusion in the Commissioning Plan.

## 3.2 Testing Sequence

The testing to be performed on site is divided into two sections as follows:

- (a) Before official commissioning commences the Contractor shall test his equipment as described below to ensure that the plant has been installed correctly.
- (b) After the Contractor has been satisfied that the equipment is in working order, the commissioning of the plant will commence in the presence of the Engineer as described below.

## 3.3 Site Testing of Equipment Prior to Commissioning

The Contractor shall timeously inform the Engineer when he intends to perform his first tests and start-up of equipment in order to allow a representative of the Engineer to witness the tests if the Engineer deems it necessary.

Before starting up any section of the plant or equipment, the Contractor shall clean out the housings and equipment or structures, and, if necessary, make arrangements with other Contractors to remove their building rubble from the structures, check that all safety devices and alarms have been set and activated, all nuts and cable terminations have been tightened correctly, that all the equipment is complete and ready for start-up, that the plant has been installed correctly, and that three copies of the operating manuals have been handed over to the engineer.

Each section of the equipment shall be started up by the contractor. Before any equipment is started or energized, the contractor shall ensure that it is safe for personnel and equipment on site to do so. Allowance for these costs shall be made in his tendered rates and sums.

The Contractor shall conduct his own tests on the equipment and, only when he is satisfied that these tests meet the requirements of the specifications, shall he notify the engineer that he is ready to conduct the official tests on completion. The Contractor shall not conduct an official test without the

Engineer being present or his approval to do so. All equipment tested shall conform to the requirements specified.

The Contractor shall:

- (a) Perform and record the results of all testing.
- (b) At each stage carry out such preparatory testing and commissioning as necessary to ensure that equipment is ready for witnessing by the Engineer.
- (c) Retain all documentation generated during the testing and commissioning process, including all test and performance data, as a commissioning record and issue four copies as part of the contract documentation.
- (d) At each stage of testing the results shall be checked by the Engineer.
- (e) Commissioning shall only proceed to the next stage if the results are approved by the Engineer. Any corrective measures shall be agreed by the Engineer.
- (f) Prerequisites for Commissioning

The Contractor shall provide Works testing, factory acceptance testing and manufacturers routine testing information and certificates of conformity to the Engineer. The documentation shall be complete, accurate, in accordance with the specifications and approved by the Engineer prior to the start of the commissioning.

All instruments and equipment used for testing and commissioning shall be controlled by a quality assurance scheme acceptable to the Engineer, and their accuracy and suitability shall be demonstrated by the Contractor.

Operation and Maintenance Manuals for the whole works shall be provided before commissioning commences.

The comprehensive training programme, which shall include the training manual, shall be provided for the training that will take place during the commissioning period.

All labelling of equipment and cabling shall be completed and correct.

The Contractor shall ensure all warning notices, guards and safety devices are installed.

All pre-commissioning tests and checks shall be agreed with the Engineer prior to the commencement therewith.

When all the tests required before commissioning, or tests before tests on completion, have been completed and accepted by the Engineer, the commissioning may proceed.

Testing and Commissioning activities shall be carefully planned, documented, and managed.

The Contractor shall provide the Engineer with full details of his testing and commissioning activities and programme for approval.

## 3.4 Final Commissioning

The Contractor shall be responsible for commissioning all sections of the works and shall perform all of the tasks set out below:

- (a) Prior notice of and proper arrangements for the commissioning shall be made with the Employer, Engineer, supply authority, and all Contractors and suppliers of equipment, which will be affected by the commissioning operation.
- (b) If plant and equipment, which has been supplied by others has to be commissioned, the relevant contractor's permission thereto, together with any specific requirements relating to commissioning shall be obtained prior to commissioning.

- (c) All sections of the works shall be carefully inspected by a responsible representative of the Contractor to ensure that all construction and installation work has been properly completed.

Commissioning and testing on site shall be carried out by experienced personnel under the Contractor's supervision.

The commissioning period shall be undertaken over a trouble-free period of at least thirty consecutive calendar days. During this period the Contractor shall instruct the operating staff in the correct procedures of operating the plant under all circumstances of operation, including emergency conditions, the correct servicing of every part, the type of oil or grease to be used, and similar instructions. This shall be done by demonstration and confirmation, in writing, and operating manuals shall be referred to for this purpose.

At least three weeks before commissioning commences the Engineer will be requested to provide the Contractor with commissioning sheets for all the equipment installed by the Contractor. These forms shall be completed by the Contractor during the commissioning period and all items listed shall be entered. Final hand-over certificates will not be issued for equipment with incomplete commissioning reports. Information that is not available or applicable, or reasons for not performing certain tests shall be agreed with the Engineer.

The thirty day commissioning period will commence with a day-one test and terminate with a day-thirty test in compliance with the commissioning report. Commissioning of the plant (which includes the thirty days between the day-one and day-thirty tests) shall include operating under conditions which shall adequately prove that all the specifications are met. All safety devices, stand-by plant, automatic controls and protection devices shall be adequately tested for reliability and correct functioning. The Contractor may be called upon to repeat testing during the maintenance period if the performance of any equipment supplied under this contract is suspected to be substandard by the Engineer. Such tests shall be for the Contractor's account and shall comply with the requirements specified. Copies of updated commissioning reports shall be provided to the Engineer within two days after a test has been performed.

Programs for the day-one tests, day-thirty tests and instruction/training sessions with the client shall be prepared by the Contractor and provided to the Engineer no less than two weeks before the commissioning period commences. Weekly updates to these schedules shall be provided by the Contractor for the duration of the commissioning period.

Note that if any equipment should fail during the 30 day commissioning period, the equipment shall be repaired or replaced by the Contractor, and testing and commissioning will commence from scratch.

During the thirty-day commissioning period, the Contractor shall be responsible for providing all labour and materials (including testing equipment) and shall carry out all the servicing and any adjustment of the plant required for ensuring that it operates as specified. Valid calibration certificates shall be available for all testing equipment on site during the commissioning period.

The Contractor shall conduct all the tests required to satisfy the Engineer that the plant is capable of performing in accordance with the specification, and shall make allowance therefor in his tendered rates and prices. Any defects detected during the commissioning period shall be made good by, and at the expense of the Contractor, including all additional costs incurred by the Employer and his representatives and the Engineer. These tests shall be conducted to certify that the plant, as installed, is operating in accordance with the specified requirements. Note that all equipment will be tested as part of a system where appropriate, and will not be passed if all protection devices, interlocking with other equipment, etc. is not fully functional.

## 3.5 Commissioning Report

A comprehensive commissioning test report shall be submitted by the Contractor prior to the issue of the Certificate of Completion and shall be inserted in the operations and maintenance manual.

After the Contractor has provided training to the Employer and provided all other contractual requirements have been met, the latter will sign the commissioning report.

Once a commissioning report is complete, the Engineer and the Contractor will sign and date the report, whereupon the Engineer will notify the Employer that maintenance for that particular piece of equipment from then on is the Employers responsibility in compliance with the general conditions of contract.

## 4 Training

### 4.1 General

The Contractor shall conduct comprehensive training courses for designated personnel in the maintenance and operation of the plant during the commissioning period.

Electronic equipment operation and maintenance training shall form part of the overall training programme.

All equipment shall be in a complete working order before training shall commence.

The training shall be designed specifically for the works and shall take into account the skill and experience levels with the installed works of personnel.

Unless otherwise specified the training shall allow for at least 4 operational staff members and 4 engineering staff members.

Where the Contractor engages specialist services for sophisticated equipment, sufficient time shall be allowed in the contract to permit expert training to be given to plant operatives and maintenance personnel.

Where the Contractor presents portions of the course material by audio visual means, copies of those audio visual presentations shall be delivered to the Employer as part of the printed training manuals.

The Employer reserves the right to videotape the training sessions for later use.

During the installation phase, the Employer may wish to nominate a person who will be closely involved with the installation and commissioning process. The intention is not to interfere with the Contractors' installation team, but to do observation in order to obtain the maximum possible information regarding the installation, to enable efficient maintenance to be undertaken by the Employer after final hand-over and expiring of the guarantee period.

### 4.2 Training Manual

Training and training manuals shall be based on the O&M Manuals.

Training manuals shall be delivered for each trainee with two additional copies which shall form part of the Operation and Maintenance Manuals. The manuals shall include an agenda, defined objectives for each course.

### 4.3 Training Schedule

A training schedule, together with the name and background of the person who will perform the training, shall be submitted to the Engineer for approval.

The training shall include operator training and technical/maintenance training.

The program for the training shall include instruction for at least one day instruction on-site.

The schedule shall at a minimum cover the following:

- (a) General system overview
- (b) Functional operation of the system i.e.:
  - (i) System start-up and shut-down procedures
  - (ii) Equipment operation
  - (iii) System access requirements
  - (iv) Alarms
  - (v) Fault Finding
  - (vi) Backup Power Procedure (if applicable)
  - (vii) Incident Reporting
- (c) Maintenance
- (d) Maintenance Schedule
- (e) Standard Maintenance Procedures
- (f) Spare Part Lists

Upon completion of the course, the operators should be fully proficient in the system operation and have no unanswered questions regarding the system.

## 4.4 Operations Training

This training shall be designed to teach operators how to operate the Electrical, Instrumentation and Control systems and shall include the following when applicable:

- (a) Start-up, shut-down and operating instruction for all operational modes for the works shall be provided. This shall be comprehensive and shall include actions to be taken in the case of all alarm conditions and basic fault finding.
- (b) A layout drawing of the installation, a process flow diagram, and a P&ID shall be provided for each Operator. The instructions described in (4.4.1a) above shall also be provided in printed form for each operator.
- (c) If a SCADA and Telemetry system is part of the control system the SCADA operations training as described in the SCADA and Telemetry standard specification shall be incorporated in the training.

## 4.5 Maintenance Training

This training shall be designed to teach maintenance personnel how to repair and maintain the electrical, instrumentation and control systems and shall include the following where applicable:

- (a) Control system software instruction.
- (b) Where and how to install spare parts.
- (c) Detail list of where to obtain spare parts locally.
- (d) Detailed overview of 11 kV protection and switchgear settings
- (e) Training on setting of 11 kV protection.
- (f) Motor protection relay and settings

- (g) Overview of PLC programming for the purposes of making changes and re-loading programs if PLC's are replaced.
- (h) If a SCADA and Telemetry system is part of the control system the SCADA maintenance training as described in the SCADA and Telemetry standard specification shall be incorporated in the training.



## **PART C4: SITE INFORMATION**

### **C4.1 LOCALITY PLAN**

(Refer to attached locality plan drawing)





CONSULTANT PROJECT NO: 1002690

ZUTARI

IMPACT. ENGINEERED.

Designed: N/A

Drawn: J NARAYAN

Checked: C L POLORIGNI

Approved: S JUGWANTH

REVISIONS:

Revision	Date	Description
A	17-12-2024	ISSUED FOR TENDER

NOTES:

CONTRACTOR ENGINEERING & APPROVAL

Mechanical Engineer	
Electrical Engineer	
Instrumentation Engineer	

APPROVED FOR CONSTRUCTION

NAME AND SURNAME

Structural Engineer

TENDER DRAWING:

SIGN

DATE

WATER AND SANITATION

ETHEKWINI MUNICIPALITY

ENGINEERING: TREATMENT WORKS DESIGN BRANCH

Contract No

31300-5W

Project Title

ISIPINGO WASTEWATER TREATMENT WORKS:CONSTRUCTION OF FUNCTIONAL IMPROVEMENTS TO SELECTED PROCESSES

Project No. (Y6975)

Drawing Title

ISIPINGO WWTW: LOCALITY PLAN

Works Project Manager:

A. Pillay

Deputy Head: Engineering:

B. Soni

Head: Water and Sanitation:

E. Msweli

Scale:

Date: DEC 2024

Drawing No.	Sheet 001	Rev. A
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**C4.2**      **CONDITIONS ON SITE**

(Refer to attached Geotechnical Investigation Report)



# Isipingo Wastewater Treatment Works Geotechnical Investigation Report

**Isipingo, KwaZulu-Natal**

## **Zutari (Pty) Ltd**

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Unit 14, Braehead Office Park, 1 Old Main Road,  
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SLR Project No.: 720.070334.00001

20 September 2024

Revision: 01  
Report No.: 01

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Author	Ahmad Patel
Reviewer	Rannel Naidoo
Keywords	Geotechnical Investigation,
Status	Final
Report No.	01
SLR Company	SLR Consulting (South Africa) Proprietary Limited

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01	20 September 2024	Ahmad Patel	Rannel Naidoo / Trevor Pape	Rannel Naidoo



## Basis of Report

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## Appendices

<b>Appendix A</b>	<b>General Site Layout</b>
<b>Appendix B</b>	<b>Previous Investigation</b>
<b>Appendix C</b>	<b>Test Pit, Inspection Pit and Borehole Logs &amp; Photographs</b>
<b>Appendix D</b>	<b>Laboratory Results</b>



## Acronyms and Abbreviations

AASHTO	American Association of State Highway and Transportation Officials
BH	Borehole
CBR	California Bearing Ratio
DCP	Dynamic Cone Penetrometer
Dwyka	Dwyka Group
IP	Inspection Pit
IWWTW	Isipingo Wastewater Treatment Works
kg	kilogram
kPa	kilopascal
m	meter
KΩ	Kilo-ohm
NWD4	Size NWD4 Drilling Bit 75.69 mm
PI	Plasticity Index
PVC	Polyvinyl chloride
Quaternary	Quaternary Deposits
SAICE	South African Institution of Civil Engineering
SANS	South African National Standards
SLR	SLR Consulting (Pty) Ltd
SPT	Standard Penetration Test
TLB	Tractor Loader Backhoe
TP	Test Pit
TRH14	Technical Recommendations for Highways- Guidelines for Road Construction Materials
USCS	Unified Soil Classification System
COLTO	Committee of Land and Transport Officials
Zutari	Zutari (Pty) Ltd



## 1.0 Introduction

SLR Consulting (Pty) Ltd (SLR) was appointed by Zutari (Pty) Ltd (Zutari) to undertake a geotechnical investigation for the proposed upgrades to selected infrastructure at the Isipingo Wastewater Treatment Works (IWWTW).

The Isipingo WWTW is located in Isipingo, south of Durban within the eThekweni Municipality, KwaZulu-Natal, South Africa.

Table 1-1 provides a summary of the proposed infrastructure upgrades.

This report outlines the geotechnical investigation undertaken which aimed to ascertain subsurface conditions to ultimately inform foundation, earthworks and pavement design.

**Table 1-1: Proposed Infrastructure**

Structure	Approximate Foundation Depth (m)	Foundation Dimension	Required Approximate Bearing Pressure (kPa)	Scope of Work
Inlet Works	3 - 4		200 - 300	New mechanical screens, vortex de-gritters, screenings washer-compactor, grit washer-classifier and hardstand area
Administration Building	0.3	700 mm strip footing	85	Refurbishment of existing building
Biofilter Pump station	4 - 5		150 - 250	Refurbishment of the existing pump station – however this scope of work is on hold
New Settled Effluent Sump	4 - 6		150 - 250	New water retaining sump
Second class water system	0-1	3.0 x 3.0 m raft	150 - 250	New installation
Temporary sludge stockpile area	0 - 1	32 x 32 m slab	120	New installation
Roads	-		-	Refurbishment of existing roads (due to evidence of cracks /rutting)
Stormwater outlet	0.5 – 1.5		-	New stormwater headwall
Stormwater channels	0.5 - 1		40 - 75	New rectangular concrete stormwater channels. New stormwater channel



Structure	Approximate Foundation Depth (m)	Foundation Dimension	Required Approximate Bearing Pressure (kPa)	Scope of Work
Stormwater Pipes	0.5 – 1.5		-	New installation

## 1.1 Objectives

The aim of this study will be achieved through the following objectives:

- Identify the subsurface geotechnical conditions including soil and rock profiles, and groundwater levels across the site through test pit excavations, rotary core drilling and in-situ penetrometer testing.
- Determine the material properties of the subsoils and rock encountered on site.
- Assess geotechnical considerations that would impact development, e.g. expansiveness soils and corrosivity of the subsoils.
- Provide recommendations and possible mitigation measures of anticipated geotechnical constraints, namely;
  - Foundation recommendations,
  - Dewatering considerations,
  - Rippability of the subsoils and rock for excavations,
  - Evaluation of excavation stability and requirements for lateral support;
  - Material suitability for reuse for pipe bedding material; and
  - Road assessment.

## 1.2 Limitations of Assessment

The findings of this report are based on data obtained from limited data points across the WWTW site. The nature of geotechnical investigations is that the complete understanding of subsurface conditions is unlikely and is based on extrapolation and interpretation. Actual conditions, differing from current interpretations, may become evident during construction, hence the recommendation for ongoing geotechnical input during construction.

Furthermore, being a brownfield investigation, the site is underlain by numerous buried services often not shown on any drawings, some of which were only revealed during test pit excavations. Thus, the decision was made to excavate the majority of the test pits by hand to reduce the risk of damaging buried services, with test pit positions governed by location of buried services as agreed with the client.

## 1.3 Codes of Practice

The geotechnical investigation was performed according to prescribed industry standards. The investigation was carried out according to the following code of practice and guideline:

- Brink and Bruin (2002), Guidelines for Soil and Rock Logging in South Africa.
- SAICE (2010), Site Investigations Code of Practice.

## 1.4 Previous Investigations

The borehole logs of a previous site investigation conducted presumably for earlier upgrades, were made available to SLR in the form of a site drawing (Drawing Number:



746/201/02/0). This drawing indicates 16 boreholes drilled across the site and is presented in Appendix B. A summary of the various soil and rock layers encountered in the past boreholes is given in Table 1-2. The descriptors for each layer indicated in Table 1-2 are taken directly from the borehole logs.

These boreholes reveal the site comprises a predominant topmost layer of soft to stiff clay often described as sandy, to depths of up to 5 m. This is subsequently underlain by either residual Dwyka Tillite or subordinate sandstone (within the tillite or as sandstone corestones). The sandstone was often described as sandstone boulders and pebbles in a clay matrix.

Shallow tillite bedrock was encountered in the northern section of the site, intercepted at 0.1 m in BH3. However, the tillite bedrock increases with depth southwards. The average depth to hard rock tillite is approximately 4.5 m below ground level.

**Table 1-2: Summary of Past Borehole Logs (16 No. Boreholes)**

BH ID	Datum (m)	Topsoil (m)	Silty Sand with occasional gravel (Sandstone) (m)	Sandy/Silty CLAY (m)	Clayey SILT (m)	Boulders and Pebbles in clay matrix (m)	Decomposed Tillite (m)	Tillite Bedrock (m)
BH1	15.4			0.0-1.6	1.6-2.9		2.9-4.0	>4.0
BH2	15.4			0.0-4.2				>4.2
BH3	15.4	0.0-0.1						>0.1
BH4	15.4			0.0-2.4				>2.4
BH5	14.4	0.0-0.2		0.2-0.8			0.8-5.0	>5.0
BH6	14.4			0.0-2.6		2.6-2.9	2.9-6.55	>6.55
BH7	14.4	0.0-0.1		1.0-3.5				>3.5
BH8	14.4			0.0-5.0		5.0-6.3	6.3-6.53	>6.53
BH9	14.1		0.0-1.0	1.0-2.1			>2.1	
BH10	14.1			0.0-4.7		4.7-5.6		>5.6
BH11	14.1		0.0-2.1					>2.1
BH12	14.1			0.0-4.0		4.0-5.4	5.4-5.6	>5.6
BH13	14.1			0.0-0.3		0.3-4.8	>4.8	
BH14	14.1			0.0-3.4		3.4-5.1	5.1-7.9	>7.9
BH15	14.1		0.0-1.9	1.9-2.4			2.4-3.8	>3.0
BH16	14.1		0.0-0.6	0.6-1.0			>1.2	
			1.0-1.2					



## 2.0 Methodology

### 2.1 Site Investigation

To understand the general conditions of the study area a site walkover was conducted on the 10<sup>th</sup> July 2024 which enabled familiarisation with the scope of works, and optimisation of investigation positions. The geotechnical site investigation commenced on the 18<sup>th</sup> July 2024.

A total of 38 No. test pits were investigated, of which 18 No. were for the road and pipeline investigations (and designated IP). The test pits were excavated by hand to depth of approximately 1.5 m and thereafter a hand auger was used to investigate further to depths of about 3 m, unless shallower refusal was encountered in either the test pits or the auger borings. Considering that the hand augers often refused earlier than the desired depth, a TLB was used to further investigate 6 No. additional test pits (TP24 to TP29). Each test pit was profiled according to the *Guidelines for Soil and Rock Logging in South Africa* (Brink and Bruin, 2002). Representative samples were retrieved from selected test pits for laboratory testing.

To further understand subsurface conditions at depth for certain proposed structures, 3 No. rotary core boreholes were drilled using a size NWD4 drilling bit having an outside set diameter of 75.8 mm and an inside set diameter of 52.4 mm. Standard Penetration Tests (SPTs) were conducted in soft material within the boreholes.

Additionally, 24 No. Dynamic Cone Penetrometer (DCP) tests were conducted alongside selected test pits, advanced from surface to assess the subsoil consistency. DCPs were conducted in inspection pits IP4, IP6, IP8, IP11 and IP15.

A summary of the investigation is provided in Table 2-1 and shown in Figure 2-1.

**Table 2-1: List of Investigation Points**

No.	Termination Depth (m)	Proposed Structure
<b>Road and Ancillary Structures Investigation Pits</b>		
IP1	1.0	Stormwater Management
IP2	1.4	Stormwater Management
IP3	0.6	Stormwater Management
IP4 (DCP)	0.9	Refurbishment to existing Road
IP5	0.75	Stormwater Management
IP6 (DCP)	0.55	Refurbishment to existing Road
IP7	1.0	Stormwater Management
IP8 (DCP)	1.45	Refurbishment to existing Road
IP9	1.5	Stormwater Management
IP10	0.95	Stormwater Management
IP11 (DCP)	1.0	Refurbishment to existing Road
IP12	1.5	Stormwater Management
IP13	1.4	Stormwater Management
IP14	1.5	Stormwater Management
IP15 (DCP)	0.9	Refurbishment to existing Road



No.	Termination Depth (m)	Proposed Structure
IP16	1.3	Stormwater Management
IP17	1.4	Stormwater Management
IP18	1.0	Stormwater Management
<b>Test Pits</b>		
TP1 (DCP)	0.85	Inlet Works
TP2 (DCP)	2.3	
TP27	1.0	
TP4	1.8	Sludge Stockpile
TP5 (DCP)	1.7	
TP6 (DCP)	1.7	
TP7 (DCP)	1.6	
TP8	2.9	
TP24	3.0	
TP25A	3.1	
TP25B	3.0	
TP10 (DCP)	1.95	Second Class Water System
TP11 (DCP)	2.3	
TP28	3.2	
TP12 (DCP)	1.6	Biofilter Pump Station
TP15 (DCP)	1.35	
TP26	2.3	
TP14 (DCP)	2.0	Admin Building
TP16 (DCP)	1.45	
TP17 (DCP)	2.6	S/W Pipe
TP18 (DCP)	2.0	Stormwater Outlet
TP19 (DCP)	3.1	S/W Pipe
TP20 (DCP)	2.9	S/W Pipe
TP21 (DCP)	1.5	S/W Pipe
TP22 (DCP)	2.2	S/W Pipe
TP23 (DCP)	0.4	Stormwater Outlet
<b>Borehole</b>		
BH1	6.5	Admin Building
BH2	7	Biofilter Pump Station and Settled Effluent Sump
BH3	13	Inlet Work



## 2.2 Laboratory Testing

Representative samples were collected from selected test pits (and inspection pits) for various laboratory testing. Tests undertaken include the following:

- Modified AASHTO
- California Bearing Ratio
- Foundation Indicator
- Road Indicator
- Moisture Content
- Electric Resistivity
- Point Load Strength Index Test (PLSI)

These laboratory tests allow for the evaluation of the geotechnical properties of the subsurface material which in turn informs the design and construction of proposed infrastructure and roads.









## **3.0 Site Characterisation**

### **3.1 Location and Description**

The site is located in Malukazi, Isipingo, approximately 20 km southwest of Durban and about 4 km inland from the Indian Ocean. Situated in southern Durban, the site is bordered to the north by the Sipingo River and lies at the gateway to Umlazi township along the M35 main road. The site locality is shown in Figure 3-1.

The Isipingo WWTW is located near the Sipingo River, which influences the site's topography and hydrogeology. Its proximity to both residential and industrial areas make it a critical infrastructure asset for the region.

The site is relatively flat, with the facility comprising various structures such as sedimentation tanks, digesters, chlorine dosing building, gas holder, pump station, maturation ponds, drying beds, and other ancillary structures and buildings.

The site is accessed via an entrance road off the M35 to the south of the facility. The treatment facility is bordered by the Sipingo River to the north, a residential compound to the west, a power station to the east and a vacant plot immediately south of the entrance to the facility.





**Figure 3-1: Site Location**

### **3.2 General Geology and Geotechnical Considerations**

The IWWTW site is primarily underlain by tillite and sandstone of the Dwyka Group (Karoo Supergroup). The Dwyka tillite, a glaciogenic diamictite formed during the late Carboniferous to early Permian periods, is characterized by its poorly sorted matrix, which comprises clay, silt, and sand, interspersed with a wide range of clasts, from gravels to boulders (subsequently lithified into rock). These deposits rest on a pre-Karoo erosional basin characterized by significant relief, resulting in variable thicknesses. In the Natal coastal region, the Dwyka tillite dips seaward at angles of 10-30°, influenced by local monoclinical folding.



This lithological composition typically results in a material with high compressive strength and low permeability, attributes that are generally advantageous for foundation construction. However, the inherent heterogeneity of the tillite, particularly the random distribution of clast sizes and types, can lead to variable mechanical properties.

Brink (1979) provides a detailed account of the engineering characteristics of Dwyka tillite, emphasizing that the weathering of this material typically produces a residual soil that is a stiff, highly plastic clay. This clayey residual soil is generally prone to expansive behaviour, particularly in response to fluctuations in moisture content, which can lead to significant volumetric changes.

In contrast, the Dwyka sandstone, which is intercalated with the tillite, is a fine- to medium-grained, well-cemented rock that generally provides a high bearing capacity. Despite its favourable load-bearing characteristics, Dwyka sandstone is susceptible to weathering processes that degrade its structural integrity. Weathering of this sandstone typically results in the formation of a loose, sandy residual material, which lacks the cohesion and strength of the unweathered rock (Brink, 1979). The transition between unweathered Dwyka sandstone and its weathered, sandy counterpart can create zones of varying bearing capacities.

Occasionally overlying the Dwyka Group formations, particularly along the Sipingo River, are Quaternary deposits, primarily composed of unconsolidated sands, silts, and clays, which have been deposited by fluvial processes. These sediments may exhibit significant lateral and vertical heterogeneity in thickness and material properties. The variability these deposits can lead to inconsistent load-bearing characteristics and increased susceptibility to erosion, particularly in the presence of groundwater.

The geological map of the IWWTW is shown in Figure 3-4.

### 3.3 General Hydrogeology

The Dwyka Group, particularly the tillite and associated sedimentary rocks, typically exhibits aquifer characteristics that are classified as secondary aquifers because the groundwater movement and storage primarily occur within fractures, joints, and weathered zones rather than within the rock matrix itself, resulting in low-yielding aquifers. Having hydraulic conductivities between  $10^{-11}$  m/s and  $10^{-12}$  m/s (Woodford and Chevallier, 2002) Its low primary permeability is due to its tightly packed matrix and unsorted nature. However, secondary permeability can be moderate to high where the rock is highly fractured or weathered.

### 3.4 Seismicity

The seismicity of Africa, especially Southern Africa is, by world standards, very moderate and of shallow nature. Kijko et al. (2003) developed a map that indicates the peak ground acceleration (PGA) with a 10% probability of exceeding in 50-year period (Figure 3-2). The seismic hazard map indicates a probable PGA of approximately 0.06 g.

SANS 10160 (2009) includes a seismic hazard map of South Africa (Figure 3-3). The map contains two zone types, namely: type I (Natural seismic activity) and type II (mining induced activity). The map has been generated using PGA values with an exceedance probability of 10% for a 50-year period. This relates to a seismic event with a 475-year return period. This map shows that the Isipingo WWTW does not fall into either category, with a PGA of less than 0.1 g. Thus, the seismic risk is naught.





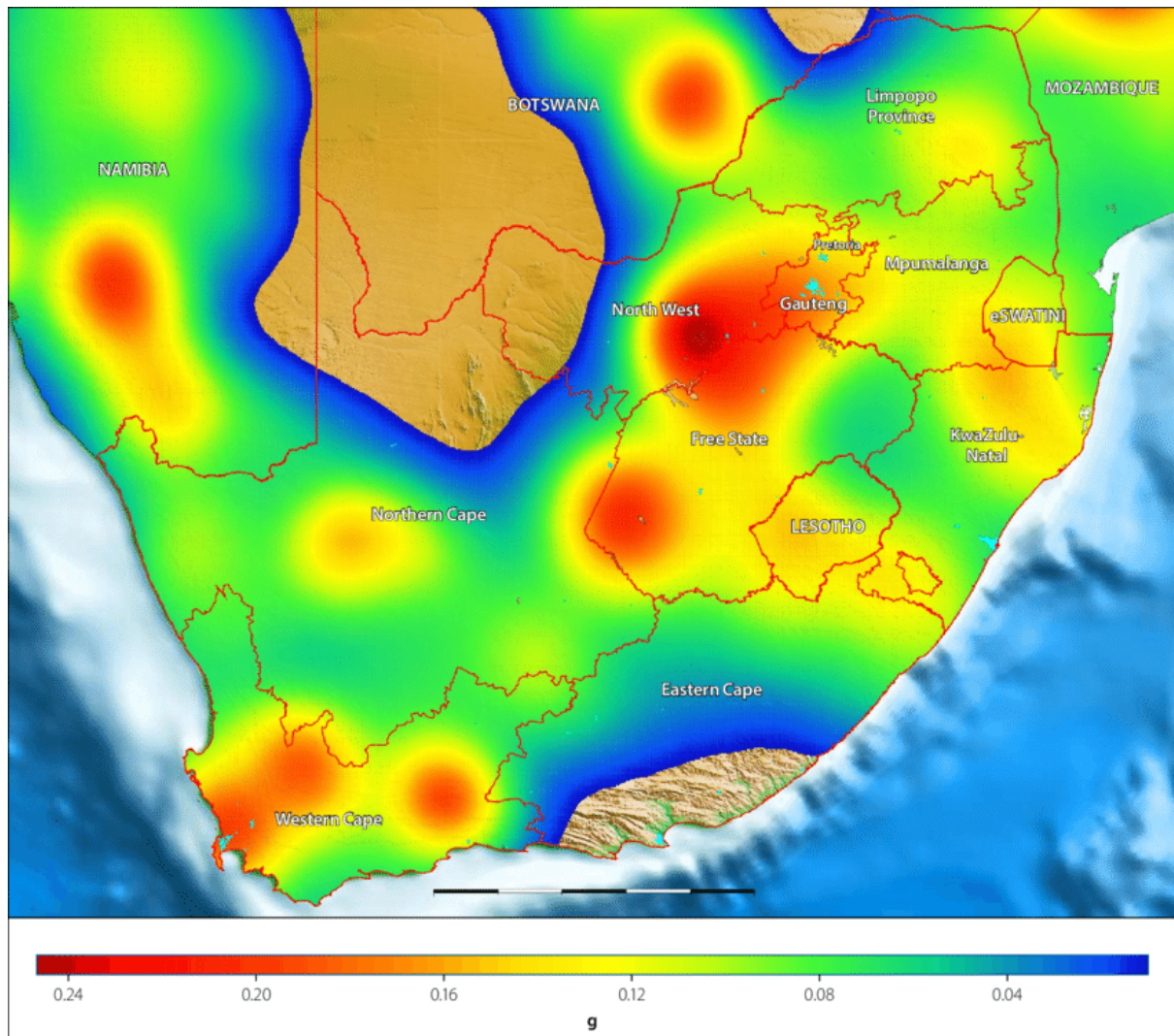


Figure 3-2: Seismic Hazard Map (after Kijko *et al*, 2003)



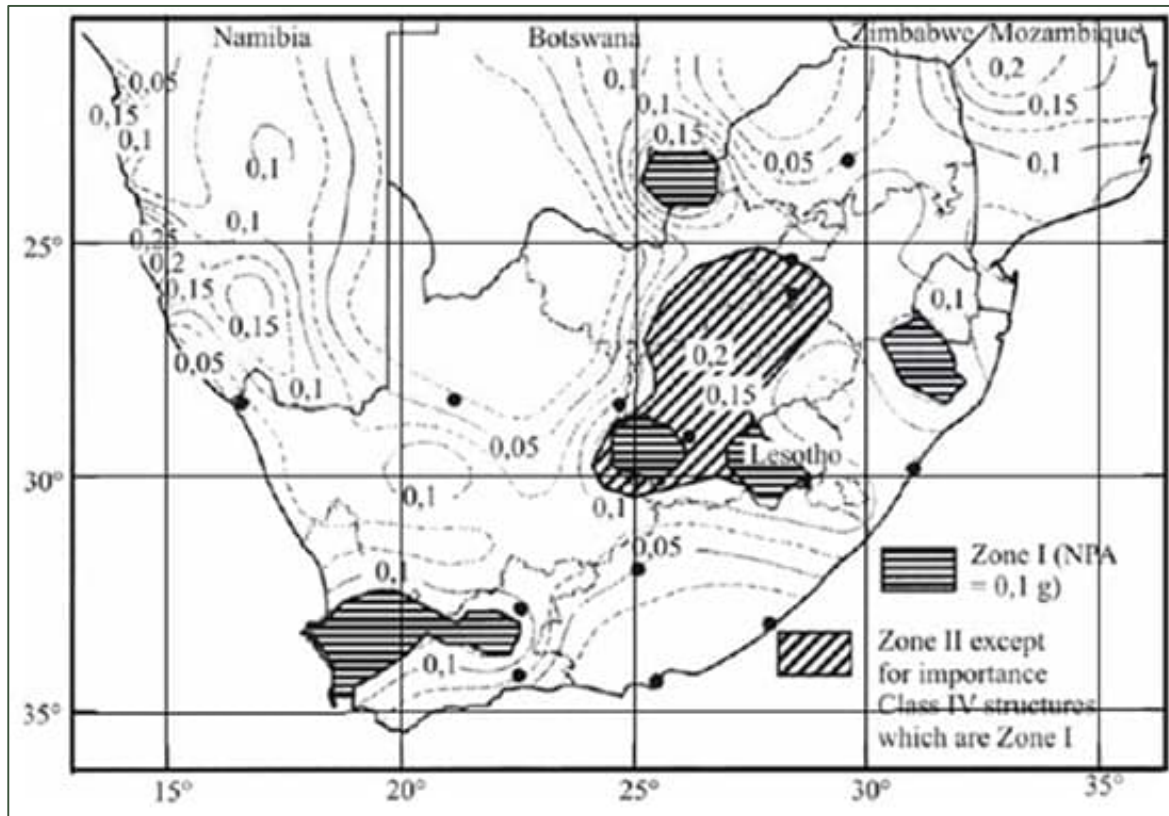


Figure 3-3: Seismic Hazard Map (SANS10160, 2009)



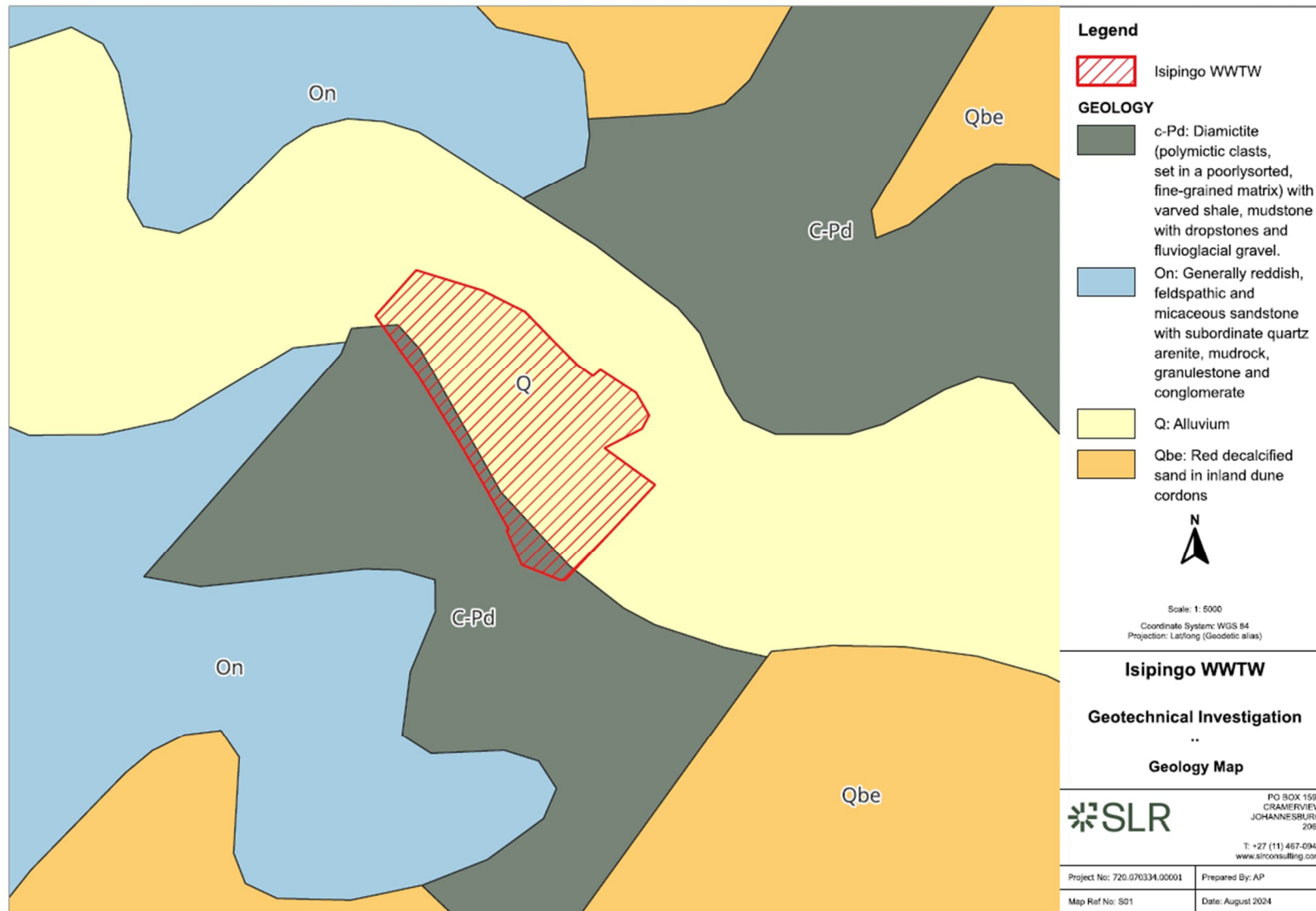


Figure 3-4: Geology Map (after the Council for Geoscience Durban 2930 1:250 000 Geological Series Map, 1988)



## 4.0 Geotechnical Investigation

The site investigation comprised 26 test pits, 18 inspection pits (at the location of roads and stormwater structures) and 3 rotary core boreholes. The inspection pits, and 20 test pits were excavated by hand to avoid damaging buried services. Six additional test pits were excavated using a TLB. Representative samples were retrieved for laboratory testing.

### 4.1 Test Pit and DCP Summary

Test pits were generally hand excavated to 1.5 m and subsequently hand augured to 3 m or shallower refusal. Test pits investigated with a TLB were excavated to 3 m or shallower refusal.

The test pit profiles, and borehole logs are provided in Appendix C and summarised in Table 4-1 for ease of reference.

Fill material straddles the site and is variable in composition and thickness across the facility. The fill overlies either residual dwyka tillite, residual subordinate sandstone or alluvium. It is evident that the majority of the northwestern portion of the site has previously been stripped of any colluvial material, hence shallow bedrock is often encountered.

The general subsoils are described as follows:

- **Fill Material:** Comprises gravels, cobbles and boulders in a silty sandy matrix. Sporadic occurrences of cohesive fill material comprising orangish brown and blotched light grey sandy silty clay, was observed in several test pits randomly distributed across the site. Rubble and waste were occasionally observed within the fill horizons encountered.
- **Alluvium:** Predominant along the northeastern boundary, adjacent to the Sipingo River. The alluvium comprises dark brown silty sand with subordinate clays. Layers of organic rich material were encountered in TP19 (located to the northern portion of the site in proximity to the sludge stockpile and northeastern stormwater pipeline).
- **Residual Tillite:** Typically occurring as a predominantly firm sandy silty clay, although also encountered as soft silty clay in TP2 as a result of elevated in situ moisture.
- **Residual Sandstone:** Conspicuously prevalent within the sludge stockpile, biofilter Pump station, settled effluent sump and administration building footprint, the residual sandstone comprises loose to medium dense clayey sand. The residual sandstone encountered was limited to this area and not widespread across the site.
- **Sandstone Bedrock:** Encountered only in TP26 at 1.4 m depth as a completely to highly weathered, fine to medium grained soft rock to hard rock sandstone, and in BH03 at 11.5 m depth as a light beige, unweathered fine to medium grained soft rock to hard rock sandstone.
- **Dwyka Tillite Bedrock:** Very soft rock to hard rock tillite bedrock predominantly underlies a major proportion of the site, intercepted at relatively shallow depth in BH01, BH02 and BH03 (encountered at depths varying between 2.0 m to 2.6 m within the boreholes).

The specific soil/rock profile at each of the proposed works is described in the subsections that follow.





**Table 4-1: Inspection Pits and Test Pit Profiles and Borehole Log Summary**

No.	Proposed Structure	Topsoil	Fill		Alluvium	Residual Tillite	Residual Sandstone	Tillite	Sandstone	Groundwater Seepage Depth (m) / Water Rest Level in BH's (m)
		Silty Sand	Non-Cohesive Silty Sand / Sandy Gravel / Cobbles & Boulders / Rubble	Cohesive Sandy Silty Clay / Silty Sandy Clay						
TP01	Inlet		0 - 0.35			0.35 - 0.65		0.65 - 0.85		-
TP02		0 - 0.15				0.15 - 2.3				-
TP27			0 - 1.0							-
TP04	Sludge Stockpile	0 - 0.05	0.05 - 0.5			1.8 - 1.85	0.5 - 1.8			-
TP05		0 - 0.05	0.05 - 0.6				0.6 - 1.7			-
TP06		0 - 0.05	0.05 - 0.6		0.6 - 1.5		1.5 - 1.8			-
TP07		0 - 0.05	0.05 - 0.7				0.7 - 1.6			-
TP08		0 - 0.1	0.1 - 1.3	1.3 - 1.6	1.6 - 2.9					2.5
TP24		0 - 0.1	0.1 - 0.7			2.3 – 3.0	0.7 – 2.3			2.6
TP25A			0 - 0.8		0.8 - 1.7		1.7 - 3.1			3.1
TP25B			0 - 0.5	0.5 - 0.9	0.9 - 2.0		2.0 - 3.0			3.0
TP10	Second Class Water System	0 - 0.05	0.05 - 0.45	0.45 - 1.35	1.35 - 1.95					1.45
TP11		0 - 0.05	0.05 - 0.8	0.8 - 1.8	1.8 - 2.3					1.5
TP28			0 - 1.0	1.0 - 1.6	1.6 - 3.2					-
TP12	Biofilter Pump Station	0 - 0.15	0.15 - 0.6				0.6 - 1.6			-
TP15		0 - 0.1					0.1 - 1.35			-
TP26			0 - 0.3				0.3 - 1.4		1.4 - 2.3	-
TP14	Admin Building	0 - 0.15	0.15 - 0.4			0.4 - 2.0				-
TP16		0 - 0.2					0.2 - 1.45			-



No.	Proposed Structure	Topsoil	Fill		Alluvium	Residual Tillite	Residual Sandstone	Tillite	Sandstone	Groundwater Seepage Depth (m) / Water Rest Level in BH's (m)
		Silty Sand	Non-Cohesive	Cohesive						
			Silty Sand / Sandy Gravel / Cobbles & Boulders / Rubble	Sandy Silty Clay / Silty Sandy Clay	Clayey Silty Sand	Clayey Silty fine Sand / Sandy Silty Clay	Clayey Silty Sand / Silty Sandy Clay	Soft Rock to Hard Rock	Soft Rock to Hard Rock	
TP17	S/W Pipe	0 - 0.1	0.1 - 0.25	0.25 - 0.5		0.5 - 2.6				1.6
TP18	Stormwater Outlet	0 - 0.15	0.15 - 2.0							-
TP19	S/W Pipe	0 - 0.1	0.1 - 0.85	0.85 - 1.5	1.5 - 3.1					2.0
TP20	S/W Pipe	0 - 0.15	0.15 - 0.9		0.9 - 2.9					2.5
TP21	S/W Pipe	0 - 0.1	0.1 - 1.1		1.1 - 1.5					1.4
TP22	S/W Pipe	0 - 0.1	0.1 - 0.35	0.35 - 1.1	1.1 - 2.2					1.35
TP23	Stormwater Outlet	0 - 0.1	0.1 - 0.4							-
BH01	Admin Building					1.55 – 2.5	0 - 1.55	2.5 - 6		0.50
BH02	Biofilter Pump Station					1.3 – 2.0	0 – 1.0 (Shelby between 1.0-1.3m)	2.0 - 7.5		0.85
BH03	Inlet			0 – 1.0		1.0 -2.60		2.6 – 8.5	11.5.0 - 13.0	0.20
								8.5-11.5 (Poor recovery of possible contact between tillite and sandstone)		

Note: Groundwater rest level in the BH's is shallower than anticipated and not a true reflection of the water table. Shallow rest levels likely due to the presence of drilling fluids which have not dissipated at the time of reading.



## 4.2 Inlet Works

The proposed inlet works lie in the northwestern portion of the site. Two potential locations have been proposed for the inlet works, annotated as A and B in Figure 4-1. DCP testing was undertaken at the location of TP01 and TP02, the results of which is include in Figure 4-2.

### Inlet Works Option A

TP27 and BH03 were investigated at the location of the Inlet Works (Option A). TP1 was investigated in close proximity to the Option A footprint, in order to avoid buried services.

The fill thickness varied between 0.35 m and 1.0 m in the vicinity of the Option A footprint. The fill is underlain by residual tillite comprising of soft to very stiff silty clay which was encountered to a depth of 0.65 m in TP01 and to 2.6 m in BH03. The residual soils are underlain by shallow very soft rock to soft rock Tillite bedrock, becoming very hard rock tillite with depth (as encountered in BH03), which extends from 2.6 to depths in excess of 13.0 m.

The results of the DCP test and SPT confirm the stiff to very stiff nature of the residual tillite.

### Inlet Works Option B

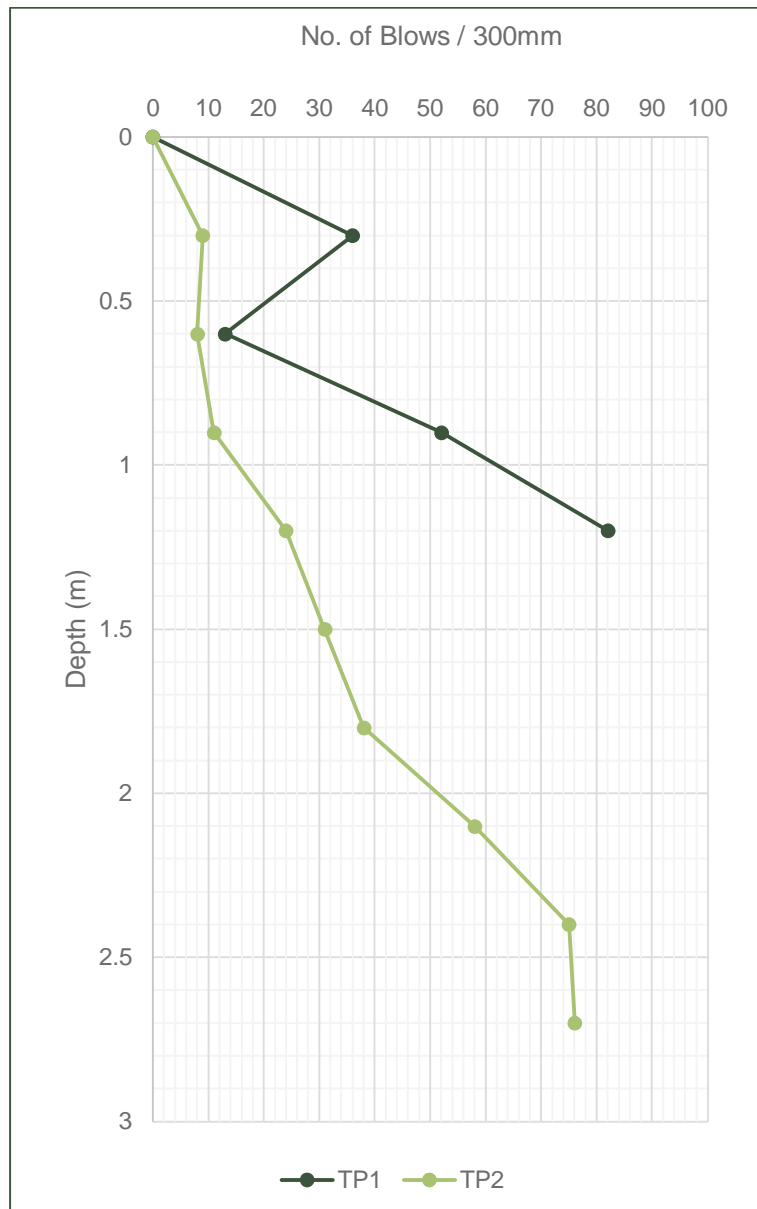
TP2 was investigated within the option B footprint and comprised soft to firm silty clay residual tillite to 2.3 m below surface. The residual tillite displayed an increase in moisture content with depth, indicative of shallow ground water.

The results of the DCP testing indicates variability in consistency, with a discrepancy between the observed consistency in the test pits indicated as soft to firm residuals soils while the DCP results indicate firm to stiff consistencies in the residual tillite to depths of approximately 1.0 m thereafter increasing to a very stiff material to depths of 2.7 m.



Figure 4-1: Proposed Inlet Works





**Figure 4-2: Inlet Works DCP Test results**

### 4.3 Sludge Stockpile

The proposed sludge stockpile is located at the northeastern boundary, along the Sipingo River (shown in Figure 4-3). Eight test pits were excavated, namely, TP04, TP05, TP06, TP07, TP08, TP24, TP25A and TP25B. TP25B was excavated adjacent to TP25A, mainly to retrieve additional samples.

Surficial fill material occurs from surface across the proposed development footprint (thickness range 0.5 m in TP4 to 1.6 m in TP8, average thickness 0.9 m). The fill varies in consistency from loose to medium dense and comprising predominantly silty sand often described as gravelly silty sand with cobbles, boulders and rubble. . However, the results of the DCP testing suggest a generally dense consistency within the fill horizons. Test pits TP8 and TP25B both contained a cohesive fill layer overlying the alluvium, described as silty sandy clay.



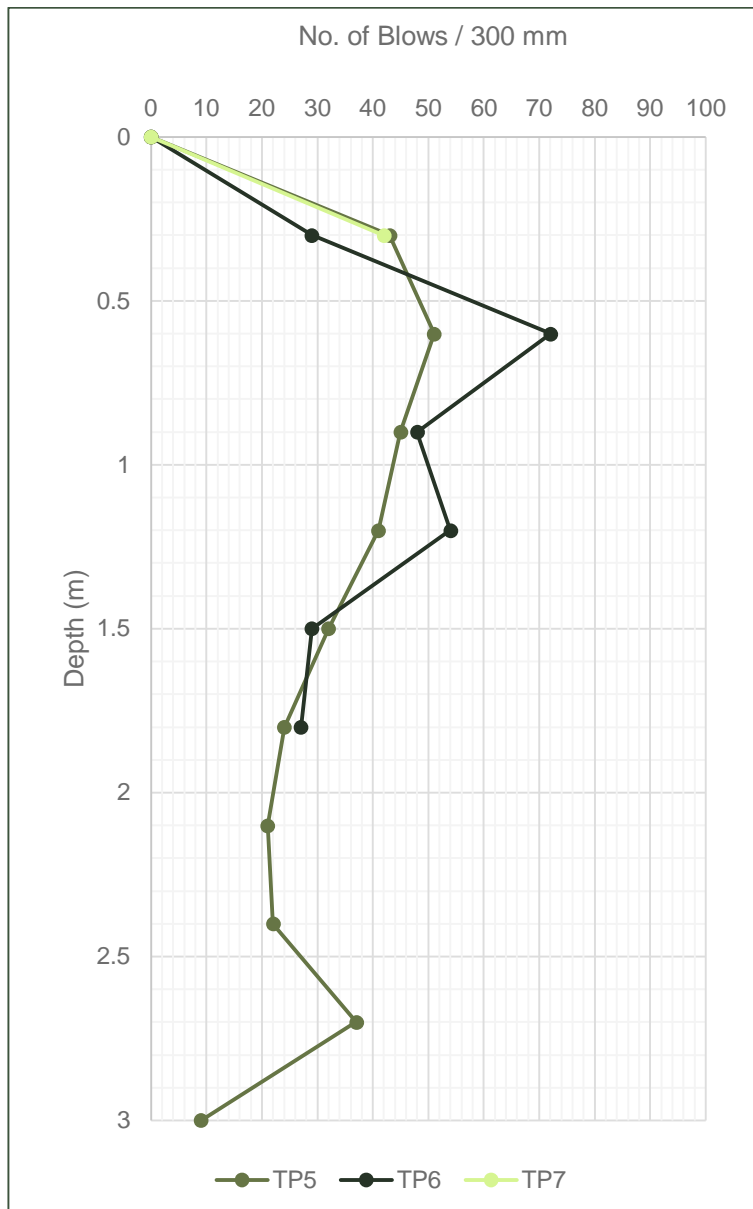
The fill overlies loose to dense alluvial silty sand, to an average depth of approximately 2.0 m, which often presented as slightly clayey silty sand. Residual sandstone comprising silty sandy clay underlies the alluvium, or in its absence, directly underlies fill material. The results of the DCP tests confirms the medium dense consistency of the residual sandstone.

Moderate water seepage at approximately 2.5 m below the surface, can be expected in this area, as was encountered in TP8, TP24, T25A and TP25B



**Figure 4-3: Proposed Sludge Stockpile**





**Figure 4-4: Sludge Stockpile DCP Test Results**

#### 4.4 Biofilter Pump Station & Settled Effluent Sump

The proposed biofilter pump station (Figure 4-5) is centrally located within the IWWTW site. Test pits TP15, TP26 and BH02 were investigated within the proposed biofilter pump station footprint. Test pits TP12, TP16 and BH01 were investigated in close proximity to the proposed footprint.

This area is characterised by a medium dense silty sand fill layer to a depth of 0.6 m. The fill is underlain by soft to firm sandy silty clay / loose to medium dense clayey silty sand with occasional gravels, residual sandstone to approximately 1.6 m. Very soft rock subordinate sandstone was found below the residual sandstone in TP26 only. Within BH02 the residual sandstone is underlain by residual tillite comprising a stiff sandy silty clay which extends to a





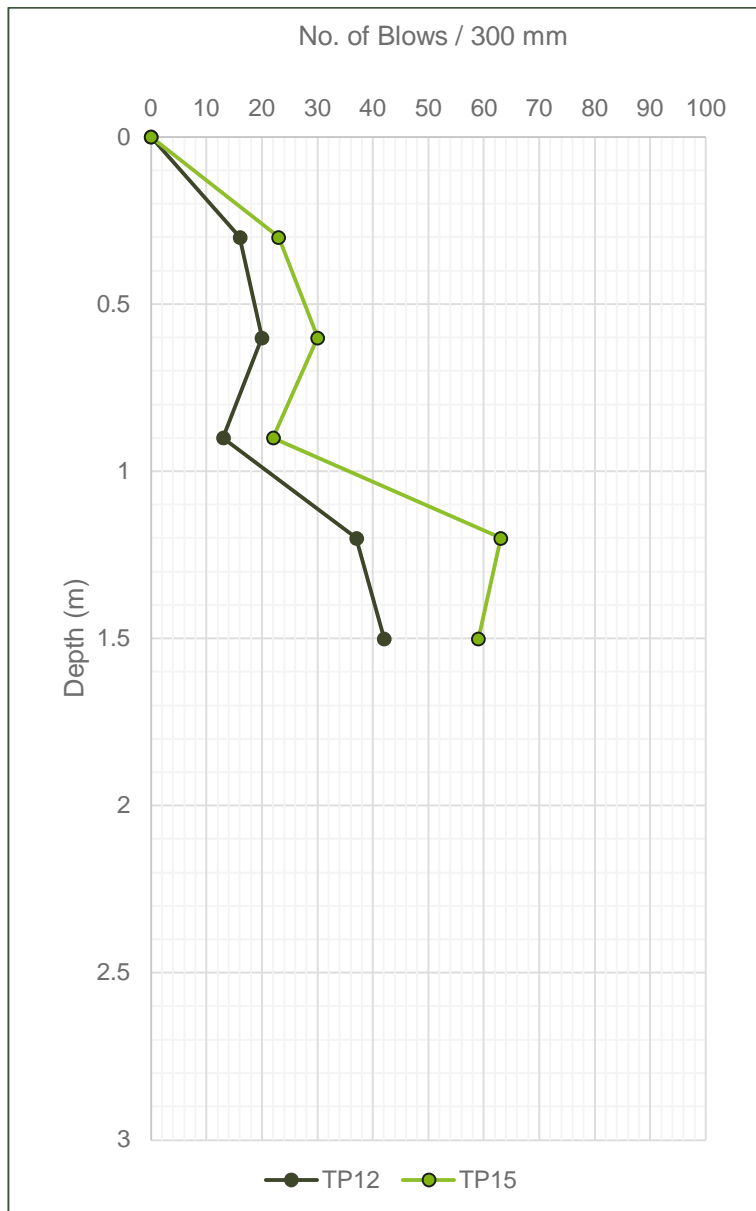
depth of 2.0 m and in turn is underlain by soft becoming medium hard and eventually hard rock tillite.

The results of the DCP testing confirm the generally stiff to very stiff / medium dense becoming dense consistency of the residuum.



**Figure 4-5: Biofilter Pump Station**





**Figure 4-6: Biofilter Pump Station DCP Test Results**

## 4.5 Administration Building

The existing administration building (Figure 4-7) is situated adjacent to the proposed biofilter pump station. Test pits TP14, TP16 and BH01 were investigated at the periphery of the existing administration building.

This area is generally underlain by fill comprising medium dense silty clayey sand with gravels, to a depth of approximately 0.4 m. The fill is underlain by residual tillite, or residual sandstone comprised of firm to stiff sandy silty clay extending to approximately 2.5 m. The residual material is underlain by very soft rock to soft rock tillite bedrock at 2.5 m, extending to depths in excess of 6.0 m, becoming very hard rock tillite with depth. The results of the DCP tests confirm the stiff to very stiff consistency of the residual subsoils.

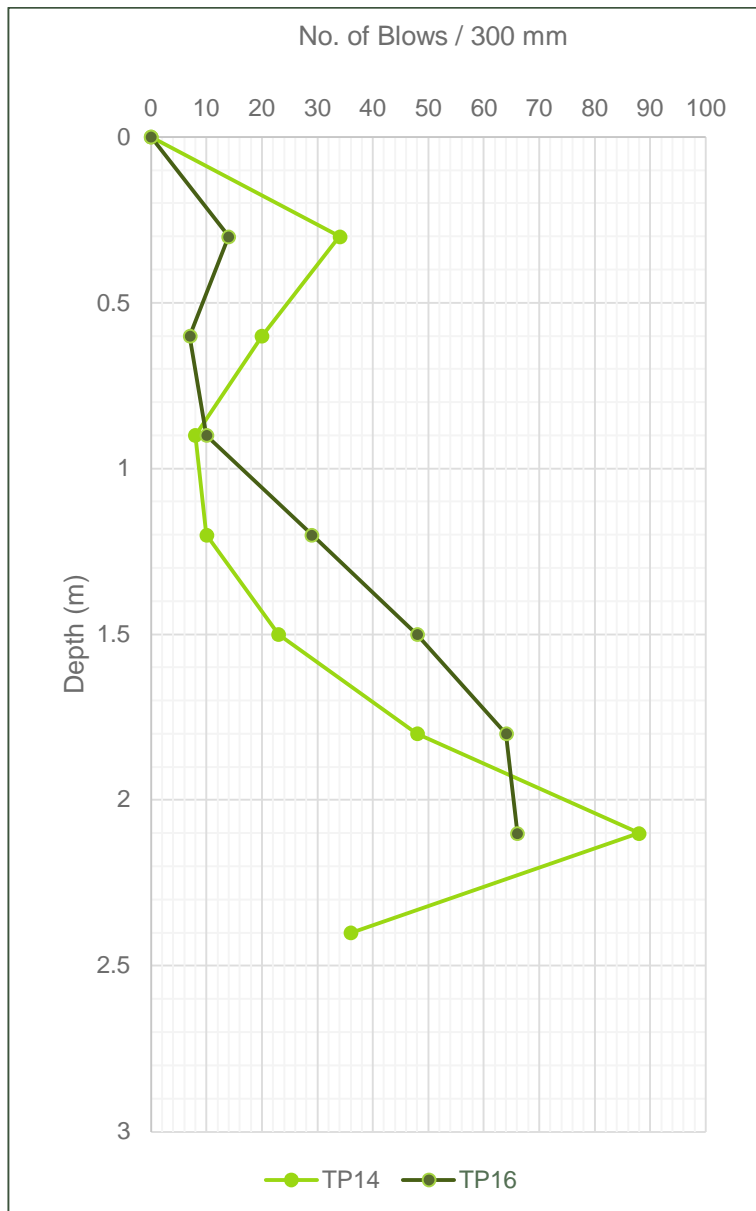






**Figure 4-7: Administration Building**





**Figure 4-8: Administration Building DCP Test Results**

## 4.6 Stormwater Pipe and Stormwater Outlet

The new stormwater pipe is proposed along the western site boundary and immediately north of the sludge drying beds toward the east (Figure 4-9).



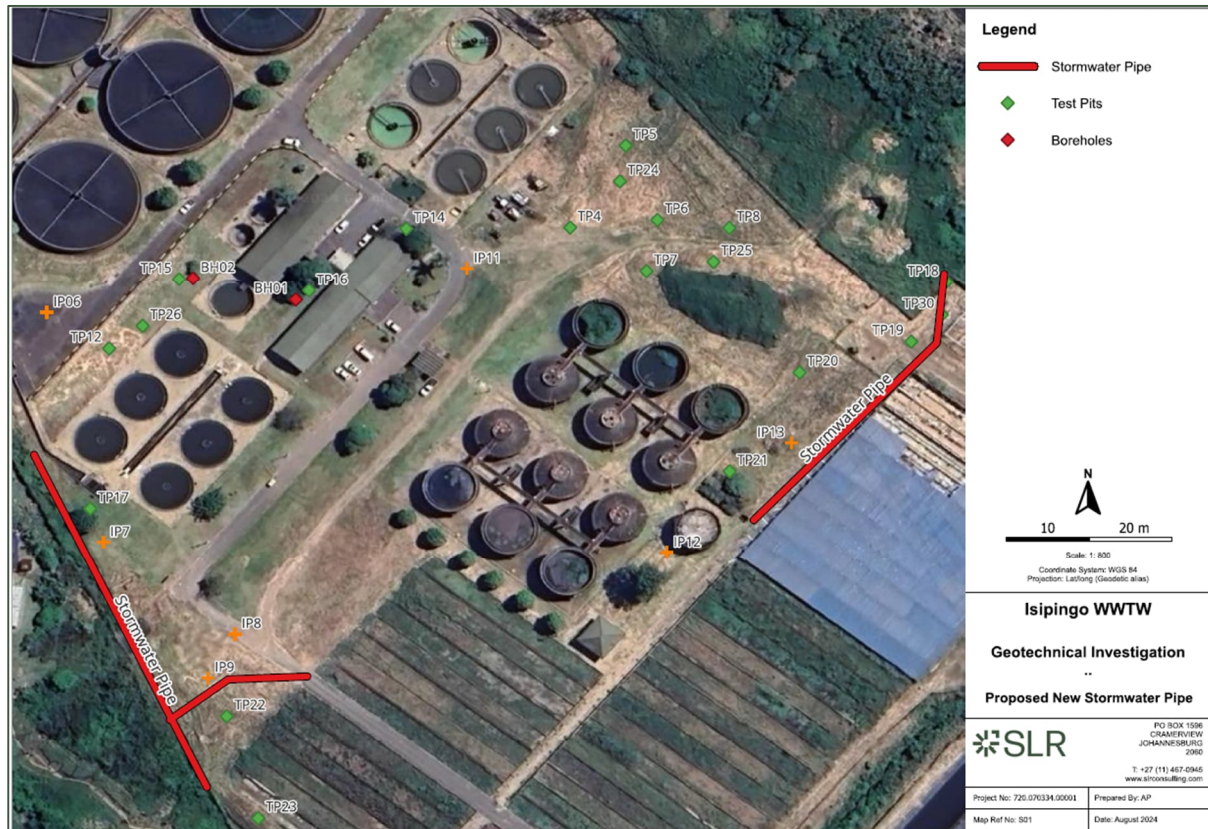


Figure 4-9: Stormwater Pipe and Outlet

#### 4.6.1 Southwestern Stormwater Pipe and Outlet

Test pits in close proximity to the southwestern stormwater pipe include TP17, TP22, TP23, IP7, IP9 and IP10. Test pit TP23 was terminated at 0.4 m as an electric cable was exposed. IP07 was terminated at 1.0 m due to a PVC pipe encountered across the base.

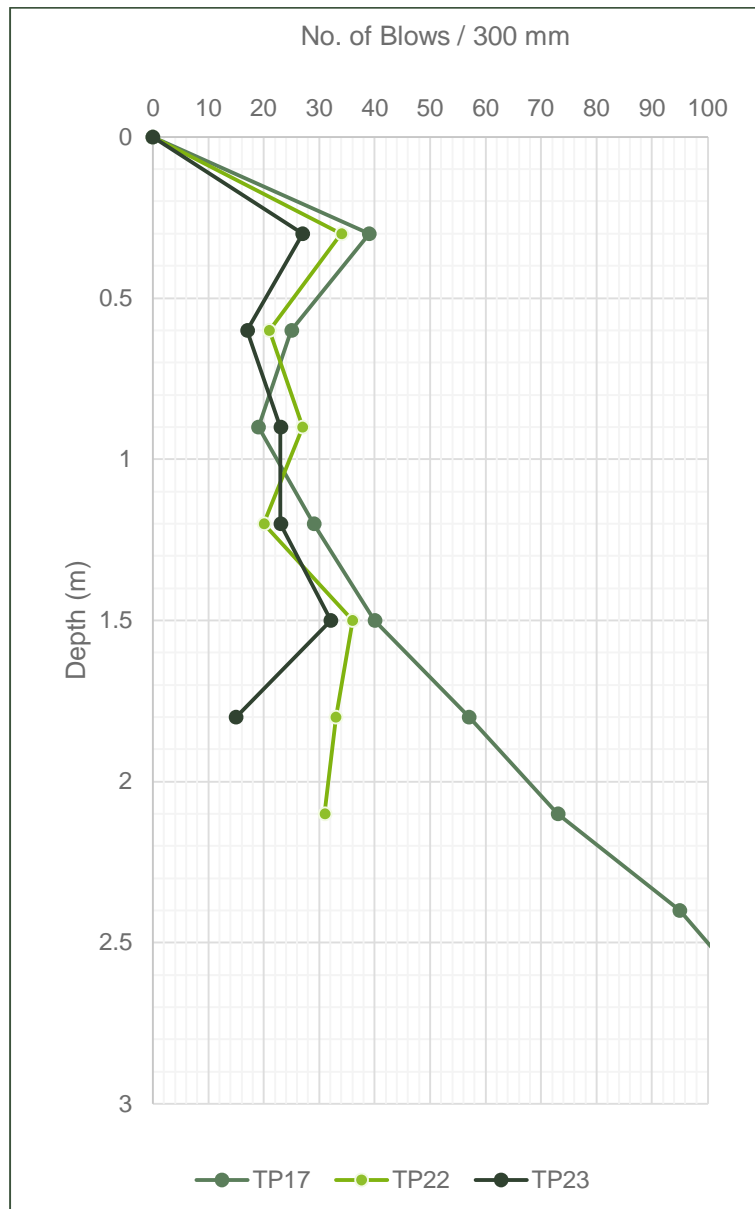
Along the proposed southwestern stormwater pipeline route, the subsoils comprise loose clayey silty sand with scattered gravel underlain by firm to very stiff sandy silty clay both of fill origin extending to a maximum of 1.1 m below existing ground level. Fill comprising medium dense to dense silty sand with frequent gravels, cobbles and boulders can be expected towards the southern extent of the proposed stormwater line which was encountered from surface to a depth greater than 0.4 m at which depth the test pit (TP23) was terminated due to an electrical cable being encountered.

The fill is underlain by either loose clayey sand or very soft sandy silty clay, alluvium (to depths in excess of 2.2 m) or firm sandy silty clay, residual tillite (to depths in excess of 2.6 m).

Groundwater seepage occurred at relatively shallow depths of approximately 0.8 m in IP07, 1.2 m in IP09, 1.35 m in TP22 and at 1.6 m in TP17.

The results of the DCP testing confirm the very stiff cohesive and medium dense non cohesive fill material within the upper meter of the subsurface horizons. However, the results indicate a generally improved consistency (medium dense to dense / very stiff) in the alluvial soils than observed in the test pits.





**Figure 4-10: Southwestern Stormwater Pipeline DCP Test Results**

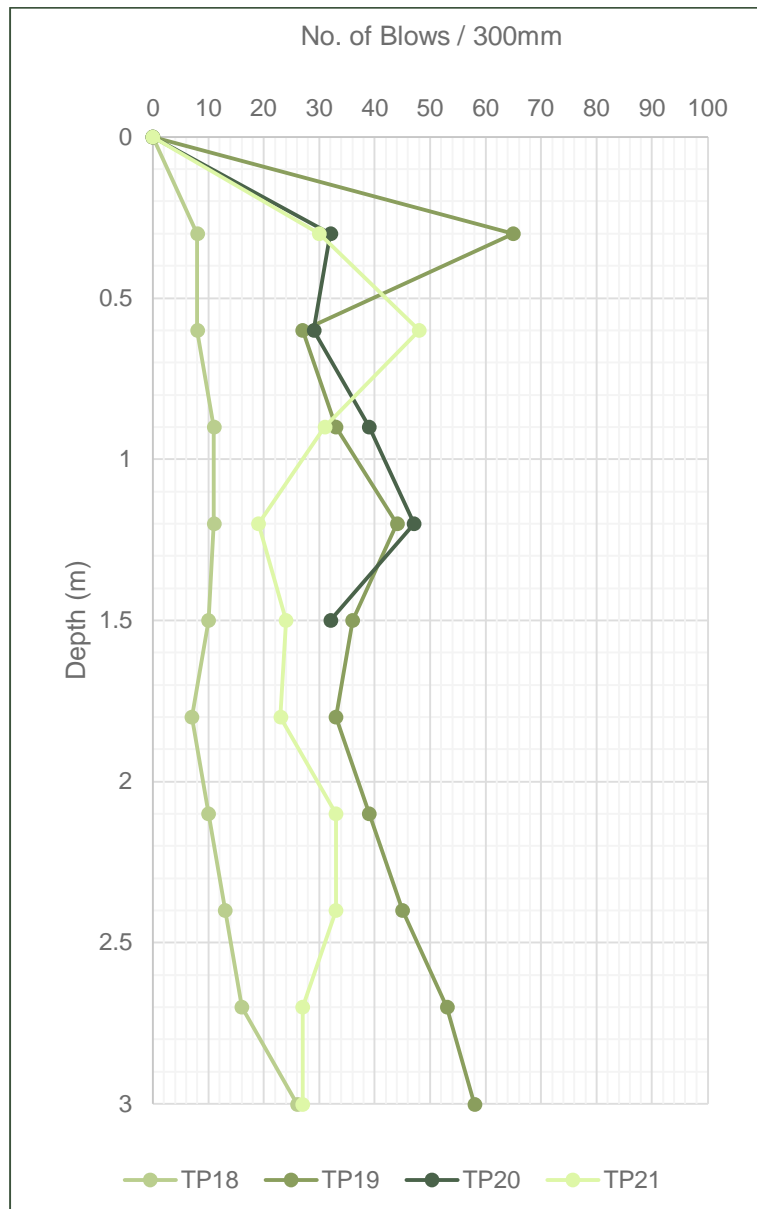
#### 4.6.2 Northeastern Stormwater Pipeline and Outlet

The test pits in proximity to the northeastern stormwater pipe include, TP18, TP19, TP20, TP21, IP12 and IP13. TP30 was abandoned due to severing a PVC sewer line, with the TLB excavation, immediately below the surface.

The eastern stormwater pipeline route comprises fill material to depths of approximately 2.0 m and comprises loose to medium dense clayey silty sand with frequent gravels, cobbles and occasional boulders and builders rubble and sporadically underlain by fill of soft sandy silty clay. The fill is underlain by intercalated layers of soft silty sandy clay and generally loose clayey silty sand with gravels of alluvial origin extending to depths in excess of 3.1 m.

Groundwater seepage can be expected between 1.4 m to 2.0 m below ground level, as observed in TP19 at 2.0 m, and TP21 at 1.4 m.





**Figure 4-11: Northeastern Stormwater Pipeline DCP Test Results**

## 4.7 Second Class Water System

The second-class water system is proposed at the southernmost end of the site, adjacent to the current chlorine plant. Three test pits, TP10, TP11 and TP28, were excavated in this area.

The subsoils are characterized by fill material consisting of loose to medium dense silty sandy gravel, or medium dense clayey silty sand with occasional gravels, cobbles and boulders to depths varying between 0.4 m and 0.8 m, underlain by a second fill layer of distinctive bright greyish-blue, soft to firm sandy silty clay with gravels, cobbles and boulders to a maximum depth of 1.8 m.

Alluvium underlies the fill comprising loose becoming medium dense clayey silty sand which extends to depths in excess of 3.2 m.

The unusual discoloration of the clay fill may be attributed to chlorine leakage, as chlorine is a strong oxidizing agent capable of causing localized reduction of iron rich minerals.





The results of the DCP test indicate the erratic consistency of the non-cohesive fill. The results further indicate that the clayey fill horizon has a very stiff consistency compared to the soft to firm consistency observed in the test pits. This could possibly be due to the presence of clasts which would affect DCP results. The result of the two DCP tests further confirm the variability in the dense to very dense alluvium compared to the observed consistency in the test pits.



**Figure 4-12: Second Class Water System**





**Figure 4-13: Second Class Water System DCP Test Results**

## 4.8 Stormwater Channel

The new stormwater channel (Figure 4-14) is proposed at the entrance to the facility. The proposed channel will either discharge stormwater to an existing catchpit or to the earth channel adjacent to the existing road. IP15, IP16, IP17 and IP18 were excavated in close proximity to the proposed stormwater channel.

IP16 and IP18 revealed fill material to an approximate average depth of 1.2 m, primarily comprising cobbles and boulders in a sandy matrix, with slight water seepage occurring at 1.0 m in IP18. IP15 was excavated within an existing road and comprised layers of selected fill to 0.9 m below road level. IP17 consist of gravelly sand, fill to 0.7 m underlain by sandy clay to 1.4 m.





**Figure 4-14: Proposed New Stormwater Channel**

## 4.9 Inspection Pits for various Stormwater Management Structures

Thirteen inspection pits (designated IP No.) were excavated across the site to assess the subsurface conditions at various stormwater management infrastructure (either in the form of stormwater channels or stormwater pipes).

Overall, fill is prevalent across the WWTW site, extending from depths of 0.1 m to 1.4 m and is variable in composition, comprising loose to medium dense clayey silty sand (with varying constituent composition of each material type) and with occasional to frequent presence of gravels, cobble and boulders including occasional builders rubble within the sand matrix. Alluvial deposits, primarily silty sand and sandy silty clay underly the fill as observed in IP9, IP12, IP13 and IP14 between depths as shallow as 0.55 m (or 1.3 m) to depths in excess 1.5 m.

Inspection Pits IP01, IP02, IP03 and IP05 were excavated in the northwestern corner of the site. Expectedly, IP01 comprised fill of sand and clay composition to a depth of 1.0 m. Inspection pits IP02 and IP03 comprised silty sand fill to an average depth of approximately 0.3 m. The fill in several pits namely IP2, IP3 and IP5, is underlain by silty clay residual tillite at depths ranging between 0.25 and 1.4 m. Very soft rock tillite was encountered in IP05 below 0.45 m. Inspection pits IP01 was terminated at 1.0 m due to presence of a concrete pipe.

Groundwater seepage was only encountered in three test pits (IP07, IP09, IP18), at depths of between 0.8 and 1.2 m.

The inspection pit profiles are provided in Appendix C and summarised in Table 4-2.





## 4.10 Road Inspection Pits

Five test pits—namely IP04, IP06, IP08, IP11, and IP15—were excavated within the existing roads across the facility. The profiles of these test pits are summarized in Table 4.3.

Each inspection pit excavated within the existing roads primarily revealed a 0.03 m to 0.1 m thick asphalt surface underlain by a base course, which varies between 0.05 m and 0.15 m in thickness consisting of coarse gravel within a sand matrix. Beneath the base course (with the exception of IP08 and IP15), a layer of selected fill material was encountered, with variations observed between the pits in the layer composition and thickness. A reddish-brown, loose to medium dense clayey silty sand commonly underlies the base course, particularly in pits IP04, IP06, and IP11.

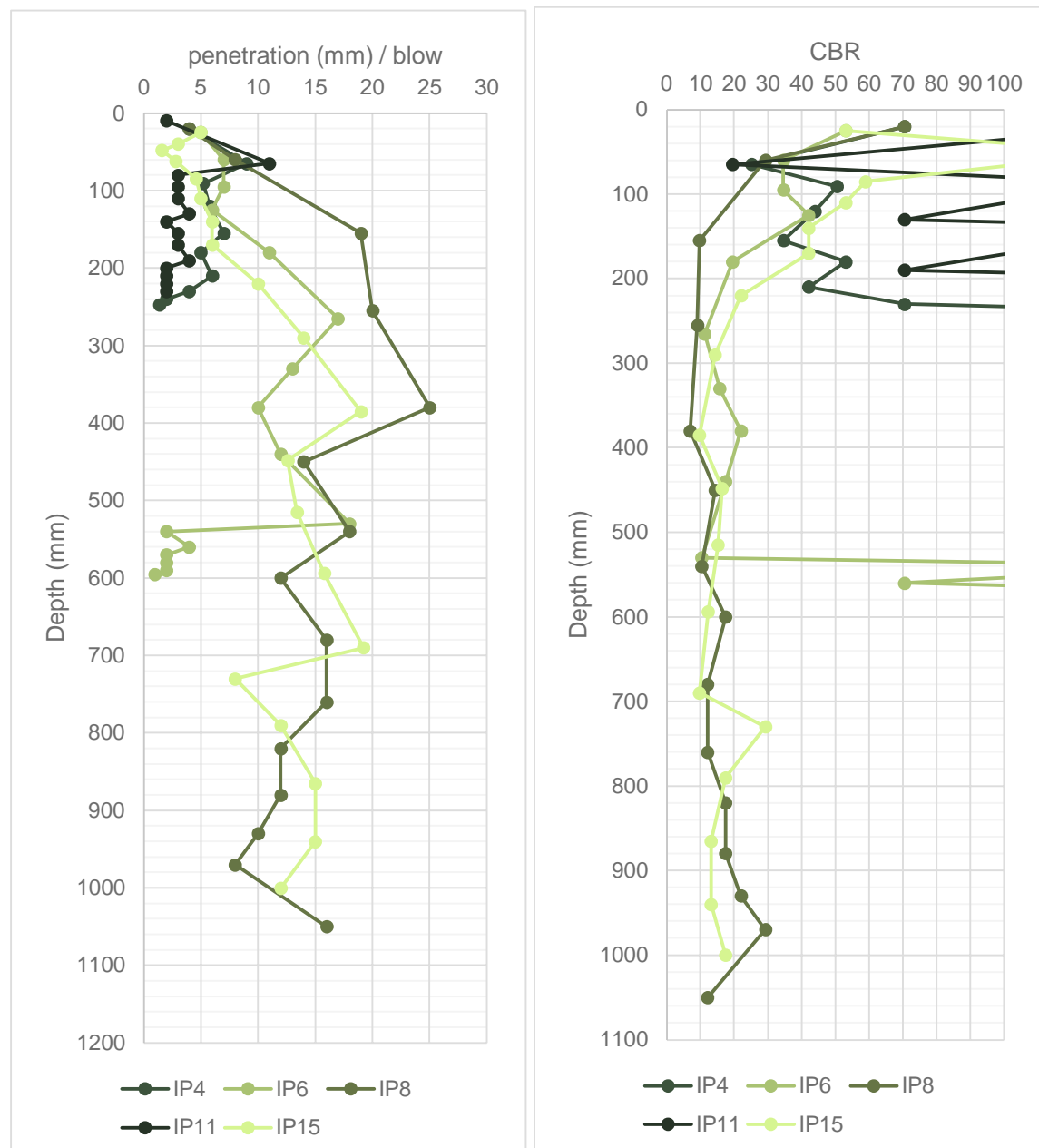
In pits IP06, IP08, and IP11, sandy silty clay residual material was encountered at an average depth of 0.8 meters below the road level. In pit IP08, a stiff sandy silty clay was found directly beneath the base course, extending to approximately 0.5 meters below the road level. This was followed by loose clayey silty sand fill material to a depth of 0.95 meters, with clayey silty sand alluvium overlying residual tillite.

In pit IP15, fill material was found beneath the base course, extending to a depth of 0.9 meters below the road level. Excavation in this pit was terminated at 0.9 meters due to the presence of a large diameter PVC pipe encountered at the base of the inspection pit.

Furthermore, solutions of phenolphthalein and hydrochloric acid were used to determine whether the base course was stabilised, and carbonation has occurred. The solutions were sprayed onto the freshly exposed face. Phenolphthalein consistently turned the base course light pink, and the hydrochloride caused the base course to effervesce, both indicating the base course has been stabilised.

The results of the DCP confirm the generally dense to very dense consistency of the base coarse and the selected fill where encountered, typically to depths of approximately 200 mm, with the underlying fill and residual soils reducing to a medium dense consistency to approximately 0.6 m to 1.0 m with the exception of IP4 which refused prematurely on boulders or remnant weathered tillite in the case of IP11.





**Figure 4-15: Road Inspection Pit DCP Test Results Graphically Represented in mm/blow vs Depth and Empirical CBR vs Depth**



**Table 4-2: Inspection Pit Profiles Summary**

No.	Topsoil	Fill		Alluvium	Residual Tillite	Residual Sandstone	Tillite	Sandstone	Groundwater Seepage Depth (m)
	Silty Sand	Non-Cohesive Silty Sand / Sandy Gravel / Pebbles, Cobbles & Boulders / Builders rubble	Cohesive Sandy Silty Clay /Silty Sandy Clay with cobble and boulders	Clayey Silty Sand	Clayey Silty fine Sand / Sandy Silty Clay	Clayey Silty Sand / Silty Sandy Clay	Soft Rock to Hard Rock	Soft Rock to Hard Rock	
IP01	0 - 0.1	0.1 - 0.25	0.25 - 1.0						-
IP02	0 - 0.1	0.1 - 0.4			0.4 - 1.4				-
IP03	0 - 0.15	0.15 - 0.25			0.25 - 0.6				-
IP05	0 - 0.15	0.15 - 0.45					0.45 - 0.75		-
IP07	0 - 0.1		0.1 - 1.0						0.8
IP09		0 - 0.35	0.35 - 0.9	0.9 - 1.5					1.2
IP10	0 - 0.15	0.15 - 0.6	0.6 - 0.95						-
IP12	0 - 0.2	0.2 - 0.65		0.65 - 1.5					-
IP13	0 - 0.1	0.1 - 0.55		0.55 - 1.4					-
IP14	0 - 0.05	0.05 - 1.3		1.3 - 1.5					-
IP16	0 - 0.1	0.1 - 1.3							-
IP17	0 - 0.1	0.1 - 0.7	0.7 - 1.4						-
IP18		0 - 1.0							1.0



**Table 4-3: Road Inspection Pit Profiles**

IP (Inspection Pit) ID	Asphalt	Base	Fill <sup>1</sup>	Concrete Slab	Fill <sup>2</sup>	Alluvium	Residual	Groundwater Seepage Depth (m)
IP11 (Road)	0 - 0.05	0.05 - 0.2	0.2 - 0.5		0.5 - 0.7		0.7 - 1.0	-
IP06 (Road)	0 - 0.03	0.03 - 0.17	0.17 - 0.3		0.3 - 0.4		0.4 - 0.55	-
IP08 (Road)	0 - 0.1	0.1 - 0.25			0.25 - 0.75	0.75 - 1.25	1.25 - 1.45	1.3
IP04 (Road)	0 - 0.1	0.1 - 0.2	0.2 - 0.35	0.35-0.45	0.45 - 0.9			0.9
IP15 (Road)	0 - 0.05	0.05 - 0.1			0.1 - 0.9			-

General material description are as follows:

- Base: Slightly moist light brownish grey, medium dense, structureless, Gravel in a sandy matrix .
- Fill<sup>1</sup>: Moist, reddish brown, loose, structureless, clayey silty SAND
- Fill<sup>2</sup>: Variable fill material comprising gravelly clayey sand, silty clayey sand and silty clay. These fill layers were not consistently observed in each road inspection pit, rather consisted of randomly sourced fill.
- Alluvium: Moist to Wet, dark black-brown, loose, structureless, clayey silty SAND
- Residual: Moist, light grey and yellowish brown, streaked and blotched orange, soft to firm, structureless, sandy silty CLAY



## 5.0 Laboratory Test Results

Soil and rock laboratory testing were undertaken by Geosure Laboratory, the results of which are summarised in Table 5-1 and Table 5-2. Detailed laboratory test results are provided in Appendix D.

The laboratory test results at each proposed structure are described below.

### 5.1 Inlet Works

The residual tillite encountered in TP01 and TP02 consist of predominantly fine material (silt and clay) averaging 51% by mass with sand making up 46%. The grading modulus ranges between 0.41 and 0.6. The average plasticity index (PI) is 15 and is classified as CL according to the Unified Soil Classification System (USCS). The results of the testing confirm the potential medium expansiveness of the residual tillite.

### 5.2 Sludge Stockpile

The residual sandstone and alluvium were subjected to indicator testing. The alluvial material comprises 80% sand by mass, showing non-plastic behaviour. These were classified as SM according to the USCS.

The residual sandstone consists of 74% sand with a PI of 9, classifying as SC according to the USCS.

### 5.3 Biofilter Pump Station/Settled Effluent Sump

Foundation Indicator, compaction and CBR tests were conducted on very soft rock sandstone samples retrieved as a gravelly material from TP26. The results indicate 60% gravel, with sand making up 24%. The PI of 4 shows minimal plasticity. Compaction test results indicate a maximum dry density and optimum moisture content of 2 057 kg/m<sup>3</sup> and 8.3% respectively. The CBR test yielded a ratio of 8.5 at 100% compaction. The material is classified as GM-GC under the USCS and G10 according to the TRH14 classification system.

### 5.4 Administration Building

Residual tillite and residual sandstone were retrieved from TP14 and TP16 respectively. The residual tillite laboratory test indicates a predominantly finer material, with silt and clay making up 61% of the sample by mass with sand comprising the remaining 39%. Atterberg limits tests indicate medium plasticity with a PI of 19. The residual tillite is classified as CL under the USCS and is confirmed as having a medium expansiveness potential.

The residual sandstone is composed of 69% sand by mass with silts and clays making the balance, showing a plasticity of 7 and classifying as SM-SC.

### 5.5 Stormwater Pipes and Outlet

Samples were retrieved from TP17 and TP22 along the western site boundary and TP18, TP20 and TP21 along the eastern section. Residual tillite test results, from TP17, indicate a predominantly sandy material with significant fines, the former making up 71% whilst the fines make up 26%. Considering shallow groundwater seepage, the moisture content of TP17 between 0.5 m and 1.6 m measure at 17.6%. Additionally, resistivity tests indicate relatively low electric resistivity of 2.64 K $\Omega$  and 1.72 K $\Omega$  for the residual tillite and alluvium respectively. The residual tillite displayed low plasticity having a PI of only 6. The alluvium from this area consists of a non-plastic sandy material having 76% sand with 22% fine sand (i.e., % < 0.425 mm).



Fill material along the eastern stormwater channel and outlet comprises 60% sand with subordinate silt and gravel. Test results indicate low plasticity with an average PI of 5. The alluvium in this area comprises non-plastic sand material having 81% sand with 19% fines. Resistivity test results indicate low to moderate resistivity of 1.81 K $\Omega$  for the fill material and 9.9 K $\Omega$  for the alluvium.

Soils with resistivity between 1 k $\Omega$  and 10 k $\Omega$  are generally considered to have a moderate potential to corrode concrete and steel, particularly if they contain moisture, salts (e.g., chlorides or sulfates), or other aggressive chemicals.

## 5.6 Second Class Water System

Alluvium from TP28 comprises 74% sand and 23% fines having no plasticity. Compaction test results indicate a maximum dry density of 2 057 kg/m<sup>3</sup> and an optimum moisture content of 10.5%, achieving a CBR of 7.8 at 100% compaction. The alluvium is classified as SM according to USCS and G10 according to the TRH14 classification system.

## 5.7 Roads

Samples retrieved from inspection pits excavated within the existing road pavement revealed the following:

- Gravelly base material, directly beneath the asphalt pavement, generally classified as G5 to G7. The average maximum dry density and optimum moisture content is 1 972 kg/m<sup>3</sup> and 7.3% respectively.
- Selected layers varied significantly in composition and classified as G8 to G10 or poorer. With the maximum dry density ranging between 1 829 kg/m<sup>3</sup> and 2 189 kg/m<sup>3</sup>, and the optimum moisture content ranging between 6.7% and 10.7%.

## 5.8 Point Load Tests

A total of six tillite core samples were tested at depths ranging from 2.73 m to 4.69 m. The results, summarised in Table 5-2, yield a maximum estimated uniaxial compressive strength of 165.18 MPa and a minimum of 71.79 MPa. Estimated using empirical conversion ratios from the ASTM D5731-02.

## 5.9 General Observation of the Laboratory Test Results

The following general observations were made based on the laboratory results:

- Residual tillite predominantly consist of fine silt and clay, averaging 47% by mass, with the grading modulus ranging between 0.36 and 0.94. The material exhibits an average plasticity index (PI) of 14 and is mostly classified as CL according to the Unified Soil Classification System (USCS).
- Residual sandstone, occasionally encountered across the site, consists of predominantly sandy material, averaging 72% with finer clay and silt contributing merely 27% combined, while having a PI of only 8. Residual sandstone is classified as SC and SM-SC.
- Alluvium comprised predominantly sand material, averaging 63% by mass with subordinate fine clays and silts making up 33%. These exhibit non plastic behaviour and classified as SM according to the USCS.
- Fill material shows significant variability with fines (clay and silt fractions) ranging from 6% to 40%, while sand and gravel average 55% and 22%, respectively and a maximum recorded PI of 12. Fill material classified as SM-SC, SC, SM and SP-SM.



- Compaction and CBR tests were conducted on very soft rock sandstone and alluvium, retrieved from TP26 and TP28 respectively. The results indicate a maximum dry density of 2057 kg/m<sup>3</sup> for both samples and an optimum moisture content of 8.3% for the very soft rock sandstone and 10.5% for the alluvium. Both samples classified as G10 according to the TRH14 classification system. Based on field observations alluvial material across the site would likely yield similar results.
- Additionally, electrical resistivity tests were performed on 5 samples. The minimum recorded value was 1.72 KΩ on samples retrieved from TP22. The highest recorded value was 9.9 kΩ on samples retrieved from TP21. The results confirm the generally corrosive nature of the subsoils.
- Additional moisture content tests were performed to determine potential seepage from the maturation ponds. The moisture content tests were done on a total of 9 samples retrieved from test pits and inspection pits in the vicinity of the maturation ponds. The results show minimum moisture content of 1.2% in IP15 at 0.2 m to 0.4 m with a maximum moisture content of 16% in TP10 at 1.2 m to 1.35 m. Generally, the moisture content increases with depth, which may well be attributed to natural groundwater.



**Table 5-1: Summary of Laboratory Results**

Test Pit	Sample Depth (m)	Description	Particle Size (%)				Atterberg Limits			Grading Modulus	Compaction		CBR						Max Swell (%)	Classification			MC (%)	Resistivity (k-ohm)
			Gravel	Sand	Silt	Clay	LL	PI	LS (%)		MDD (kg/m³)	OMC (%)	100%	98%	97%	95%	93%	90%		USCS	TRH14	PE		
INLET																								
TP1	0.35-0.65	Dark yellowish orange clayey sandy SILT. Residual Tillite	5	50	24	21	30	14	7	0.6										CL		Med		3.41
TP2	0.15-1.3	Light reddish orange sandy clayey SILT. Residual Tillite	2	42	25	31	35	16	8	0.41										CL		Med		
SLUDGE STOCKPILE																								
TP8	2.1-2.9	Dark yellow SAND. Alluvium	0	79	17	4	NP	NP	0	0.8										SM		Low		
TP24	0.7-1.9	Dark reddish orange clayey silty SAND. Residual Sandstone	3	74	15	8	20	9	4	0.93										SC		Low		
TP25B	0.9-2.0	Light grey silty SAND. Alluvium	0	80	17	3	NP	NP	0	0.85										SM		Low		
SETTLED EFFLUENT SUMP/ BIOFILTER PUMP STATION																								
TP26	1.8-2.5	Light yellowish brown silty sandy GRAVEL. Very soft rock sandstone	60	24	13	3	17	4	2	1.82	2057	8.3	8.5	6.9	6.2	5.1	4.1	3.0	0.1	GM - GC	G10	Low		
ADMIN BUILDING																								
TP14	0.4-2.0	Light yellowish orange clayey SAND. Residual Tillite	0	39	26	35	42	19	9	0.36										CL		Med		
TP16	0.2-1.45	Light grey yellowish brown clayey silty SAND. Residual Sandstone	0	69	14	17	25	7	3	0.84										SM -SC		Low		
STORMWATER PIPES & OUTLET																								
TP17	0.5-1.6	Light grey yellowish brown sandy CLAY. Residual Tillite	3	71	9	17	22	6	2	0.94										SM -SC		Low	17.6	2.64





Test Pit	Sample Depth (m)	Description	Particle Size (%)				Atterberg Limits			Grading Modulus	Compaction		CBR						Max Swell (%)	Classification			MC (%)	Resistivity (k-ohm)
			Gravel	Sand	Silt	Clay	LL	PI	LS (%)		MDD (kg/m <sup>3</sup> )	OMC (%)	100%	98%	97%	95%	93%	90%		USCS	TRH14	PE		
TP18	0.5-1.5	Dark greyish brown gravelly silty SAND. Fill	12	63	22	3	20	4	2	1.02										SM-SC		Low		
TP20	0.15-0.9	Light brown blotched orange silty gravelly SAND. Fill	24	57	14	5	10	5	2	1.34										SM-SC		Low		1.81
TP21	1.4-1.5	Dark yellow SAND. Alluvium	0	81	16	3	NP	NP	0	0.85										SM		Low		9.90
TP22	1.1-1.7	Dark greyish brown blotched yellow SAND. Alluvium	2	76	21	1	NP	NP	0	0.77										SM		Low		1.72
<b>SECOND CLASS WATER SYSTEM</b>																								
TP10	1.20-1.35	Dark yellowish greyish brown gravelly sandy CLAY. Fill																					16.0	1.88
TP11	0.30-0.60	Light greyish brown silty clayey sandy GRAVEL. Fill																					6.8	
TP11	0.80-1.55	Dark yellowish brown gravelly sandy CLAY. Fill																					13.6	
TP28	1.9-3.2	Dark grey silty SAND. Alluvium	3	74	19	4	NP	NP	0	0.84	2057	10.5	7.8	7.3	7.1	6.7	6.3	5.8	0	SM	G10	Low		
<b>INSPECTION PITS</b>																								
IP4	0.20-0.35	Dark reddish orange SAND with occasional Gravel. Fill	8	82	10		NP	NP	0	1.08	1850	10.1	47	38	34	28	22	16	0	SP-SM	G7			
IP5	0.45-0.75	Dark yellowish brown silty clayey sandy GRAVEL. Very soft rock tillite	38	41	15	6	25	8	4	1.6										SC		Low		
IP6	0.03-0.17	Dark red SAND with occasional Gravel. Fill	4	84	12		NP	NP	0	0.97	1883	7.6	46	33	28	20	14	8.7	0	SP-SM	G9			
IP6	0.40-0.55	Dark yellow clayey gravelly SAND. Residual tillite	40	42	18		23	9	4.5	1.71	2036	9.6	67	43	34	22	14	7.2	0.5	SC	G9			



Test Pit	Sample Depth (m)	Description	Particle Size (%)				Atterberg Limits			Grading Modulus	Compaction		CBR						Max Swell (%)	Classification			MC (%)	Resistivity (k-ohm)
			Gravel	Sand	Silt	Clay	LL	PI	LS (%)		MDD (kg/m <sup>3</sup> )	OMC (%)	100%	98%	97%	95%	93%	90%		USCS	TRH14	PE		
IP8	0.1-0.25	Pale red sandy GRAVEL. Fill	70	24	6		SP	SP	1	2.46	2183	4.2	97	75	66	51	39	27	0	GW, GM	G5			
IP8	0.25-0.55	Dark yellow clayey silty gravelly SAND. Fill	14	48	38		21	9	4	0.97	1973	10.7	6.3	4.9	4.4	3.5	2.8	1.9	1.3	SC	>G10			
IP9	0.35-0.9	Dark orangish brown sandy clayey SILT. Fill	2	58	12	28	33	12	6	0.64										SC		Low		
IP11	0.20-0.50	Dark reddish orange silty clayey sandy GRAVEL. Fill	48	46	6		NP	NP	0	1.96	1829	9.7	45	36	33	27	22	16	0	SP-SM	G7			
IP11	0.50-0.70	Dark yellowish brown silty SAND. Fill	3	62	35		SP	SP	0.5	0.79	2189	6.7	50	36	31	22	16	10	0	SM	G7			
IP15	0.10-0.20	Light greyish brown silty sandy GRAVEL. Fill	42	36	22		NP	NP	0	1.82										SM				
IP15	0.20-0.40	Dark reddish orange gravelly SAND. Fill	15	71	14		NP	NP	0	1.21	2001	9.8	33	23	19	14	9.6	5.6	0.4	SM	G10			
IP18	0.05-0.80	Dark yellowish brownish grey gravelly silty clayey SAND. Fill	34	51	15		NP	NP	0	1.71										SM				
IP14	0.30-0.50	Light grey silty SAND. Fill																					3.9	
IP14	0.50-0.90	Light brown clayey silty gravelly SAND. Fill																					5.3	
IP14	0.90-1.30	Light yellow silty sandy gravelly CLAY. Fill																					12.0	
IP15	0.20-0.40	Dark reddish orange silty sandy gravelly CLAY. Fill																					1.2	
IP15	0.40-0.90	Dark yellow gravelly SAND. Fill																					4.5	

LL = Liquid Limit, PI = Plasticity Index, LS = Linear Shrinkage, MDD = Max. Dry Density, OMC = Optimum Moisture Content, PE = Potential Expansiveness, MC = Moisture Content.

CL = Inorganic clays of low to medium plasticity, SM = Silty sand (sand silt mix), SC = Clayey sand (sand clay mix), GM = Silty gravels (gravel sand silt mix), GC = Clayey gravels (grave sand clay mix), GW = Well graded grave and gravel sand mix.



**Table 5-2: Summary of Point Load Test on Intact Rock Core Samples**

BH No.	Depth (m)	Rock Type	Load Direction	P(kN)	Corrected Is (MPa)	Estimated Uniaxial Compressive strength (Mpa)	Classification
BH01	2.73-2.83	Tillite	Axial	12.38	3.9	95.46	Very hard rock
BH01	3.0-3.11	Tillite	Diametric	8.18	3.13	75.21	Hard rock
BH02	4.22-4.3	Tillite	Axial	21.78	5.67	139.03	Very hard rock
BH02	2.74-2.8	Tillite	Axial	12.60	3.71	90.83	Very hard rock
BH02	4.5-4.69	Tillite	Diametric	18.14	6.88	165.18	Hard rock
BH03	4.51-4.62	Tillite	Diametric	7.9	2.99	71.79	Very hard rock



## 6.0 Geotechnical Evaluation

### 6.1 Expansive soils

Expansive soils are fine-grained, clay-rich soils that exhibit significant volumetric changes in response to moisture fluctuations. These soils contain minerals, primarily montmorillonite, that have a high affinity for water, causing the soil to swell upon wetting and shrink upon drying. This cyclicity can induce differential heaving, posing serious risks to the integrity of structures and infrastructure.

Residual tillite, formed from the weathering of Dwyka tillite, generally contains significant amounts of clay minerals, including montmorillonite, known for its relatively high swelling potential.

Laboratory test results indicate that the residual tillite samples obtained from TP01 (situated at the proposed Option A Inlet), TP02 (situation at the proposed Option B Inlet), and TP14 (north of the existing administration building) exhibits a medium potential for expansiveness, suggesting a moderate risk of volume changes in response to moisture variation. Taking into account the depth of the expansive layers which is encountered within the upper 0.4m below ground in proximity to the Inlet Works and the Admin Building and considering a layer thickness at these locations of approximately 1.0m (at the Inlet Works) and about 1.5m at the Admin building, heave of 15 to 20mm can be expected (based on Van der Merwe and Savage, 1979). It is however noted that the expansive soils will be removed at the location of the inlet works which will be constructed at depths between 3.0 to 4.0 m, however, will need to be considered with respect to founding conditions at the administration building.

The remaining residual sandstone, alluvial, and fill samples showed a low potential for expansiveness, indicating minimal risk of heave.

### 6.2 Excavatability

In accordance with the SANS1200DA soft excavation conditions can be expected within the residual and alluvial materials across the site. Excavation conditions in fill are generally soft however an allowance should be made for sporadic occurrences of boulder excavation due to the presence of tillite boulders within the fill and possibly as corestones in residual tillite.

Excavatability (rippability) for the deep foundations of the Inlet works (3-4 m), Biofilter PS and Effluent Sump (4-6 m), and possible new foundations at the administration building (1-2.5 m) is considered to be favourable within the expected soil deposits and highly weathered rock strata and may be “easy” to “hard” digging using conventional earthworks machinery.

However, allowance for localized occurrences of hard sandstone or tillite rock should be made particularly for excavations at the administration building, biofilter PS and Effluent Sump where medium hard to hard rock was encountered at depths in excess of 2.5m. Such conditions will require the use of pneumatic tools to facilitate weakening and ripping of these horizons, with allowance to be included for blasting in the case of hard rock at depths in excess of 3.5m particularly in the Biofilter Pump Station and Settled Effluent Sump area.

Table 6-1 provides an indication of the excavation classes expected at depth at each of the proposed structures.



**Table 6-1: Anticipated Excavation Classes at each Structure**

Structural Element	Proposed Founding Level (m)	Average Depth of Excavation		
		Soft	Intermediate	Hard
Inlet	3-4m	0.0-2.5	2.5-5.0	>5.0
Sludge Stockpile	0-1m	0.0-3.0	NE	NE
Biofilter Pump Station and Settled Effluent Sump	4-5m	0.0-2.0	2.0-3.5	>3.5
New Settled Effluent Sump	4-6m	0.0-2.0	2.0-3.5	>3.5
Second Class Water System	0m	0.0-3.0	NE	NE
Admin Building	1-2.5m	0.0-2.5	NE	>2.5
S/W Outlet	0.5-1.5m	0.0-2.0	NE	NE
Stormwater Channels	0.5-1.0m	0.0-2.0	NE	NE
S/W Pipe	0.5-1.5m	0.0-2.0	NE	NE

NE = Not Encountered / Indeterminate

## 6.3 Stability of Excavations

Test pit excavations generally exhibited overall stability in the short term. However, in the presence of deep cuts that need to remain open during construction works, stability could be compromised, particularly under load or during extended open excavation periods.

For the temporary earthworks and foundation excavations due consideration must be given to the final excavation depths, subsurface profile, working space and/or existing structures, the groundwater levels and proposed construction loading around the area.

Generally, open battered cut slopes and excavations are expected, but in the event that a more robust system is required or land-take requirements govern the maximum slope angles, sheet piles, soil nailed, or rock bolted lateral support may need to be considered where practical and feasible.

It is noted that the presence of shallow rock may present challenges for sheet pile installation and the presence of existing structures and underground services in proximity to the biofilter PS and effluent sump (although understood that this may not be part of the scope of work at the moment) may present challenges for soil nails or rock anchored walls.

Table 6-2 provides slope batters to be considered for excavations during construction activities.

However, sufficient allowance must be made for the inspection and mapping of side walls after excavation works by a qualified geotechnical professional to evaluate the rock mass characteristics and stability by way of kinematic analyses, and to verify the need for lateral support to stabilize deep excavations particularly where wet conditions are encountered.

The main considerations that usually govern the stability of open excavations are the type of soil, groundwater conditions, and the length of time over which the excavation is required to remain open. Prior to excavation works the contractor shall make their own and appropriate stability assessments to establish any measures required to make excavations remain stable. No man-entry shall be allowed into excavations unless appropriately battered or shored and assessed by a competent person.

To improve stability of excavations, dewatering is essential and can be achieved by sump pumps to lower the groundwater level hence reducing pore water pressure and enhancing



soil strength. Furthermore, where slumping or wet conditions prevail additional support in the form of sandbags placed at the toe of excavations or other suitable temporary support measures may be required.

Additionally regular inspections should focus on identifying signs of instability, such as cracks on the slope surface and at the crest of the excavation, sloughing of soil, bulging or water seepage near the excavation base. Immediate action, such as shoring or increase pumping of water from the sump should be taken if these signs are observed.

**Table 6-2: Provisional Estimates Slope Angles for Excavations under Dry Conditions**

Strata	Slope or Cut Depth (m)	Maximum Slope Angle	Remarks
Unconsolidated material (fill, residual and alluvial soils)	< 3.0	1V : 1.5H (in dry conditions) 1V:2H (in wet conditions)	Safe slope angles to be adjusted for soil classification, space limitations, surcharges and groundwater conditions.
Tillite and Subordinate Sandstone bedrock	< 6.0	1V : 1H (in very soft to soft rock) 1V:1.5 H (in medium hard to very hard rock)	Slope angles in rock is dependent on rock joint orientation and the presence of joints or other fractures daylighting out the cut slopes, space limitations, surcharge and groundwater conditions.  Shallower slopes may be required in less competent rock (anticipated more likely at weathered shallow depth) or in adverse kinematic conditions

## 6.4 Lateral Support Considerations

Generally, open-battered side slopes are recommended where feasible, as discussed in 6.3. The competency, weathering and shear strength of the rock mass situated below about 2.0 m to 2.5 m depth and discontinuity strength and spacing/orientation will ultimately dictate whether the temporary 1V:1.5H or 1V:1H slope is feasible for the deep excavations required for the inlet works, the pump station and settled effluent sump. However, where battering would encroach on adjacent structures (and excavations potentially undermining foundations thereof) or space is constrained, full lateral support will need to be considered.

Lateral support techniques that could be employed include the following:

- Soils nails/rock dowels with gunite.
- Contiguous piled walls.
- Sheet piled walls.
- Shoring and bracing.

The type of lateral support system will have to consider the following:

- The specific soil/rock profile at the proposed structure.
- The depth to the water table at the proposed structure.
- The presence of existing services.
- The proximity of existing structures and their potential loading upon the installed lateral support system.



## 6.5 Seepage

Groundwater seepage was primarily encountered in four areas. These are summarised in Table 6-3.

**Table 6-3: Water Seepage**

Site	Seepage Depth (m)
Sludge Stockpile	2.5 – 3.0
Western Stormwater Pipeline	1.35 – 1.7
Eastern Stormwater Pipeline	1.4 – 2.0
Second Class Water System	1.45 – 1.5

The presence of fine-textured soils with orange to red discoloration within the profile suggests periodic wet conditions.

Groundwater is likely to be present within the excavation depths proposed for several of the deeper structures and water control (groundwater and surface) must be implemented for a safe excavation and successful construction of the new structures. Based on the expected high permeability of the fill and alluvial materials and any highly weathered and jointed rock mass that has been identified from the limited geotechnical investigation, as well as the nearby presence of the Sipingo River, groundwater control solutions should be considered.

Due to the potentially high permeability of the various subsurface layers, consideration of appropriate groundwater control solutions will be required in deep excavations. Groundwater control measures should include for sump dewatering systems during construction.

In light of the shallow groundwater conditions the following recommendations are provided for buried structures and foundations to ensure structural integrity and longevity:

- Installation of drainage systems on the perimeter / and at the base of the structure (e.g. subsoil aggregate drain with perforated pipes, or blanket drain below the base connected to side drains where significant volumes of seepage is encountered) to channel water away from the structure, reducing hydrostatic pressure. Furthermore, the placing of a gravel layer with geotextile filters around the drainage pipes to prevent clogging from fine soils while ensuring efficient water flow. Water from the subsoils should be directed to a sump from which the water is pumped into the stormwater system.
- Utilize waterproof or water-resistant concrete mixes to minimize water penetration into the buried structure or foundations.

## 6.6 Pipe Backfill Material

According to SANS 1200LB – Standardised Specification for Civil Engineering Construction, Bedding (Pipes), two specific material types are required for construction along pipe alignments, namely: Selected Granular Material and Selected Fill Material.

Selected granular material comprises granular non-cohesive material that is singularly graded between 0.6mm and 19, with a compactability factor not exceeding 0.4. Based on the laboratory results the subsoils encountered on site are not singularly graded and not considered suitable as a selected granular material. Therefore, bedding material for the stormwater pipes will have to be imported.





The 'Selected Fill Material', for above the pipe in its trench cradle is to be free of organic vegetation, include no particles larger than 30 mm and have a plasticity index (PI) not exceeding 6.

The fill encountered on site were variable in composition and is laterally inconsistent, with the presence of gravels, cobbles and boulders (including builders rubble) hence rendering this material unsuitable for reuse as pipe bedding.

In generally the residual sandstone and residual tillite typically has PI values greater than 6 and is thus unsuitable for reuse.

The alluvial soils generally comprised a negligible gravel composition with PI values far lower than the upper limit of 6 and hence may be considered suitable for reuse as selected fill material. However, the difficulty of delineating this horizon during material excavation may be challenging and impractical. However, if easily demarcated and stockpiled during excavation, may be considered reusable as selected fill.

## **6.7 Roads and Ancillary Stormwater Management Structures**

### **6.7.1 Road Layers**

The DCP's undertaken adjacent to the road inspection pits were used to confirm the consistency of the material, depths of probe refusal, and to correlate empirical California Bearing Ratio (CBR) values for the near-surface road layer.

The CBR of the road layers were inferred from the penetration rate per blow. Although empirical, this relationship can be used as a guide to determine material strength characteristics of the road layers road alignment assessed.

The five DCP results indicate that the near-surface road layers to approximately 0.2 m have CBR which varies between 10 up to well over 70. Several of the DCP results refused at a depth of 200 mm, with the exception of three tests where CBR values varied between about 7 and 20 up to a depth of 1 m.

Samples retrieved from inspection pits excavated within the existing road pavement revealed that the base layer beneath the asphalt surface is of G5 to G7 according the TRH14 specification, and hence is really only considered suitable as subbase and as selected layers.

Based on the CBR values empirically derived from the DCP tests the consistency becomes poorer between 0.2 m and 1.0 m, with CBR values of between 7 and 20. Although these values are relatively high in terms of consistency, confirming medium dense to dense / stiff conditions, the value is misleading regarding TRH14 classification due to the fine grained constituents of the soil, and visually appear to be of poorer quality, rather than G6 to G9 quality according to empirically derived CBR value alone. Furthermore, the underlying subbase / selected fill layer encountered only sporadically in the road pavements and to depths between 0.4m and 0.7m (where encountered) varied significantly in composition and classifying as G8 to G10 or poorer.

Based on the result of the investigation within the roads, at areas where possible cracking and stress is apparent; it was confirmed that the pavement layers suffer from poor-quality material, inconsistent layer thicknesses, and a lack of uniformity in the pavement material composition and consistency. Furthermore, the presence of visible cracks suggests potential infiltration of groundwater, which, combined with the substandard layerworks (and compaction), may have contributed to the deterioration over time. However, it remains inconclusive whether the damage to the road is solely due to the poor quality and consistency layerworks or as result of groundwater infiltration or is likely a combination of both.





Remediation may hence require replacement of poor-quality pavement layers. Furthermore, proper drainage infrastructure (such as stormwater channels and stormwater lines) should be rehabilitated or constructed (where absent) to prevent any ingress of water into the road layers, with surface cracks to be sealed to prevent runoff ingress.

Lastly routine maintenance of the road surface, and the drainage management systems will go a long way in ensuring the longevity of the road pavements.

### 6.7.2 Subgrade Conditions at Stormwater Management System

Thirteen additional inspection pits were excavated at locations specified by the client as part of the road investigation. These pits were not within existing pavement layers and is understood to be areas where various stormwater management structures such as pipes or channels are proposed at these locations.

The profiles recorded at these pits confirm the variability of the subsoils across the site. The pits encountered cohesive and non-cohesive fill with the presence of cobbles, boulders and builders' rubble to varying depths of between 0.55 m and 1.4 m with several pits extending into alluvium, or residual tillite below the fill horizons.

It is thus considered necessary for any fill material to be stripped as it is considered unsuitable as a subgrade horizon, at the base of any engineered structures. The removed fill will need to be reinstated with soils considered suitable as a subgrade layer typically of G8 /G9 classification.

Should the base of excavations reveal non-cohesive residual or alluvial horizons, this soil will require nominal basal compaction of at least 300 mm prior to the commencement of conventional layerworks.

Should the residual or alluvium horizons comprise cohesive soils (which may be potentially expansive as in the case of residual tillite) it is recommended that consideration be given to the removal and replacement of the cohesive soils below the base of the layerworks, with the depth of removal dependent on the infrastructure proposed and its loading at the specific location under consideration. The removed cohesive soils will need to be reinstated with subsoils considered suitable as a subgrade layer typically of G8 /G9 classification.

Furthermore, should wet or saturated conditions prevail consideration for an initial rockfill (100-200mm particle diameter) pioneer layer will need to be placed before the placement of the G8/G9 material.

Bedrock (either tillite or sandstone) will make for a competent founding /subgrade horizon with limited to no basal compaction.

## 6.8 Corrosivity

Subsoils may exhibit corrosive properties depending on their chemical composition and moisture content. Corrosive soils may lead to the degradation of construction materials, particularly concrete and steel. The level of corrosiveness in subsoils can severely affect the long-term durability and structural integrity of foundations and underground structures in contact with these soils. Table 6-4 includes the results of the resistivity testing and associated corrosivity.

**Table 6-4: Resistivity and related Corrosivity of the Subsoil**

Structure	Material Type	Depth (m)	Resistivity (Ohm)	Corrosivity
Inlet	Residual tillite (clayey sandy silt)	0.35-0.65	3410	Corrosive



Structure	Material Type	Depth (m)	Resistivity (Ohm)	Corrosivity
Stormwater Pipes and Outlet	Residual tillite (sandy clay)	0.5-1.6	2640	Corrosive
Stormwater Pipes and Outlet	Fill (silty gravelly sand)	0.15-0.9	1810	Very corrosive
Stormwater Pipes and Outlet	Alluvium (sand)	1.4-1.5	9900	Mildly corrosive
Stormwater Pipes and Outlet	Alluvium (sand)	1.1-1.7	1720	Very corrosive
Second Class Water System	Fill (gravelly sandy clay)	1.2-1.35	1880	Very corrosive

The results of the laboratory testing confirm the potentially corrosive nature of the residual tillite material, fill and alluvial soils. As such measures to protect against chemical degradation of concrete and steel will be necessary to mitigate the potential corrosiveness of the subsoils on site. This may include for the following measures:

- Incorporate pozzolanic additives (e.g., fly ash) to enhance the impermeability of concrete mix will reduce the ingress of chlorides and other corrosive agents.
- Installation of effective waterproofing systems may further eliminate moisture infiltration and ensure that the structures are not exposed to corrosive soils over prolonged periods.
- Protective coatings or cathodic protection will be essential to steel piles to minimize corrosion. Alternatively, opt for non-corrosive materials such as composite or stainless-steel pipes.

Proper design, and protective measures can significantly enhance the durability and longevity of concrete and steel pipework in corrosive environments.

It is recommended that more conclusive testing, such as the Langelier and Ryznar indices, be conducted to derive the Basson aggressiveness index in order to definitively quantify the corrosivity, where deemed necessary.

## 6.9 Founding and Surface Bed Conditions and Recommendations

Test pits and boreholes revealed that the site is underlain by a variable surficial fill layer, which overlies residual Dwyka tillite, residual sandstone, or alluvium. In the northwestern portion of the site, shallow bedrock is encountered.

Fill material across the site includes a mix of gravel, cobbles, and boulders in a silty sand matrix, with varying thicknesses and compositions including waste and rubble.

Subsoil conditions vary, with alluvium along the northeastern boundary consisting of dark brown silty sand and clay, and organic-rich layers present in some areas.

Residual tillite generally appears as firm to soft silty clay, depending on moisture levels, while residual sandstone is typically a sandy clay and subordinately a silty sand.

Sandstone and tillite are present, with sandstone as weathered or unweathered fine to medium-grained sandstone, and Dwyka tillite underlying much of the site ranging from highly weather to unweathered at depths greater than approximately 5 m.

The choice of the most suitable founding solution is dictated by the following factors:

- Variable soil conditions across the site.
- Structural loads, structural tolerance and sensitivity to settlement.



The structural tolerances to settlement have not been made available. Thus, recommendations are based solely on given structural loads and based on the conditions observed on site.

### **6.9.1 Inlet Works**

With option A being considered the preferred site for the Inlet works which is expected to be constructed with a founding depth of 3 to 4 m, the anticipated founding horizon is expected to be within the very soft rock tillite. This should provide an adequate founding medium for the inlet works, with an allowable bearing pressure of 750 kPa being considered for design purposes.

Should differential founding conditions appear to be possible due to the inlet structure straddling completely weathered tillite (soil) and very soft rock (which is expected at this depth) it is suggested that all soil be removed to the depth of soft rock and backfilled up to founding level with soilcrete (or mass concrete).

Settlement of the foundation on the tillite rock is expected to be negligible.

Upon excavation to the final base level, the in-situ surface must be properly prepared before the placement of the raft slab, or surface bed. This preparation involves thoroughly clearing the area to remove any loose soil or rock material, as well as removing as much standing seepage water as practically possible. Once the surface is cleaned, a concrete blinding layer should be applied to the prepared ground. This provides a stable base on which the surface bed or slab can be constructed, ensuring proper support and integrity of the structure.

### **6.9.2 Sludge Stockpile**

The sludge stockpile area at the northeastern boundary, adjacent to the Sipingo River, has a surficial fill layer ranging from surface to depths of 0.5 to 1.6 m, which overlies silty sand alluvium which in turn overlies residual sandstone of variable composition.

The variable composition, presence of builder's rubble, and erratic consistency between the test pit observations and the DCP results confirms the potential unsuitability of the fill subsoils across the sludge stockpile area. It is thus considered necessary for any fill material to depths of approximately 1.0 m to be stripped as it is considered unsuitable as a subgrade horizon below the proposed stockpile. The removed fill should be reinstated with a 300 mm thick pioneer layer placed on the insitu soil which should be ripped and recompacted to 90-93% Mod AASHTO. The pioneer layer should comprise 100-200 mm sized / diameter particles with a geofabric placed over the pioneer layer to prevent washing of fines from above into the layer. This in turn should be overlain by engineered fill considered of G6 classification which should be compacted to 95% Mod AASHTO density, at -1% to +2% of optimum moisture content, in 150 mm lifts. An allowable bearing pressure of approximately 120 kPa may be considered for design considerations, with elastic settlement of approximately 75 mm anticipated (assuming a concrete raft of 32 m x 32 m).

Additionally, proper drainage measures should be implemented to prevent water accumulation and ingress and maintain soil strength.

### **6.9.3 Biofilter Pump Station & Settled Effluent Sump**

The results of the site investigation indicate that the subsurface profile at the location of the pump station (which is currently on hold) and the proposed settled effluent sump are underlain by tillite which occurs at depths of approximately 2.0 m to depths in excess of 7.5 m. It is understood that the proposed structures are expected (for the proposed sump) to be founded at depths in the order of 4 to 6 m.



The weathered, medium hard to hard rock expected at the founding level should provide an adequate founding medium for the proposed structures with an allowable bearing pressure of 1.5 MPa anticipated for design purposes.

Where differential founding conditions appear to be possible, due to the structure straddling soil and rock (i.e. where the conditions vary from that found from the field investigation), it is suggested that all soil be removed to the depth of soft rock and backfilled up to founding level with mass concrete or soilcrete.

Settlement of the foundation on the tillite rock is expected to be negligible.

Upon excavation to the final base level, the in-situ surface must be properly prepared before the placement of the raft slab, or surface bed. This preparation involves thoroughly clearing the area to remove any loose soil or rock material, as well as removing as much standing seepage water as practically possible. Once the surface is cleaned, a concrete blinding layer should be applied to the prepared ground. This provides a stable base on which the surface bed or slab can be constructed, ensuring proper support and integrity of the structure.

#### **6.9.4 Administration Building**

The area around the existing administration building is generally underlain by clayey residual soils with shallow bedrock encountered at approximately 2.5 m below the existing ground level, as indicated in BH01.

The results of the DCP and SPT testing indicated that the allowable bearing pressure of the upper residual soils to a depth of 1.5 m is approximately 75 kPa. Hence any additional loading as a result of renovations to the existing administration building needs to be restricted to 75 kPa. This allowable bearing pressure assumes the structure is presently founded within the residual soils on shallow conventional footings, with elastic settlement of approximately 10mm anticipated (assuming a strip footing of 0.7 m width).

It is however noted that the residual tillite underlying the administration building is prone to moisture related movement (classifying as having a medium expansiveness potential), and hence to avoid any differential conditions, new footings need to be taken below the expansive residual tillite and founded on the tillite rock anticipated at approximately 2.5 m depth, where negligible settlement is expected.

Given the depth of the tillite, such deep excavations may not be practical, as such it is recommended that new footings should be founded on a soil raft constructed to a depth of 1.5 times the footing width and 1.0m beyond the perimeter of the structure. The soil raft should comprise of at least G6 quality engineered material in compacted layers not exceeding 150 mm thickness to 95% Mod AASHTO density, at -1% to +2% of optimum moisture content, up to the desired founding levels. A bearing capacity of at least 85 kPa (as required according to loads provided) can be attained within the soil raft with total elastic settlement of approximately 10mm anticipated (assuming a strip footing of 0.7m width and differential settlement taken as 50% of total settlement).

Furthermore, any new foundations should be isolated from the existing building foundations by isolation joints to mitigate against differential settlement conditions and hence ensuring the structural integrity of the existing and new building components.

#### **6.9.5 Stormwater Pipe, Channel and Outlet**

##### **6.9.5.1 Stormwater Pipe**

Based on the soil profiles at the northeastern and southwestern stormwater pipeline, excavation to the depth of the proposed pipeline of 1.5 m is considered to categorise as soft,



according to SANS 1200D. As groundwater is expected at the depths of the pipeline trenches, it is recommended that sumps are excavated at regular intervals along the pipeline trench from which the water is to be pumped out in order to provide dry working conditions during pipe installation

According to SANS 1200LB – Standardised Specification for Civil Engineering Construction, Bedding (Pipes), two specific material types are required for construction along pipe alignments, namely, Selected Granular Material and Selected Fill Material.

Due to the variable nature of the subsoils (including the presence of cobbles and boulders, and builders rubble), the materials for the bedding cradle will have to be sourced from commercial sources.

The alluvial soils were found to have particle sizes smaller than the required 30mm and a Plasticity Index (PI) of less than 6 which is stipulated as material requirements for a selected fill blanket. The results of the testing indicate that the alluvial soils are considered suitable for use as selected fill blanket, provided that the horizon can be feasibly demarcated and separated during excavation and stockpiled for reuse. If the volume of these soils is insufficient for use as selected fill material, or if this unit cannot be adequately demarcated, it may be necessary to import suitable selected fill material as well.

In general, the in-situ subsoils excavated from the pipe trenches appears to be suitable only as main fill provided that all rubble is removed and all cobbles and boulder greater than 100 mm diameter are removed.

#### **6.9.5.2 Stormwater Outlet**

The results of the investigation indicate no bedrock at the location of the proposed stormwater outlets of the northeastern and southwestern pipelines. The discharge velocity and flow of the water is expected to result in continuous erosion and scour of the soil banks. As such measures such as the use of gabion baskets and Reno mattresses to create a barrier/ protective structure to prevent scour and erosion of the subsoils will be necessary. Additional hydraulic studies may be necessary to assess the impacts of the discharge water into the streams, as deemed necessary.

#### **6.9.5.3 Headwall**

The subsoils at the location of the two outlets are consider unsuitable as a founding medium given its poor consistency and the presence of builder's rubble in the fill horizons. As such in order to improve the allowable bearing pressure and mitigate any movement of the headwall and subsequently the pipe, it is recommended that the structures be founded on top of a 0.6 m thick soil raft.

This will involve the removal of the fill soils to a depth and width of at least 0.6 m below the headwall. The in-situ soil at the base of the excavation should then be compacted to at least 90-93% Mod AASHTO. The removed material should be replaced with an imported and approved G6 engineered material or better-quality material in compacted layers not exceeding 150 mm thickness to 95% Mod AASHTO density, at -1% to +2% of optimum moisture content, up to the desired founding levels. A bearing capacity of at least 75 kPa can be attained within the soil raft.

As a general rule, settlement of the fill is taken as 0.1% of the fill height for the well compacted fill.

#### **6.9.5.4 Stormwater Channel**

The subsoil profile at the location of the stormwater channel which extends westwards along the southwest pipeline (in the vicinity of TP17) is underlain by fill of clayey silty sand and sandy silty clay of variable consistency, which in turn is underlain by residual tillite





comprising firm sandy silty clay. It is proposed that the stormwater channel should be placed over a 0.45 m soil raft of G6 compacted layers not exceeding 150 mm thickness to 93% Mod AASHTO density, at -1% to +2% of optimum moisture content.

### 6.9.6 Second Class Water System

The area designated for the new second class water system, located at the southernmost end of the site adjacent to the current chlorine plant, is characterized by fill material of variable composition which extends to depths of up to 1.8 m with erratic consistency. The fill in turn is underlain by loose to dense silty sand alluvium which extends to depth in excess of 3.2 m.

Given the unsuitability of the alluvium as a founding medium due to its variable consistency, it is recommended that the proposed structure which will comprises a 300 mm concrete raft slab which shall be founded on a soil raft. The soil raft should reduce the potential settlements, improve the allowable bearing capacity, and negate the effects of differential movement.

This will involve the removal of the fill and alluvium to a depth of at least 1.0 m the below the founding level. The in-situ soil at the base of the excavation should then be ripped and compacted to at least 90-93% Mod AASHTO. The removed material should be replaced with a 300 mm pioneer layer. The pioneer layer should comprise 100-200 mm sized / diameter particles with a geofabric placed over the layer to prevent washing of fines into the rockfill. This in turn should be followed by an imported G6 engineered material compacted in layers not exceeding 150 mm thickness to 95% Mod AASHTO, density at -1% to +2% of optimum moisture content, up to the desired founding levels. A bearing capacity of at least 100 kPa is achievable within the soil raft with expected total elastic settlement of up to 20 mm assuming a 3.0 m x 3.0 m raft slab). Differential settlement is taken as 50% of total settlement in this instance.

As a general rule, settlement of the engineered fill may be estimated as 0.1% of the fill height for the well compacted fill.

### 6.10 Maturation Pond Seepage

Concerns related to the possible seepage from the Maturation ponds have been raised. As such preliminary assessments included the testing of soils adjacent the ponds to establish where these concerns are warranted. Samples were retrieved from IP14 and IP15, along the northern boundary of the maturation ponds, and from TP10 and TP11 along the southern boundary. Each test pit was excavated within 4 to 5 m from the maturation pond.

The results of the moisture content testing conducted on samples taken from test pits in proximity to the maturation ponds indicate varying levels of saturation, with elevated values in TP10 (16.0%) and TP11 (6.8% and 13.6%). These elevated moisture levels, particularly at greater depths—such as TP10 between 1.20-1.35 m—suggest potential seepage from the maturation pond. However, the rise in moisture content with depth, as seen in IP14 (from 3.9% at 0.30-0.50 m to 12.0% at 0.90-1.30 m), could also be influenced by the shallow groundwater table, as observed across the site. Thus, while these results hint at seepage, they remain inconclusive.

Given the shallow groundwater conditions, relying solely on moisture content testing may not definitively confirm leakage. To reach a clearer conclusion, further detailed investigations are recommended. Installing piezometers would provide valuable data by allowing for continuous monitoring of groundwater levels and flow patterns. Additionally, soil contamination testing, ground-penetrating radar (GPR), and electrical resistivity surveys could help identify seepage zones. Dye tracer tests in the pond, with subsequent



groundwater or soil monitoring for the presence of dyes, would further aid in confirming seepage.

## 6.11 Overall Conclusions

The geological and geotechnical conditions across the site are highly variable, which is expected given its history as a developed brownfield site with multiple WWTW component structures of variable configurations. The subsurface profile reflects this variability, with layers of fill materials of differing compositions, alluvial deposits of a heterogenous nature, and residual soils, all underlain by tillite (or to a limited extent by subordinate sandstone).

Due to the presence of existing structures and subsurface services, this investigation was limited to a restricted number of boreholes and test pits, confined to areas accessible near the proposed new structures. This limitation made it challenging to fully define the geological profile at each proposed structure location.

As a result, it is crucial that the **geological findings be verified during construction by a geotechnical specialist. This will ensure that any discrepancies or previously unidentified conditions can be addressed when access restrictions and limitations related to the existing site infrastructure and subsurface services are no longer an issue.**

The results of the investigation confirm the suitability of the site for the proposed infrastructure provided cognisance is taken of the finding of this geotechnical investigation.

The scope of this report is limited to the specific area and conditions investigated at the time of the assessment. Variations in subsurface conditions may exist beyond the investigated locations.

Regards,

**SLR Consulting (South Africa) Proprietary Limited**



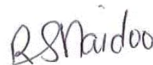
**Ahmad Patel**

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**Trevor Pape**

Technical Director – Geotechnical Engineering  
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**Rannel Naidoo**

Technical Discipline Manager – Geotechnical Engineering  
[rnaidoo@slrconsulting.com](mailto:rnaidoo@slrconsulting.com)



## References

- Brink, A. B. A. (1979). Engineering geology of Southern Africa. V. 3
- Brink, A. B. A., & Bruin, R. M. H. (2002). Guidelines for soil and rock logging in South Africa, 2nd impression.
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- South African Standard SANS 10160 (2010)
- South African Institution of Civil. Engineering - Geotechnical Division (2010), Site Investigation Code of Practice, 1st Edition.
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Van der Merwe, D.H. (1964). Prediction of Heave from the Plasticity Index and Percent Fraction of Soils. *The Civil Engineer in* , Vol 6, No 6, June 1964, pp 103-107., Vol 6, No 6, June 1964, pp 103-107.

## Record of Report Distribution

SLR Reference:	720.070334.00001
Title:	Isipingo Wastewater Treatment Works Geotechnical Investigation Report
Report Number:	01
Client:	Zutari (Pty) Ltd

Name	Entity	Copy No.	Date Issued	Issuer
S Jugwanth	Zutari	1 (e-copy)	20 September 2024	RN
T Moodley	Zutari	1 (e-copy)	20 September 2024	RN



# Appendix A    General Site Layout

## Isipingo Wastewater Treatment Works Geotechnical Investigation Report

Isipingo, KwaZulu-Natal

Zutari (Pty) Ltd

SLR Project No.: 720.070334.00001

20 September 2024










TEST PIT SETOUT TABLE		
BH No.	EASTING (m)	NORTHING (m)
TP01	9167.62	3318875.54
TP02	9114.45	3318880.54
TP4	9038.33	3318964.12
TP5	9024.94	3318941.38
TP6	9017.30	3318961.99
TP7	9019.89	3318976.18
TP8	8999.93	3318964.20
TP10	9024.47	3319277.15
TP11	9013.75	3319289.44
TP12	9149.57	3318997.90
TP14	9077.89	3318964.48
TP15	9132.69	3318978.61
TP16	9100.54	3318981.82
TP17	9154.06	3319042.14
TP18	8947.51	3318979.23
TP19	8955.99	3318995.87
TP20	8982.91	3319004.42
TP21	8999.78	3319031.70
TP22	9121.11	3319099.76
TP23	9113.47	3319127.91
TP24	9026.34	3318951.30
TP25A	9005.71	3318968.64
TP25B	9004.04	3318967.43
TP26	9141.48	3318991.66
TP27	9184.95	3318849.56
TP28	9020.18	3319280.78

INSPECTION PIT SETOUT TABLE		
BH No.	EASTING (m)	NORTHING (m)
IP1	9193.29	3318866.47
IP2	9194.71	3318891.97
IP3	9200.38	3318922.12
IP4	9120.83	3318858.10
IP5	9187.89	3318975.99
IP6	9164.63	3318987.94
IP7	9150.87	3319051.45
IP8	9119.11	3319077.03
IP9	9125.65	3319089.12
IP10	9094.15	3319145.41
IP11	9055.02	3318974.88
IP12	9014.91	3319054.11
IP13	8964.92	3319023.82
IP14	8970.65	3319137.21
IP15	9009.40	3319185.36
IP16	9057.51	3319232.39
IP17	9042.72	3319268.96
IP18	9062.88	3319274.41

BOREHOLE SETOUT TABLE		
BH No.	EASTING (m)	NORTHING (m)
BH01	9104.51	3318984.35
BH02	9129.31	3318978.38
BH03	9164.44	3318859.35

LEGEND	
	BOREHOLES
	INSPECTION PITS
	TEST PITS

[illegible]





# Appendix B   Previous Investigation

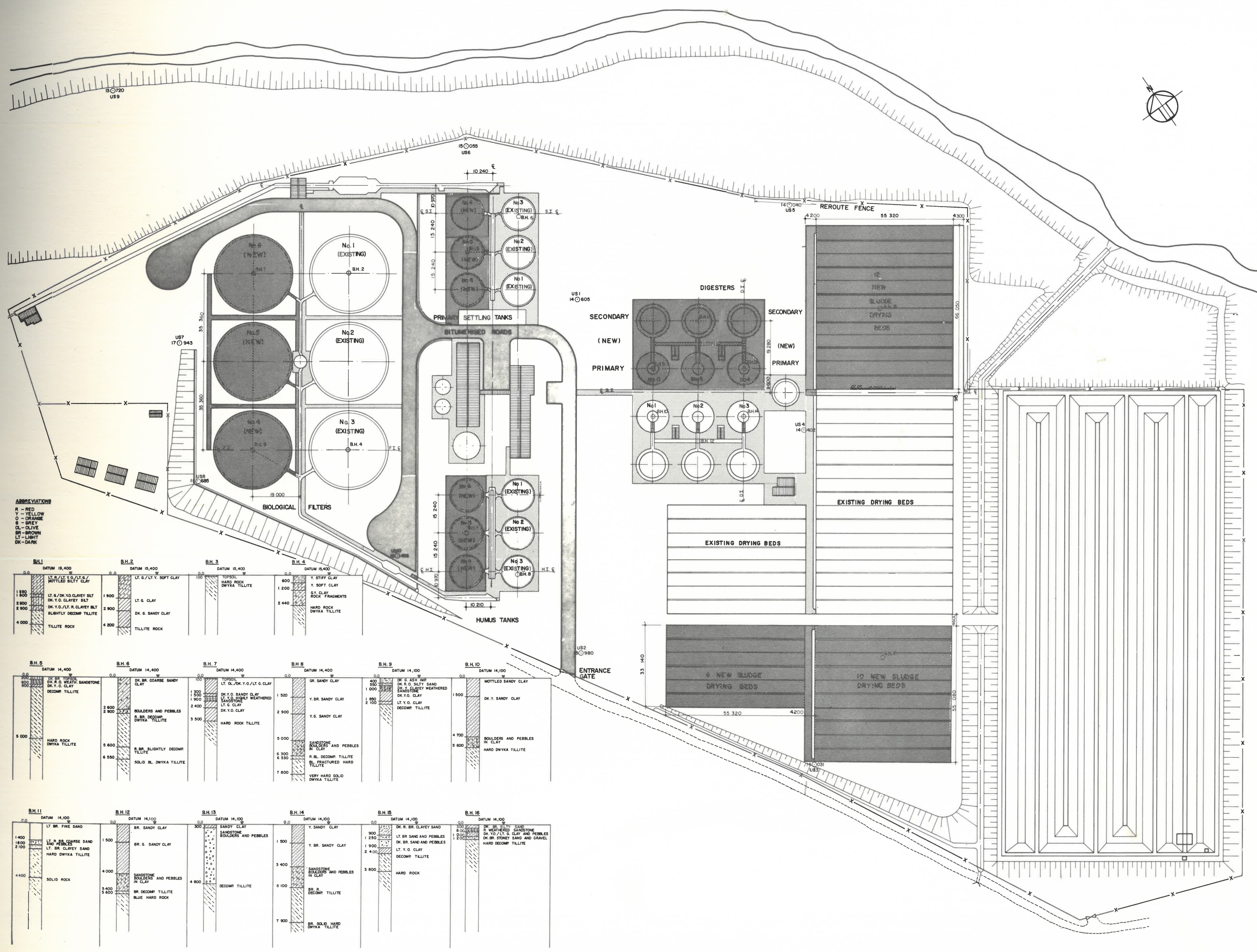
## **Isipingo Wastewater Treatment Works Geotechnical Investigation Report**

**Isipingo, KwaZulu-Natal**

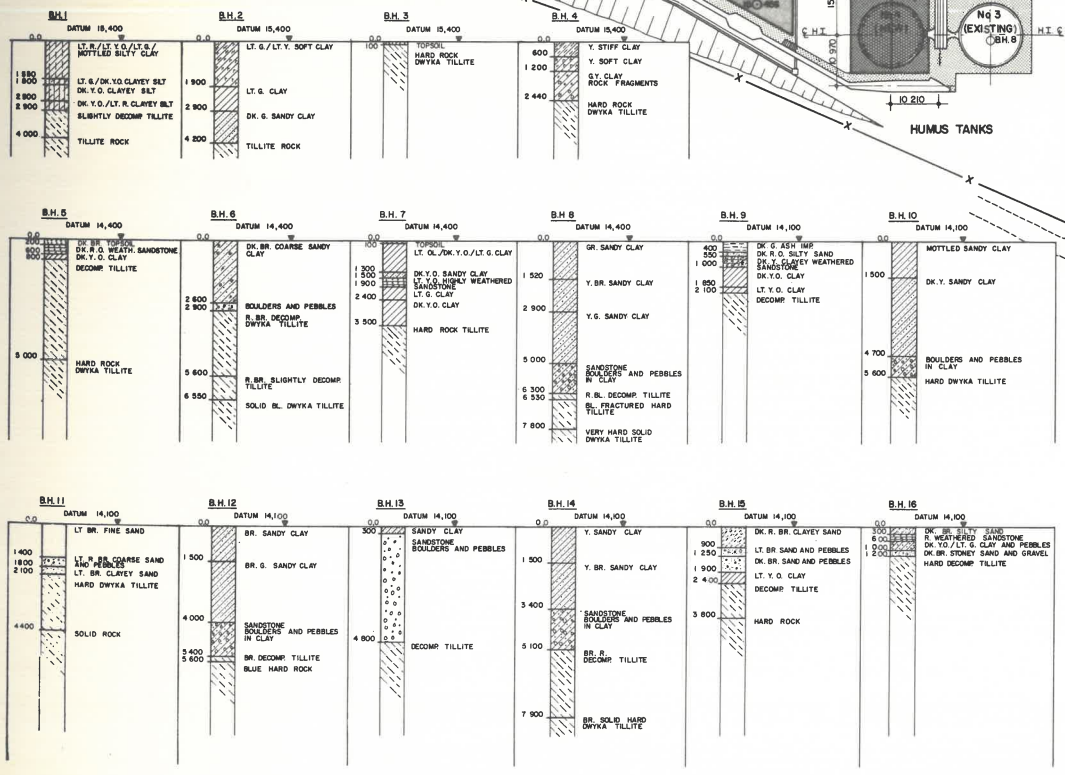
**Zutari (Pty) Ltd**

SLR Project No.: 720.070334.00001

20 September 2024



**ABBREVIATIONS**  
 R - RED  
 Y - YELLOW  
 O - ORANGE  
 G - GREEN  
 BL - BLUE  
 LT - LIGHT  
 DK - DARK



REDUCED DRAWING



NO NR	WYSIGINGS	AMENDMENTS	APPR GDK	DAT.
<b>GEUSTYN, FORSYTH &amp; JOUBERT</b> 0000, PIERA, T.A. & E. REG. FIRM T.A. & E.				
<b>RAADGEWENDE SIVILE &amp; STRUKTURELE INGENIEURS</b> CONSULTING CIVIL & STRUCTURAL ENGINEERS				
SURVEYED / OPGEMEET		TRACED / NAGETREK		
COMPILED / SAAMGESTEL		ADAPTED / AANGEPAS		
DRAWN / GETEKEN		CHECKED / NAGESIEN		
DESIGNED / ONTWERP		APPROVED / GOEDGEKEUR		
746/201/02/0		PROJECT NO. _____ PROJECT NAME _____ PROJECT DATE _____		
PLAN NR. / NO.		DATE / DATUM		
NAAM EN ADRES VAN OPDRAG-AGENT NAME AND ADDRESS OF COMMISSION AGENT				
NOT APPLICABLE				
AANBEVEEL		RECOMMENDED		
NA		DATE / DATUM		
 <b>DEPARTEMENT VAN ONTWIKKELINGSHULP</b> <b>DEPARTMENT OF DEVELOPMENT AID</b>				
HOOFDIREKTORAAT: WERKE DIREKTORATE: SIVILE EN LANDBOU INGENIEURSDIENSTE CHIEF DIRECTORATE: WORKS DIRECTORATES: CIVIL AND AGRIC. ENGINEERING SERVICES				
AANBEVEEL		RECOMMENDED		
GOEDGEKEUR		DATE / DATUM		
APPROVED		DATE / DATUM		
GEBIED / REGION AND DEPARTMENT				
KWAZULU				
PROJEKTITEL / PROJECT TITLE UMLAZI SEWAGE TREATMENT WORKS GENERAL LAYOUT PLAN: SETTING OUT AND FOUNDATION TRIAL HOLES				
PROJEK NR. / PROJECT NO.		LEER / FILE		
Z710		E5/6/6/710		
SKAAL: 1:750				
DEPT PLAN NR. BD 53/MP/5.3				
DEPT PLAN NO.				
VEL SHEET	3	VAN OF	38	VELLE SHEETS REV.



# **Appendix C    Test Pit, Inspection Pit and Borehole Logs & Photographs**

## **Isipingo Wastewater Treatment Works Geotechnical Investigation Report**

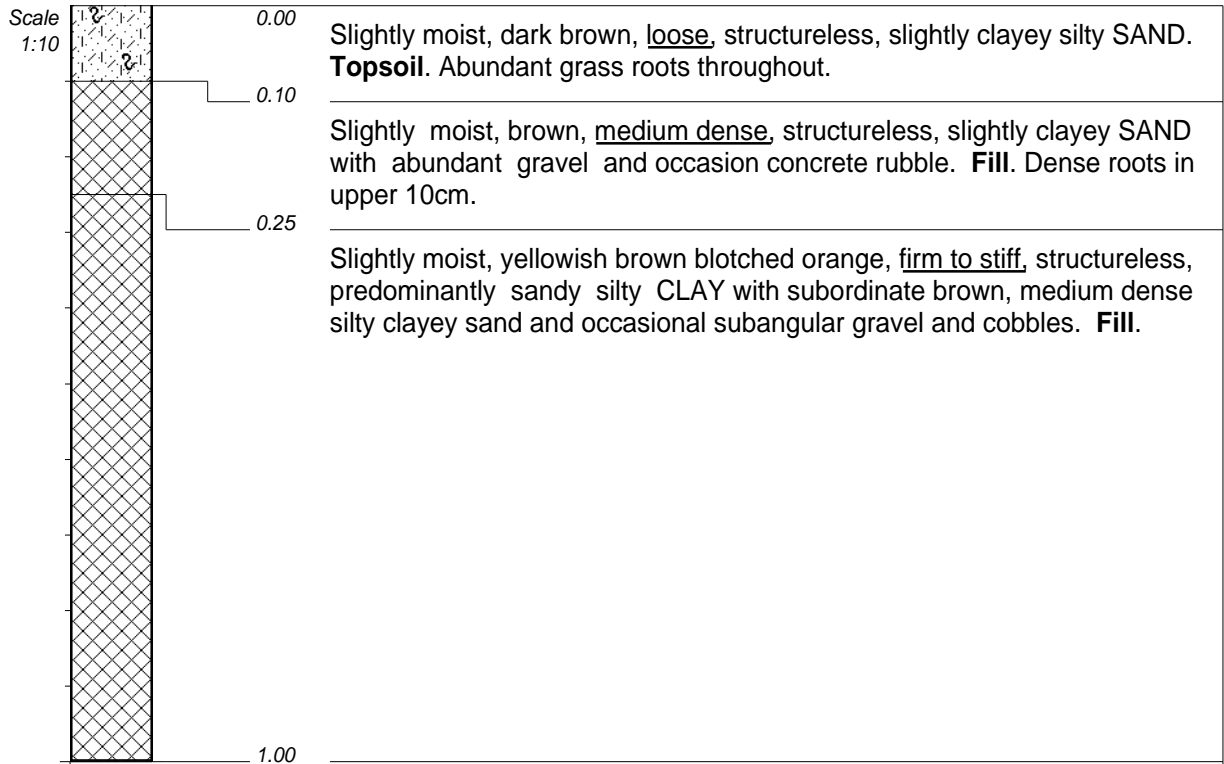
**Isipingo, KwaZulu-Natal**

**Zutari (Pty) Ltd**

SLR Project No.: 720.070334.00001

20 September 2024





END OF HOLE

#### NOTES

- 1) Stopped at 1,0m due to concrete pipe (not shown on drawing).
- 2) Concrete block at 0,7m.
- 3) No groundwater seepage encountered.
- 4) Sidewalls stable.
- 5) No samples taken.

CONTRACTOR :  
MACHINE : Hand excavated  
DRILLED BY :  
PROFIED BY : A. Patel  
TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

INCLINATION : Vertical  
DIAM :  
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DATE : 24 July 2024  
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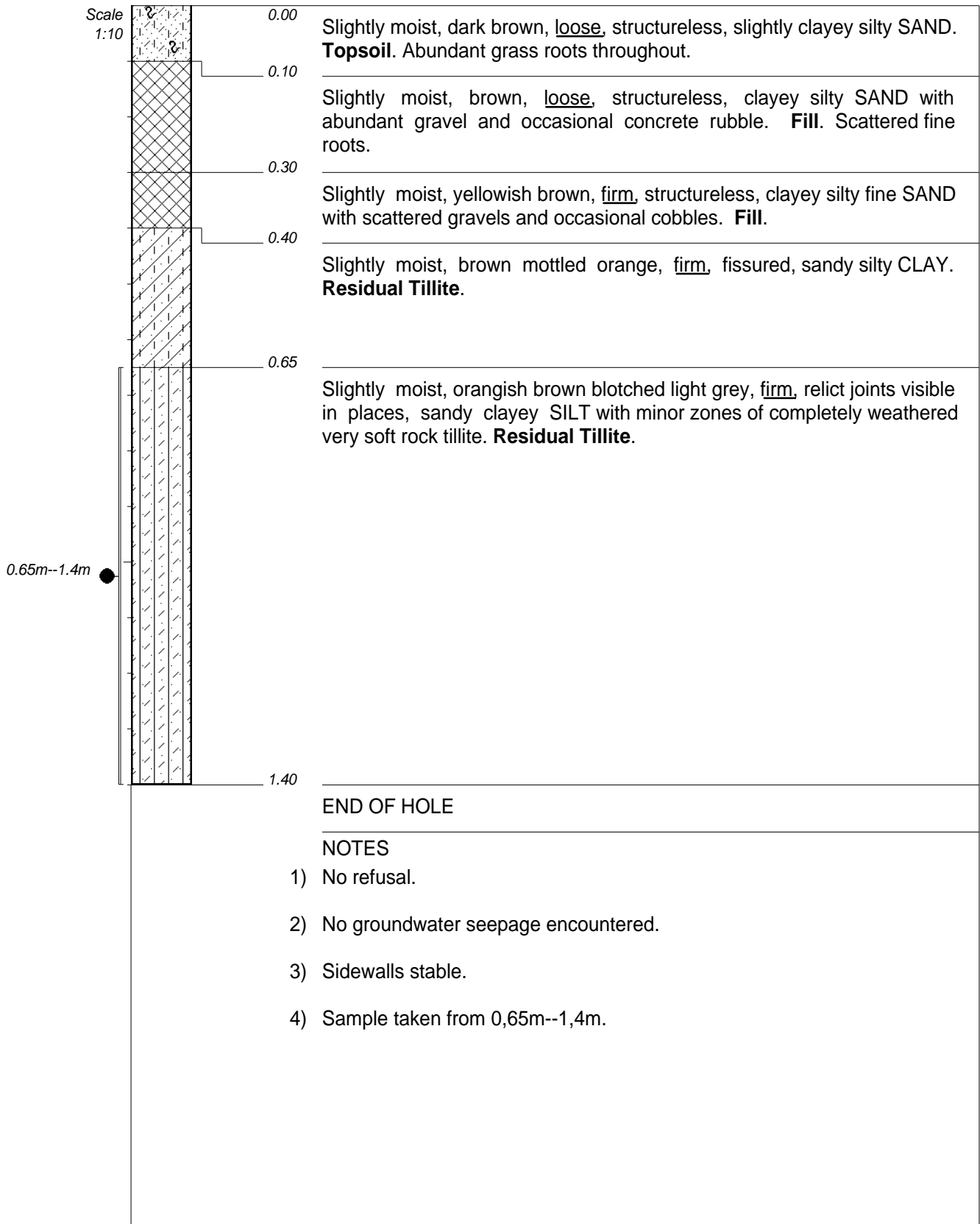
ELEVATION :  
X-COORD : 30°54'17.03"E  
Y-COORD : 29°59'19.38"S

**HOLE No: IP01**

IP01







CONTRACTOR :  
MACHINE : Hand excavated  
DRILLED BY :  
PROFIED BY : A. Patel  
TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

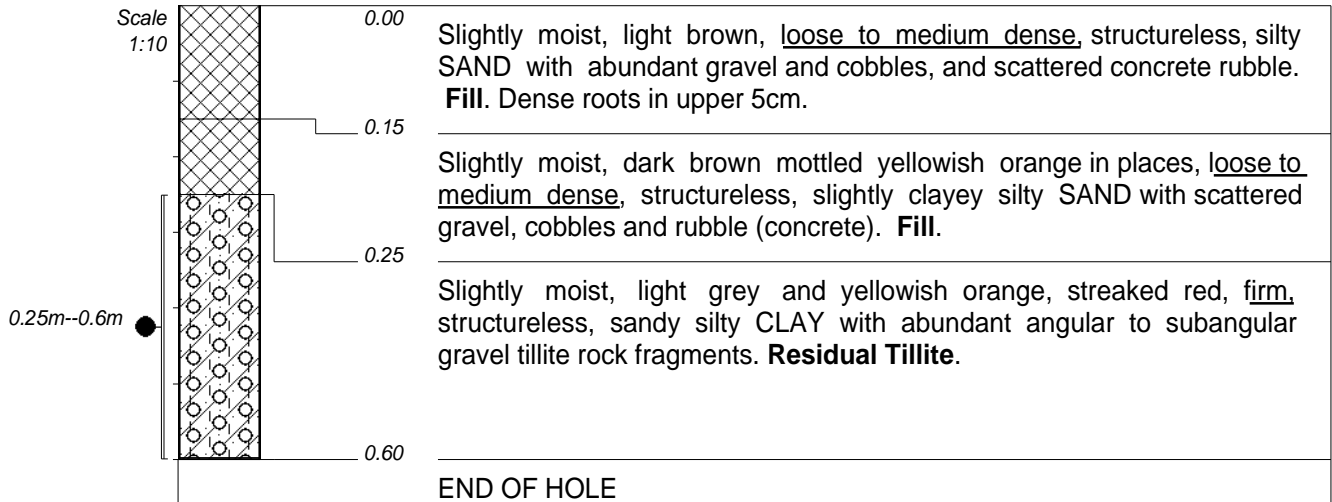
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ELEVATION :  
X-COORD : 30°54'16.97"E  
Y-COORD : 29°59'20.21"S

**HOLE No: IP02**

**IP02**





#### NOTES

- 1) Refusal on soft rock tillite.
- 2) No groundwater seepage encountered.
- 3) Sidewalls stable.
- 4) Sample taken from 0,25m--0,6m.

CONTRACTOR :  
MACHINE : Hand excavated  
DRILLED BY :  
PROFILED BY : A. Patel  
TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

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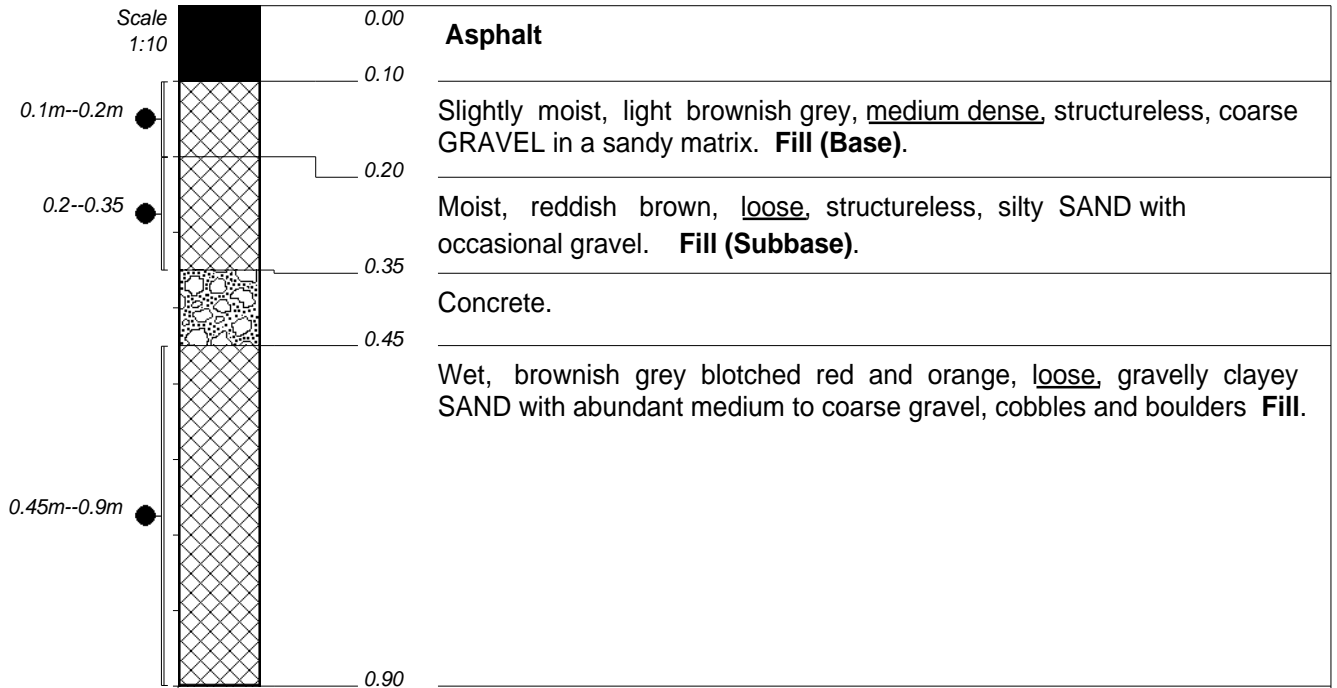
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X-COORD : 30°54'16.76"E  
Y-COORD : 29°59'21.19"S

**HOLE No: IP03**



IP03





END OF HOLE

**NOTES**

- 1) Refusal on boulders.
- 2) Slight seepage at base.
- 3) Sidewalls stable.
- 4) Samples taken at 0,1m--0,2m; 0,2--0,35; 0,45m--0,9m.

CONTRACTOR :  
MACHINE : Hand excavated  
DRILLED BY :  
PROFILED BY : A. Patel  
TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

INCLINATION : Vertical  
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DATE : 29 July 2024  
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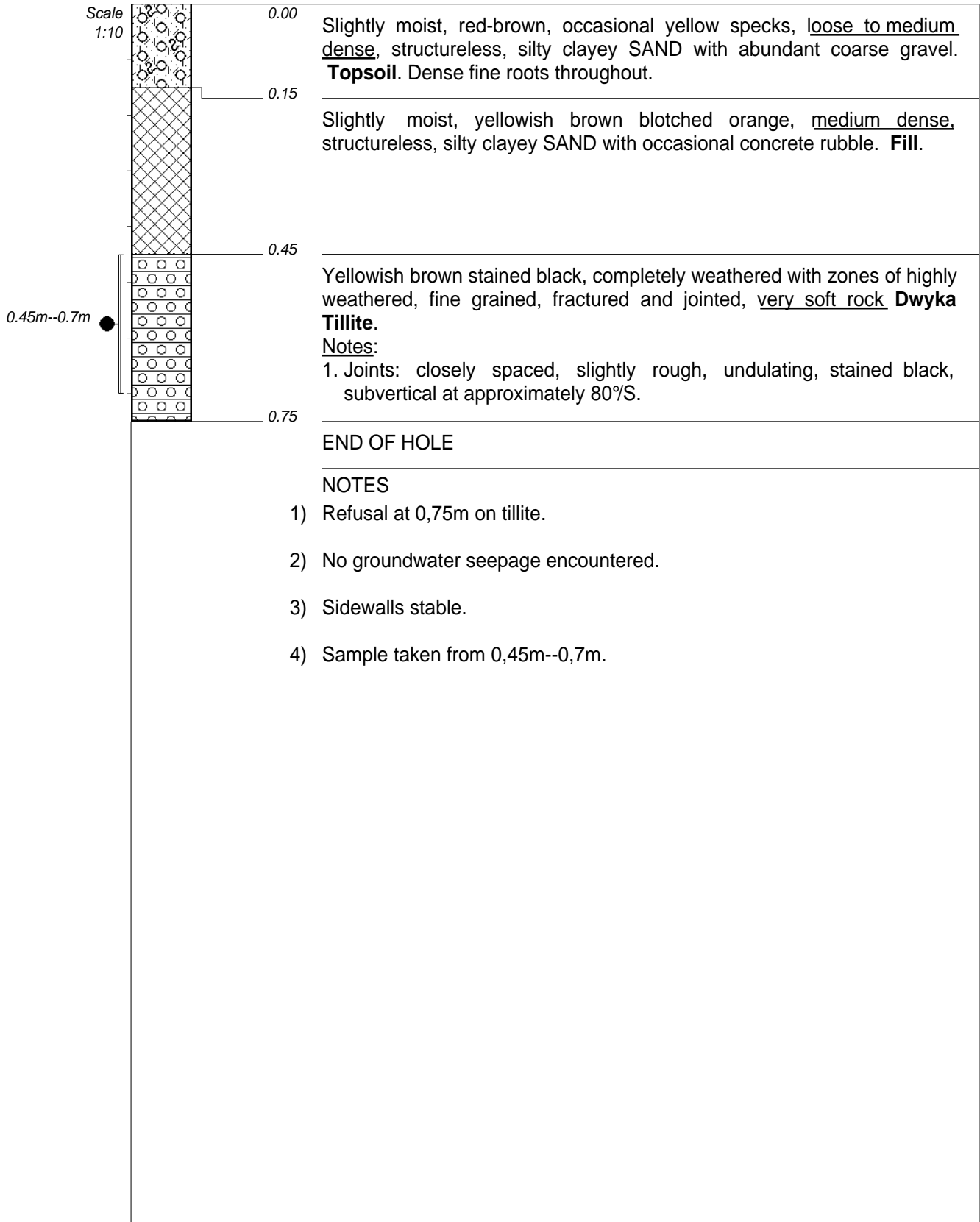
ELEVATION :  
X-COORD : 30°54'19.73"E  
Y-COORD : 29°59'19.11"S

**HOLE No: IP04**



**IP04**





CONTRACTOR :  
MACHINE : Hand excavated  
DRILLED BY :  
PROFIED BY : A. Patel  
TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

INCLINATION : Vertical  
DIAM :  
DATE : 19 July 2024  
DATE : 19 July 2024  
DATE : 05/09/2024 16:28  
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ELEVATION :  
X-COORD : 30°54'17.23"E  
Y-COORD : 29°59'22.94"S

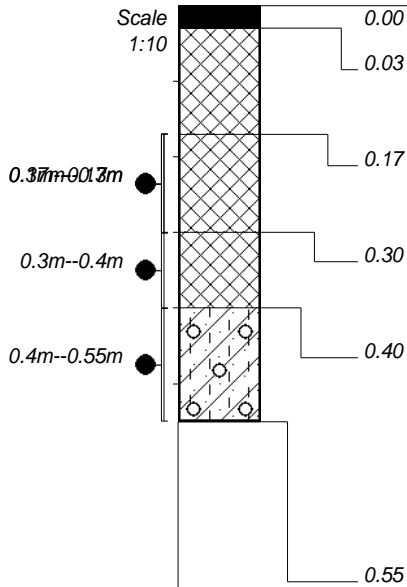
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IP05







### Asphalt.

Slightly moist, brownish grey, medium dense, structureless, GRAVEL in a sandy matrix. **Fill (Base).**

Moist, dark reddish brown, loose to medium dense, structureless, clayey silty SAND. **Fill (Subbase).**

Moist, dark brown, loose to medium dense, structureless, slightly clayey silty SAND. **Selected Fill** (subgrade).

Moist, light grey and yellowish brown, streaked orange, soft to firm, structureless, silty clayey SAND with scattered medium to coarse gravel and completely to highly weathered tillite corestones. **Residual Tillite.**

### Note:

1. Soft rock tillite at base.

END OF HOLE

### NOTES

- 1) Refusal at 0,55m on highly weathered soft rock tillite.
- 2) No groundwater seepage encountered.
- 3) Sidewalls stable.
- 4) Samples taken from 0,3m--0,17m, 0,17m--0,3m, 0,3m--0,4m and 0,4m--0,55m.

CONTRACTOR :  
MACHINE : Hand excavated  
DRILLED BY :  
PROFIED BY : A. Patel  
TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

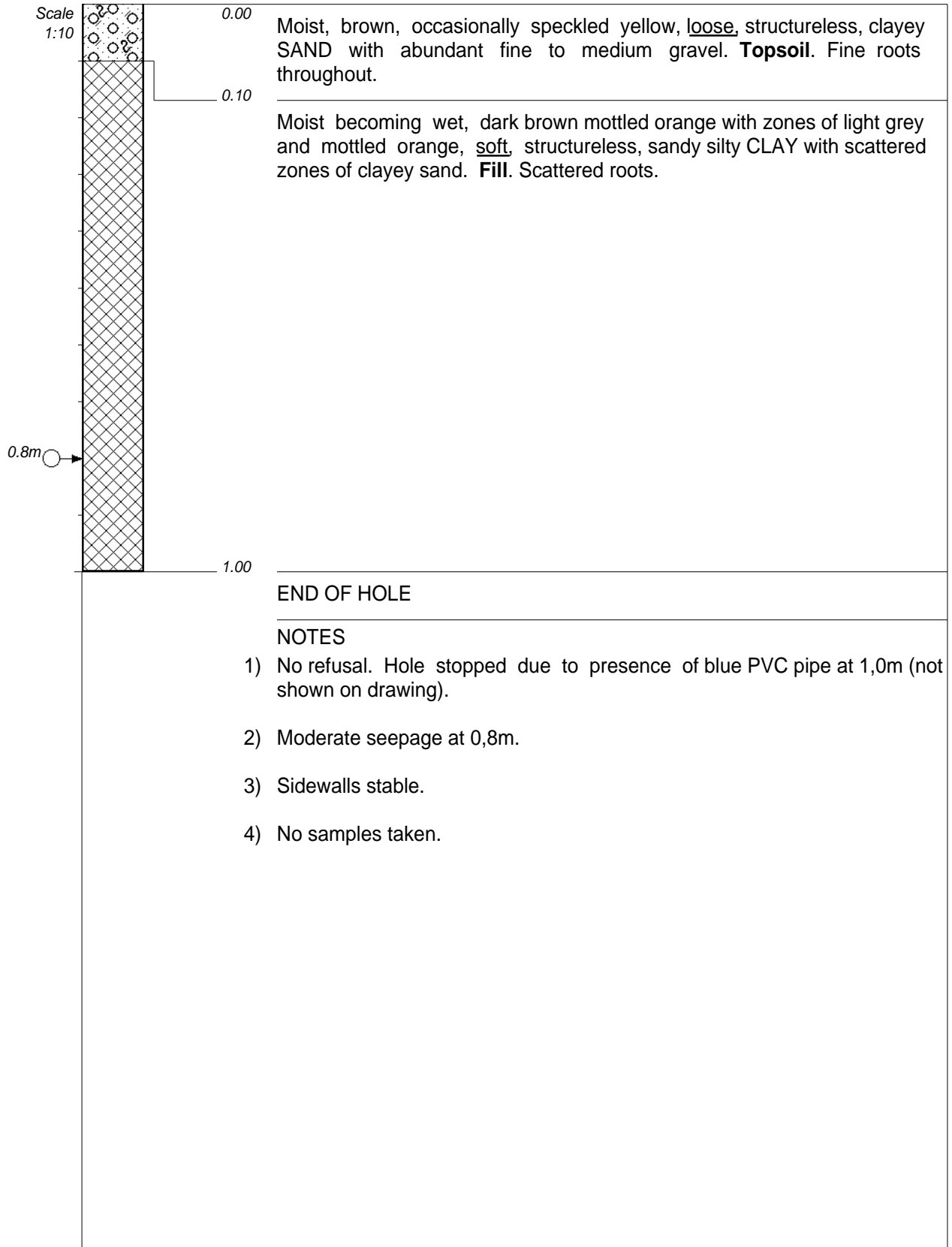
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DATE : 26 July 2024  
DATE : 26 July 2024  
DATE : 05/09/2024 16:28  
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ELEVATION :  
X-COORD : 30°54'18.09"E  
Y-COORD : 29°59'23.33"S

**HOLE No: IP06**

IP06





CONTRACTOR :  
MACHINE : Hand excavated  
DRILLED BY :  
PROFIED BY : A. Patel  
TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

INCLINATION : Vertical  
DIAM :  
DATE : 19 July 2024  
DATE : 19 July 2024  
DATE : 05/09/2024 16:28  
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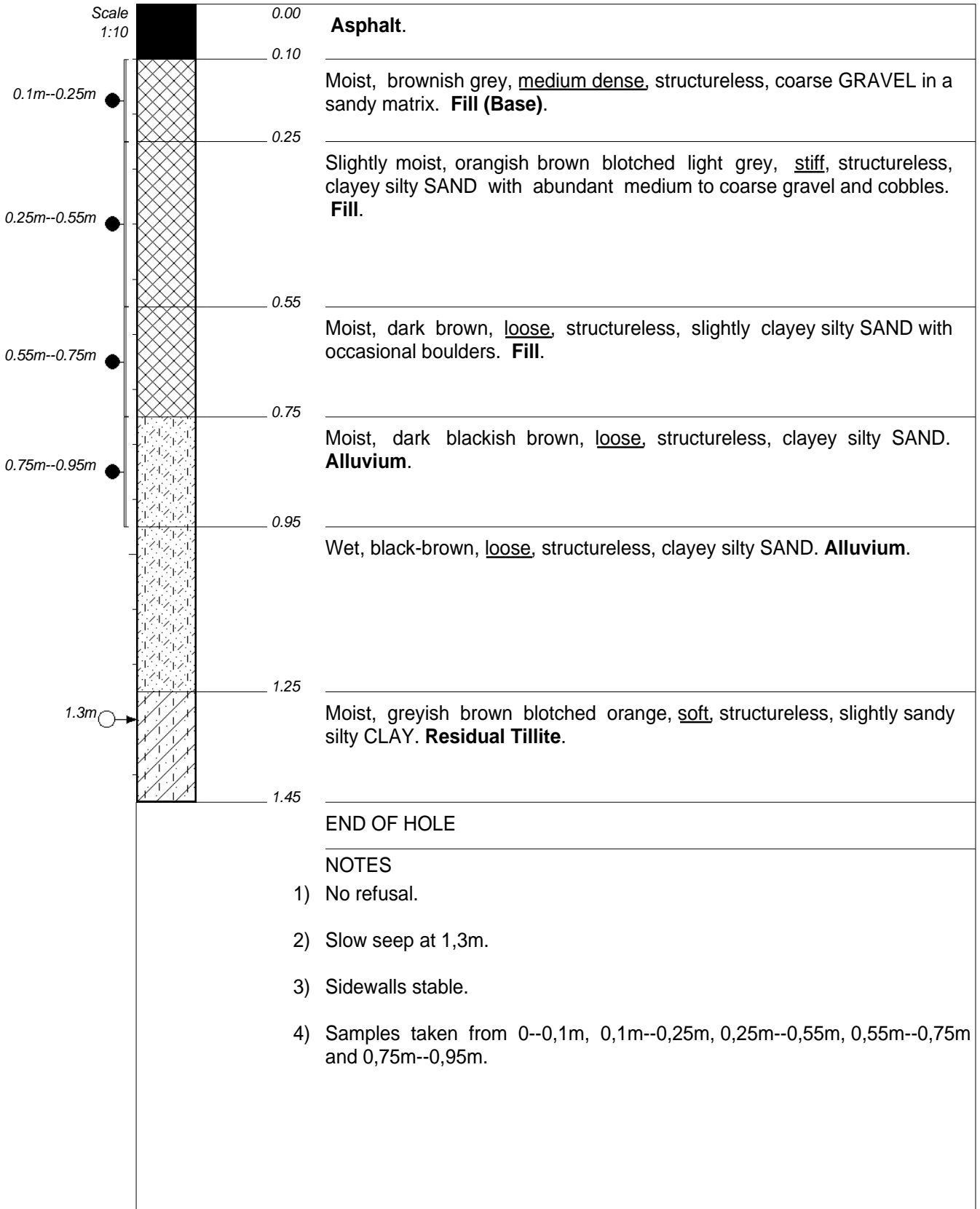
ELEVATION :  
X-COORD : 30°54'18.60"E  
Y-COORD : 29°59'25.39"S

**HOLE No: IP07**



IP07





CONTRACTOR :  
MACHINE : Hand excavated  
DRILLED BY :  
PROFIED BY : A. Patel  
TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

INCLINATION : Vertical  
DIAM :  
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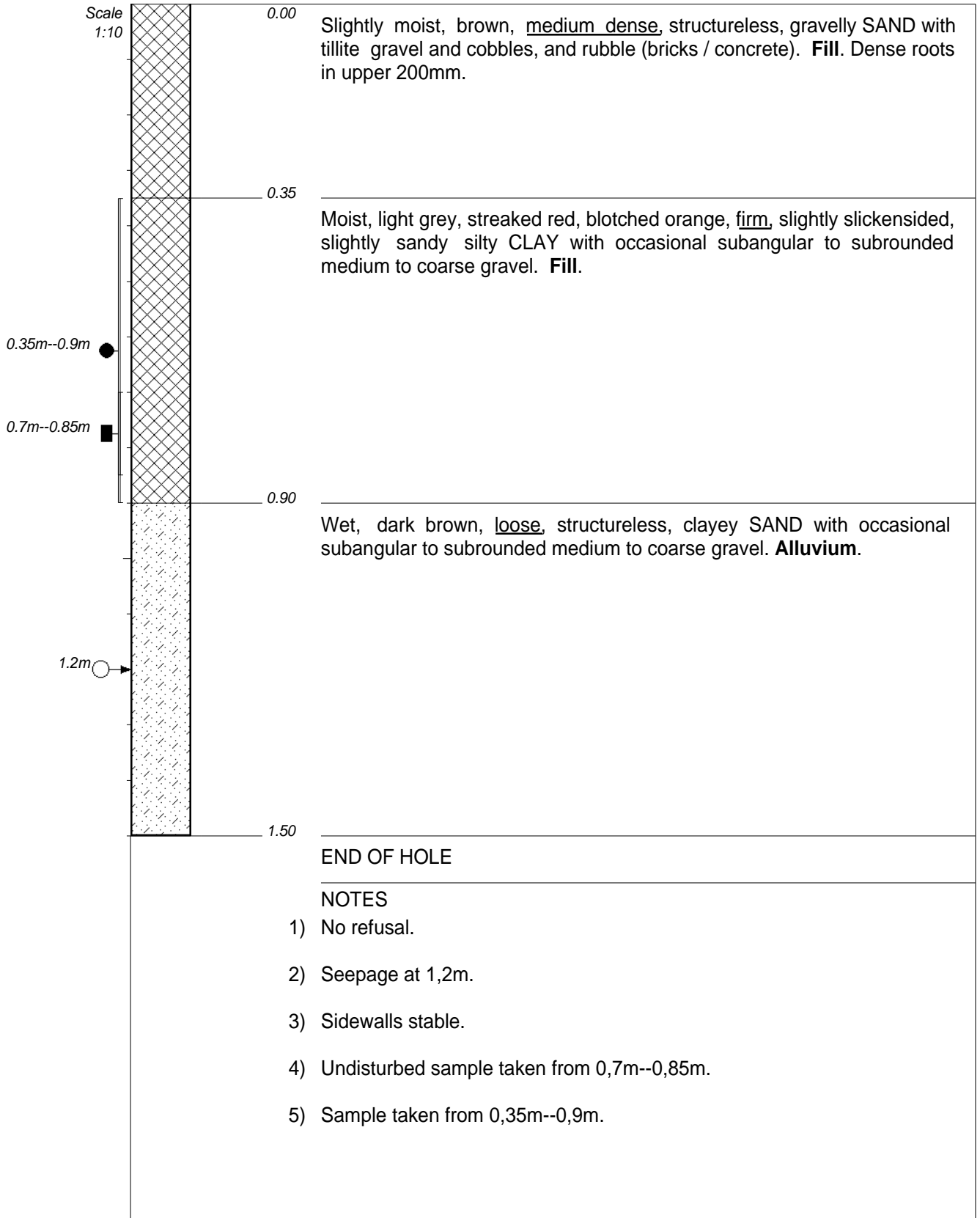
ELEVATION :  
X-COORD : 30°54'19.79"E  
Y-COORD : 29°59'26.22"S

HOLE No: IP08



IP08





**CONTRACTOR :**  
**MACHINE :** Hand excavated  
**DRILLED BY :**  
**PROFIED BY :** A. Patel  
**TYPE SET BY :** Beth  
**SETUP FILE :** STANDARD.SET

**INCLINATION :** Vertical  
**DIAM :**  
**DATE :** 22 July 2024  
**DATE :** 22 July 2024  
**DATE :** 05/09/2024 16:28  
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**ELEVATION :**  
**X-COORD :** 30°54'19.54"E  
**Y-COORD :** 29°59'26.61"S

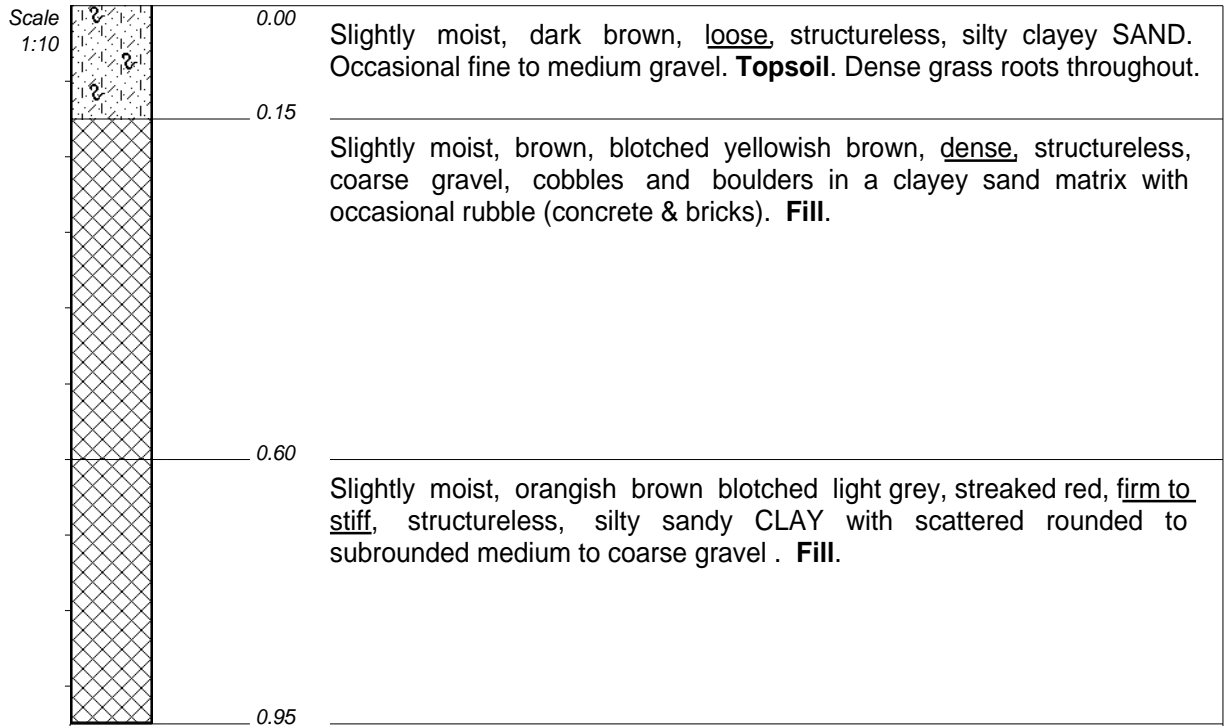
**HOLE No: IP09**



**IP09**







#### NOTES

- 1) No refusal.
- 2) No groundwater seepage encountered.
- 3) Sidewalls stable.
- 4) No samples taken.
- 5) Difficult hand excavation throughout due to abundant tillite boulders.

CONTRACTOR :  
MACHINE : Hand excavated  
DRILLED BY :  
PROFIED BY : A. Patel  
TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

INCLINATION : Vertical  
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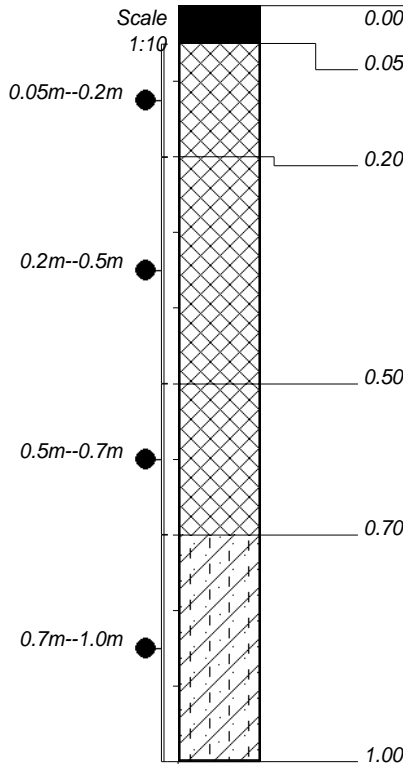
ELEVATION :  
X-COORD : 30°54'20.72"E  
Y-COORD : 29°59'28.44"S

**HOLE No: IP10**

IP10







### Asphalt.

Moist, light grey, dense to very dense, structureless, coarse GRAVEL in Sandy matrix. **Fill (Base)**

Moist, dark reddish brown, blotched white in places, dense to very dense, structureless, silty clayey SAND with abundant coarse gravel and cobbles. **Fill (Subbase).**

Slightly moist, greyish brown blotched orange, medium dense to dense, structureless, silty clayey SAND with scattered coarse gravel and cobbles. **Fill.**

Moist, yellowish brown blotched orange and light grey, soft to firm, structureless, sandy silty CLAY with occasional zones of completely weathered tillite. **Residual Tillite.**

END OF HOLE

### NOTES

- 1) No refusal.
- 2) No groundwater seepage encountered.
- 3) Sidewalls stable.
- 4) Samples taken from 0,05m--0,2m, 0,2m--0,5m, 0,5m--0,7m and 0,7m--1,0m.

CONTRACTOR :  
MACHINE : Hand excavated  
DRILLED BY :  
PROFIED BY : A. Patel  
TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

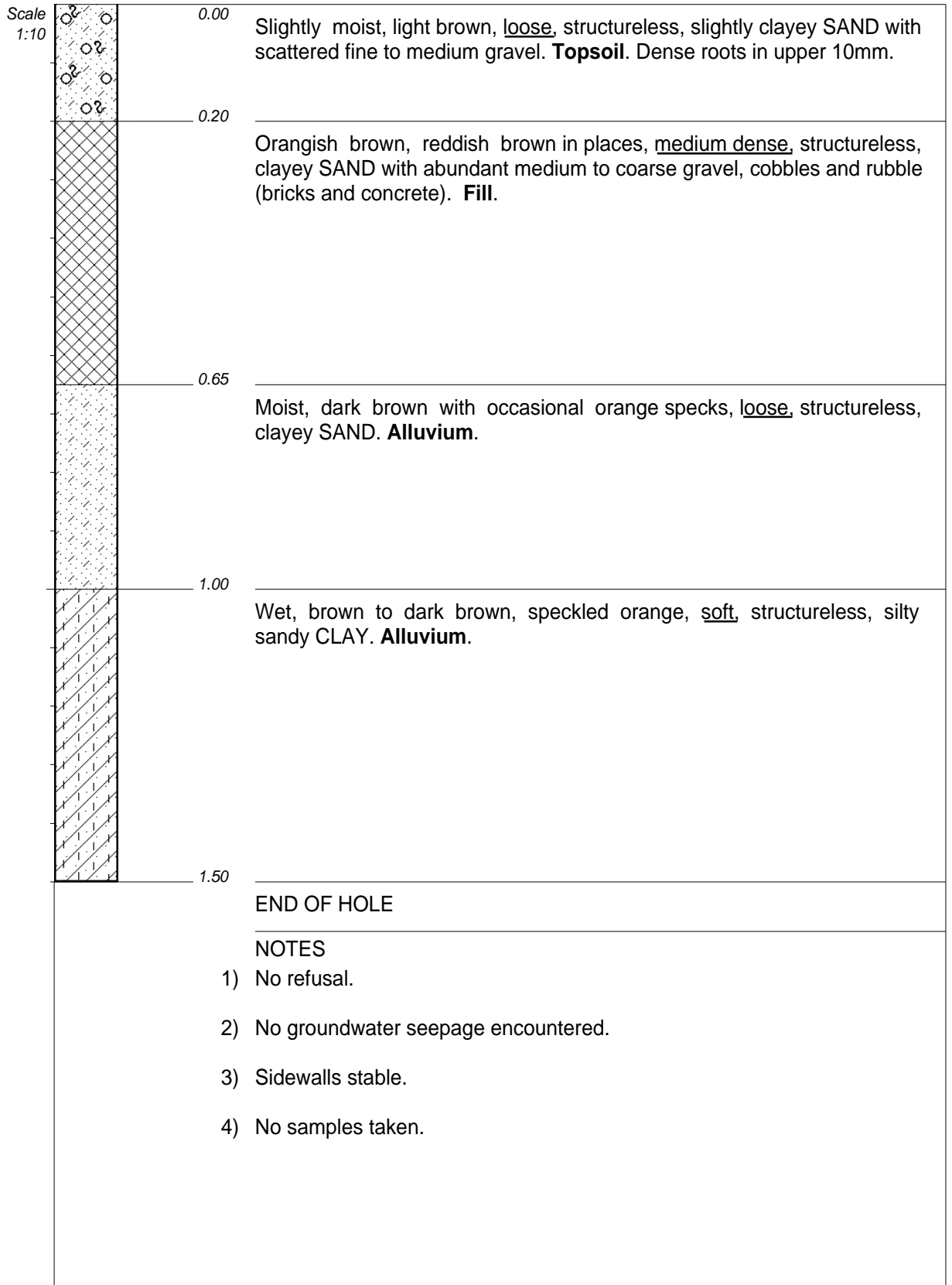
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DATE : 26 July 2024  
DATE : 05/09/2024 16:28  
TEXT : ..OPVISIPINGOIPPROAPR4.TXT

ELEVATION :  
X-COORD : 30°54'21.91"E  
Y-COORD : 29°59'22.87"S

**HOLE No: IP11**

IP11





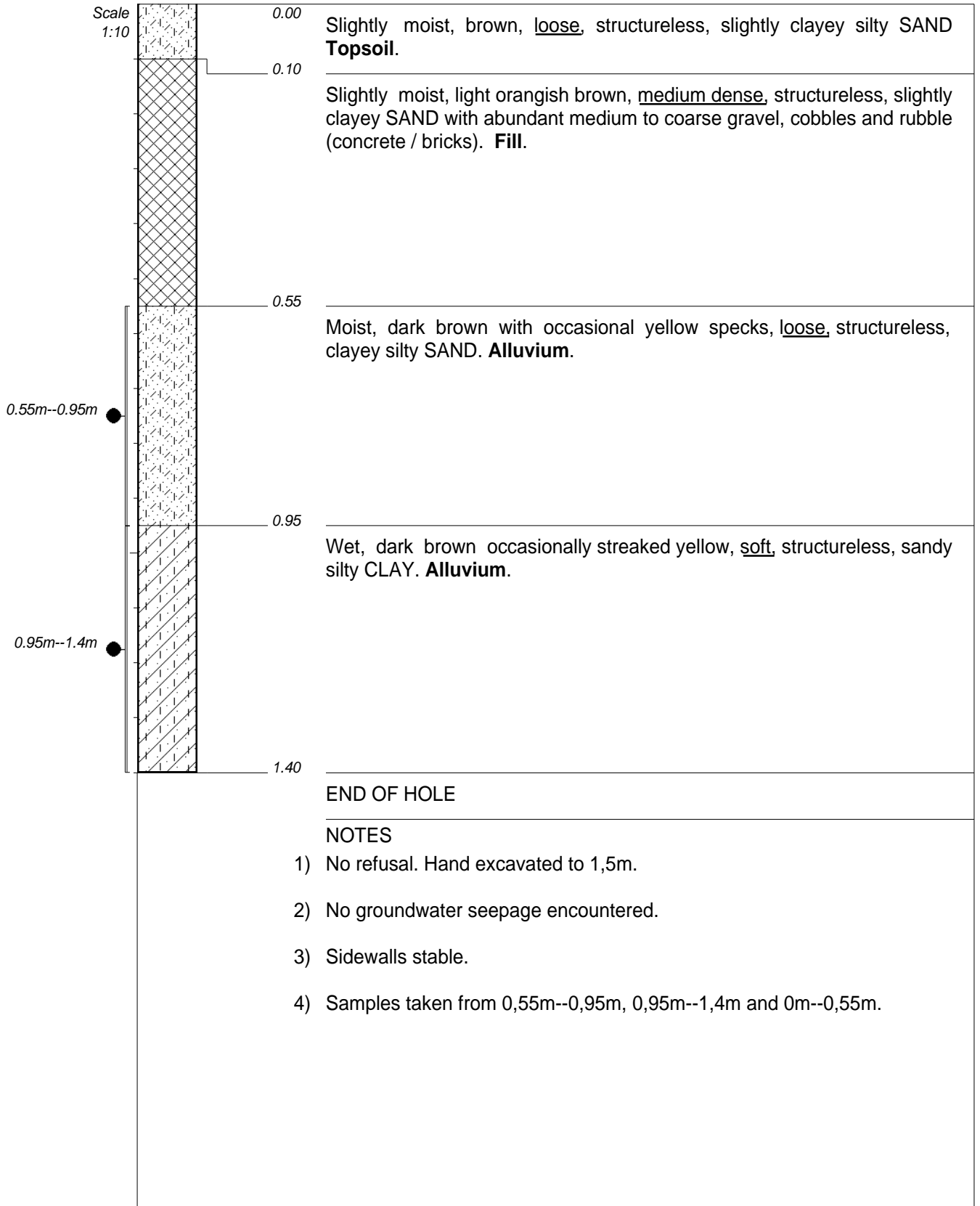
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PROFIED BY : A. Patel  
TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

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DATE : 18 July 2024  
DATE : 05/09/2024 16:28  
TEXT : ..OPVISIPINGOIPPROAPR4.TXT

ELEVATION :  
X-COORD : 30°54'23.68"E  
Y-COORD : 29°59'25.48"S

**HOLE No: IP12**





CONTRACTOR :  
MACHINE : Hand excavated  
DRILLED BY :  
PROFILED BY : A. Patel  
TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

INCLINATION : Vertical  
DIAM :  
DATE : 18 July 2024  
DATE : 18 July 2024  
DATE : 05/09/2024 16:28  
TEXT : ..OPVISIPINGOIPPROAPR4.TXT

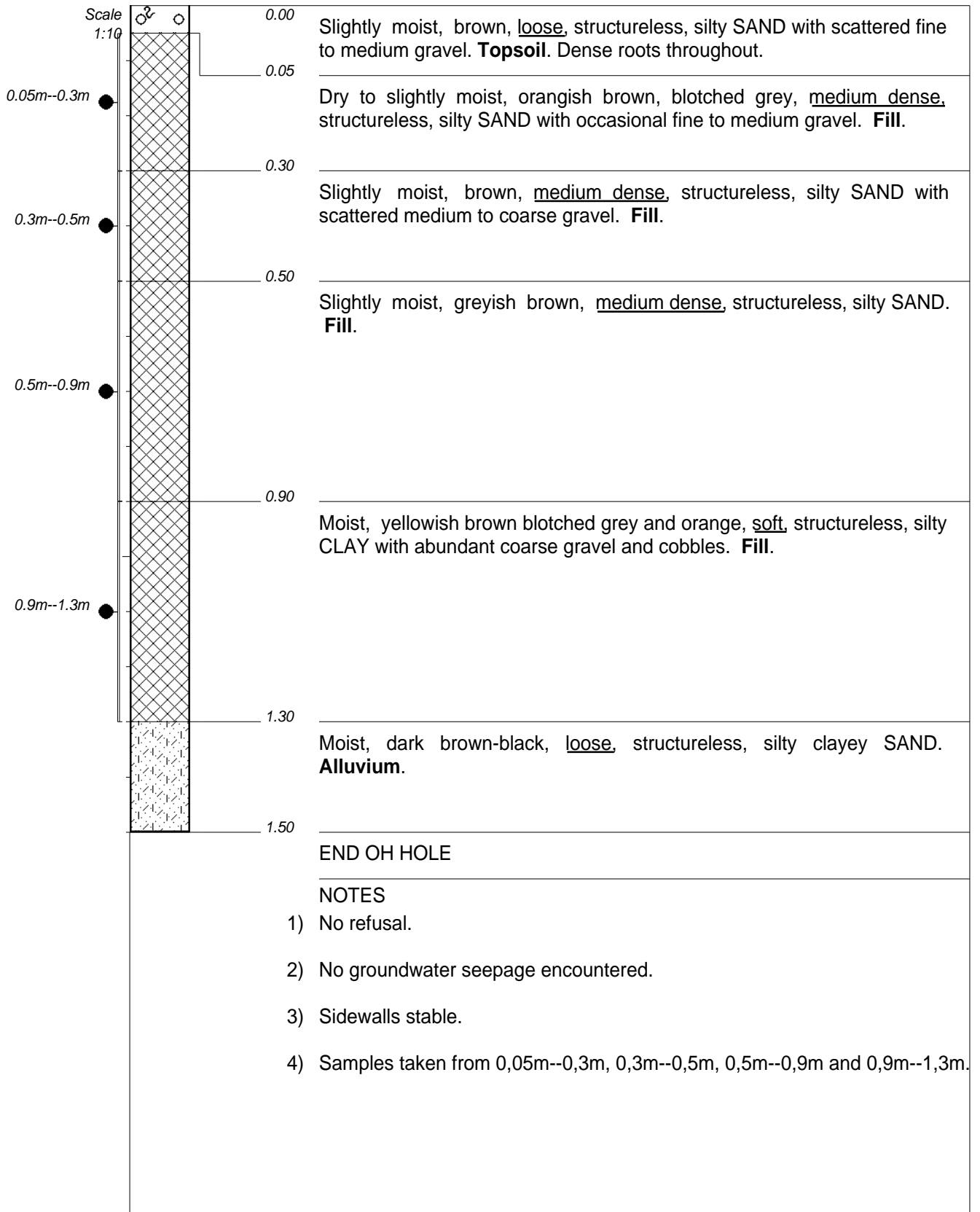
ELEVATION :  
X-COORD : 30°54'24.80"E  
Y-COORD : 29°59'24.50"S

**HOLE No: IP13**

IP13







CONTRACTOR :  
MACHINE : Hand excavated  
DRILLED BY :  
PROFIED BY : A. Patel  
TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

INCLINATION : Vertical  
DIAM :  
DATE : 30 July 2024  
DATE : 30 July 2024  
DATE : 05/09/2024 16:28  
TEXT : ..OPVISIPINGOIPPROAPR4.TXT

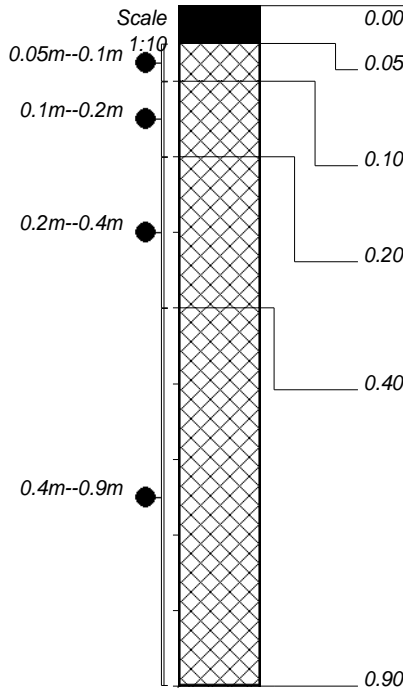
ELEVATION :  
X-COORD : 30°54'25.33"E  
Y-COORD : 29°59'28.18"S

HOLE No: IP14



**IP14**





**Asphalt.**

Slightly moist, brownish grey, medium dense, structureless, coarse GRAVEL in a sandy matrix. **Fill (Base).**

Slightly moist, dark grey-brown, medium dense, structureless, slightly clayey sandy GRAVEL. **Fill (Subbase).**

Slightly moist, colour varies across test pit from dark reddish brown to yellowish brown and blotched black and red, medium dense, structureless, gravelly SAND with intermixed zones of sandy clay. **Fill.**

Moist, mid brown, loose, structureless, fine to coarse SAND with scattered gravel. **Fill.**

**END OF HOLE**

**NOTES**

- 1) Refusal on pipe at 0,9m.
- 2) No groundwater seepage encountered.
- 3) Sidewalls stable.
- 4) Samples taken at 0,05m--0,1m, 0,1m--0,2m, 0,2m--0,4m, 0,4m--0,9m

CONTRACTOR :  
MACHINE : Hand excavated  
DRILLED BY :  
PROFILED BY : A. Patel  
TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

INCLINATION : Vertical  
DIAM :  
DATE : 29 July 2024  
DATE : 29 July 2024  
DATE : 05/09/2024 16:28  
TEXT : ..OPVISIPINGOIPPROAPR4.TXT

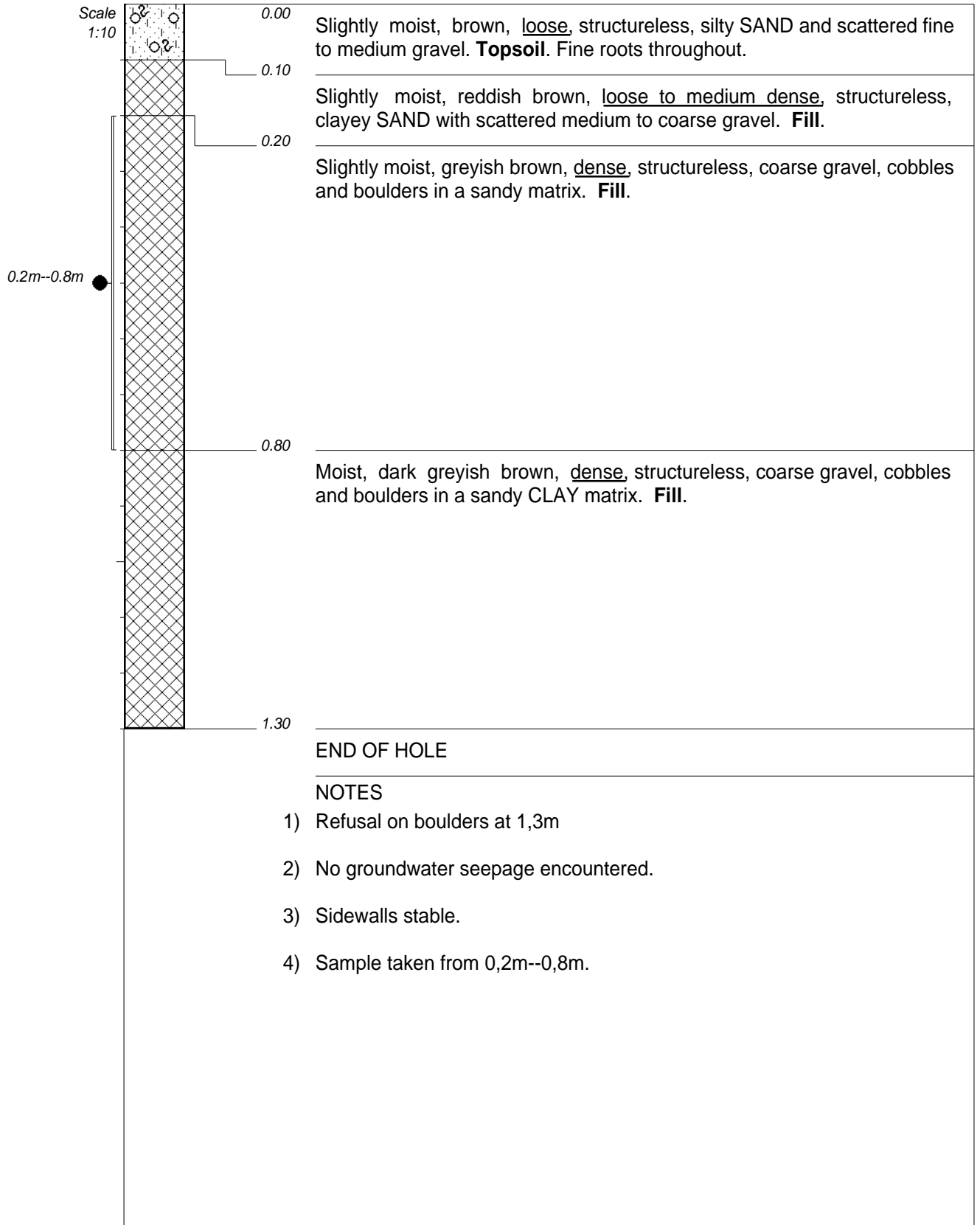
ELEVATION :  
X-COORD : 30°54'23.88"E  
Y-COORD : 29°59'29.74"S

**HOLE No: IP15**



**IP15**





CONTRACTOR :  
MACHINE : Hand excavated  
DRILLED BY :  
PROFIED BY : A. Patel  
TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

INCLINATION : Vertical  
DIAM :  
DATE : 30 July 2024  
DATE : 30 July 2024  
DATE : 05/09/2024 16:28  
TEXT : ..OPVISIPINGOIPPROAPR4.TXT

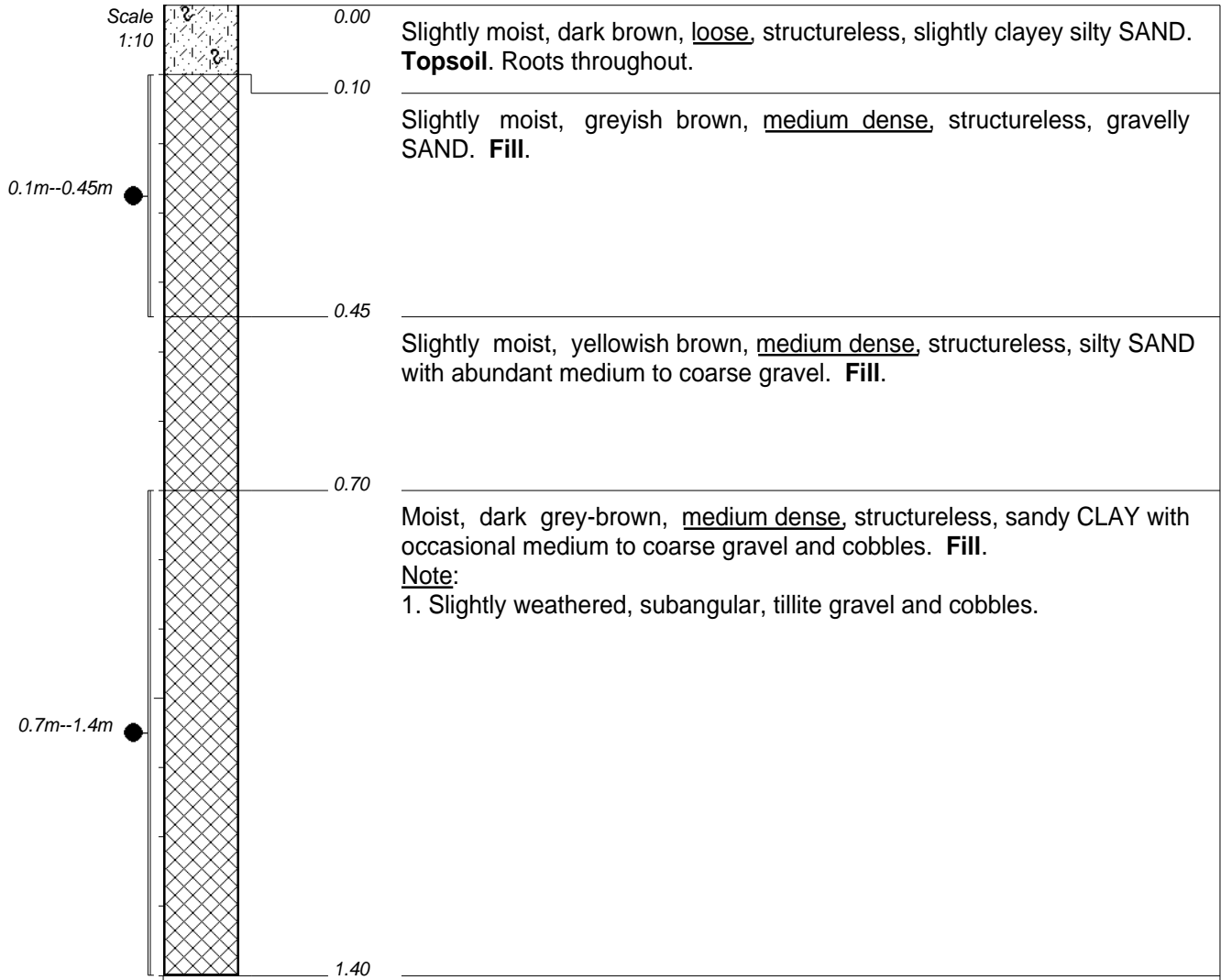
ELEVATION :  
X-COORD : 30°54'22.08"E  
Y-COORD : 29°59'31.27"

**HOLE No: IP16**



**IP16**





END OF HOLE

#### NOTES

- 1) No refusal.
- 2) No groundwater seepage encountered.
- 3) Sidewalls stable.
- 4) Samples taken from 0,1m--0,45m and 0,7m--1,4m.

CONTRACTOR :  
MACHINE : Hand excavated  
DRILLED BY :  
PROFILED BY : A. Patel  
TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

INCLINATION : Vertical  
DIAM :  
DATE : 30 July 2024  
DATE : 30 July 2024  
DATE : 05/09/2024 16:28  
TEXT : ..OPVISIPINGOIPPROAPR4.TXT

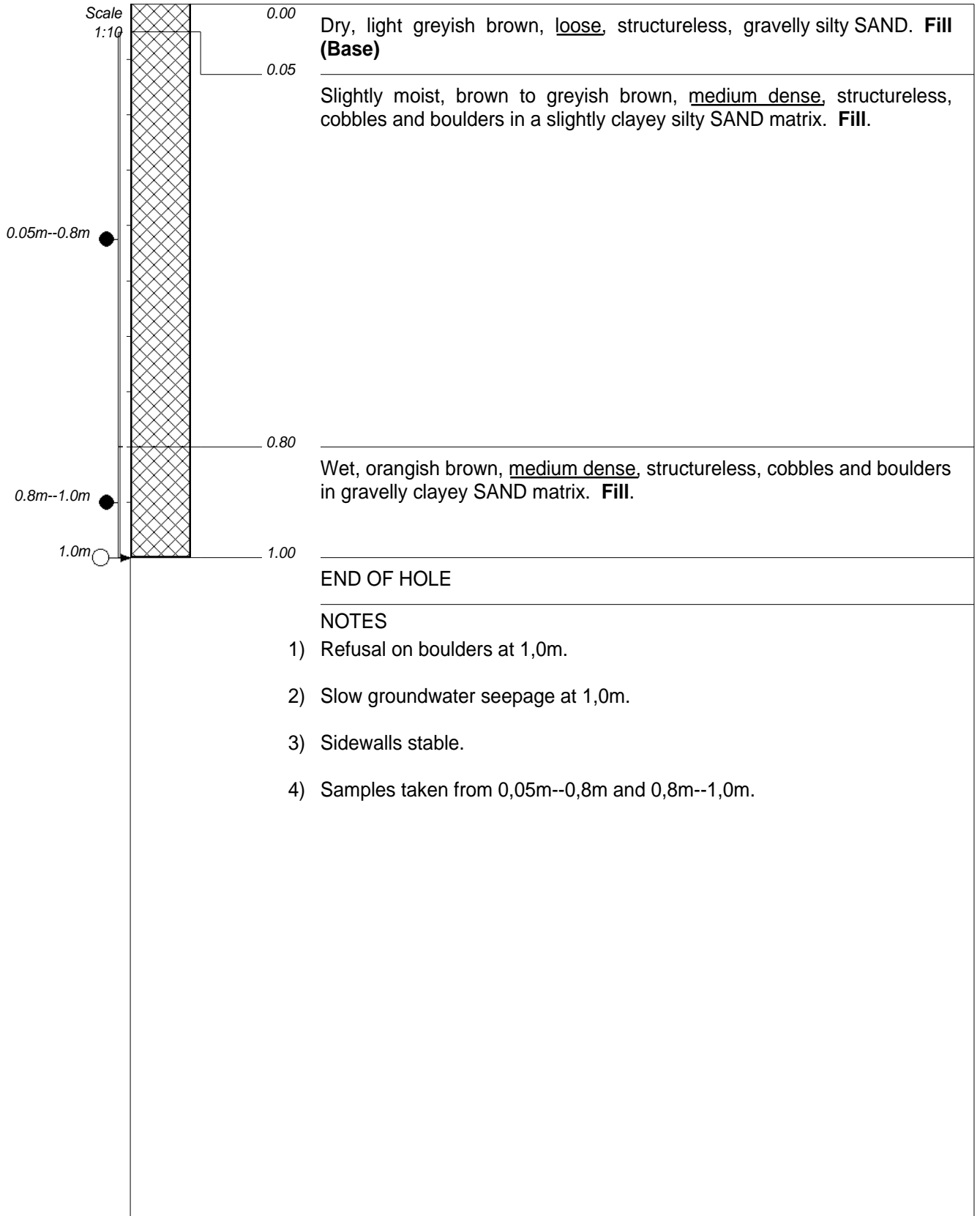
ELEVATION :  
X-COORD : 30°54'22.63"E  
Y-COORD : 29°59'32.46"S

**HOLE No: IP17**



**IP17**





CONTRACTOR :  
MACHINE : Hand excavated  
DRILLED BY :  
PROFIED BY : A. Patel  
TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

INCLINATION : Vertical  
DIAM :  
DATE : 5 August 2024  
DATE : 5 August 2024  
DATE : 05/09/2024 16:28  
TEXT : ..OPVISIPINGOIPPROAPR4.TXT

















ELEVATION :  
X-COORD : 30°54'21.88"E  
Y-COORD : 29°59'32.63"

**HOLE No: IP18**



**IP18**



	GRAVEL	{SA02}
	GRAVELLY	{SA03}
	SAND	{SA04}
	SANDY	{SA05}
	SILT	{SA06}
	SILTY	{SA07}
	CLAY	{SA08}
	CLAYEY	{SA09}
	TILLITE	{SA10}
	FILL	{SA32}
	CONCRETE	{SA34}
Name 	UNDISTURBED SAMPLE	{SA37}
Name 	DISTURBED SAMPLE	{SA38}
	ROOTS	{SA40}
14.5 	WATER SEEPAGE/water strike	{CH50}
	ASPHALT	{LE01}

CONTRACTOR :  
MACHINE :  
DRILLED BY :  
PROFILED BY :

TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

INCLINATION :  
DIAM :  
DATE :  
DATE :

DATE : 05/09/2024 16:28  
TEXT : ..OPVISIPINGOIPPROAPR4.TXT

ELEVATION :  
X-COORD :  
Y-COORD :

**LEGEND**  
SUMMARY OF SYMBOLS

**HOLE No: BH01**  
**Sheet 1 of 1**

**JOB NUMBER: 720.070334.00001**



Zutari/eThekweni Municipality  
Isipingo  
Wastewater Treatment Works

**HOLE No: BH01**  
**Sheet 1 of 1**

**JOB NUMBER: 720.070334.00001**

NXC	77	0	0	-	-		<div><div><div>Scale 1:75</div><div>WATER LEVEL</div></div></div>
SPT	-	0	0	-	10		
Shelby Ref SPT Ref	82	0	0	-	-		
NWD4	66	45	0	8	-		
NWD4	91	84	33	13	-		
NWD4	104	87	51	11	-		
				</			

D061 SLR Consulting

*dotPLOT 7022 PBpH67*



**BH01**



**HOLE No: BH02**  
**Sheet 1 of 1**

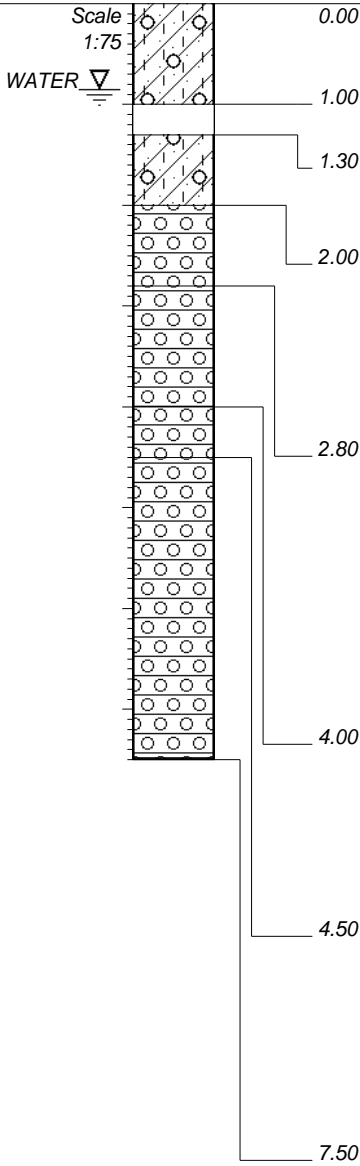
**JOB NUMBER: 720.070334.00001**



Zutari/eThekweni Municipality  
Isipingo  
Wastewater Treatment Works

**HOLE No: BH02**  
**Sheet 1 of 1**

**JOB NUMBER: 720.070334.00001**

[illegible]

Dark greyish brown,blotched light grey, black and orange, structureless, silty sandy CLAY with scattered gravel. **Residual Sandstone.**

## Shelby Sample

Light grey blotched orange and red, sandy silty CLAY with scattered gravel. Structureless. **Residual Tillite.**

Light brown, stained black on joints, fine grained with coarse grain inclusions, highly fractured, highly weathered, very soft rock to soft rock  
**Tillite.**

Note:

1. Significant core loss.

Brownish grey speckled white, highly to moderately weathered, fine grained with coarse grained inclusions, highly fractured, medium hard rock **Tillite**.

Note:

1. Four Joint sets: 10°, 45°, 60° and 90° closely spaced, rough, planar to undulating, light grey clay infill up to 4mm thick.
2. Very highly fractured zone of very soft rock, recovered as angular cobbles at 3 m - 3,15 m and 3,8 m - 3.9 m.

Dark grey speckled white, slightly weathered, fine grained with coarse grained and gravel inclusions, , hard rock Tillite.

Note:

1.4 Joint sets: 0°, 90°, 45° and 80°, closely spaced, slightly rough, undulating, stained black.

Dark grey speckled white, unweathered, fine grained with coarse grained inclusions, moderately fractured, hard rock Tillite.

Note:

1. Three Joint sets: 0°, 70° and 20°, medium spacing, smooth to slightly rough planar, stained orange, sandy rock gouge infill approximately 1mm thick.

END OF HOLE

## NOTES

1) Water rest level at 0,85m.

CONTRACTOR : Geopractica  
MACHINE : Rotary Core Drilling Rig  
DRILLED BY :  
PROFILED BY : A. Patel

TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

*INCLINATION*: Vertical

*DIAM :*

DATE : 25 July 2024

DATE : 25 July 2024

DATE : 05/09/2024 16:03

TEXT : ..P\ISIPINGOBHLOGSAPR4.TXT

ELEVATION : -  
X-COORD : 30°54'19.41"E  
Y-COORD : 29°59'23.02"S

**HOLE No: BH02**



**BH02**

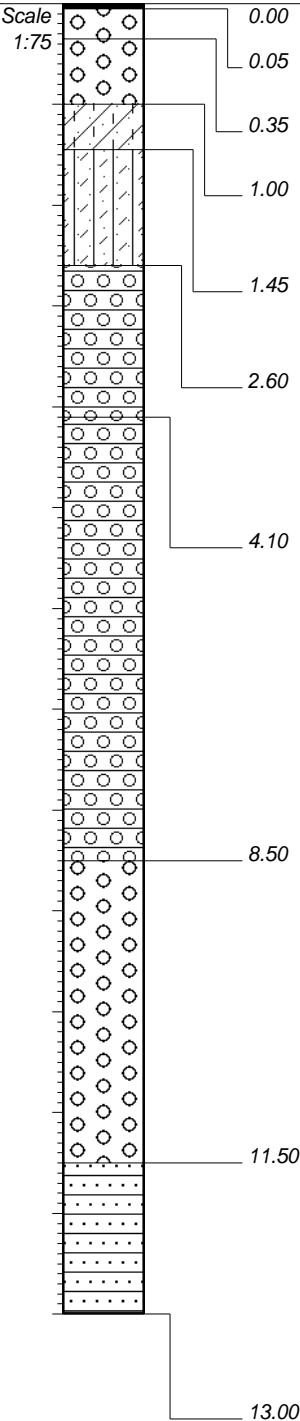




JOB NUMBER: 720.070334.00001

JOB NUMBER: 720.070334.00001

NXC	45	0	0			
NXC	17	0	0	-		
SPT	-	0	0		51	
NWD4	113	0	0	-		
SPT	80	0	0	-		
NWD4	29	3	0	-		
NWD4	82	53	8	>20		
NWD4	39	14	0	>20		
NWD4	86	31	0	>20		
NWD4	7	0	0	>20		
NWD4	28	0	0	>20		
NWD4	61	41	28	6		
Drill Method	% Total Core Recovery	% Solid Core Recovery	% RQD	Fracture Frequency	SPT N Value	DEPTH Scale 1:75



Asphalt.

Coarse Gravel. **Base.**

Beige blotched and speckled red stabilised Gravel. **Base.**

Orangish brown and light grey in places, relict jointing apparent, sandy silty CLAY. **Residual Tillite.**

Light grey blotched orange, stained black and red on relict joints, relict jointed, sandy clayey SILT. **Residual Tillite.**

Light brownish grey, highly weathered, fine grained with coarse grain inclusions, friable, highly fractured, very soft rock **Tillite.**  
Note:  
1. Significant core loss, recovered as silty sand and coarse gravel.

Dark grey, moderately weathered, fine grained with coarse grain inclusions, massive, highly fractured, medium hard rock, **Tillite.**  
Note:  
1. Five joint sets approximately 10°, 40°, 60°, 80° and 90°, very closely jointed, smooth to rough, planar and undulating, stained orange, occasional silty sand infill up to 2 mm thick  
2. Completely weathered, friable, very soft rock tillite, recovered as coarse gravel between 4,35 m to 4,55 m.

Very poor recovery comprising highly weathered tillite and sandstone coarse gravel. Possible contact zone between tillite and sandstone.

Light pinkish beige, medium grained, slightly weathered to unweathered, massive, highly to moderately fractured hard rock **Sandstone.** Abundant quartz veins (20-100mm).  
Note:  
1. Three Joint sets approximately 20°, 45° & 70°, close to medium spaced, smooth to rough, undulating and planar, occasional calcite infill up to 1 thick.

END OF HOLE

CONTRACTOR : Geopractica  
MACHINE : Rotary Core Drilling Rig  
DRILLED BY :  
PROFILED BY : A. Patel  
TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

INCLINATION : Vertical  
DIAM :  
DATE : 25 July 2024  
DATE : 25 July 2024  
DATE : 05/09/2024 16:03  
TEXT : ..PVISIPINGOBHLOGSAPR4.TXT

ELEVATION :  
X-COORD : 30°54'18.10"E  
Y-COORD : 29°59'19.15"S



**BH03**







	GRAVEL	{SA02}
	GRAVELLY	{SA03}
	SANDY	{SA05}
	SILT	{SA06}
	SILTY	{SA07}
	CLAY	{SA08}
	CLAYEY	{SA09}
	TILLITE	{SA10}
	SANDSTONE	{SA11}
	WATER TABLE REST LEVEL/perched water table	{SA36}
	ASPHALT	{LE01}

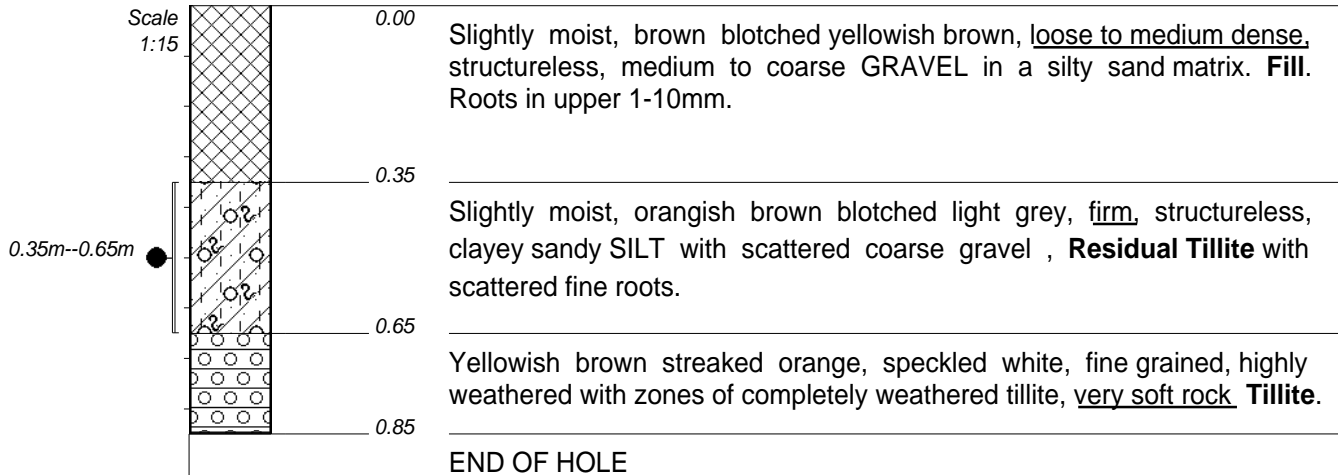
CONTRACTOR :  
MACHINE :  
DRILLED BY :  
PROFILED BY :

TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

INCLINATION :  
DIAM :  
DATE :  
DATE :

DATE : 05/09/2024 16:03  
TEXT : ..PVISIPINGOBHLOGSAPR4.TXT

ELEVATION :  
X-COORD :  
Y-COORD :



#### NOTES

- 1) Refusal on very soft rock tillite at 0,85m.
- 2) No groundwater seepage encountered.
- 3) Sidewalls stable.
- 4) Sample taken from 0,35m--0,65m.
- 5) No auger due to tillite rock encountered.

CONTRACTOR :  
MACHINE : Hand excavated  
DRILLED BY :  
PROFILED BY : A.P  
TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

INCLINATION : Vertical  
DIAM :  
DATE : 25 July 2024  
DATE : 25 July 2024  
DATE : 05/09/2024 16:38  
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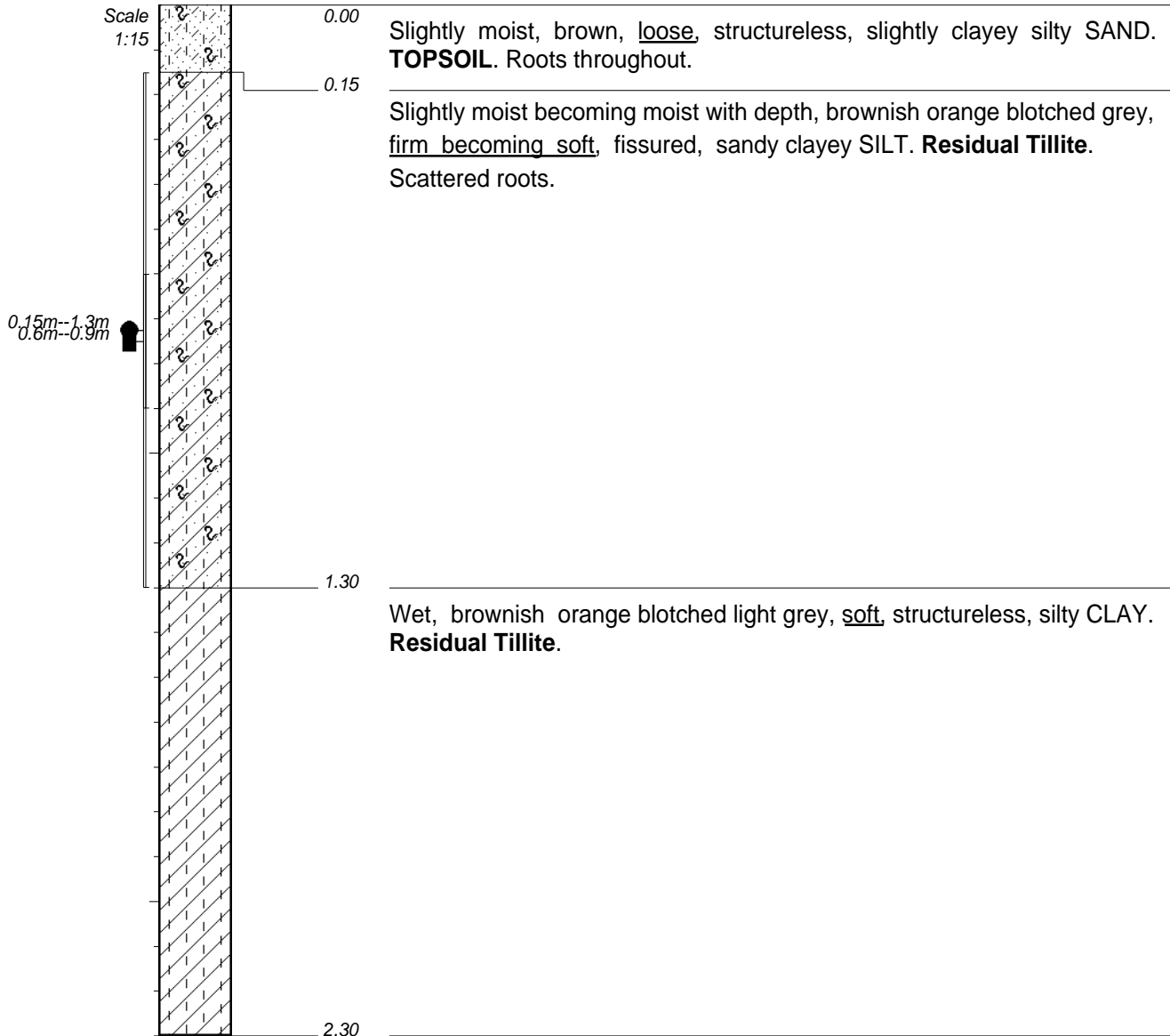
ELEVATION :  
X-COORD : 30°54'17.99"E  
Y-COORD : 29°59'19.68"S

**HOLE No: TP01**

**TP01**







END OF HOLE

#### NOTES

- 1) No refusal.
- 2) No groundwater seepage encountered.
- 3) Sidewalls stable.
- 4) Sample taken from 0,15m--1,3m.
- 5) Undisturbed sample taken from 0,6m--0,9m.
- 6) Auger from 1,3 m - 2,3 m.

CONTRACTOR :  
MACHINE : Hand / Auger  
DRILLED BY :  
PROFIED BY : A.P  
TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

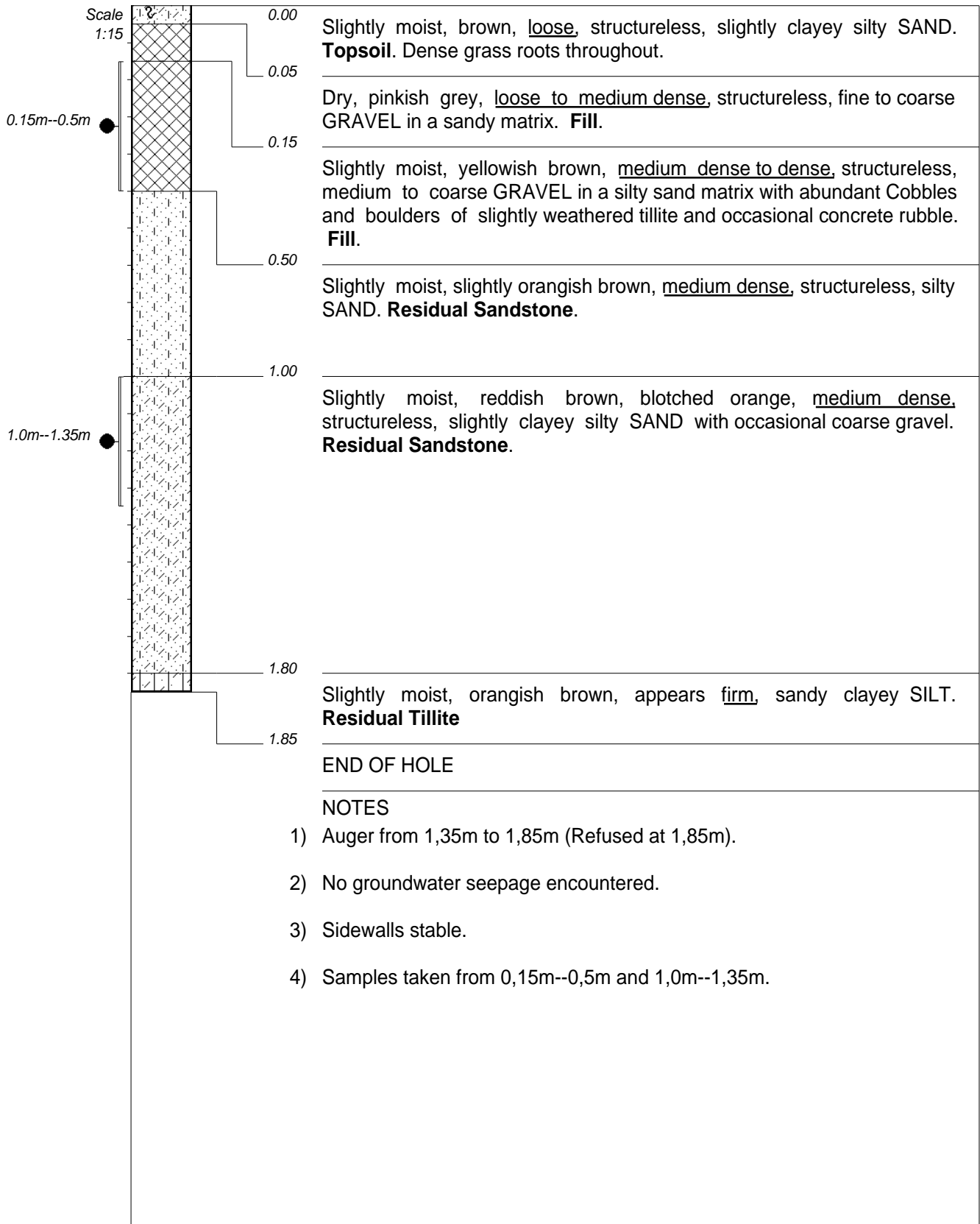
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DIAM :  
DATE : 30 July 2024  
DATE : 30 July 2024  
DATE : 05/09/2024 16:38  
TEXT : ..OPVISIPINGOTPPROAPR4.TXT

ELEVATION :  
X-COORD : 29°59'19.85"S  
Y-COORD : 30°54'19.99"E

HOLE No: TP02

**TP02**





CONTRACTOR :  
MACHINE : Hand / Auger  
DRILLED BY :  
PROFIED BY : A.P  
TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

INCLINATION : Vertical  
DIAM :  
DATE : 2 August 2024  
DATE : 2 August 2024  
DATE : 05/09/2024 16:38  
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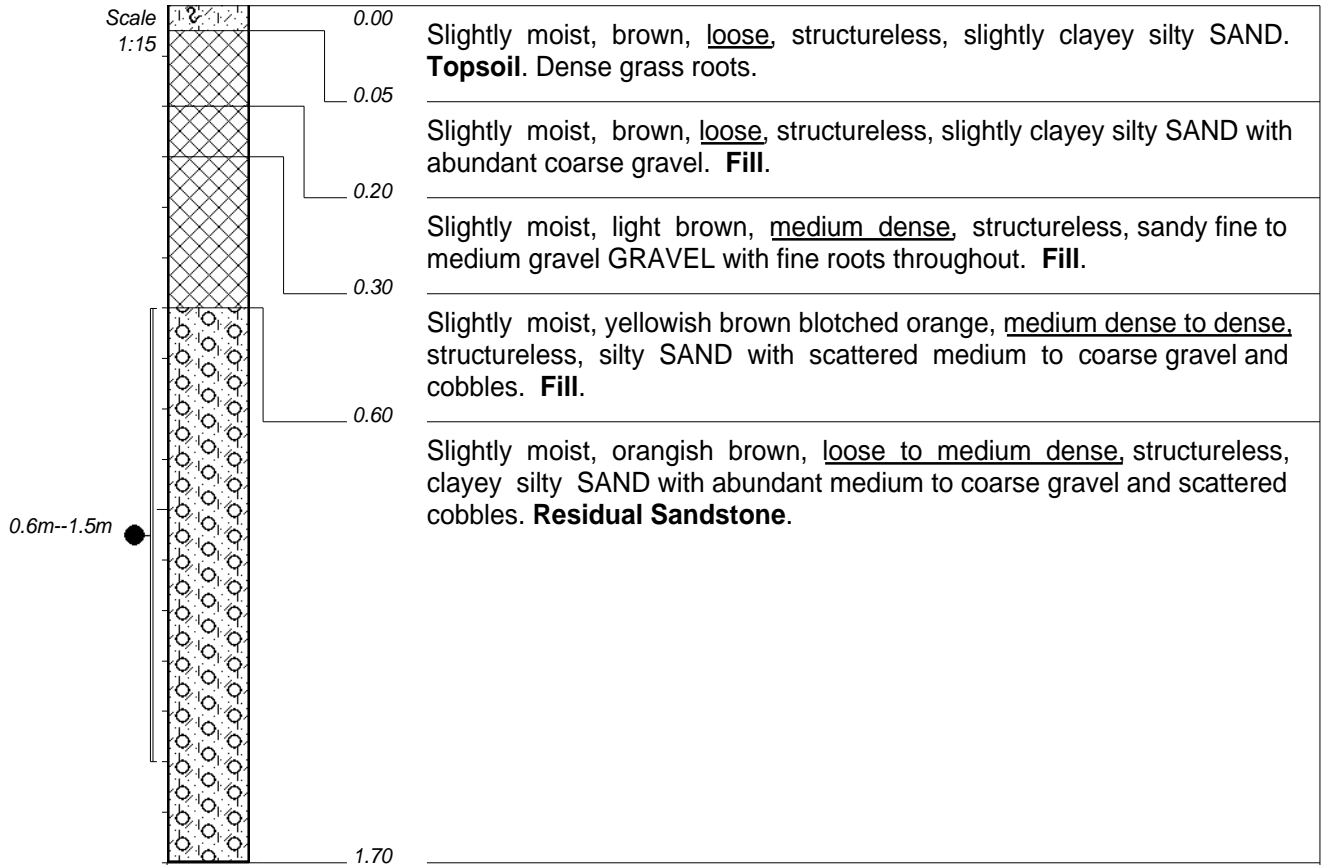
ELEVATION :  
X-COORD : 30°54'22.81"E  
Y-COORD : 29°59'22.56"S

**HOLE No: TP04**



**TP04**





END OF HOLE

#### NOTES

- 1) Auger refusal on boulder, from 1,5m-1,7m.
- 2) No groundwater seepage encountered.
- 3) Sidewalls stable.
- 4) Sample taken from 0,6m--1,5m.

CONTRACTOR :  
MACHINE : Hand / Auger  
DRILLED BY :  
PROFIED BY : A.P  
TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

INCLINATION : Vertical  
DIAM :  
DATE : 2 August 2024  
DATE : 2 August 2024  
DATE : 05/09/2024 16:38  
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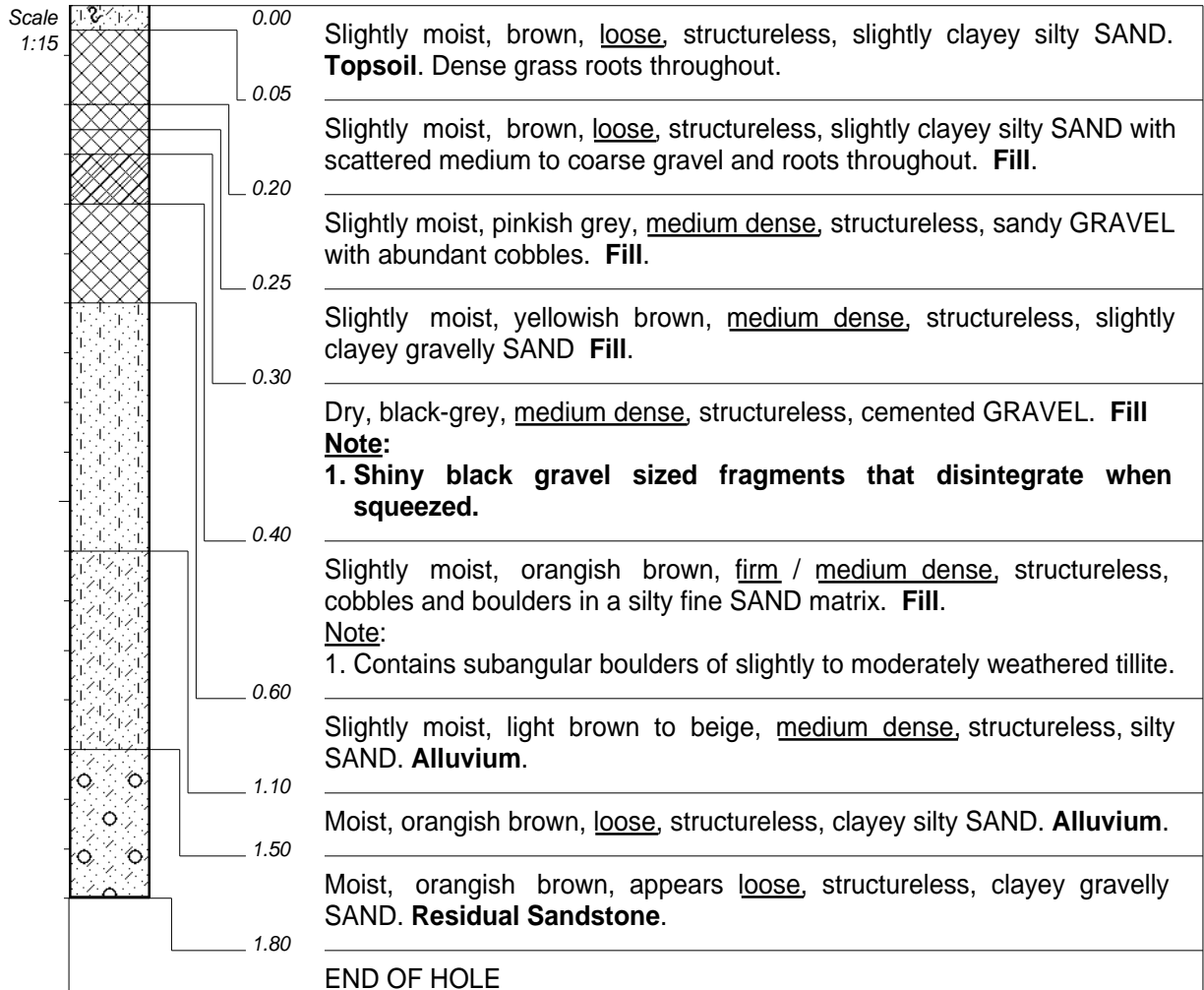
ELEVATION :  
X-COORD : 30°54'23.31"E  
Y-COORD : 29°59'21.82"S

**HOLE No: TP05**



**TP05**





#### NOTES

- 1) Auger from 1,5m to 1,8m. Refusal on what appears as residual tillite, orange brown, clayey silty sand.
- 2) No groundwater seepage encountered.
- 3) Sidewalls stable.
- 4) No samples taken.

CONTRACTOR :  
MACHINE : Hand / Auger  
DRILLED BY :  
PROFIED BY : A.P  
TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

INCLINATION : Vertical  
DIAM :  
DATE : 2 August 2024  
DATE : 2 August 2024  
DATE : 05/09/2024 16:38  
TEXT : ..OPVISIPINGOTPPROAPR4.TXT

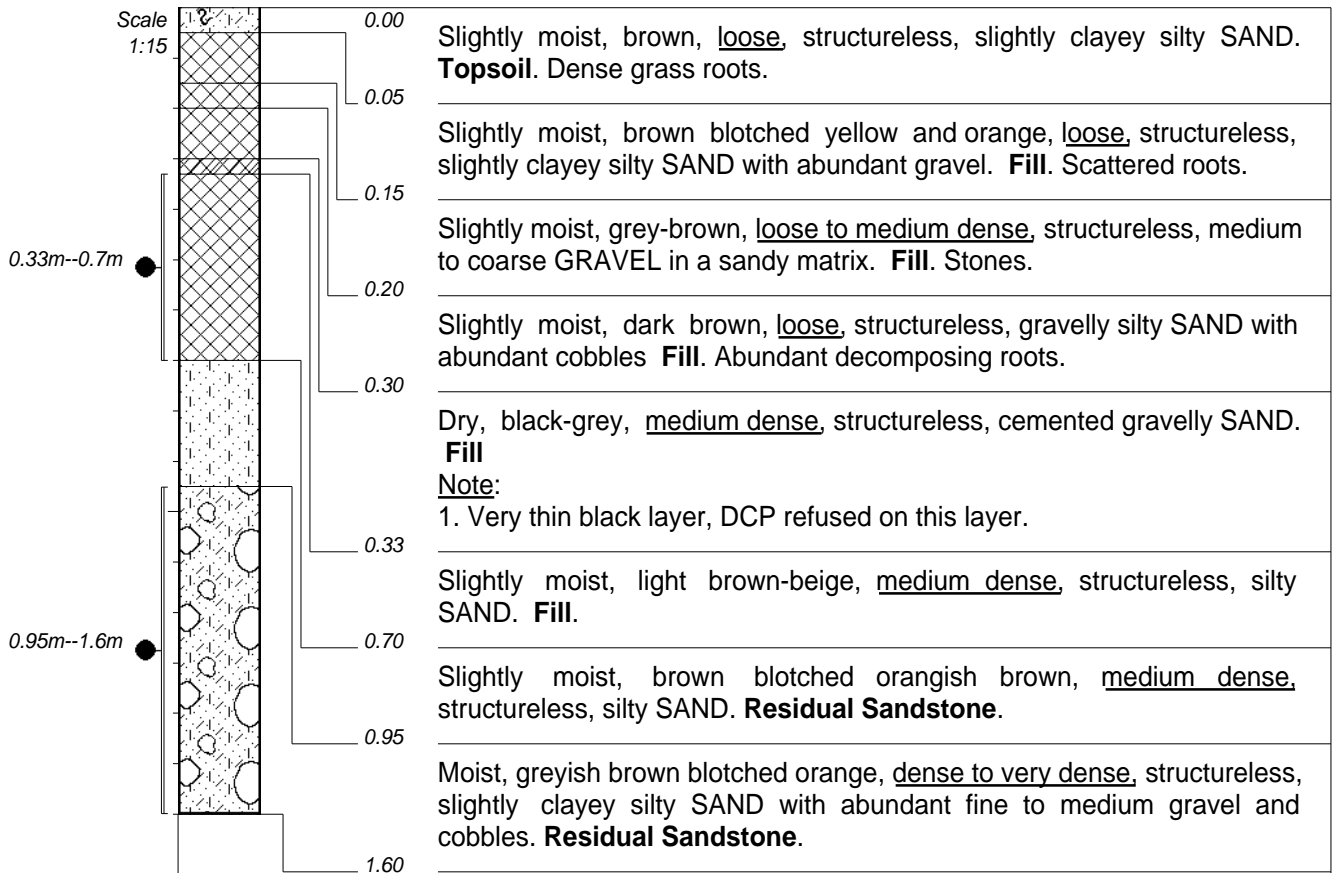
ELEVATION :  
X-COORD : 30°54'23.59"E  
Y-COORD : 29°59'22.49"S

HOLE No: TP06



**TP06**





END OF HOLE

#### NOTES

- 1) Auger 1,5m to 1,6m. Refusal at 1,6m.
- 2) No groundwater seepage encountered.
- 3) Sidewalls stable.
- 4) Samples taken from 0,33m--0,7m and 0,95m--1,6m.

CONTRACTOR :  
MACHINE : Hand / Auger  
DRILLED BY :  
PROFIED BY : A.P  
TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

INCLINATION : Vertical  
DIAM :  
DATE : 2 August 2024  
DATE : 2 August 2024  
DATE : 05/09/2024 16:38  
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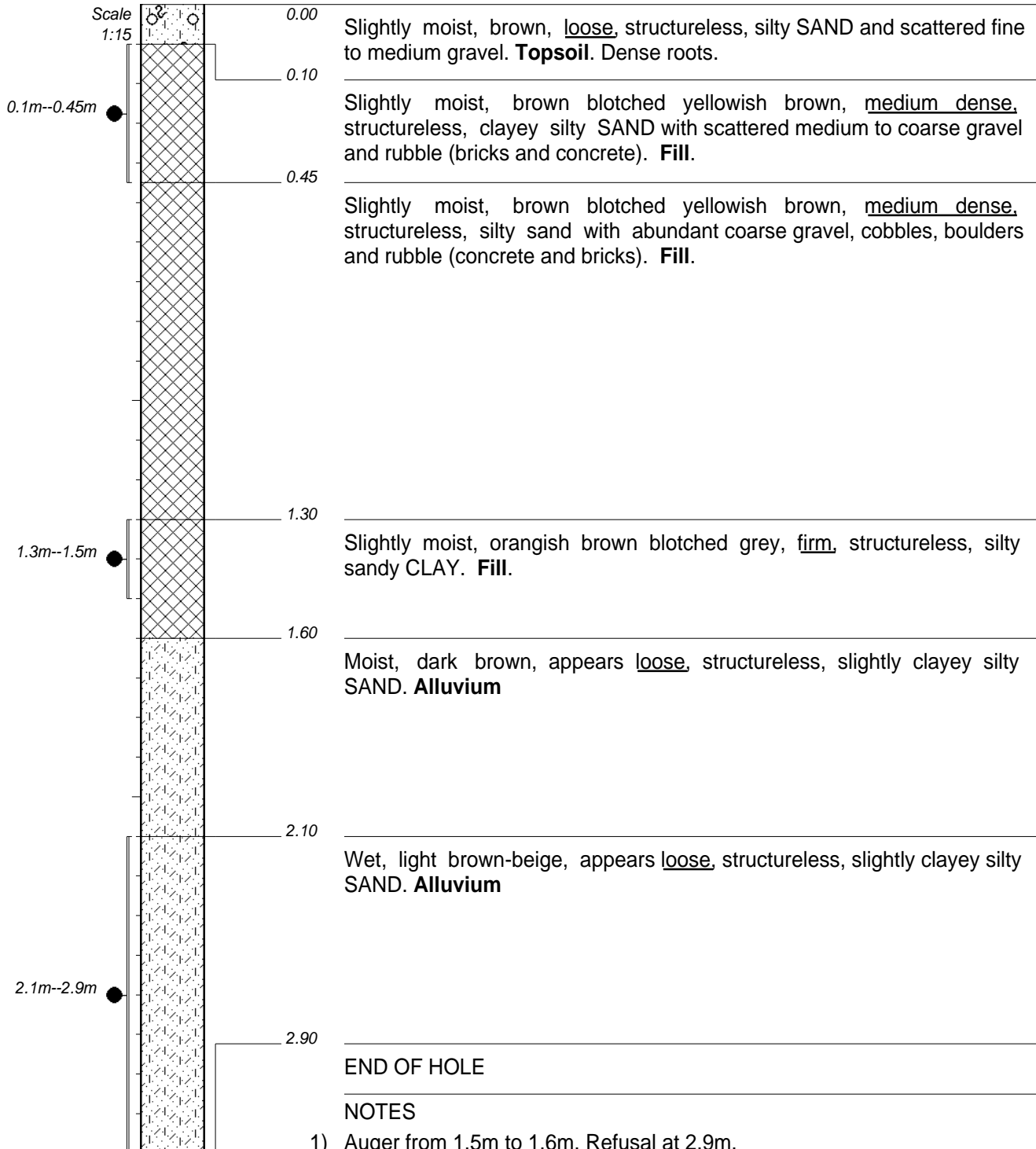
ELEVATION :  
X-COORD : 30°54'23.49"E  
Y-COORD : 29°59'22.95"S

**HOLE No: TP07**



**TP07**





CONTRACTOR :  
MACHINE : Hand / Auger  
DRILLED BY :  
PROFILED BY : A.P  
TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

INCLINATION : Vertical  
DIAM :  
DATE : 5 August 2024  
DATE : 5 August 2024  
DATE : 05/09/2024 16:38  
TEXT : ..OPVISIPINGOTPPROAPR4.TXT

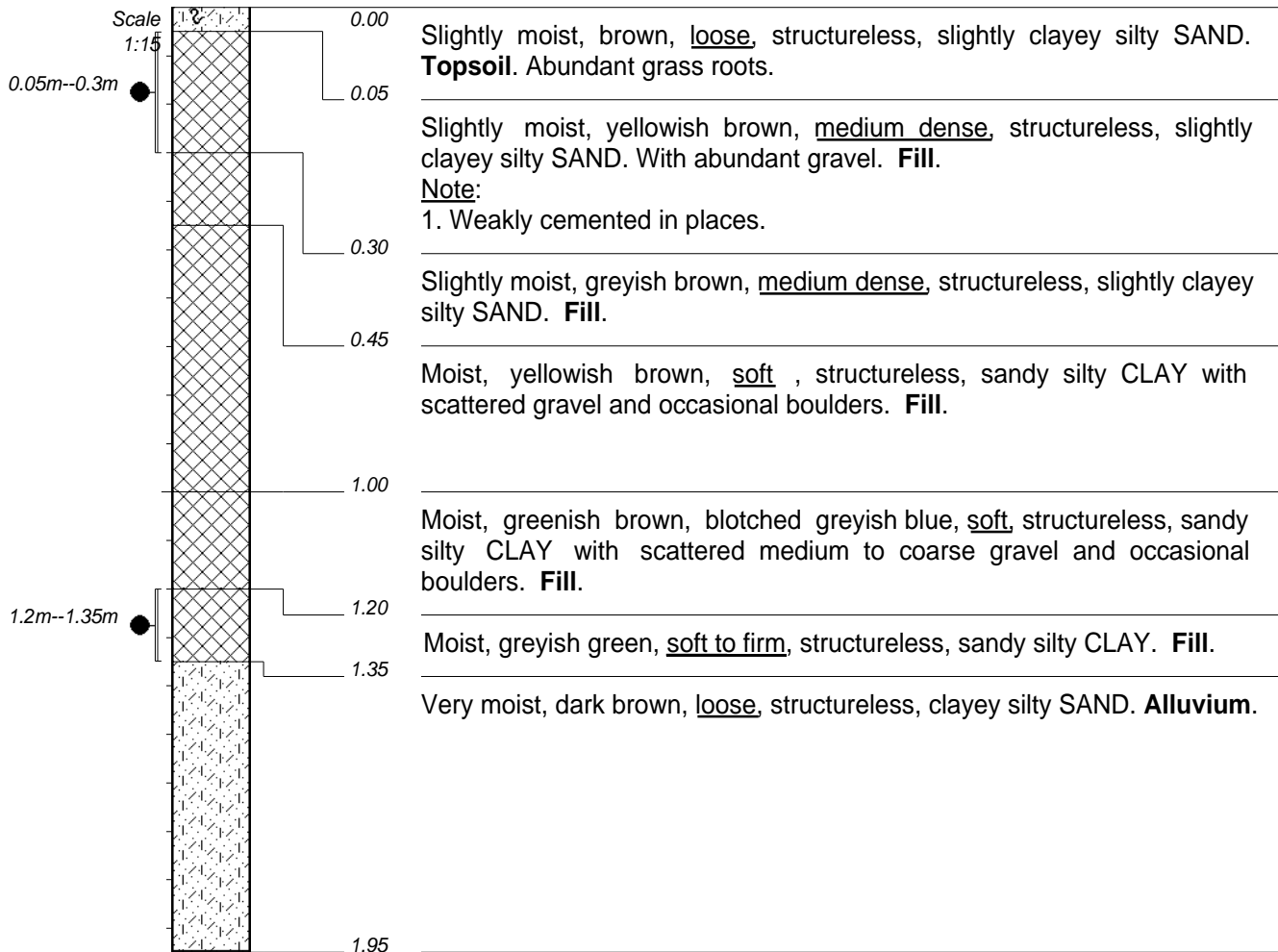
ELEVATION :  
X-COORD : 30°54'24.24"E  
Y-COORD : 29°59'22.56"S

HOLE No: TP08



**TP08**





END OF HOLE

#### NOTES

- 1) Auger from 1,35m to 1,95m. Refusal at 1,95m.
- 2) Slight seepage at base (1,45m).
- 3) Sidewalls stable.
- 4) Samples taken from 0,05m--0,3m and 1,2m--1,35m.

CONTRACTOR :  
MACHINE : Hand / Auger  
DRILLED BY :  
PROFIED BY : A.P  
TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

INCLINATION : Vertical  
DIAM :  
DATE : 1 August 2024  
DATE : 1 August 2024  
DATE : 05/09/2024 16:38  
TEXT : ..OPVISIPINGOTPPROAPR4.TXT

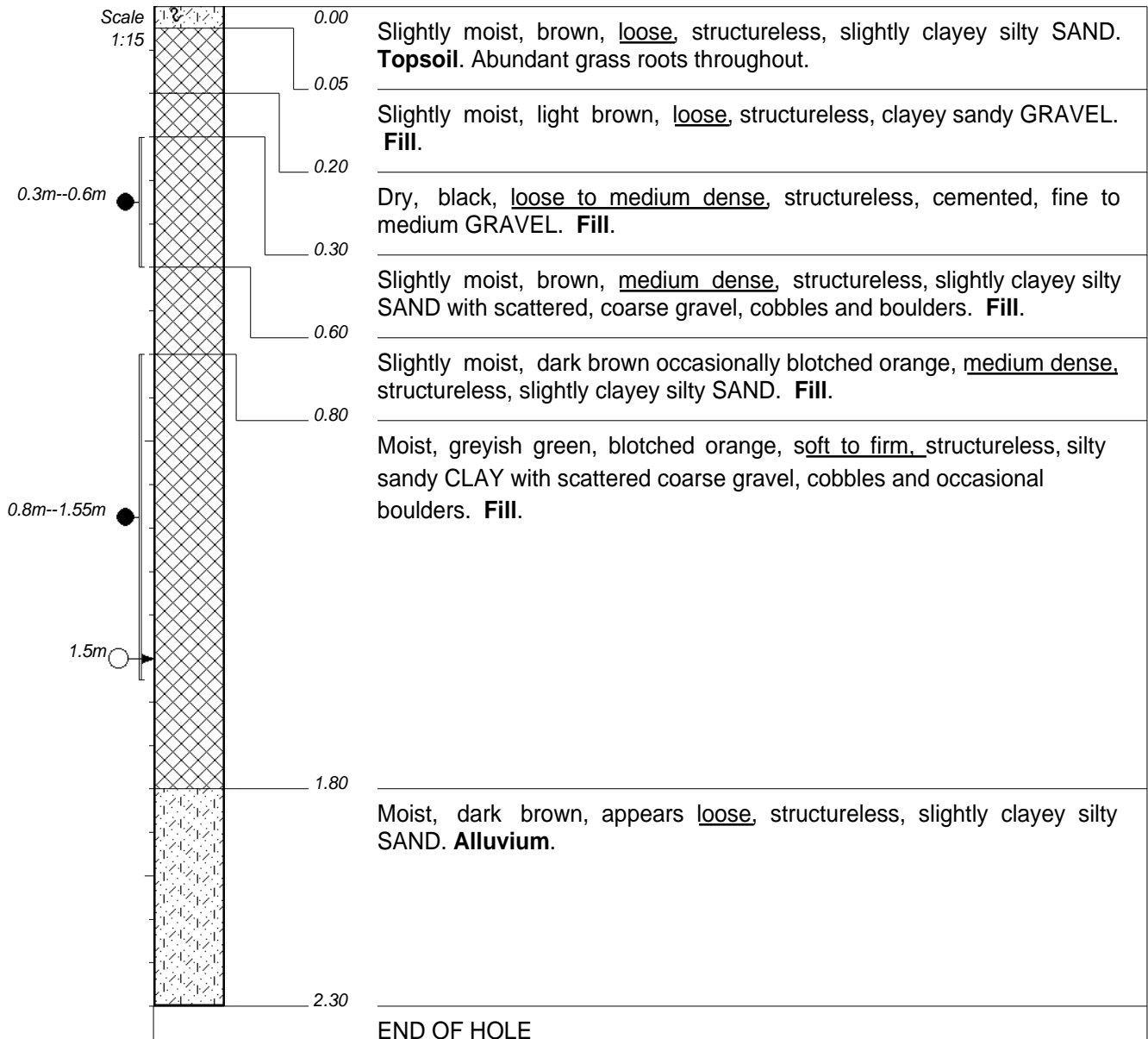
ELEVATION :  
X-COORD : 30°54'23.31"E  
Y-COORD : 29°59'32.72"S

HOLE No: TP10



**TP10**





#### NOTES

- 1) Auger from 1,55m to 2,3m. Refusal at 2,3m on rock / boulder.
- 2) Slow seepage at 1,5m.
- 3) Sidewalls stable.
- 4) Samples taken from 0,3m--0,6m and 0,8m--1,55m.

CONTRACTOR :  
MACHINE : Hand / Auger  
DRILLED BY :  
PROFIED BY : A.P  
TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

INCLINATION : Vertical  
DIAM :  
DATE : 1 August 2024  
DATE : 1 August 2024  
DATE : 05/09/2024 16:38  
TEXT : ..OPVISIPINGOTPPROAPR4.TXT

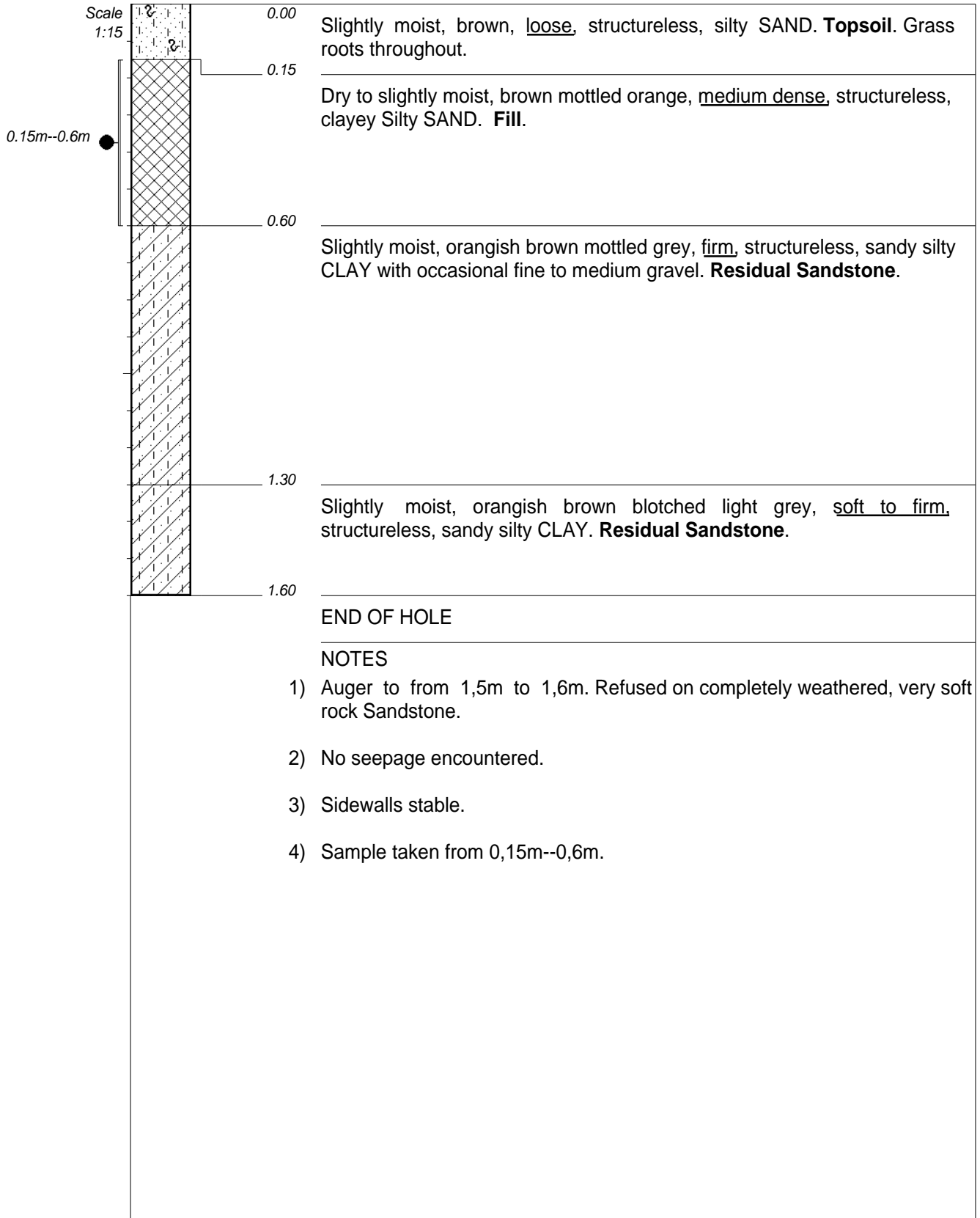
ELEVATION :  
X-COORD : 30°54'23.71"E  
Y-COORD : 29°59'33.12"S

HOLE No: TP11



TP11





CONTRACTOR :  
MACHINE : Hand / Auger  
DRILLED BY :  
PROFILED BY : A.P  
TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

INCLINATION : Vertical  
DIAM :  
DATE : 31 July 2024  
DATE : 31 July 2024  
DATE : 05/09/2024 16:38  
TEXT : ..OPVISIPINGOTPPROAPR4.TXT

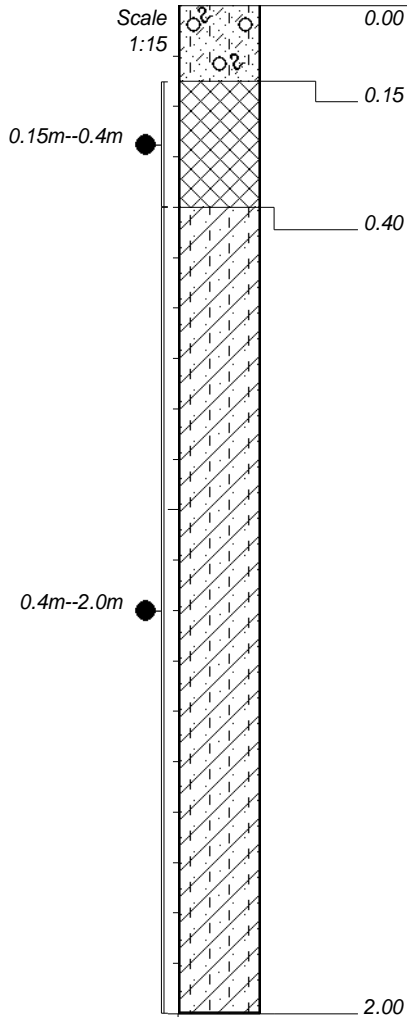
ELEVATION :  
X-COORD : 30°54'18.66"E  
Y-COORD : 29°59'23.65"S

**HOLE No: TP12**



**TP12**





Slightly moist, dark greyish brown, loose, structureless, silty clayey SAND with scattered fine to medium gravel. **Topsoil**. Abundant tree roots.

Slightly moist, greyish brown blotched orange, weakly cemented, medium dense, structureless, silty clayey SAND with abundant medium to coarse gravel. **Fill**. Occasional Tree roots.

Slightly moist, orangish brown blotched light grey, firm, fissured, clayey fine SAND. **Residual Tillite**

**END OF HOLE**

#### NOTES

- 1) Hand auger from 1,4m to 2,0m (difficult auger at 2m+).
- 2) No seepage encountered.
- 3) Sidewalls stable.
- 4) Sample taken from 0,15m--0,4m and 0,4m--2,0m.

CONTRACTOR :  
MACHINE : Hand / Auger  
DRILLED BY :  
PROFILED BY : A.P  
TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

INCLINATION : Vertical  
DIAM :  
DATE : 29 July 2024  
DATE : 29 July 2024  
DATE : 05/09/2024 16:38  
TEXT : ..OPVISIPINGOTPPROAPR4.TXT

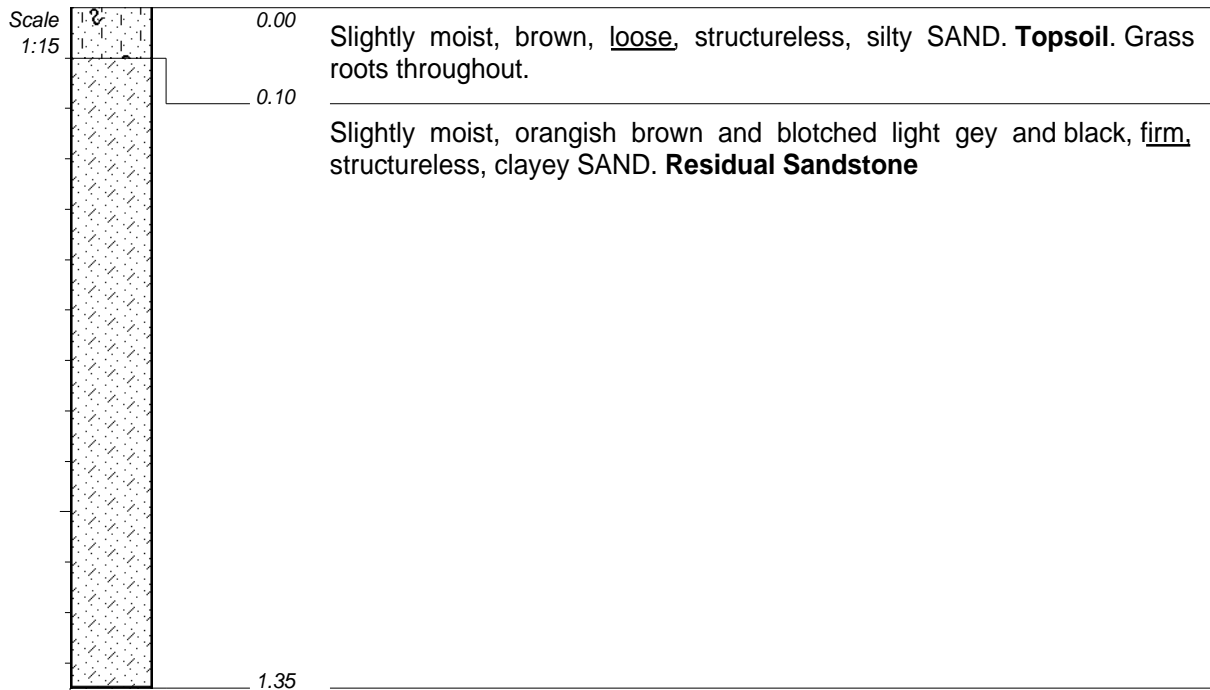
ELEVATION :  
X-COORD : 30°54'21.33"E  
Y-COORD : 29°59'22.57"S

**HOLE No: TP14**



**TP14**





END OF HOLE

NOTES

- 1) Hand augured. Refusal on hard rock tillite.
- 2) No seepage encountered.
- 3) Sidewalls stable.
- 4) No samples taken.
- 5) Slightly to moderately weathered hard rock tillite at base.

CONTRACTOR :  
MACHINE : Hand  
DRILLED BY :  
PROFIED BY : A.P

TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

INCLINATION : Vertical

DIAM :  
DATE : 31 July 2024  
DATE : 31 July 2024

DATE : 05/09/2024 16:38  
TEXT : ..OPVISIPINGOTPPROAPR4.TXT

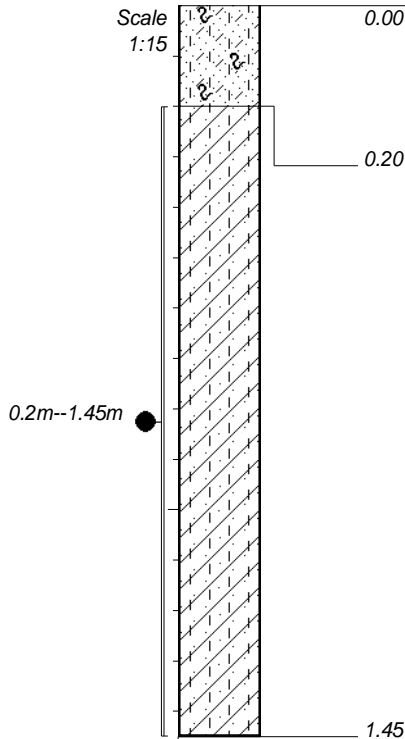
ELEVATION :  
X-COORD : 30°54'19.29"E  
Y-COORD : 29°59'23.02"S

**HOLE No: TP15**



**TP15**





Slightly moist, loose, structureless, silty clayey SAND. **Topsoil**. Fine roots throughout.

**Note:**

1. Thin reddish brown ferruginised layer at base, approx. 2-3 cm thick.

Slightly moist, orangish brown and light grey streaked black and dark brown, firm to stiff, fractured, clayey silty SAND with fissures infilled with dark brown clayey sand. **Residual Sandstone**.

END OF HOLE

**NOTES**

- 1) Attempted auger. Auger stuck at bottom on stiff clays.
- 2) No groundwater seepage encountered, however BH01 water level at 0,5m.
- 3) Sidewalls stable.
- 4) Sample taken from 0,2m--1,45m.

CONTRACTOR :  
MACHINE : Hand excavated  
DRILLED BY :  
PROFIED BY : A.P  
TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

INCLINATION : Vertical  
DIAM :  
DATE : 25 July 2024  
DATE : 25 July 2024  
DATE : 05/09/2024 16:38  
TEXT : ..OPVISIPINGOTPPROAPR4.TXT

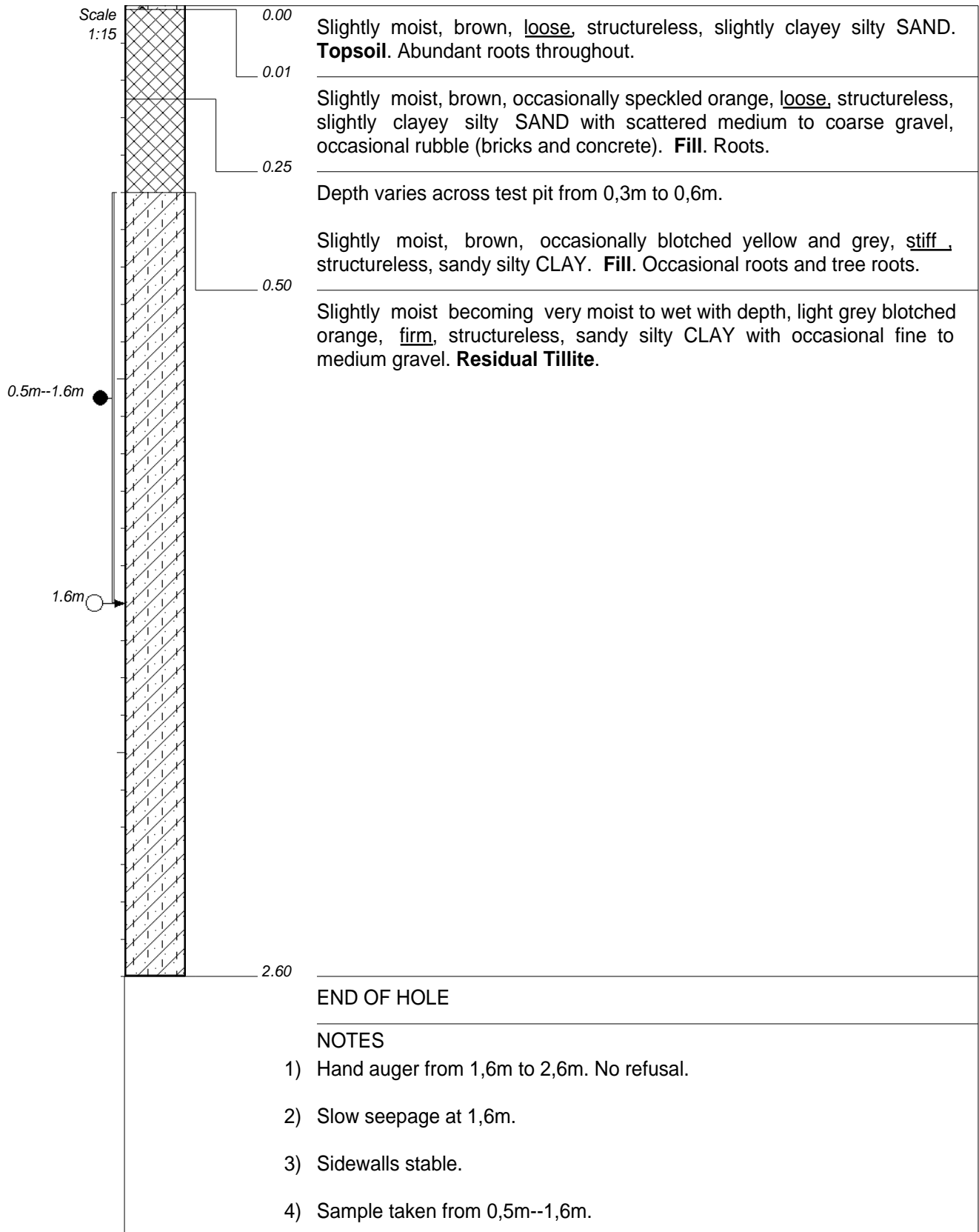
ELEVATION :  
X-COORD : 30°54'20.36"E  
Y-COORD : 29°59'23.23"S

**HOLE No: TP16**



**TP16**





CONTRACTOR :  
MACHINE : Hand / Auger  
DRILLED BY :  
PROFIED BY : A.P  
TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

INCLINATION : Vertical  
DIAM :  
DATE : 1 August 2024  
DATE : 1 August 2024  
DATE : 05/09/2024 16:38  
TEXT : ..OPVISIPINGOTPPROAPR4.TXT

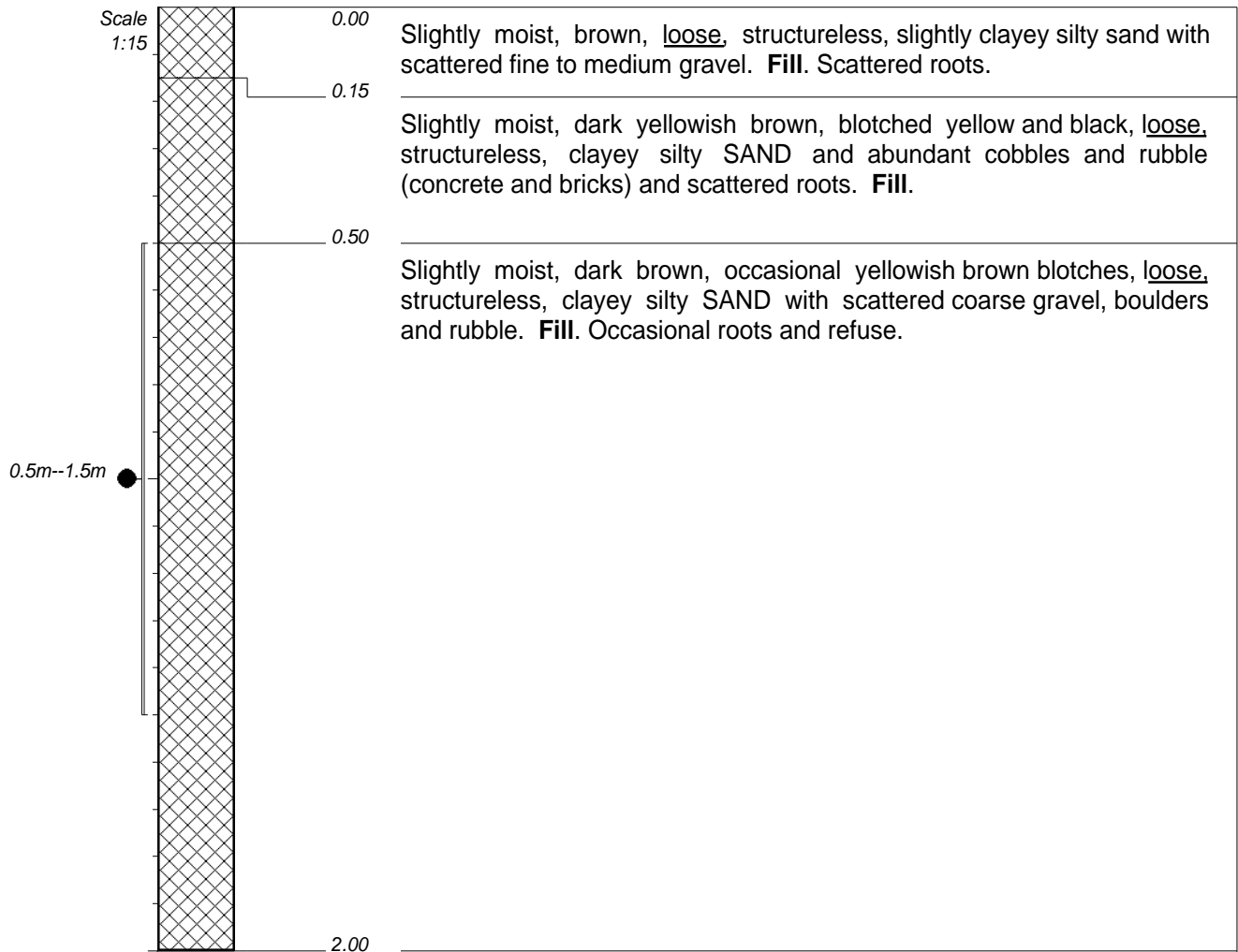
ELEVATION :  
X-COORD : 30°54'18.49"E  
Y-COORD : 29°59'25.09"S

**HOLE No: TP17**



TP17





**END OF HOLE**

**NOTES**

- 1) Auger from 1,5m to 2,0m. Refusal on boulder at 2,0m.
- 2) No groundwater seepage encountered.
- 3) Sidewalls stable.
- 4) Sample taken from 0,5m--1,5m.

CONTRACTOR :  
MACHINE : Hand / Auger  
DRILLED BY :  
PROFILED BY : A.P  
TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

INCLINATION : Vertical  
DIAM :  
DATE : 5 April 2024  
DATE : 5 April 2024  
DATE : 05/09/2024 16:38  
TEXT : ..OPVISIPINGOTPPROAPR4.TXT

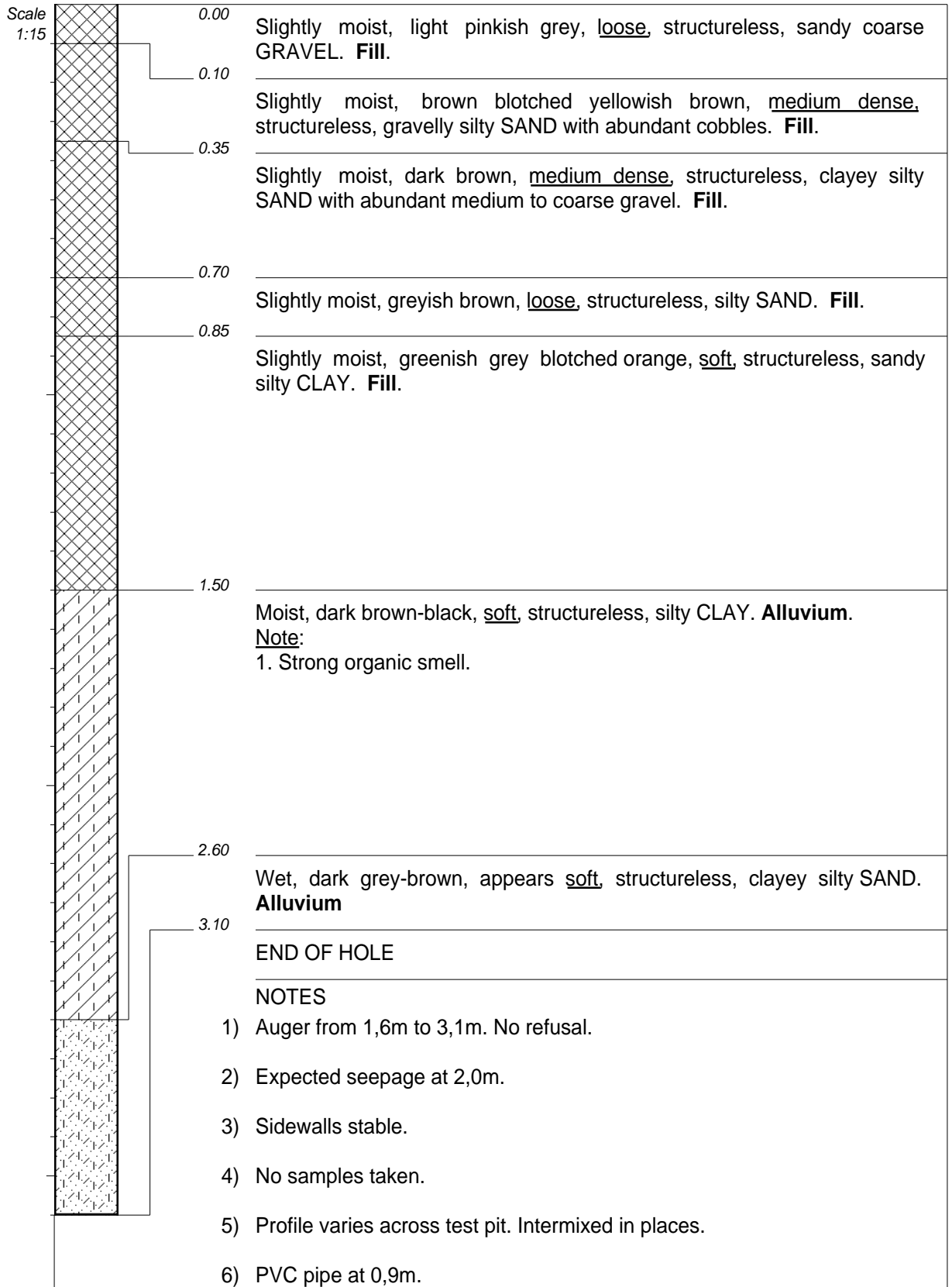
ELEVATION :  
X-COORD : 30°54'26.19"E  
Y-COORD : 29°59'23.05"S

**HOLE No: TP18**



**TP18**





CONTRACTOR :  
MACHINE : Hand / Auger  
DRILLED BY :  
PROFILED BY : A.P  
TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

INCLINATION : Vertical  
DIAM :  
DATE : 5 April 2024  
DATE : 5 April 2024  
DATE : 05/09/2024 16:38  
TEXT : ..OPVISIPINGOTPPROAPR4.TXT

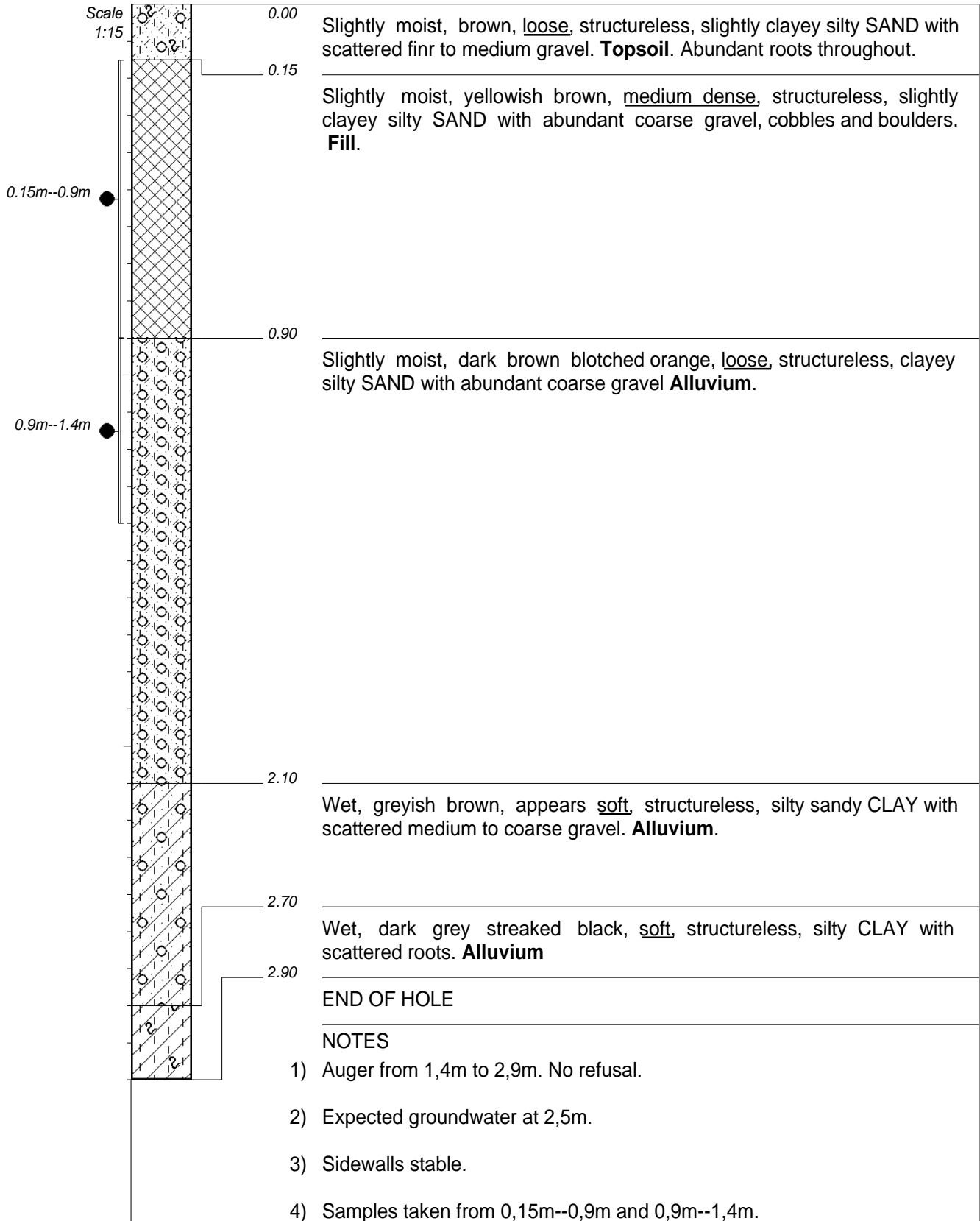
ELEVATION :  
X-COORD : 30°54'25.88"E  
Y-COORD : 29°59'23.59"S

**HOLE No: TP19**



TP19





CONTRACTOR :  
MACHINE : Hand / Auger  
DRILLED BY :  
PROFILED BY : A.P  
TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

INCLINATION : Vertical  
DIAM :  
DATE : 5 August 2024  
DATE : 5 August 2024  
DATE : 05/09/2024 16:38  
TEXT : ..OPVISIPINGOTPPROAPR4.TXT

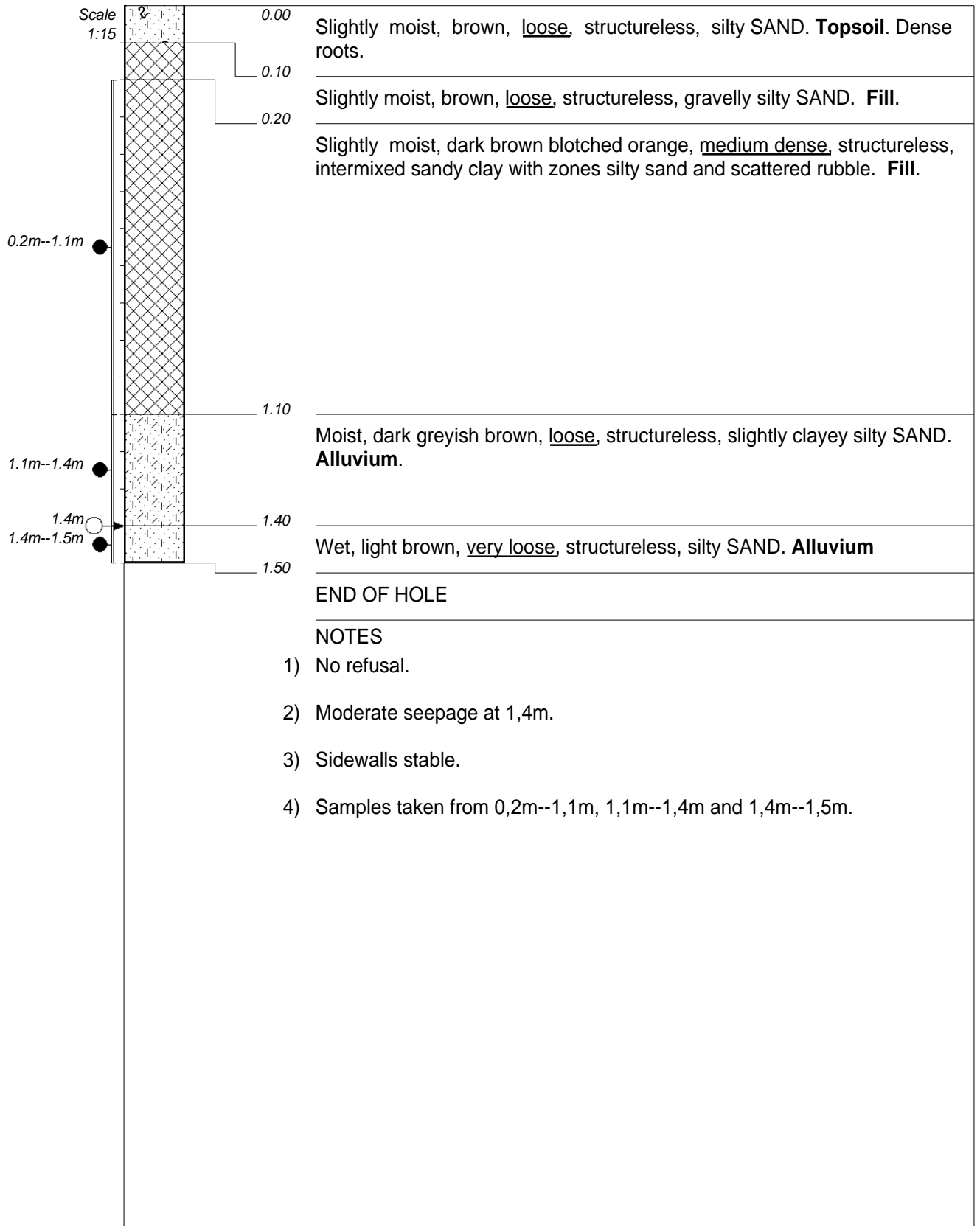
ELEVATION :  
X-COORD : 30°54'24.87"E  
Y-COORD : 29°59'23.87"S

HOLE No: TP20



TP20





CONTRACTOR :  
MACHINE : Hand excavated  
DRILLED BY :  
PROFILED BY : A.P  
TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

INCLINATION : Vertical  
DIAM :  
DATE : 31 July 2024  
DATE : 31 July 2024  
DATE : 05/09/2024 16:38  
TEXT : ..OPVISIPINGOTPPROAPR4.TXT

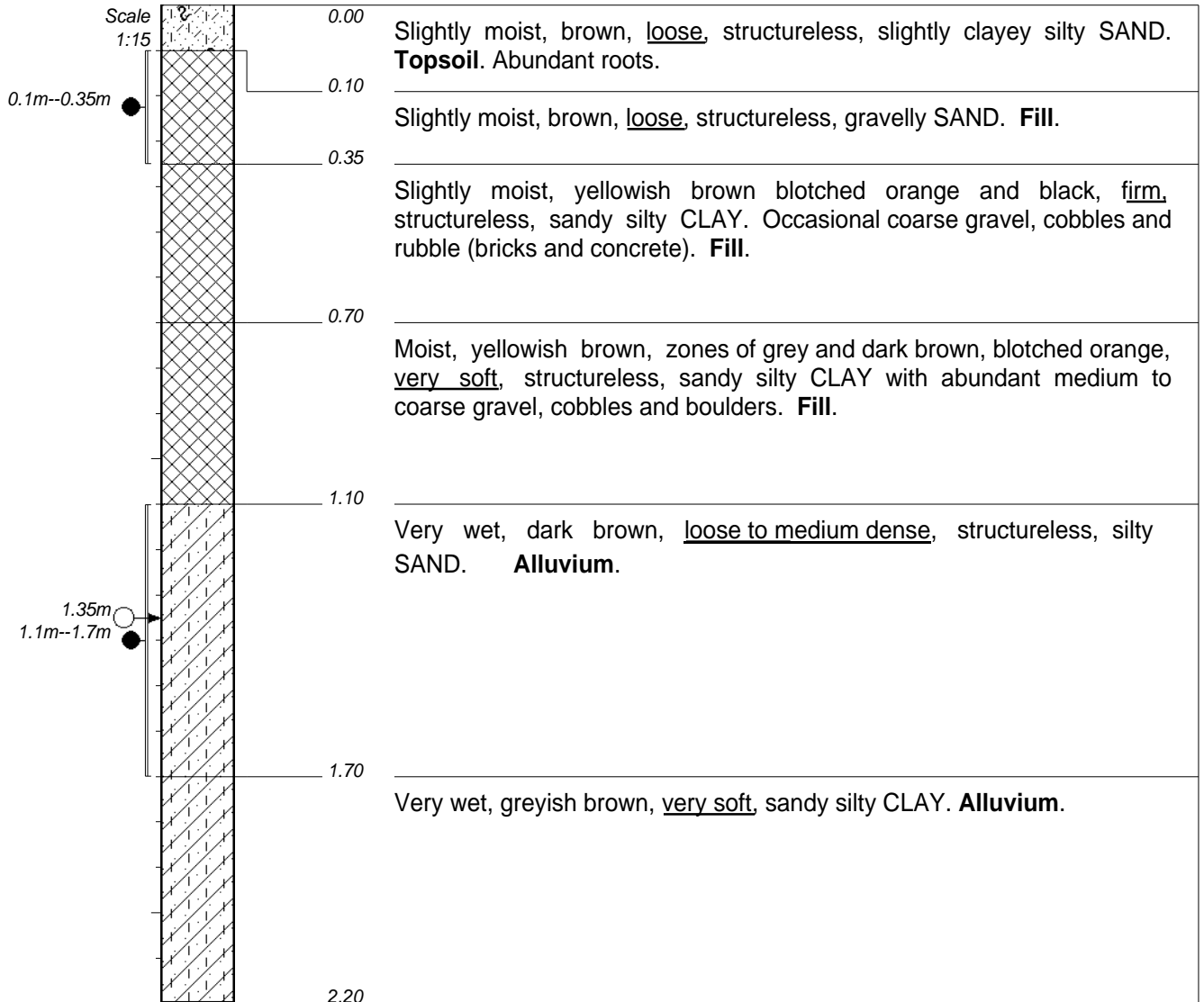
ELEVATION :  
X-COORD : 30°54'24.24"E  
Y-COORD : 29°59'24.75"S

HOLE No: TP21



TP21





END OF HOLE

#### NOTES

- 1) Hand auger from 1,5m to 2,2m and refusal at 2,2m on possible stone / boulder.
- 2) Moderate groundwater seepage at 1,35m.
- 3) Sidewalls stable.
- 4) Samples taken from 1,1m--1,7m and 0,1m--0,35m.

CONTRACTOR :  
MACHINE : Hand excavated  
DRILLED BY :  
PROFILED BY : A.P  
TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

INCLINATION : Vertical  
DIAM :  
DATE : 1 August 2024  
DATE : 1 August 2024  
DATE : 05/09/2024 16:38  
TEXT : ..OPVISIPINGOTPPROAPR4.TXT

ELEVATION :  
X-COORD : 30°54'19.71"E  
Y-COORD : 29°59'26.96"S

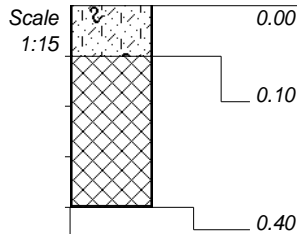
HOLE No: TP22



TP22







Slightly moist, brown, loose, structureless, slightly clayey silty SAND.  
**Topsoil.** Abundant roots throughout.

Slightly moist, brown, dark brown, medium dense to dense, structureless,  
silty SAND with abundant medium to coarse gravel, cobbles and  
occasional boulders. **Fill.**

END OF HOLE

#### NOTES

- 1) Hole stopped due to presence of cable at 0,4m. Did not excavate further due to risk of damaging electric cable.
- 2) No seepage encountered.
- 3) Sidewalls stable.
- 4) No samples taken.

CONTRACTOR :  
MACHINE : Hand excavated  
DRILLED BY :  
PROFILED BY : A.P  
TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

INCLINATION : Vertical  
DIAM :  
DATE : 26 July 2024  
DATE : 26 July 2024  
DATE : 05/09/2024 16:38  
TEXT : ..OPVISIPINGOTPPROAPR4.TXT

ELEVATION :  
X-COORD : 30°54'20.00"E  
Y-COORD : 29°59'27.87"S

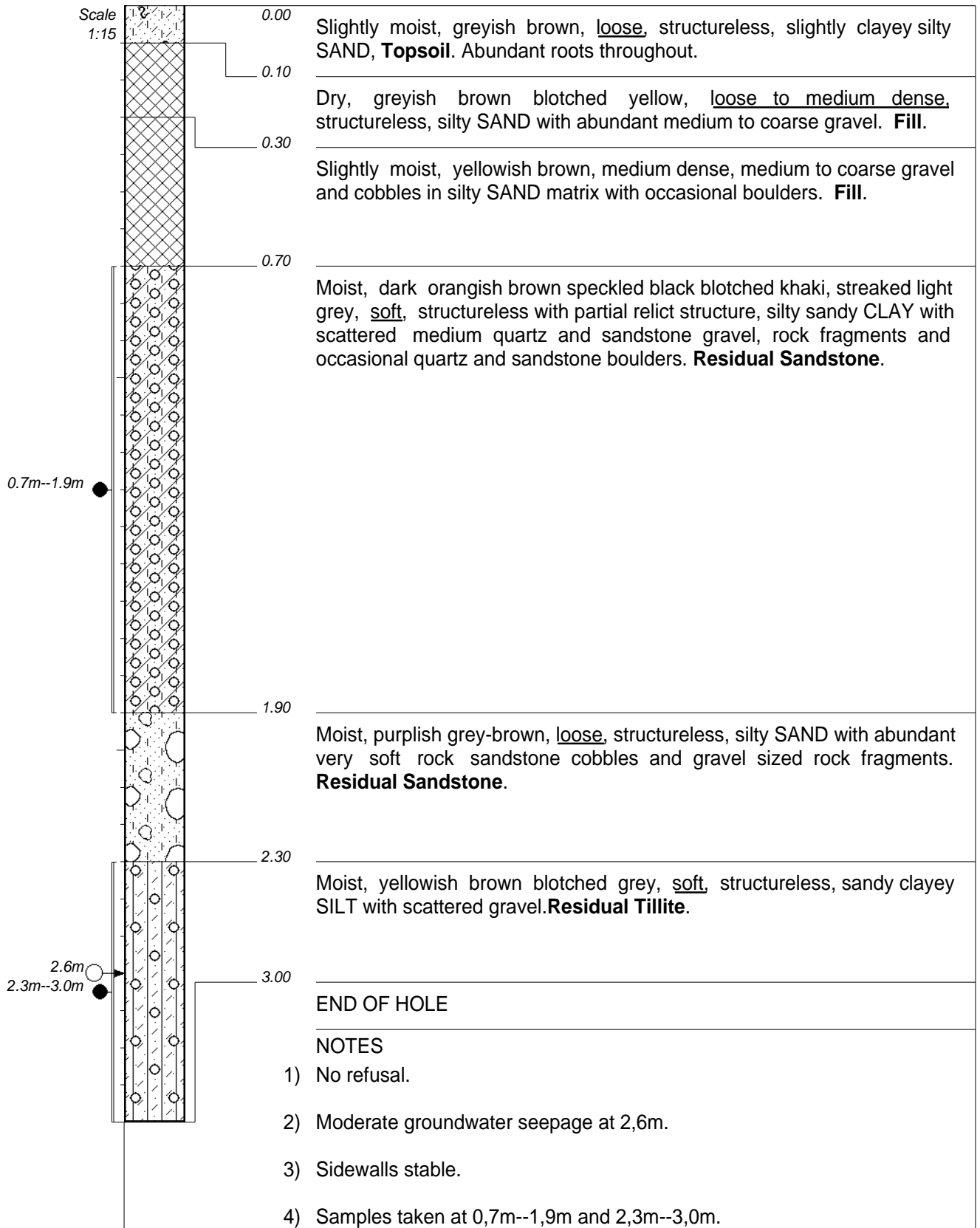
**HOLE No: TP23**



**TP23**







CONTRACTOR :  
MACHINE : TLB Case 570T  
DRILLED BY :  
PROFIED BY : A.P  
TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

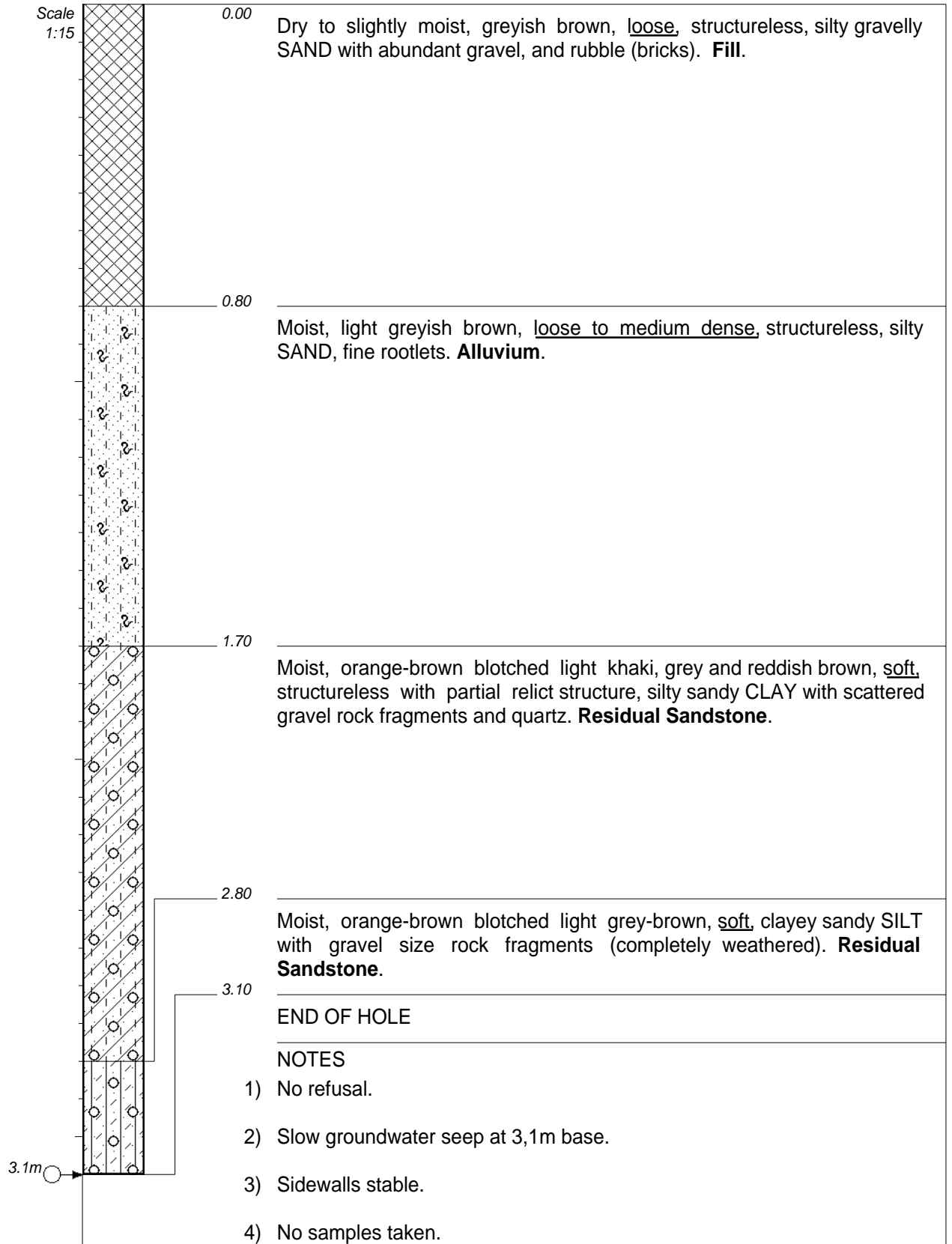
INCLINATION : Vertical  
DIAM :  
DATE : 15 August 2024  
DATE : 15 August 2024  
DATE : 05/09/2024 16:38  
TEXT : ..OPVISIPINGOTPPROAPR4.TXT

ELEVATION :  
X-COORD : 30°54'23.25"E  
Y-COORD : 29°59'22.14"S

HOLE No: TP24

**TP24**



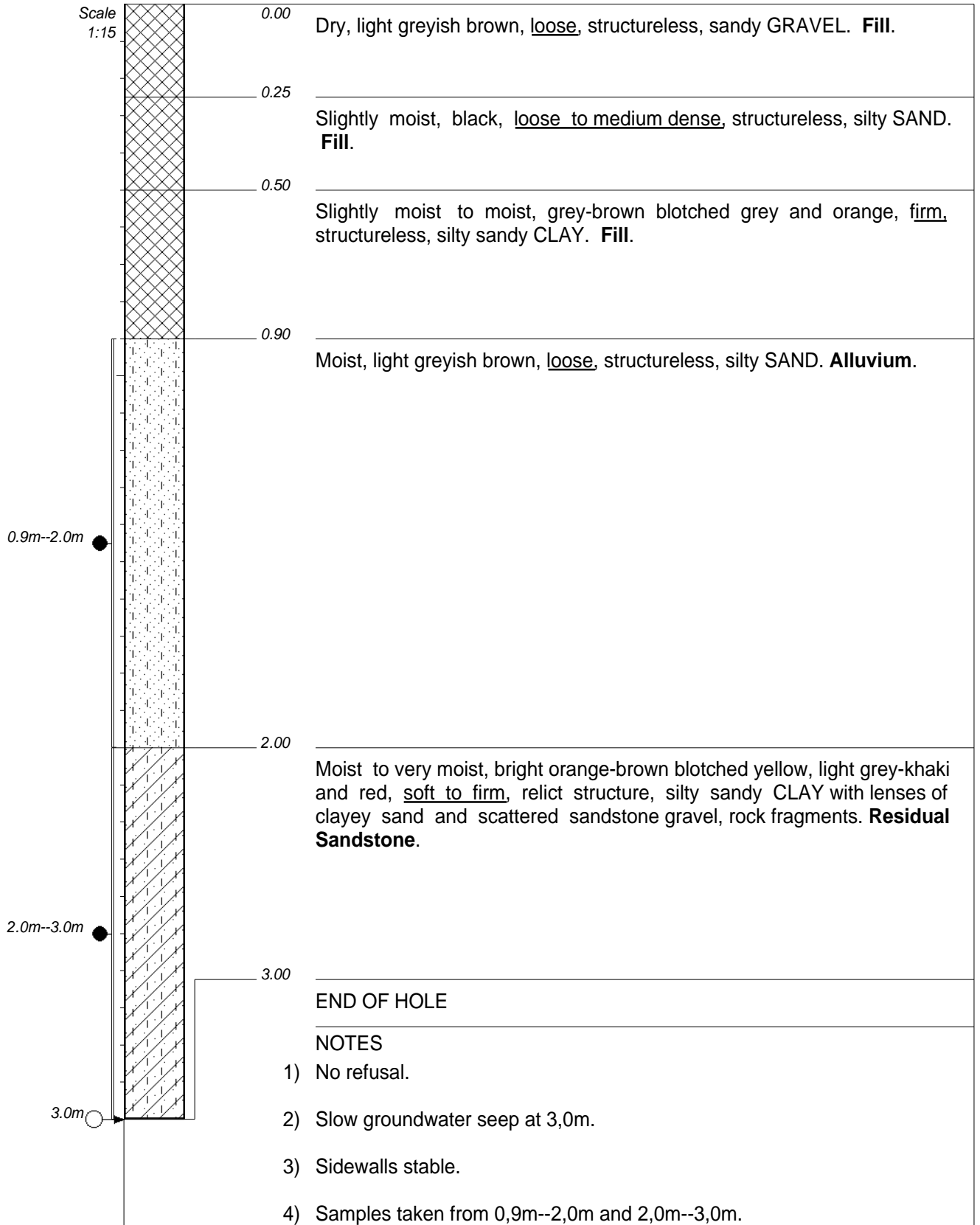


CONTRACTOR :  
MACHINE : TLB Case 570T  
DRILLED BY :  
PROFILED BY : A.P  
TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

INCLINATION : Vertical  
DIAM :  
DATE : 15 August 2024  
DATE : 15 August 2024  
DATE : 05/09/2024 16:38  
TEXT : ..OPVISIPINGOTPPROAPR4.TXT

ELEVATION :  
X-COORD : 30°54'24.10"E  
Y-COORD : 29°59'22.87"S

HOLE No: TP25A



CONTRACTOR :  
MACHINE : TLB Case 570T  
DRILLED BY :  
PROFILED BY : A.P  
TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

INCLINATION : Vertical  
DIAM :  
DATE : 15 August 2024  
DATE : 15 August 2024  
DATE : 05/09/2024 16:38  
TEXT : ..OPVISIPINGOTPPROAPR4.TXT

ELEVATION :  
X-COORD : 30°54'24.10"E  
Y-COORD : 29°59'22.87"S

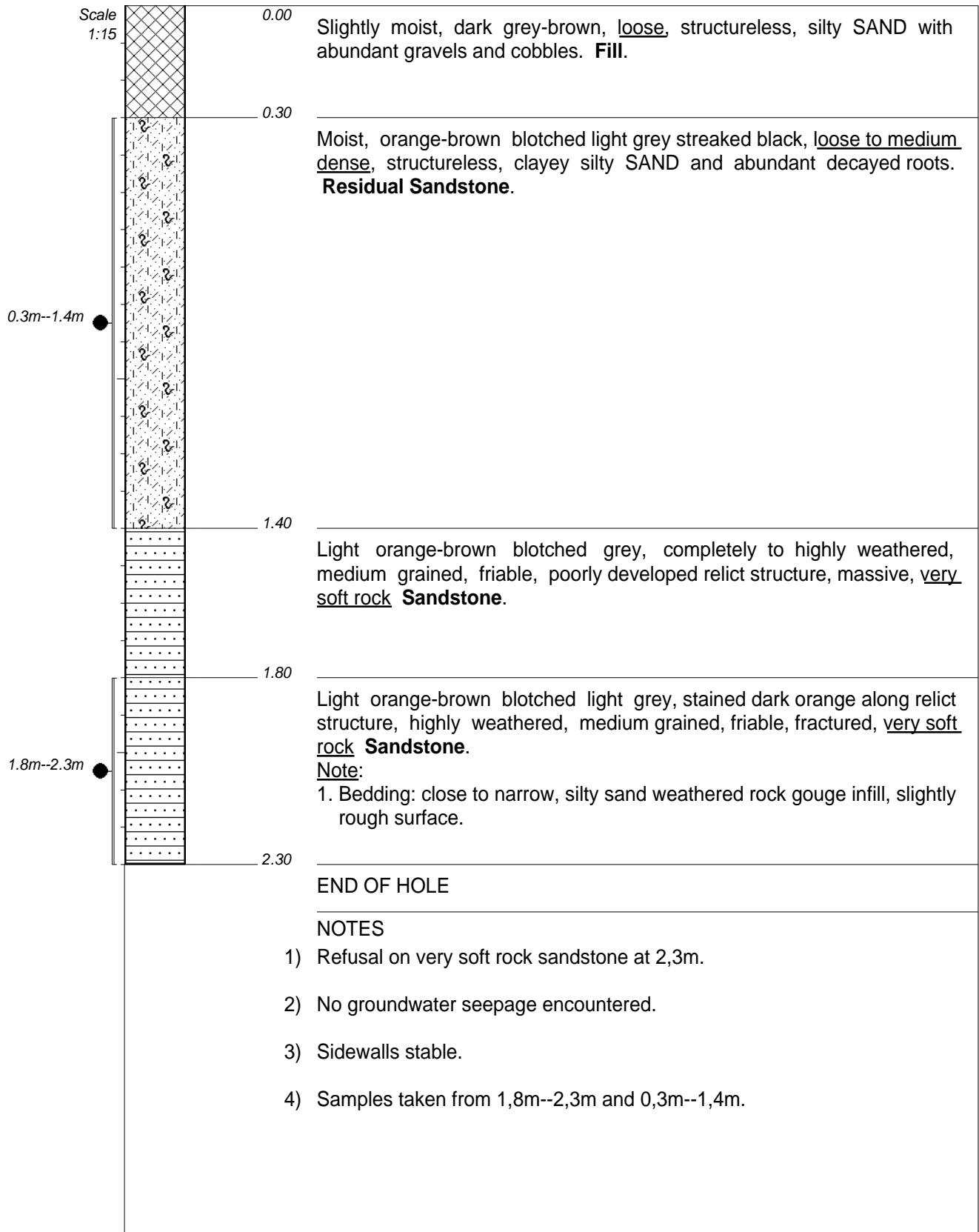
HOLE No: TP25B



**TP25B**







CONTRACTOR :  
MACHINE : TLB Case 570T  
DRILLED BY :  
PROFIED BY : A.P  
TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

INCLINATION : Vertical  
DIAM :  
DATE : 15 August 2024  
DATE : 15 August 2024  
DATE : 05/09/2024 16:38  
TEXT : ..OPVISIPINGOTPPROAPR4.TXT

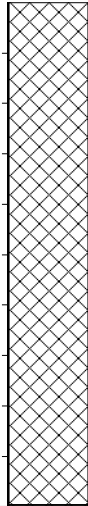
ELEVATION :  
X-COORD : 30°54'18.96"E  
Y-COORD : 29°59'23.45"S

HOLE No: TP26

**TP26**



Scale  
1:15



0.00

Slightly moist, brown, loose, structureless, gravelly silty SAND with abundant cobbles. **Fill.**

1.00

**END OF HOLE**

**NOTES**

- 1) Stopped at 1,0m due to pipe.
- 2) No groundwater seepage encountered.
- 3) Sidewalls stable.
- 4) No samples taken.

CONTRACTOR :  
MACHINE : TLB Case 570T  
DRILLED BY :  
PROFILED BY : A.P  
TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

INCLINATION : Vertical  
DIAM :  
DATE : 15 August 2024  
DATE : 15 August 2024  
DATE : 05/09/2024 16:38  
TEXT : ..OPVISIPINGOTPPROAPR4.TXT

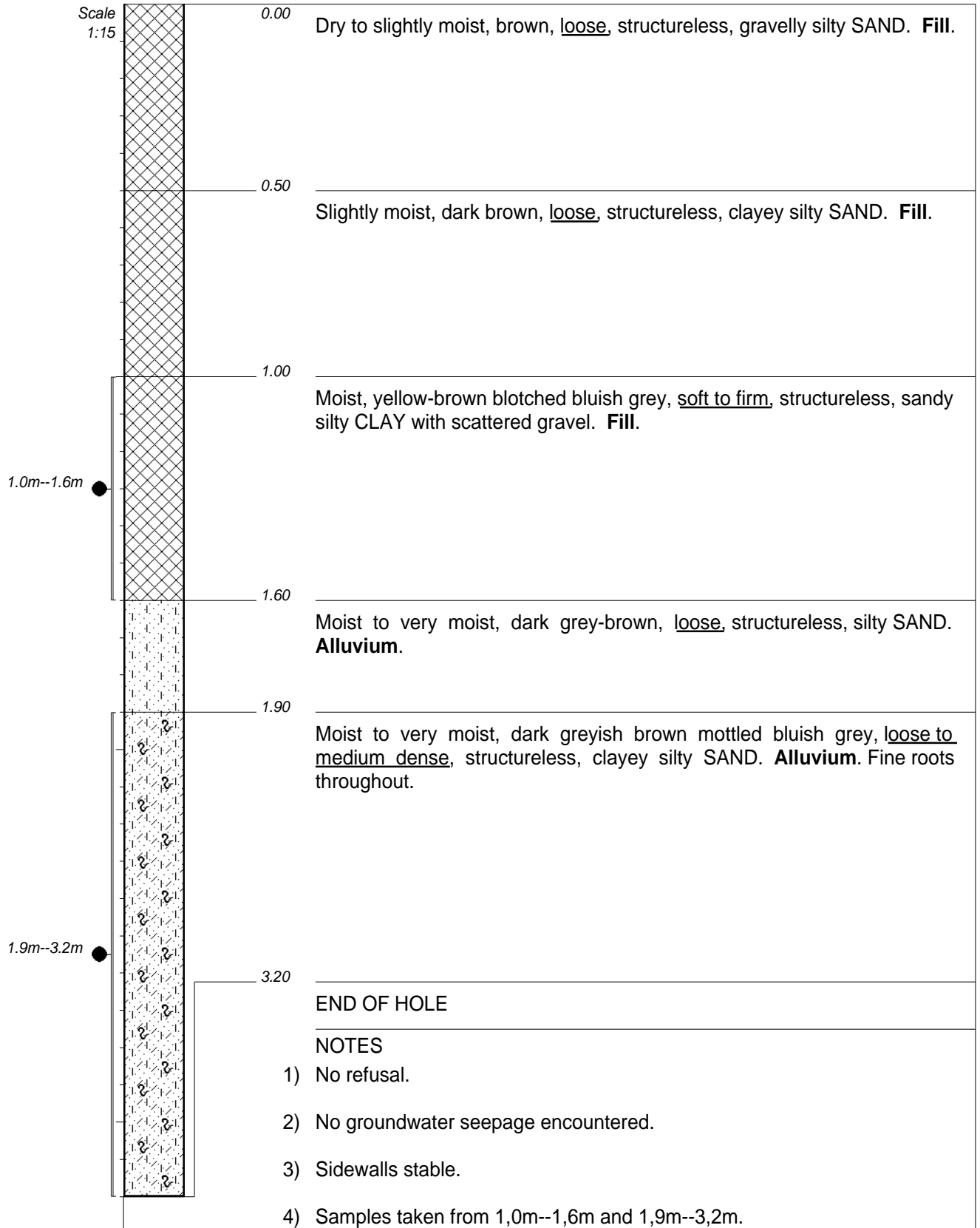
ELEVATION :  
X-COORD : 30°54'17.34"E  
Y-COORD : 29°59'18.83"S

**HOLE No: TP27**



**TP27**





CONTRACTOR :  
MACHINE : TLB Case 570T  
DRILLED BY :  
PROFIED BY : A.P  
TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

INCLINATION : Vertical  
DIAM :  
DATE : 15 August 2024  
DATE : 15 August 2024  
DATE : 05/09/2024 16:38  
TEXT : ..OPVISIPINGOTPPROAPR4.TXT


















ELEVATION :  
X-COORD : 30°54'23.52"E  
Y-COORD : 29°59'32.90"S

**HOLE No: TP28**



**TP28**



	GRAVEL	{SA02}
	GRAVELLY	{SA03}
	SAND	{SA04}
	SANDY	{SA05}
	SILT	{SA06}
	SILTY	{SA07}
	CLAY	{SA08}
	CLAYEY	{SA09}
	TILLITE	{SA10}
	SANDSTONE	{SA11}
	FILL	{SA32}
Name 	UNDISTURBED SAMPLE	{SA37}
Name 	DISTURBED SAMPLE	{SA38}
	ROOTS	{SA40}
14.5 	WATER SEEPAGE/water strike	{CH50}
	COBBLES	{SA58}
	CEMENTED GRAVEL	{LE03}

CONTRACTOR :  
MACHINE :  
DRILLED BY :  
PROFILED BY :

TYPE SET BY : Beth  
SETUP FILE : STANDARD.SET

INCLINATION :  
DIAM :  
DATE :  
DATE :

DATE : 05/09/2024 16:38  
TEXT : ..OPVISIPINGOTPPROAPR4.TXT

ELEVATION :  
X-COORD :  
Y-COORD :

**LEGEND**  
SUMMARY OF SYMBOLS





# Appendix D    Laboratory Results

## **Isipingo Wastewater Treatment Works Geotechnical Investigation Report**

**Isipingo, KwaZulu-Natal**

**Zutari (Pty) Ltd**

SLR Project No.: 720.070334.00001

20 September 2024

CLIENT : SLR Consulting (South Africa) (Pty) Ltd  
 PHYSICAL ADDRESS : Unit 14, Braehead Office Park, 1 Old Main Rd, Kloof, Durban, 3640  
 ATTENTION : Mrs R. Naidoo  
 PROJECT : Isipingo WWTW

**TEST REPORT REFERENCE NUMBER: 79999**

**Dear Sir/Madam,**

Enclosed herewith, please find the original reports pertaining to the above-mentioned project.

Date Received	14.08.2024						
Date Tested	16.08 to 29.08.2024						
Sample Location	Refer to report						
Sampling Method	Unknown						
Sample Condition	Good						
Sampling Environmental Condition	Unknown						
Sampler(s) Name	Client						
Total Number of Pages	37						
Test Carried Out							
SANS3001 GR1	✓	SANS3001 GR11		SANS3001 AS1		SANS3001 AS2	
SANS3001 GR10	✓	SANS3001 GR12	✓	SANS3001 AS10		SANS3001 AS11	
SANS3001 GR20	✓	SANS3001 GR30	✓	SANS3001 AS20		SANS3001 AG1	
SANS3001 GR31		SANS3001 GR40	✓	SANS3001 AG2/3		SANS3001 AG5	
SANS3001 GR50		SANS3001 GR51		SANS3001 AG5		SANS3001 AG10	
SANS3001 GR52		SANS3001 GR53		SANS3001 AG14		SANS3001 AG15	
SANS3001 GR54		SANS3001 GR55		SANS3001 AG20		SANS3001 AG21	
SANS3001 GR57		SANS3001 GR58		SAN5833		SANS3001 AG23	
SANS3001 GR5		ASTM D422	✓	SANS202#		SANS5849	
SANS3001 GR60		SANS3001 GR61		SANS6243		SANS6245	
TMH1 A10b		SANS5836		SANS5850-1		TMH1 B6	
SANS3001 C03-2		SANS5831		UCT Manual Part 3		TMH1 B9	
✓ - Tick denotes tests that were carried out.							

**We would like to take this opportunity of thanking you for your continued support.**

**Should you have any queries please do not hesitate to contact me.**

**Refer to Appendix A for Uncertainty of Measurement and notes on the Decision Rule**

**Yours faithfully**



**Technical Signatory,**

**Darren Samuel for Geosure (Pty) Ltd.**

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<b>Head Office</b> 122 Intersite Avenue, Umgeni Business Park, Durban 4091, South Africa PO Box 1461, Westville, 3630, South Africa Tel.: +27 (0)861 GEOSURE / 0861 436 7873 Fax: +27 (0)86 689 5506 Mobile: +27 (0)82 784 0544 E-mail: geosure@iafrica.com	<b>Civil Engineering Laboratory</b> 122 Intersite Avenue, Umgeni Business Park, Durban, 4091, South Africa PO Box 1461, Westville, 3630, South Africa Tel: 031 701 9732 Fax: +27 (0) 86 684 9785 Mobile: 072 870 2621 E-mail: lab@geosure.co.za	<b>Gauteng Branch</b> P. O. Box 32381, Kyalami 1684 Tel.: 0861 GEOSURE / 0861 436 7873 Fax: 086 689 8327 Mobile: 083 377 6559 Email: gauteng@geosure.co.za
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LABORATORY AND HEAD OFFICE ADDRESS:		Reg.No.: 92/03145/07	
LABORATORY CONTACT INFO.:		122 Intersite Avenue, Umgeni Business Park, Durban, 4091	
HEAD OFFICE CONTACT INFO.:		Tel.: +27(0) 31 701 9732	Fax: 086 684 9785
WEBSITE:		Mobile: +27(0) 72 870 2621	e-mail: <a href="mailto:lab@geosure.co.za">lab@geosure.co.za</a>
		Tel.: +27(0) 31 266 0458	Fax: 086 689 5506
		Mobile: +27(0) 82 784 0544	e-mail: <a href="mailto:geosure@iafrica.com">geosure@iafrica.com</a>
		<a href="http://www.geosure.co.za">www.geosure.co.za</a>	

Client : SLR Consulting (South Africa) (Pty) Ltd Our Ref. : 79999  
Project : Isipingo WWTW Your Ref. : -

Date Tested : 16.08.2024 to 29.08.2024

Attention : Mrs R. Naidoo Date Reported : 04.09.2024

Sample No.	T53076	T53081	T53091	T53092	T53093
Field No.	IP5	IP9	TP1	TP2	TP8
Position in Field	-	-	-	-	-
Depth (m)	0.45-0.75	0.35-0.90	0.35-0.65	0.15-1.3	2.10-2.90
Material Description	Dark yellowish brown silty clayey sandy GRAVEL	Dark orange brown greyish brown sandy clayey SILT	Dark yellowish orange clayey sandy SILT	Light reddish orange sandy CLAYEY SILT	Dark yellow SAND

**Sieve Analysis ( Wet Preparation ) - SANS3001 GR 1 - Percent Passing Sieve Size**

% Passing	100.0 mm	100	100	100	100	100
	75.0 mm	100	100	100	100	100
	63.0 mm	100	100	100	100	100
	50.0 mm	100	100	100	100	100
	37.5 mm	98	100	100	100	100
	28.0 mm	86	100	100	100	100
	20.0 mm	79	100	99	100	100
	14.0 mm	76	100	99	100	100
	5.00 mm	69	99	97	99	100
	2.00 mm	62	98	95	98	100
	0.425 mm	52	94	90	96	90
	0.250 mm	42	81	78	87	71
	0.150 mm	34	63	68	77	51
	0.075 mm	27	44	55	64	30

**Hydrometer Analysis - ASTM - D422 - Percent Passing Particle Diameter (<0.425mm)**

% Passing	0.060 mm	23	42	49	60	25
	0.050 mm	21	40	45	56	21
	0.040 mm	19	39	41	53	17
	0.026 mm	16	37	36	48	12
	0.015 mm	13	35	32	46	9
	0.010 mm	11	34	29	44	8
	0.0074 mm	10	30	28	43	7
	0.0036 mm	7	29	24	35	6
	0.0020 mm	6	28	21	31	4
	0.0015 mm	6	28	20	28	4

**Mechanical analysis - SANS3001 GR1 - Percent of Soil Mortar (<2 mm) for Grain Size range**

Coarse Sand	%	16	5	5	3	10
Coarse Fine Sand	%	16	13	12	9	18
Medium Fine Sand	%	13	18	11	11	20
Fine Fine Sand	%	13	20	14	12	21
Silt & Clay	%	43	44	58	65	30
Grading Modulus		1.60	0.64	0.60	0.41	0.80

**Atterberg Limits - SANS3001 GR10, GR12 (<0.425mm)**

Liquid Limit	%	25	33	30	35	NP
Plasticity Index	%	8	12	14	16	NP
Linear Shrinkage	%	4.0	6.0	7.0	8.0	0.0
AASHTO Classification (Group Index)*		A-2-4 (0)	A-6 (2)	A-6 (5)	A-6 (8)	A-2-4 (0)
Unified Classification*		SC	SC	CL	CL	SM
Moisture Content	%					

Remarks:	Date Received: 14.08.2024
	Sampled by Client.
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**Client** : SLR Consulting (South Africa) (Pty) Ltd

**Job No.** : 79999

**Project** : Isipingo WWTW

**Your Ref.No.** : -

**Date Tested** : 16.08.2024 to 29.08.2024

**Attention** : Mrs R. Naidoo

**Date Reported** : 04.09.2024

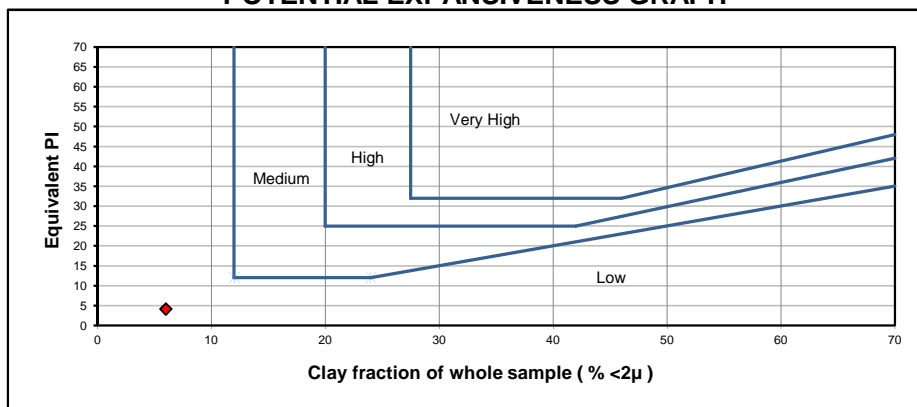
**Sample Number** : T53076

**Field No.** : IP5

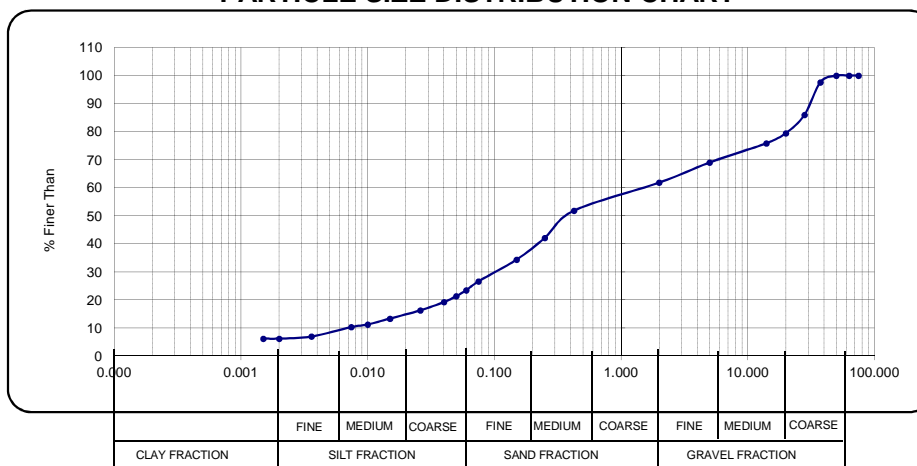
**Sample Description** : Dark yellowish brown silty clayey sandy GRAVEL

**Equivalent PI** : 4 **Clay fraction of whole sample (% <2 $\mu$ )** : 6

### POTENTIAL EXPANSIVENESS GRAPH



### PARTICLE SIZE DISTRIBUTION CHART



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**Date Reported** : 04.09.2024

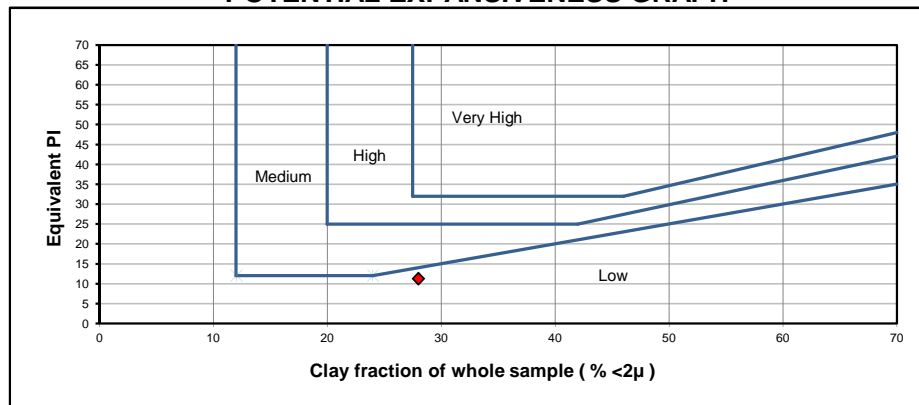
**Sample Number** : T53081

**Field No.** : IP9

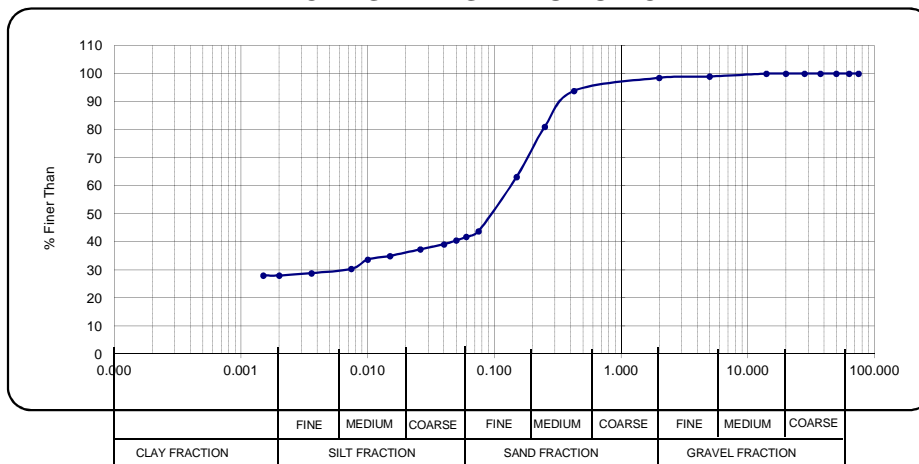
**Sample Description** : Dark orange brown greyish brown sandy clayey SILT

**Equivalent PI** : 11 **Clay fraction of whole sample (% <2 $\mu$ )** : 28

### POTENTIAL EXPANSIVENESS GRAPH



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**Date Reported** : 04.09.2024

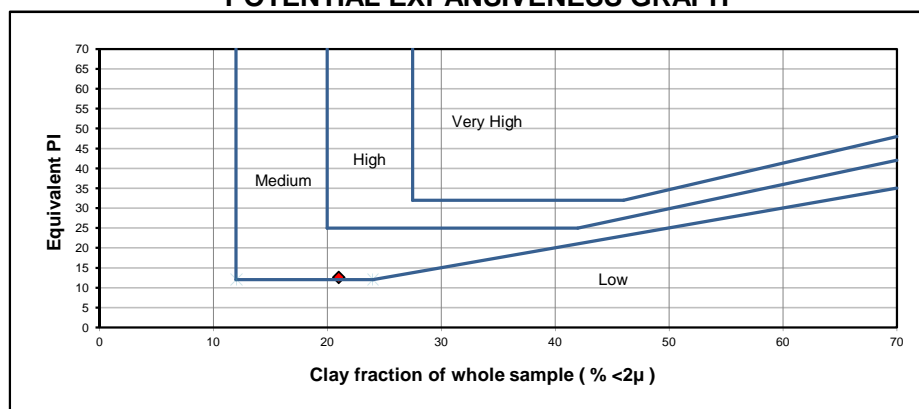
**Sample Number** : T53091

**Field No.** : TP1

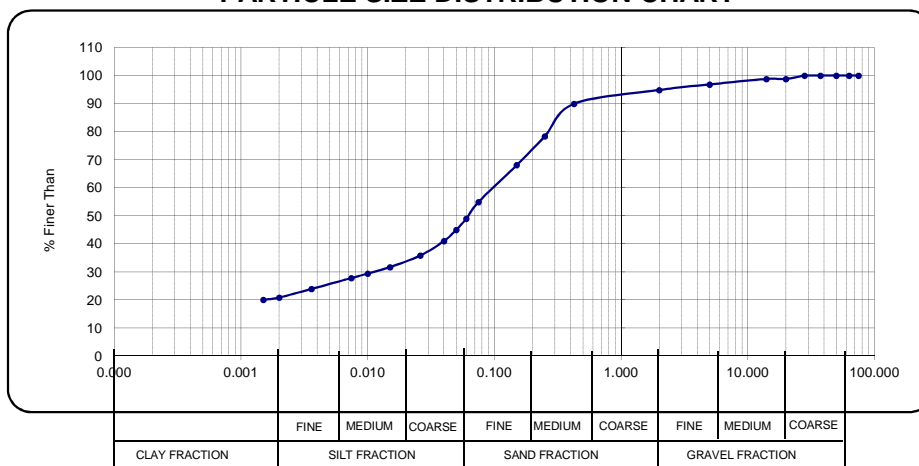
**Sample Description** : Dark yellowish orange clayey sandy SILT

**Equivalent PI** : 13 **Clay fraction of whole sample (% <2 $\mu$ )** : 21

### POTENTIAL EXPANSIVENESS GRAPH



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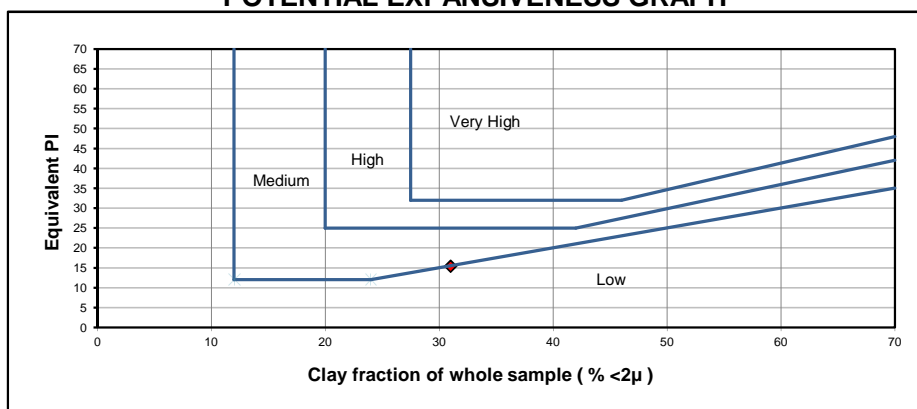
**Sample Number** : T53092

**Field No.** : TP2

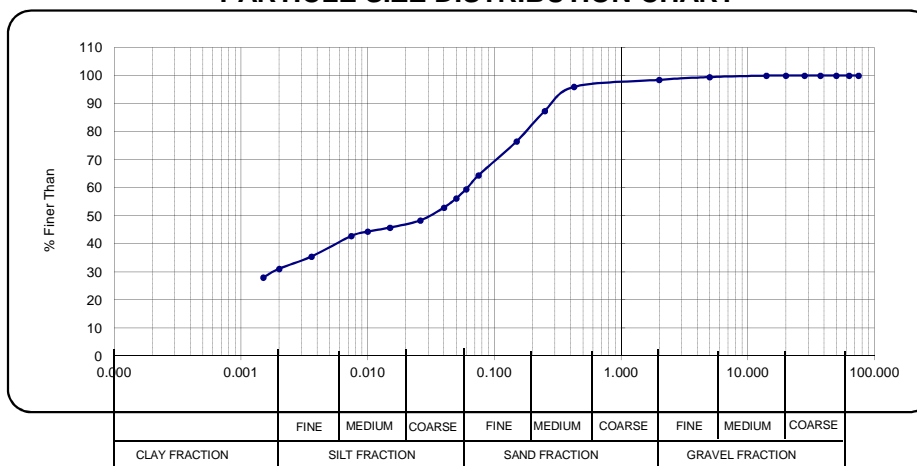
**Sample Description** : Light reddish orange sandy CLAYEY SILT

**Equivalent PI** : 15 Clay fraction of whole sample (% <2 $\mu$ ) : 31

### POTENTIAL EXPANSIVENESS GRAPH



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**Attention** : Mrs R. Naidoo

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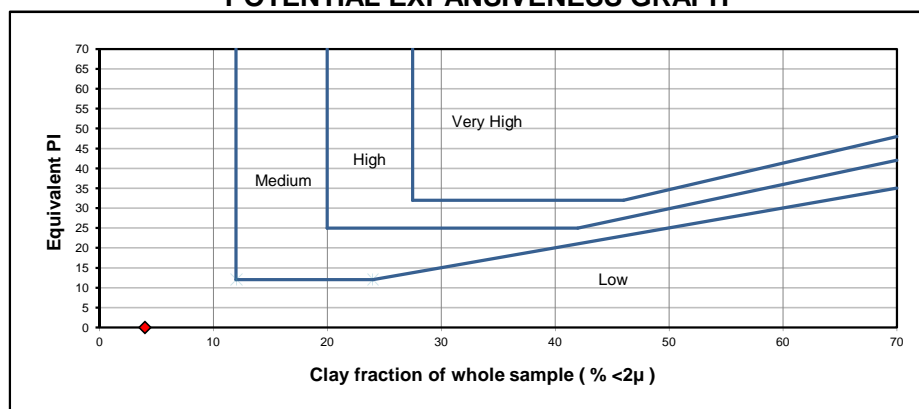
**Sample Number** : T53093

**Field No.** : TP8

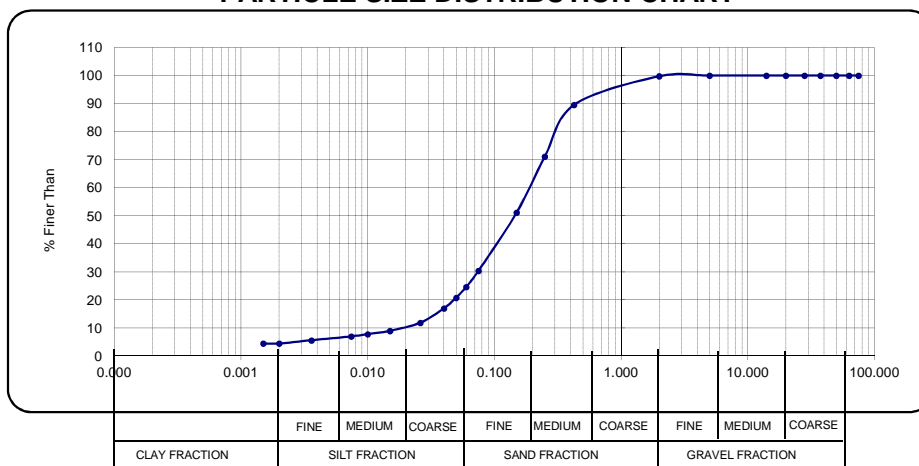
**Sample Description** : Dark yellow SAND

**Equivalent PI** : NP Clay fraction of whole sample (% <2 $\mu$ ) : 4

### POTENTIAL EXPANSIVENESS GRAPH



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Client : SLR Consulting (South Africa) (Pty) Ltd Our Ref. : 79999  
Project : Isipingo WWTW Your Ref. : -

Date Tested : 16.08.2024. to 29.08.2024

Attention : Mrs R. Naidoo Date Reported : 05.09.2024

Sample No.	T53097	T53098	T53099	T53100	T53101
Field No.	TP14	TP16	TP17	TP18	TP20
Position in Field	-	-	-	-	-
Depth (m)	0.40-2.00	0.20-1.45	0.50-1.60	0.50-1.50	0.15-0.90
Material Description	Light yellowish orange silty CLAYEY SAND	Light grey yellowish brown clayey silty SAND	Light grey yellowish brown sandy CLAY	Dark greyish brown gravelly silty SAND	Light brown blotched orange silty gravelly SAND

**Sieve Analysis ( Wet Preparation ) - SANS3001 GR 1 - Percent Passing Sieve Size**

% Passing	100.0 mm	100	100	100	100	100
	75.0 mm	100	100	100	100	100
	63.0 mm	100	100	100	100	100
	50.0 mm	100	100	100	100	95
	37.5 mm	100	100	100	100	89
	28.0 mm	100	100	100	100	87
	20.0 mm	100	100	100	100	87
	14.0 mm	100	100	100	97	84
	5.00 mm	100	100	100	92	79
	2.00 mm	100	100	97	88	76
	0.425 mm	98	81	82	76	66
	0.250 mm	88	63	57	58	51
	0.150 mm	79	47	38	44	37
	0.075 mm	66	35	27	34	25

**Hydrometer Analysis - ASTM - D422 - Percent Passing Particle Diameter (<0.425mm)**

% Passing	0.060 mm	63	32	26	28	21
	0.050 mm	61	31	26	25	19
	0.040 mm	59	29	25	21	17
	0.026 mm	55	26	25	16	14
	0.015 mm	51	23	23	11	11
	0.010 mm	49	22	21	9	9
	0.0074 mm	46	20	21	7	8
	0.0036 mm	39	18	18	3	6
	0.0020 mm	35	17	17	3	5
	0.0015 mm	34	16	17	3	4

**Mechanical analysis - SANS3001 GR1 - Percent of Soil Mortar (<2 mm) for Grain Size range**

Coarse Sand	%	2	19	16	14	13
Coarse Fine Sand	%	9	19	26	20	20
Medium Fine Sand	%	9	16	19	15	19
Fine Fine Sand	%	13	12	11	11	16
Silt & Clay	%	66	35	28	39	33
Grading Modulus		0.36	0.84	0.94	1.02	1.34

**Atterberg Limits - SANS3001 GR10, GR12 (<0.425mm)**

Liquid Limit	%	42	25	22	20	18
Plasticity Index	%	19	7	6	4	5
Linear Shrinkage	%	9.0	3.0	2.0	2.0	2.0
AASHTO Classification (Group Index)*		A-7-6 (11)	A-4 (0)	A-2-4 (0)	A-2-4 (0)	A-2-4 (0)
Unified Classification*		CL	SM-SC	SM-SC	SM-SC	SM-SC
Moisture Content	%					

Remarks:	Date Received: 14.08.2024
	Sampled by Client.
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**Your Ref.No.** : -

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**Attention** : Mrs R. Naidoo

**Date Reported** : 05.09.2024

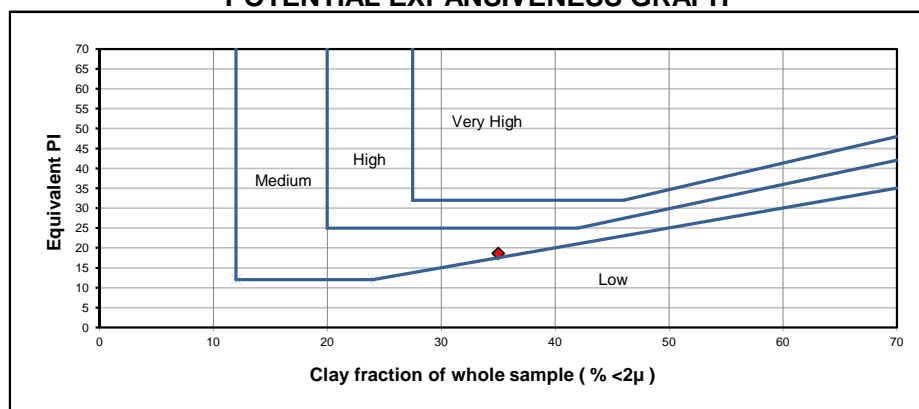
**Sample Number** : T53097

**Field No.** : TP14

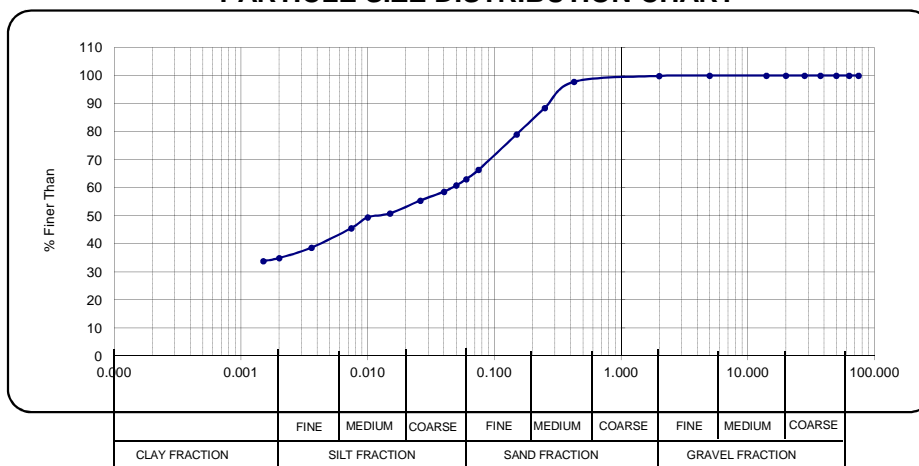
**Sample Description** : Light yellowish orange silty CLAYEY SAND

**Equivalent PI** : 19 **Clay fraction of whole sample (% <2 $\mu$ )** : 35

### POTENTIAL EXPANSIVENESS GRAPH



### PARTICLE SIZE DISTRIBUTION CHART



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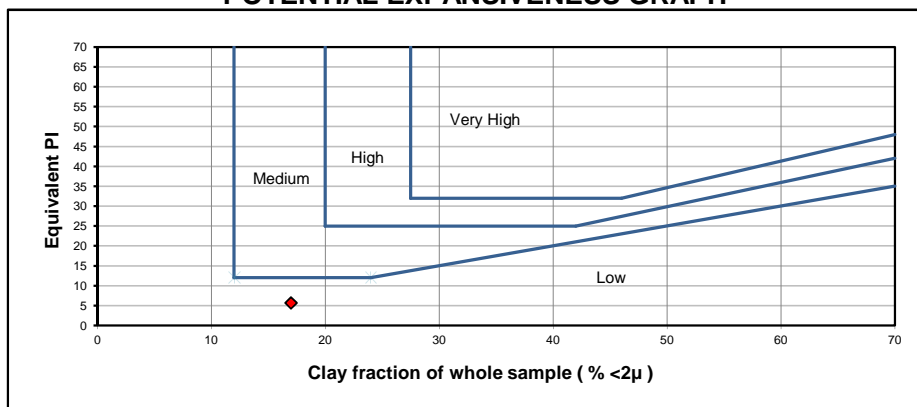
**Sample Number** : T53098

**Field No.** : TP16

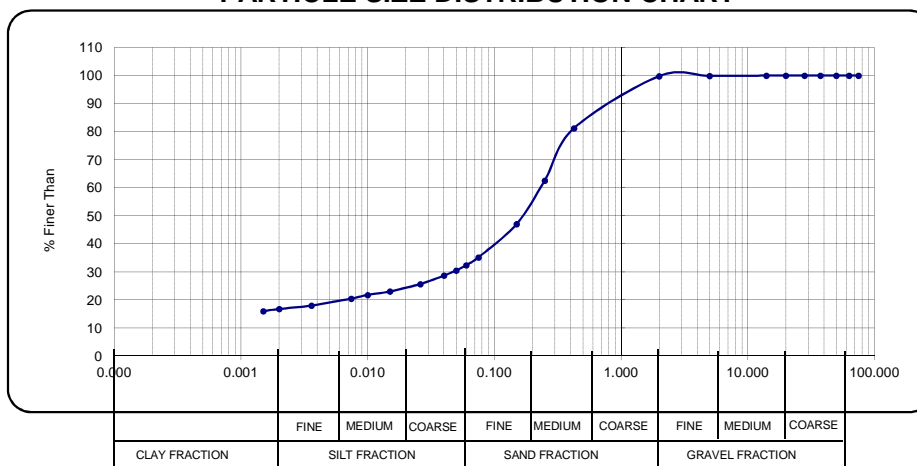
**Sample Description** : Light grey yellowish brown clayey silty SAND

**Equivalent PI** : 6 **Clay fraction of whole sample (% <2 $\mu$ )** : 17

### POTENTIAL EXPANSIVENESS GRAPH



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**Your Ref.No.** : -

**Date Tested** : 16.08.2024. to 29.08.2024

**Attention** : Mrs R. Naidoo

**Date Reported** : 05.09.2024

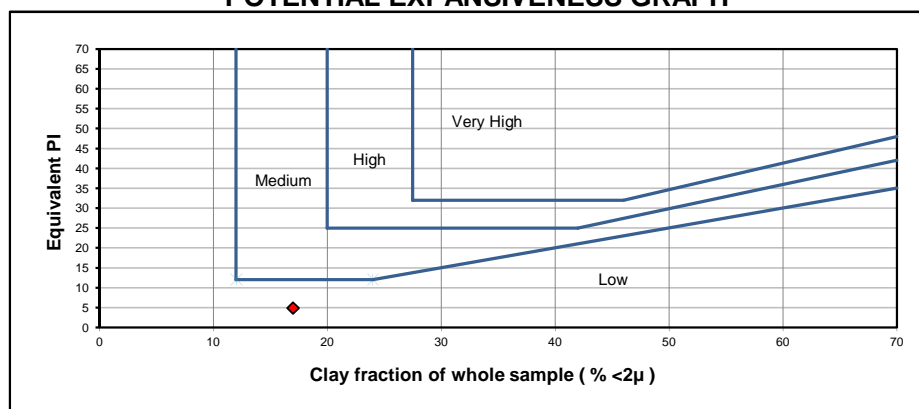
**Sample Number** : T53099

**Field No.** : TP17

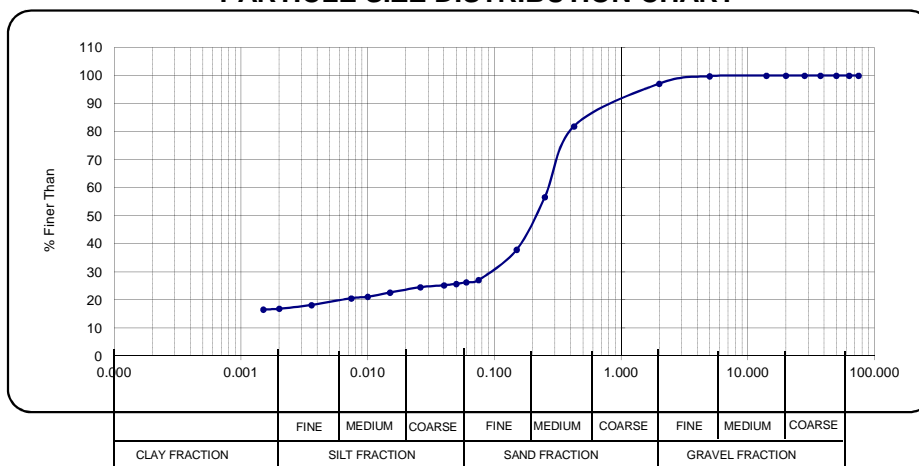
**Sample Description** : Light grey yellowish brown sandy CLAY

**Equivalent PI** : 5 **Clay fraction of whole sample (% <2 $\mu$ )** : 17

### POTENTIAL EXPANSIVENESS GRAPH



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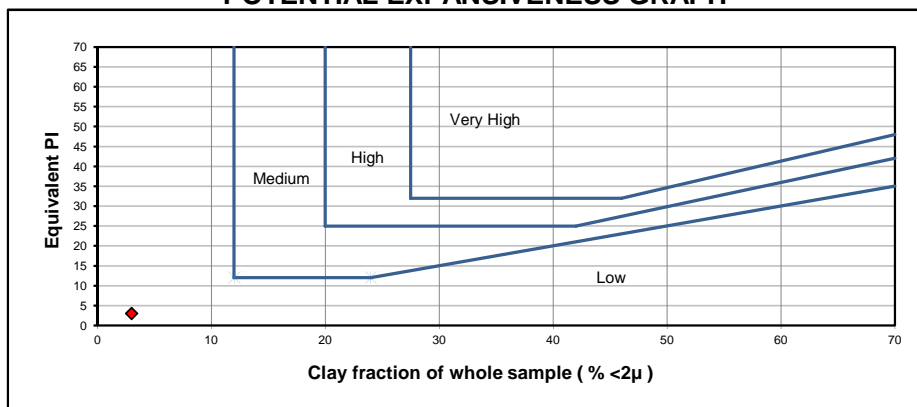
**Sample Number** : T53100

**Field No.** : TP18

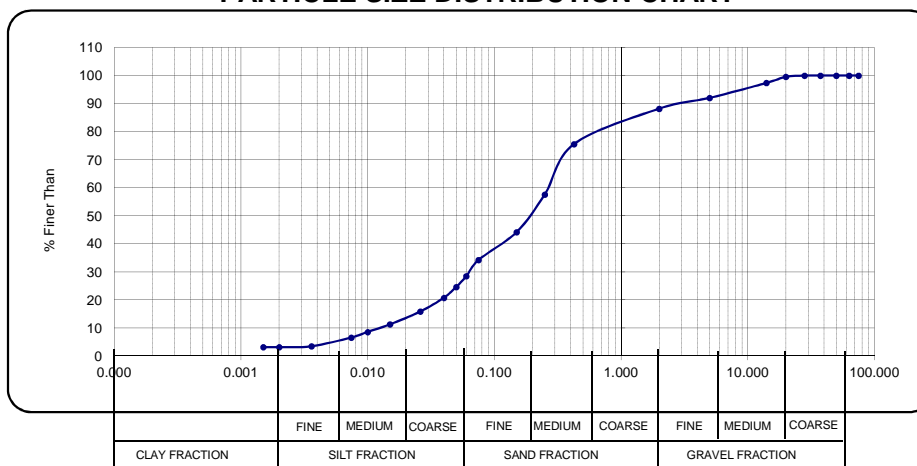
**Sample Description** : Dark greyish brown gravelly silty SAND

**Equivalent PI** : 3 **Clay fraction of whole sample (% <2 $\mu$ )** : 3

### POTENTIAL EXPANSIVENESS GRAPH



### PARTICLE SIZE DISTRIBUTION CHART



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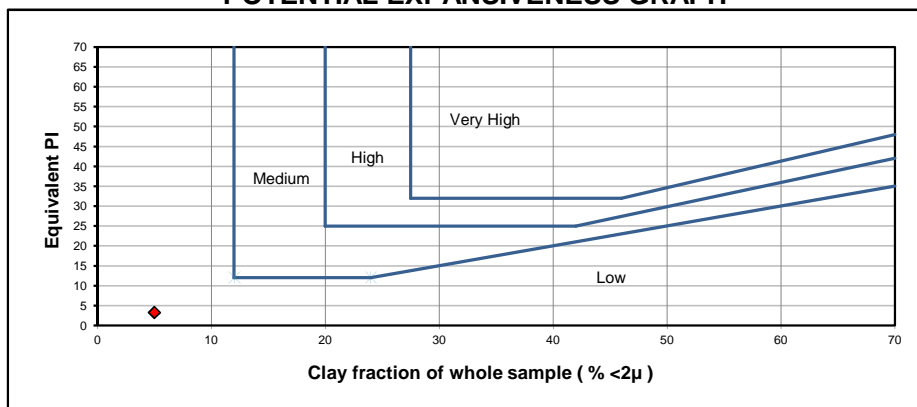
**Sample Number** : T53101

**Field No.** : TP20

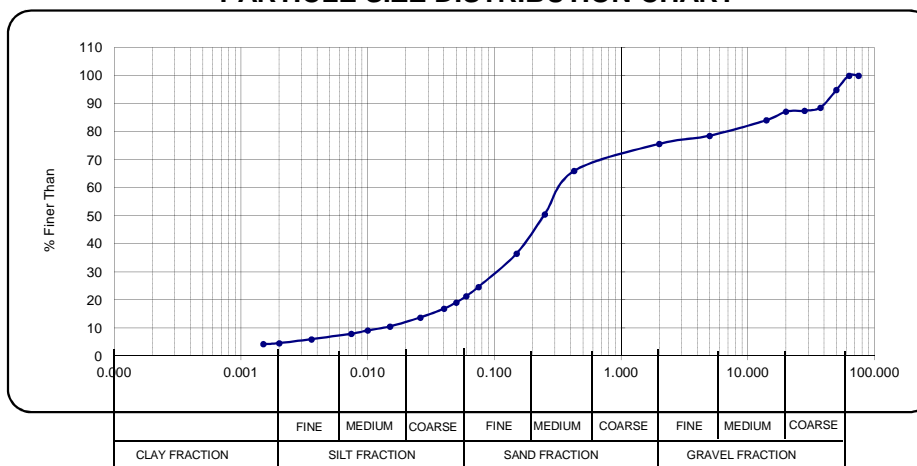
**Sample Description** : Light brown blotched orange silty gravelly SAND

**Equivalent PI** : 3 **Clay fraction of whole sample (% <2 $\mu$ )** : 5

### POTENTIAL EXPANSIVENESS GRAPH



### PARTICLE SIZE DISTRIBUTION CHART



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WEBSITE:		<a href="http://www.geosure.co.za">www.geosure.co.za</a>	

Client : SLR Consulting (South Africa) (Pty) Ltd Our Ref. : 79999  
 Project : Isipingo WWTW Your Ref. : -

Date Tested : 16.08.2024. to 29.08.2024

Attention : Mrs R. Naidoo Date Reported : 05.09.2024

Sample No.	T53102	T53103			
Field No.	TP21	TP22			
Position in Field	-	-			
Depth (m)	1.40-1.50	1.10-1.70			
Material Description	Dark yellow SAND	Dark greyish brown blotched yellow SAND			

**Sieve Analysis ( Wet Preparation ) - SANS3001 GR 1 - Percent Passing Sieve Size**

% Passing	100.0 mm	100	100			
	75.0 mm	100	100			
	63.0 mm	100	100			
	50.0 mm	100	100			
	37.5 mm	100	100			
	28.0 mm	100	100			
	20.0 mm	100	100			
	14.0 mm	100	99			
	5.00 mm	100	98			
	2.00 mm	100	98			
	0.425 mm	90	90			
	0.250 mm	71	72			
	0.150 mm	46	53			
	0.075 mm	25	35			

**Hydrometer Analysis - ASTM - D422 - Percent Passing Particle Diameter (<0.425mm)**

% Passing	0.060 mm	21	27			
	0.050 mm	19	22			
	0.040 mm	16	17			
	0.026 mm	13	12			
	0.015 mm	10	10			
	0.010 mm	7	7			
	0.0074 mm	5	5			
	0.0036 mm	4	2			
	0.0020 mm	3	1			
	0.0015 mm	3	1			

**Mechanical analysis - SANS3001 GR1 - Percent of Soil Mortar (<2 mm) for Grain Size range**

Coarse Sand	%	10	7			
Coarse Fine Sand	%	19	19			
Medium Fine Sand	%	25	20			
Fine Fine Sand	%	21	18			
Silt & Clay	%	25	36			
Grading Modulus		0.85	0.77			

**Atterberg Limits - SANS3001 GR10, GR12 (<0.425mm)**

Liquid Limit	%	NP	NP			
Plasticity Index	%	NP	NP			
Linear Shrinkage	%	0.0	0.0			
AASHTO Classification (Group Index)*		A-2-4 (0)	A-4 (0)			
Unified Classification*		SM	SM			
Moisture Content	%					

Remarks: Date Received: 14.08.2024

Sampled by Client.

\*Opinions expressed herein fall outside the scope of SANAS accreditation.

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**Client** : SLR Consulting (South Africa) (Pty) Ltd

**Job No.** : 79999

**Project** : Isipingo WWTW

**Your Ref.No.** : -

**Date Tested** : 16.08.2024. to 29.08.2024

**Attention** : Mrs R. Naidoo

**Date Reported** : 05.09.2024

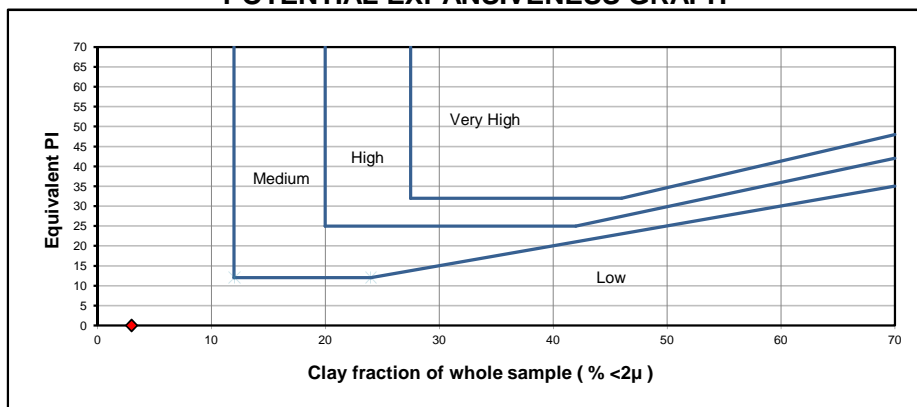
**Sample Number** : T53102

**Field No.** : TP21

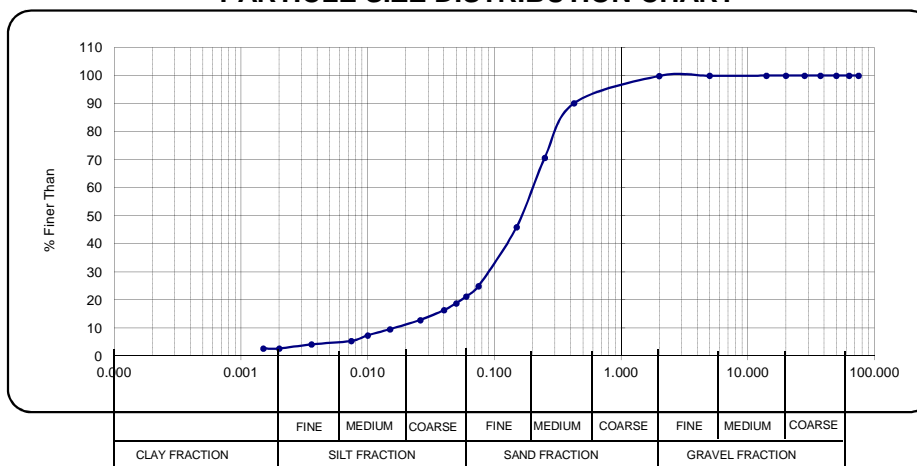
**Sample Description** : Dark yellow SAND

**Equivalent PI** : NP **Clay fraction of whole sample (% <2 $\mu$ )** : 3

### POTENTIAL EXPANSIVENESS GRAPH



### PARTICLE SIZE DISTRIBUTION CHART



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**Job No.** : 79999

**Project** : Isipingo WWTW

**Your Ref.No.** : -

**Date Tested** : 16.08.2024. to 29.08.2024

**Attention** : Mrs R. Naidoo

**Date Reported** : 05.09.2024

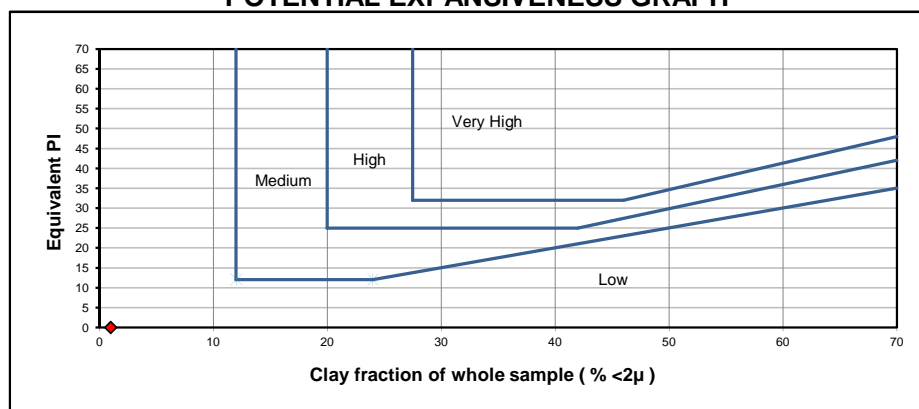
**Sample Number** : T53103

**Field No.** : TP22

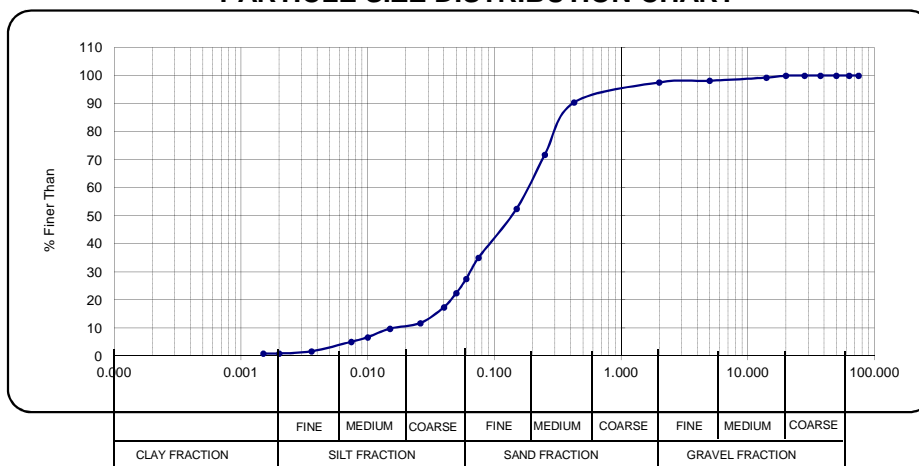
**Sample Description** : Dark greyish brown blotched yellow SAND

**Equivalent PI** : NP Clay fraction of whole sample (% <2 $\mu$ ) : 1

### POTENTIAL EXPANSIVENESS GRAPH



### PARTICLE SIZE DISTRIBUTION CHART



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Client : SLR Consulting (Soth Africa) (Pty) Ltd Your Ref No. : -  
Project : Ispingo WWTW Our Ref No. : 79999  
Attention : Mrs. R. Naidoo Date Reported : 12/09/2024

### Test Report - SANS 3001

<b>Sample No.</b>	T53075	T53077	T53078	T53079	T53080
<b>Field No.</b>	IP4	IP6	IP6	IP8	IP8
<b>Position</b>	-	-	-	-	-
<b>Depth ( m )</b>	0.20-0.35	0.03-0.17	0.40-0.55	0.1-0.25	0.25-0.55
<b>Method of Preparation</b>	Scalped	N/A	Scalped	N/A	N/A
<b>Material Description</b>	Dark reddish orange SAND with occasional Gravel	Dark red SAND with occasional Gravel	Dark yellow clayey gravelly SAND	Pale red sandy GRAVEL	Dark yellow clayey silty gravelly SAND

Sieve Analysis - Percent Passing Sieve Size						
Sieve Aperture (mm)	100.00					
	75.00			100		
	63.00			91		
	53.00			91		
	50.00			87		
	37.50	100		87		100
	28.00	99		86		99
	26.50	99	100	86	100	99
	20.00	98	99	84	81	94
	19.00	98	99	84	81	94
	14.00	97	98	78	62	92
	13.20	97	98	78	62	92
	5.00	94	97	66	40	88
	4.750	94	97	66	40	88
	2.000	92	96	60	30	86
	0.425	90	95	51	19	79
	0.075	10	12	18	6	38
<b>Grading Modulus</b>		1.08	0.97	1.71	2.46	0.97
Mechanical analysis - Percent of Soil Mortar (<2 mm) for Grain Size range						
Coarse Sand	2.000 - 0.425	2	1	14	36	8
Coarse-Fine Sand	0.425 - 0.250	20	13	28	18	16
Medium-Fine Sand	0.250 - 0.150	54	65	18	15	16
Fine-Fine Sand	0.150 - 0.075	14	9	11	11	16
Silt and Clay	< 0.075	11	13	29	19	43
Atterberg Limits SANS 3001 on <0.425 mm fraction						
Liquid Limit	% or symbol	NP	NP	23	SP	21
Plasticity Index	% or symbol	NP	NP	9	SP	9
Linear Shrinkage	%	0.0	0.0	4.5	1.0	4.0
Maximum Dry Density and Optimum Moisture Content						
<b>Maximum Dry Density (kg/m³)</b>		1850	1883	2036	2183	1973
<b>Optimum moisture content (%)</b>		10.1	7.6	9.6	4.2	10.7
California Bearing Ratio						
CBR @100% Compaction	%	47	46	67	97	6.3
CBR @ 98% Compaction	%	38	33	43	75	4.9
CBR @ 97% Compaction	%	34	28	34	66	4.4
CBR @ 95% Compaction	%	28	20	22	51	3.5
CBR @ 93% Compaction	%	22	14	14	39	2.8
CBR @ 90% Compaction	%	16	8.7	7.2	27	1.9
Swell @100% Compaction	%	0.0	0.0	0.5	0.0	1.3
<b>COLTO Classification (1998)***</b>		G7 (#)	G8 (#)	G8 (#)	G5 (63)	Cannot be Determined
<b>TRH 14 Classification (1985)**</b>		G7	G9	G9	G5	Poorer than G10
<b>AASHTO Classification (Group Index)**</b>		A-3 (0)	A-2-4 (0)	A-2-4 (0)	A-1-a (0)	A-4 (0)
<b>Unified Classification **</b>		SP-SM	SP-SM	SC	GW-GM	SC

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**Remarks:** \*Subject to further testing as required by TRH14.

† Subject to further testing as required by COLTO. COLTO above uses only: Atterberg Limits (<0.425 mm fraction; not arithmetic mean), Nominal Max Size, Grading Curve, Coarse Sand Ratio, Grading Modulus, Strength (CBR), and Swell.

# Check that Max Size <= 2/3 of compacted layer thickness.

\*\* Opinions and interpretations expressed herein are outside the scope of SANAS accreditation  
Version 5.05 - 14 February 2018

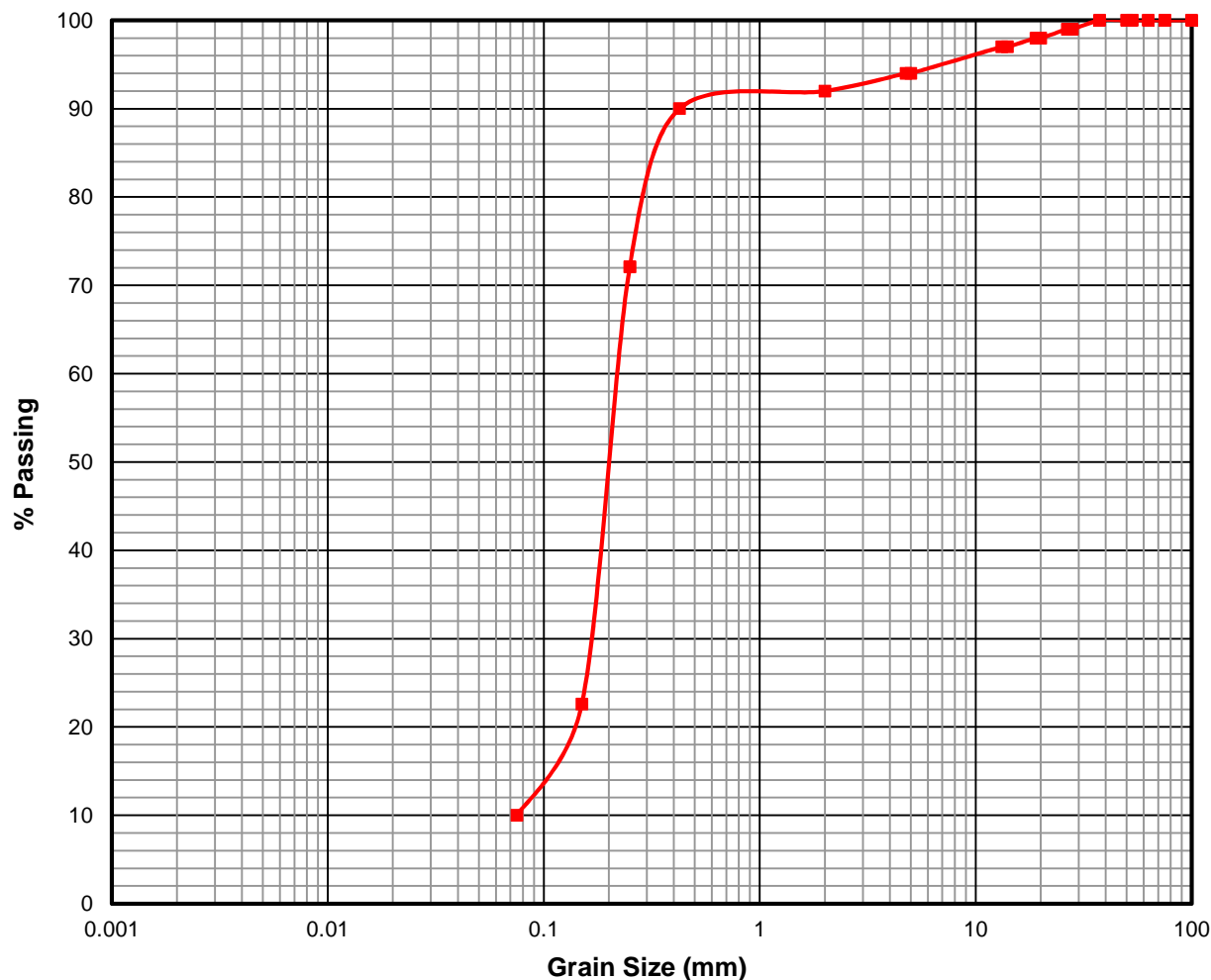
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**Client :** SLR Consulting (Soth Africa) (Pty) Ltd  
**Project :** Ispingo WWTW  
**Attention :** Mrs. R. Naidoo

**Your Ref No.:** -  
**Our Ref No. :** 79999  
**Date Reported :** 12/09/2024

### Grading Curve for Sample T53075 – SANS 3001



Clay	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse
	Silt			Sand			Gravel		

**Thick Red Line is the Grading Curve (COLTO Classification = G7 (#)) (TRH 14 Classification = G7)**

Sieve Aperture Size	0.075	0.150	0.250	0.425	2.00	4.75	5.00	13.20	14.00	19.00	20.00	26.50	28.0	37.5	50.0	53.0	63	75	100
Percentage Passing	10%	23%	72%	90%	92%	94%	94%	97%	97%	98%	98%	99%	99%	100%	100%	100%	100%	100%	100%

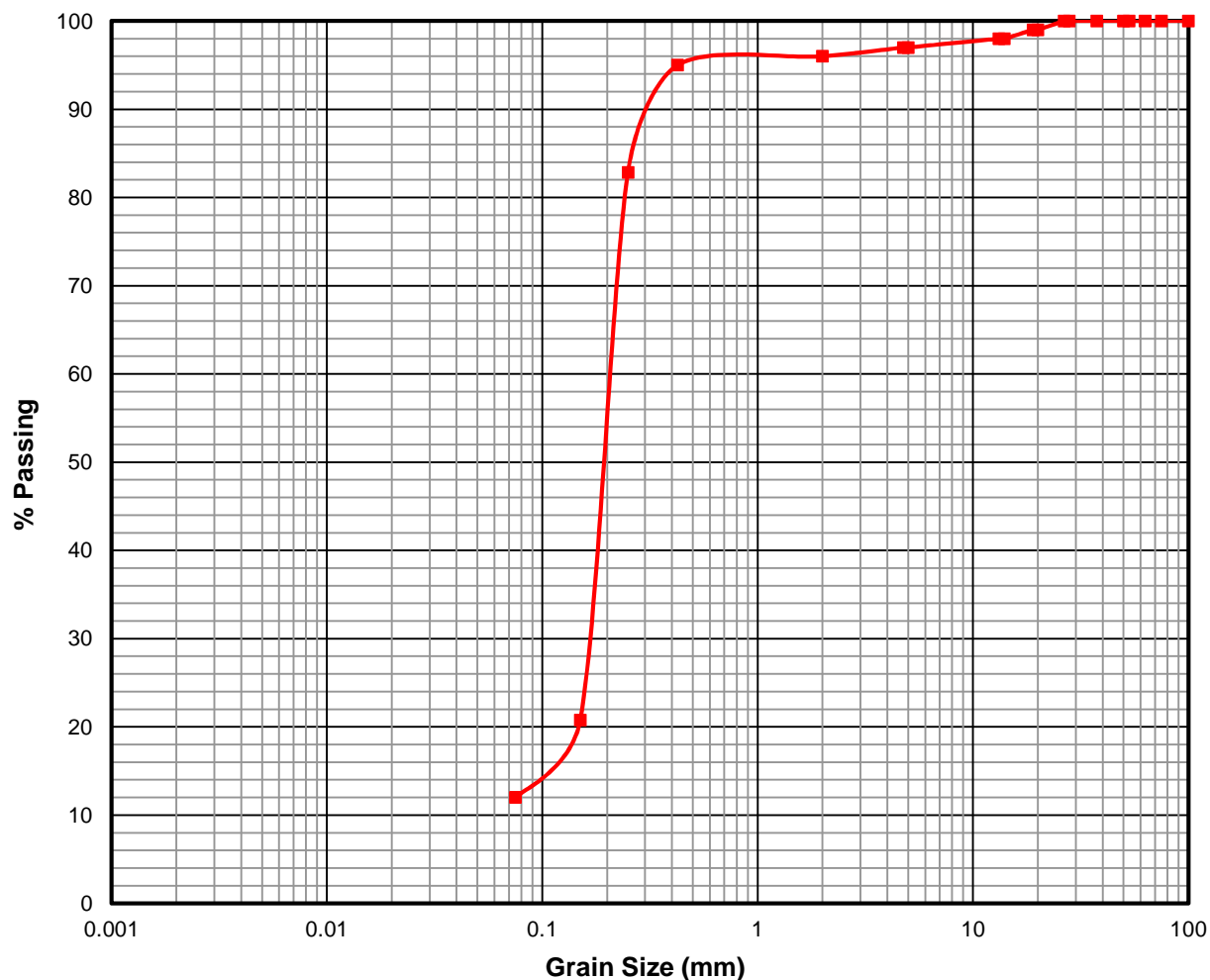
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**Project : Ispingo WWTW**  
**Attention : Mrs. R. Naidoo**

**Your Ref No.: -**  
**Our Ref No. : 79999**  
**Date Reported : 12/09/2024**

## Grading Curve for Sample T53077 – SANS 3001



Clay	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse
	Silt			Sand			Gravel		

**Thick Red Line is the Grading Curve (COLTO Classification = G8 (#)) (TRH 14 Classification = G9)**

Sieve Aperture Size	0.075	0.150	0.015	0.026	0.05	0.06	5.00	13.20	14.00	19.00	20.00	26.50	28.0	37.5	50.0	53.0	63	75	100
Percentage Passing	12%	21%	83%	95%	96%	97%	97%	98%	98%	99%	99%	100%	100%	100%	100%	100%	100%	100%	100%

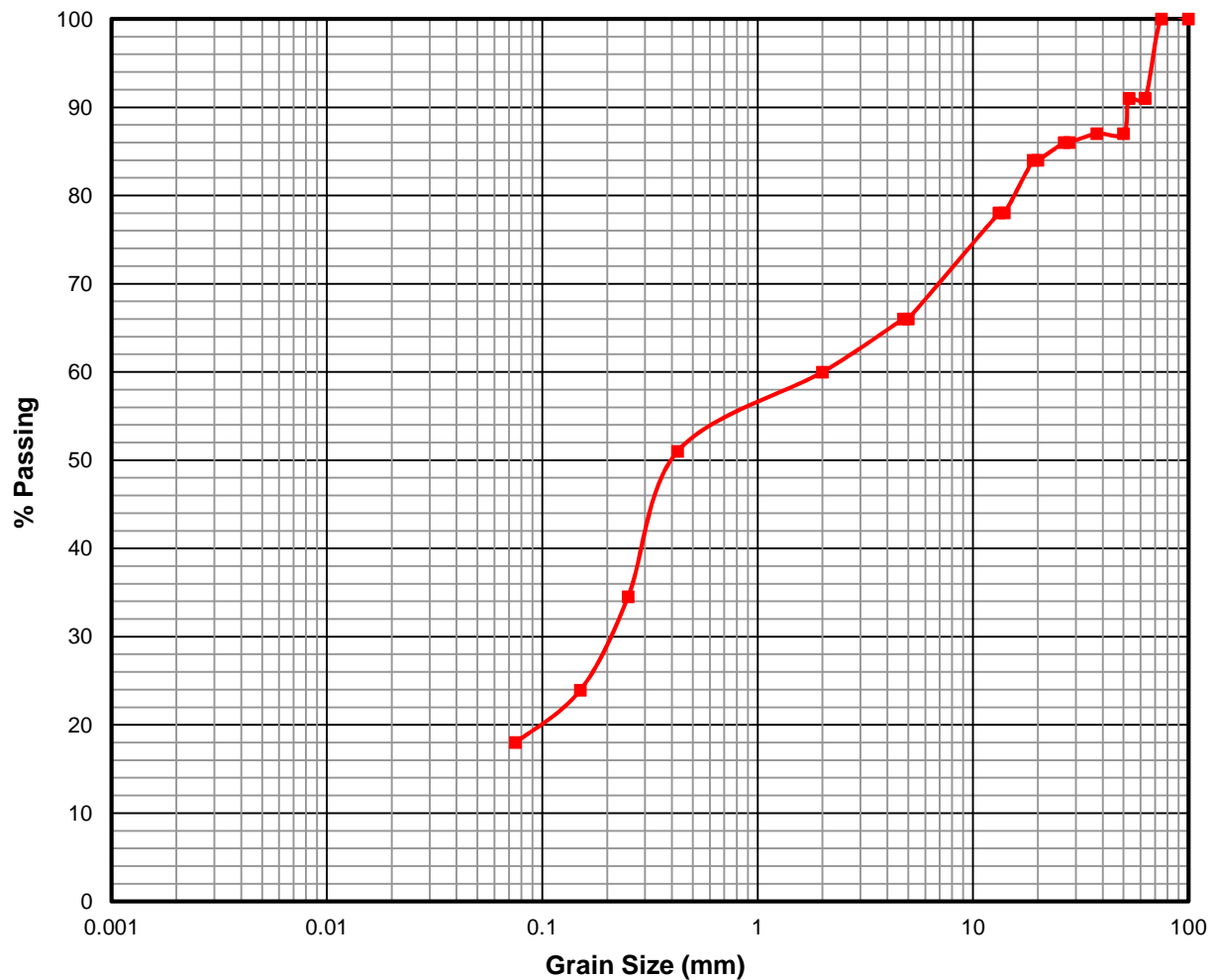
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**Client : SLR Consulting (Soth Africa) (Pty) Ltd**  
**Project : Ispingo WWTW**  
**Attention : Mrs. R. Naidoo**

**Your Ref No.: -**  
**Our Ref No. : 79999**  
**Date Reported : 12/09/2024**

### Grading Curve for Sample T53078 – SANS 3001



Clay	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse
	Silt			Sand			Gravel		

**Thick Red Line is the Grading Curve (COLTO Classification = G8 (#)) (TRH 14 Classification = G9)**

Sieve Aperture Size	0.075	0.150	0.250	0.425	2.00	4.75	5.00	13.20	14.00	19.00	20.00	26.50	28.0	37.5	50.0	53.0	63	75	100
Percentage Passing	18%	24%	35%	51%	60%	66%	66%	78%	78%	84%	84%	86%	86%	87%	87%	91%	91%	100%	100%



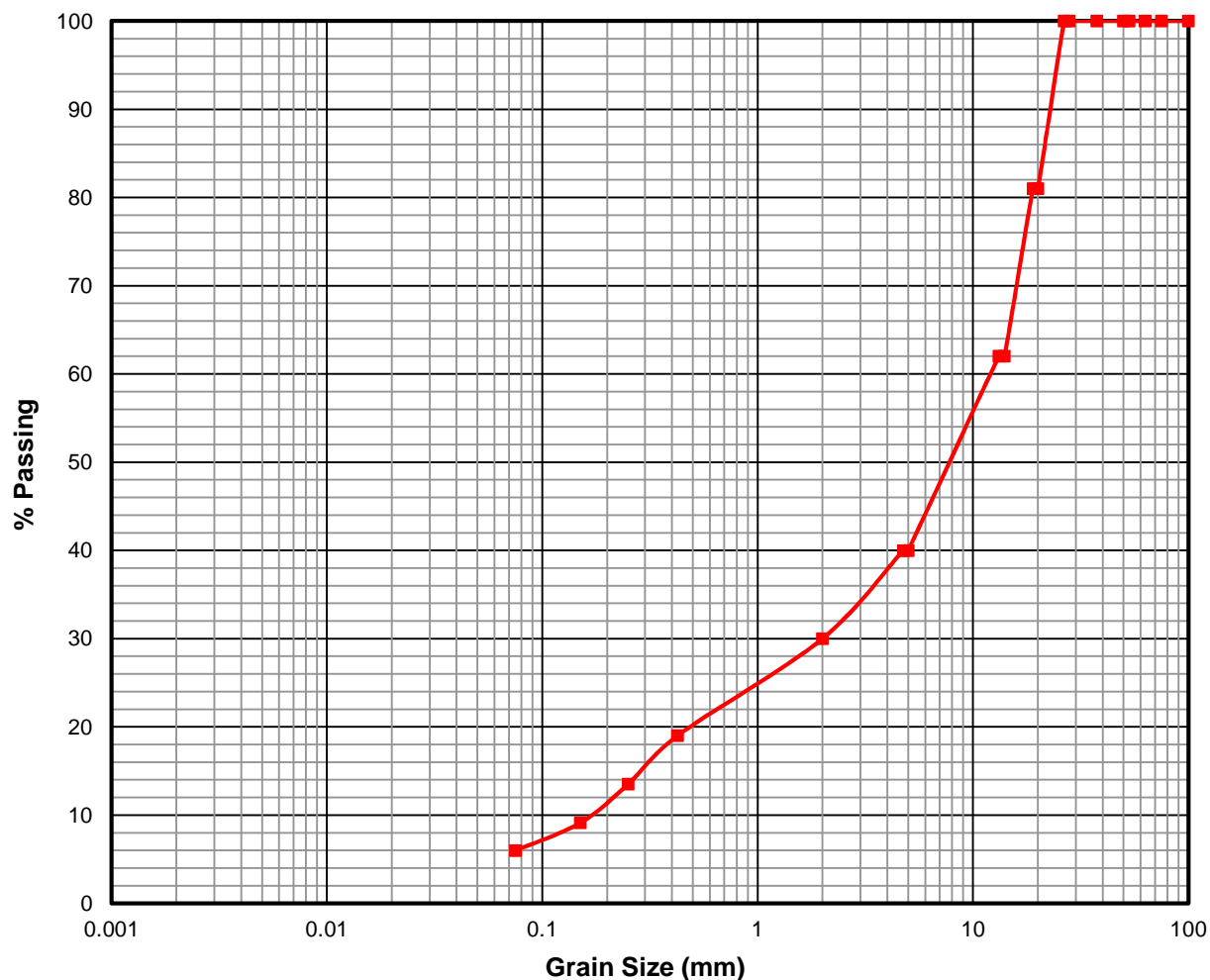
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**Project :** Ispingo WWTW  
**Attention :** Mrs. R. Naidoo

**Your Ref No.:** -  
**Our Ref No.:** 79999  
**Date Reported :** 12/09/2024

### Grading Curve for Sample T53079 – SANS 3001



**Thick Red Line is the Grading Curve (COLTO Classification = G5 (63)) (TRH 14 Classification = G5)**

Sieve Aperture Size	0.075	0.150	0.250	0.425	2.00	4.75	5.00	13.20	14.00	19.00	20.00	26.50	28.0	37.5	50.0	53.0	63	75	100
Percentage Passing	6%	9%	13%	19%	30%	40%	40%	62%	62%	81%	81%	100%	100%	100%	100%	100%	100%	100%	100%

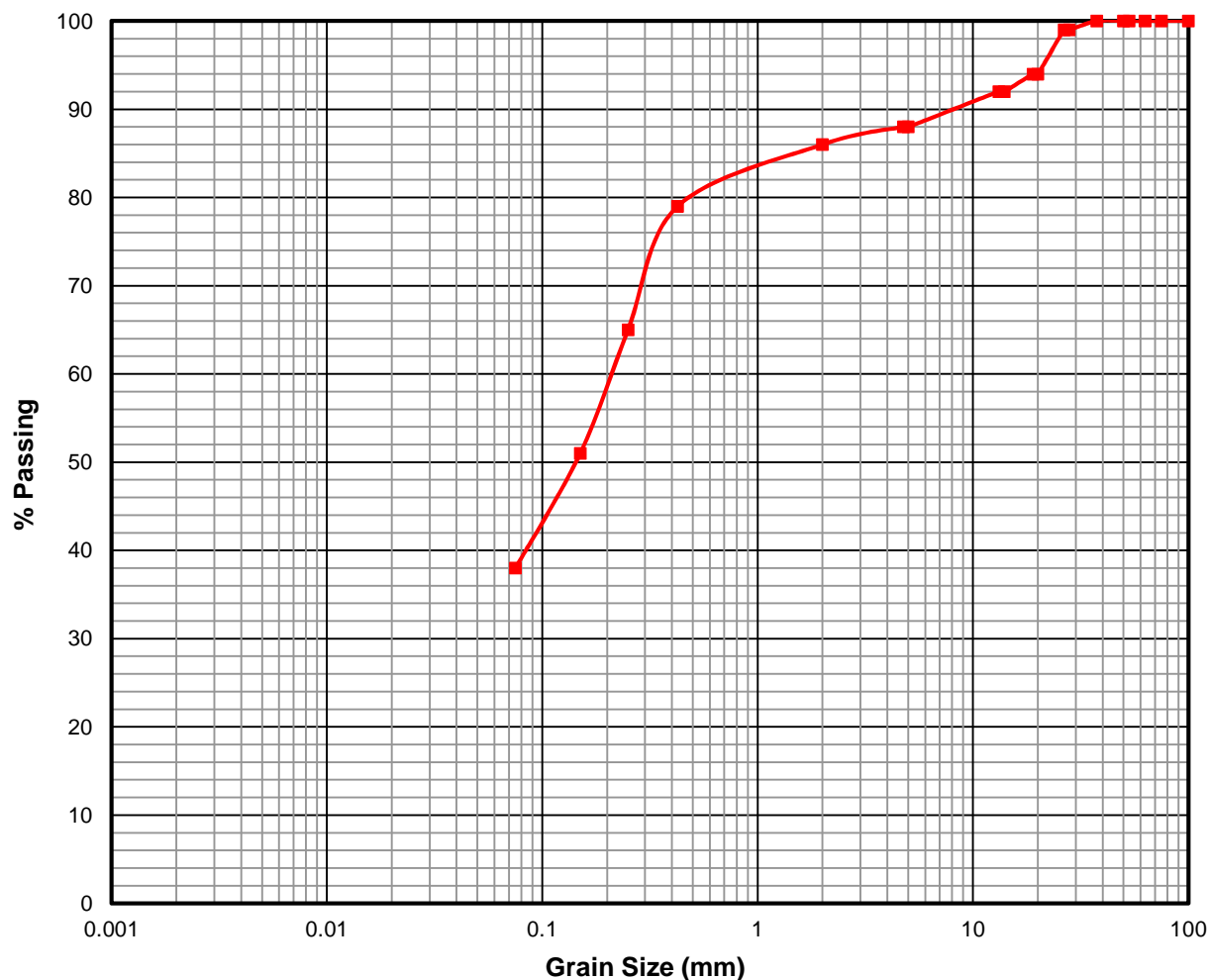
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**Project : Ispingo WWTW**  
**Attention : Mrs. R. Naidoo**

**Your Ref No.: -**  
**Our Ref No. : 79999**  
**Date Reported : 12/09/2024**

## Grading Curve for Sample T53080 – SANS 3001



Clay	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse
	Silt			Sand			Gravel		

**ick Red Line is the Grading Curve (COLTO Classification = Cannot be Determined) (TRH 14 Classification = Poorer than G**

Sieve Aperture Size	0.075	0.150	0.250	0.425	2.00	4.75	5.00	13.20	14.00	19.00	20.00	26.50	28.0	37.5	50.0	53.0	63	75	100
Percentage Passing	38%	51%	65%	79%	86%	88%	88%	92%	92%	94%	94%	99%	99%	100%	100%	100%	100%	100%	100%

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<b>Client</b> : SLR Consulting (Soth Africa) (Pty) Ltd <b>Project</b> : Ispingo WWTW <b>Attention</b> : Mrs. R. Naidoo	<b>Your Ref No. : -</b> <b>Our Ref No. : 79999</b> <b>Date Reported : 12/09/2024</b>
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### Test Report - SANS 3001

Sample No.	T53082	T53083	T53087	T53088	T53090
Field No.	IP11	IP11	IP15	IP15	IP18
Position	-	-	-	-	-
Depth ( m )	0.20-0.50	0.50-0.70	0.10-0.20	0.20-0.40	0.05-0.80
Method of Preparation	Scalped	N/A		N/A	
Material Description	Dark reddish orange silty clayey sandy GRAVEL	Dark yellowish brown silty SAND	Light greyish brown silty sandy GRAVEL	Dark reddish orange gravelly SAND	Dark yellowish brownish grey gravelly silty clayey SAND

Sieve Analysis - Percent Passing Sieve Size						
Sieve Aperture (mm)	100.00	100				
	75.00	96				
	63.00	91				
	53.00	91				
	50.00	86				
	37.50	80		100		
	28.00	78		99		
	26.50	78		99	100	100
	20.00	77		97	99	94
	19.00	77		97	99	94
	14.00	73		90	91	91
	13.20	73	100	90	91	91
	5.00	57	99	69	86	77
	4.750	57	99	69	86	77
	2.000	52	97	58	85	66
	0.425	47	88	38	80	49
	0.075	6	35	22	14	15
Grading Modulus		1.96	0.79	1.82	1.21	1.71
Mechanical analysis - Percent of Soil Mortar (<2 mm) for Grain Size range						
Coarse Sand	2.000 - 0.425	10	9	35	6	26
Coarse-Fine Sand	0.425 - 0.250	22	22	7	32	20
Medium-Fine Sand	0.250 - 0.150	45	18	9	34	18
Fine-Fine Sand	0.150 - 0.075	12	15	11	12	14
Silt and Clay	< 0.075	11	36	39	16	23
Atterberg Limits SANS 3001 on <0.425 mm fraction						
Liquid Limit	% or symbol	NP	SP	NP	NP	NP
Plasticity Index	% or symbol	NP	SP	NP	NP	NP
Linear Shrinkage	%	0.0	0.5	0.0	0.0	0.0
Maximum Dry Density and Optimum Moisture Content						
Maximum Dry Density (kg/m³)		1829	2189		2001	
Optimum moisture content (%)		9.7	6.7		9.8	
California Bearing Ratio						
CBR @ 100% Compaction	%	45	50		33	
CBR @ 98% Compaction	%	36	36		23	
CBR @ 97% Compaction	%	33	31		19	
CBR @ 95% Compaction	%	27	22		14	
CBR @ 93% Compaction	%	22	16		9.6	
CBR @ 90% Compaction	%	16	10		5.6	
Swell @ 100% Compaction	%	0.0	0.0		0.4	
COLTO Classification (1998)**		G6 (#)	G7 (#)	Cannot be Determined	G9 (#)	Cannot be Determined
TRH 14 Classification (1985)**		G7	G7	Cannot be Determined	G10	Cannot be Determined
AASHTO Classification (Group Index)**		A-1-b (0)	A-2-4 (0)	A-1-b (0)	A-2-4 (0)	A-1-b (0)
Unified Classification **		SP-SM	SM	SM	SM	SM

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**Remarks:** \*Subject to further testing as required by TRH14.

† Subject to further testing as required by COLTO. COLTO above uses only: Atterberg Limits (<0.425 mm fraction; not arithmetic mean), Nominal Max Size, Grading Curve, Coarse Sand Ratio, Grading Modulus, Strength (CBR), and Swell.

\* Check that Max Size <= 2/3 of compacted layer thickness.

\*\* Opinions and interpretations expressed herein are outside the scope of SANAS accreditation  
 Version 5.05 - 14 February 2018

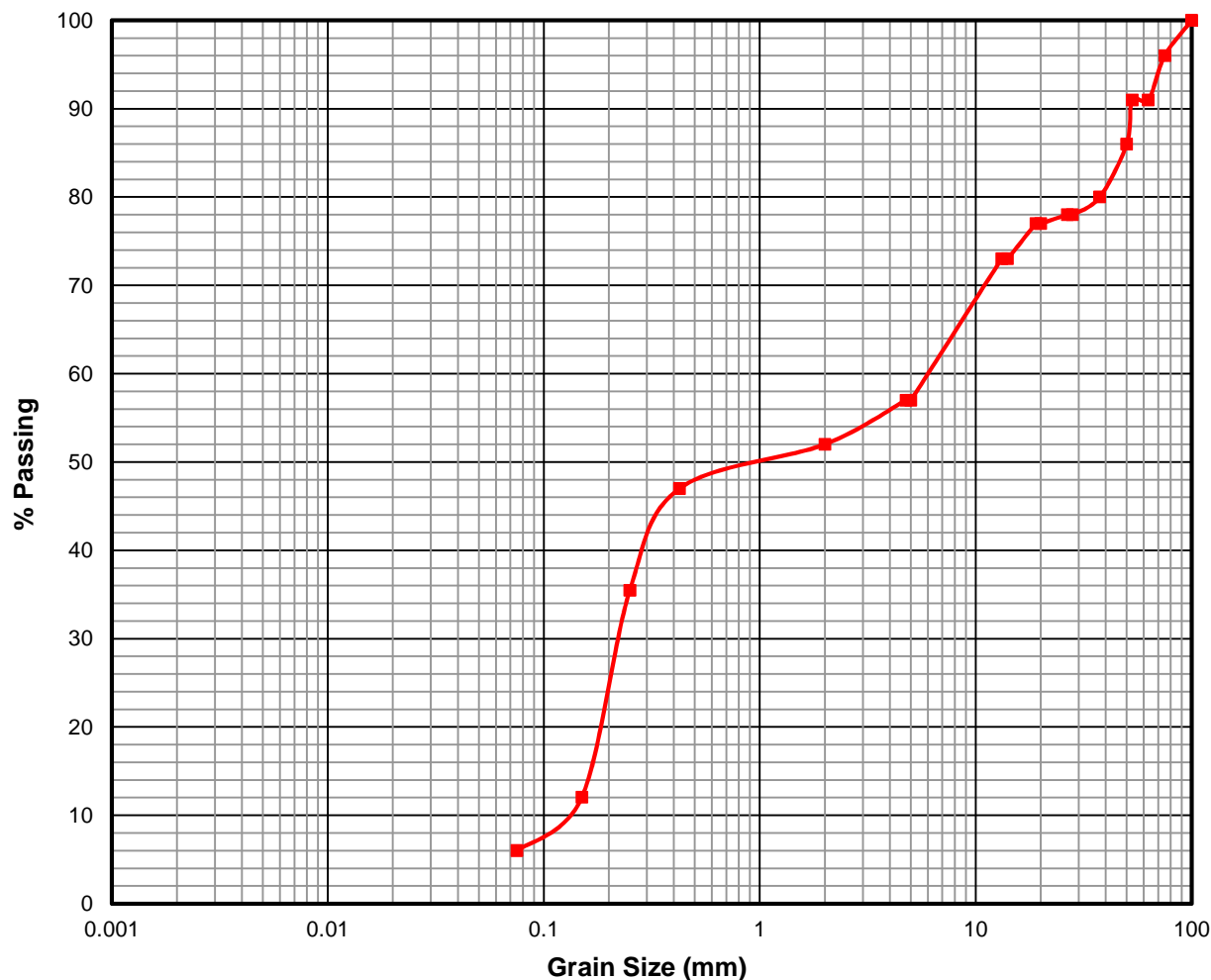
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**Client :** SLR Consulting (Soth Africa) (Pty) Ltd  
**Project :** Ispingo WWTW  
**Attention :** Mrs. R. Naidoo

**Your Ref No.:** -  
**Our Ref No.:** 79999  
**Date Reported :** 12/09/2024

## Grading Curve for Sample T53082 – SANS 3001



Clay	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse
	Silt			Sand			Gravel		

**Thick Red Line is the Grading Curve (COLTO Classification = G6 (#)) (TRH 14 Classification = G7)**

Sieve Aperture Size	0.075	0.150	0.250	0.425	2.00	4.75	5.00	13.20	14.00	19.00	20.00	26.50	28.0	37.5	50.0	53.0	63	75	100
Percentage Passing	6%	12%	35%	47%	52%	57%	57%	73%	73%	77%	77%	78%	78%	80%	86%	91%	91%	96%	100%

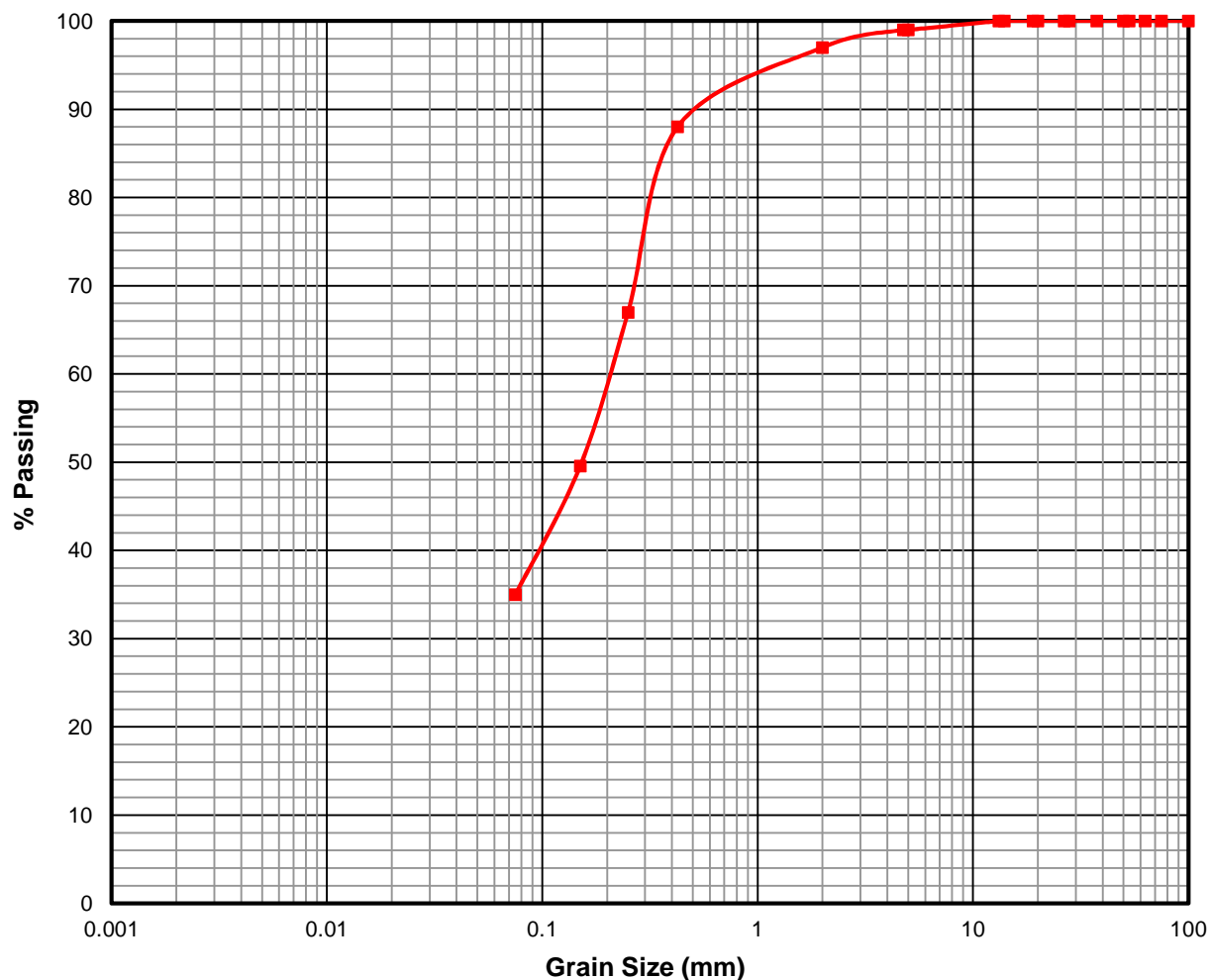
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## Grading Curve for Sample T53083 – SANS 3001



Clay	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse
	Silt			Sand			Gravel		

**Thick Red Line is the Grading Curve (COLTO Classification = G7 (#)) (TRH 14 Classification = G7)**

Sieve Aperture Size	0.075	0.150	0.015	0.026	0.05	0.06	5.00	13.20	14.00	19.00	20.00	26.50	28.0	37.5	50.0	53.0	63	75	100
Percentage Passing	35%	50%	67%	88%	97%	99%	99%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

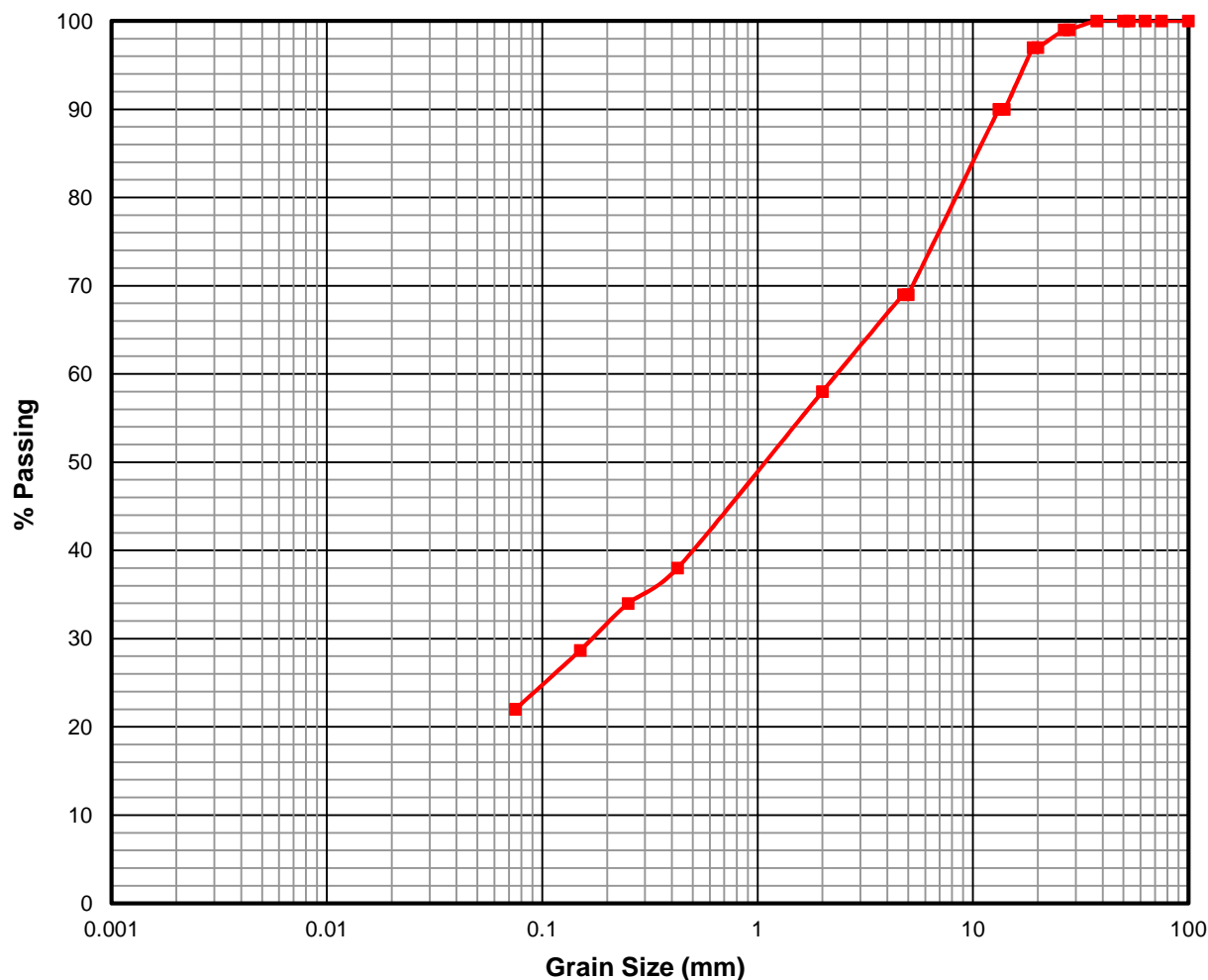
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**Date Reported :** 12/09/2024

### Grading Curve for Sample T53087 – SANS 3001



Clay	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse
	Silt			Sand			Gravel		

**Red Line is the Grading Curve (COLTO Classification = Cannot be Determined) (TRH 14 Classification = Cannot be Determined)**

Sieve Aperture Size	0.075	0.150	0.250	0.425	2.00	4.75	5.00	13.20	14.00	19.00	20.00	26.50	28.0	37.5	50.0	53.0	63	75	100
Percentage Passing	22%	29%	34%	38%	58%	69%	69%	90%	90%	97%	97%	99%	99%	100%	100%	100%	100%	100%	100%

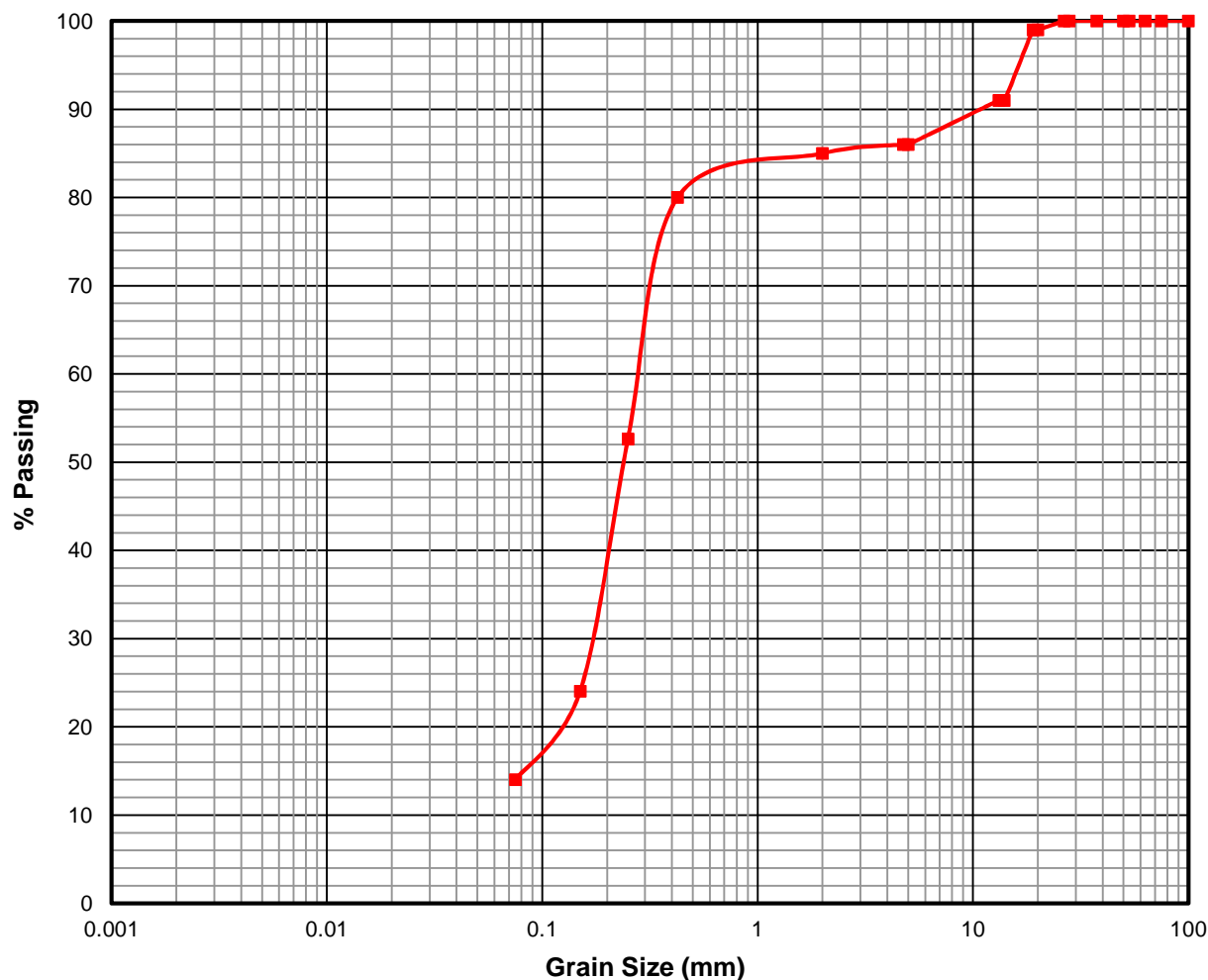
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**Date Reported :** 12/09/2024

## Grading Curve for Sample T53088 – SANS 3001



Clay	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse
	Silt			Sand			Gravel		

**Thick Red Line is the Grading Curve (COLTO Classification = G9 (#)) (TRH 14 Classification = G10)**

Sieve Aperture Size	0.075	0.150	0.250	0.425	2.00	4.75	5.00	13.20	14.00	19.00	20.00	26.50	28.0	37.5	50.0	53.0	63	75	100
Percentage Passing	14%	24%	53%	80%	85%	86%	86%	91%	91%	99%	99%	100%	100%	100%	100%	100%	100%	100%	100%



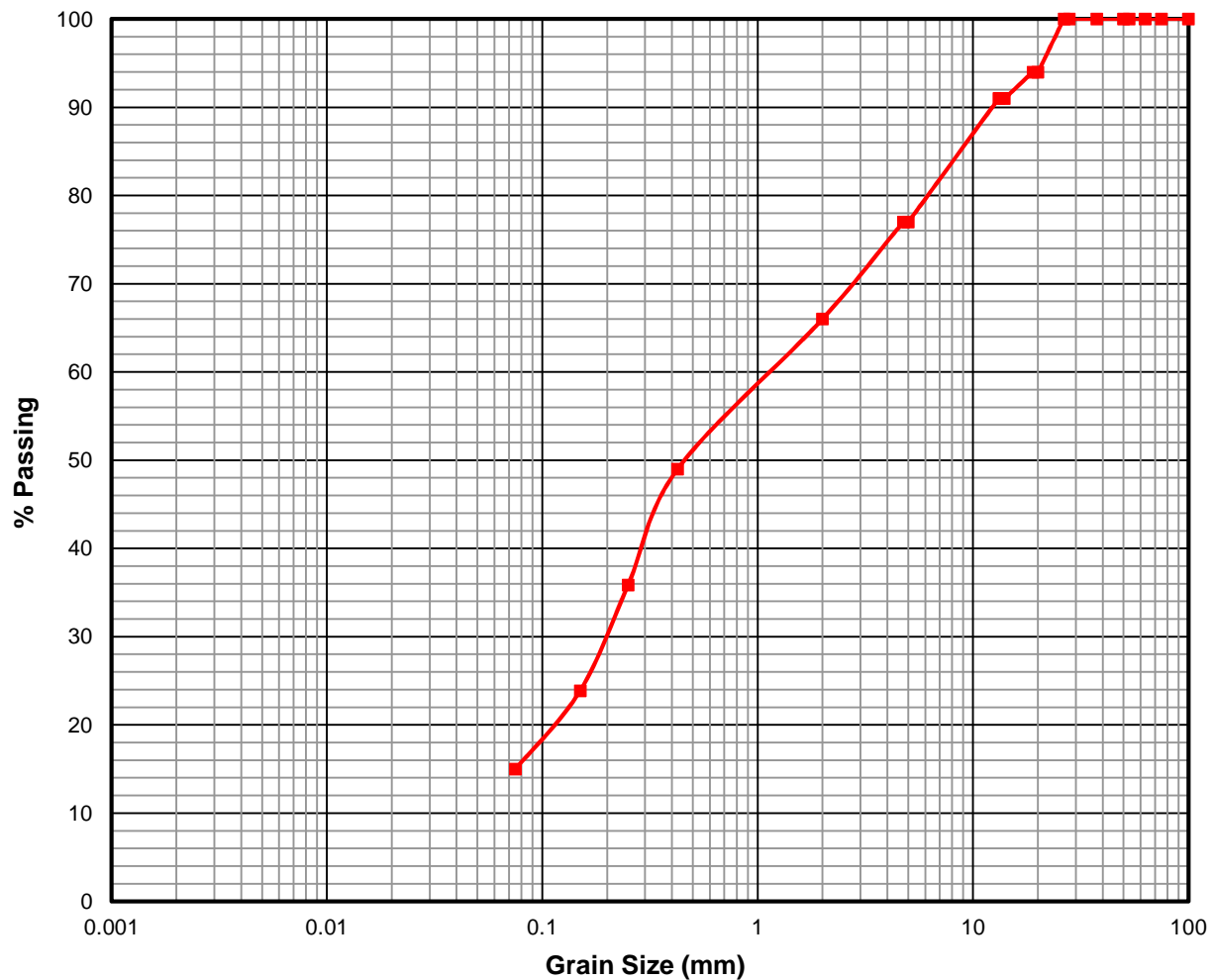
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**Date Reported :** 12/09/2024

### Grading Curve for Sample T53090 – SANS 3001



Clay	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse
	Silt			Sand			Gravel		

**Red Line is the Grading Curve (COLTO Classification = Cannot be Determined) (TRH 14 Classification = Cannot be Determined)**

Sieve Aperture Size	0.075	0.150	0.250	0.425	2.00	4.75	5.00	13.20	14.00	19.00	20.00	26.50	28.0	37.5	50.0	53.0	63	75	100
Percentage Passing	15%	24%	36%	49%	66%	77%	77%	91%	91%	94%	94%	100%	100%	100%	100%	100%	100%	100%	100%



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**Project** : Ispingo WWTW

**Attention** : Mrs R. Naidoo

**Your Ref No.** : -

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**Date Reported** : 19.08.2024

### SANS 3001 Moisture/Density Relationship

Sample No. : T53075

Method of preparation : Scalped

Natural/Stabilised : Natural

Material Description : Dk.Rd.Or.SAND with occasional Gravel

Field No. : IP4

Depth (m) : 0.20-0.35

Origin : -

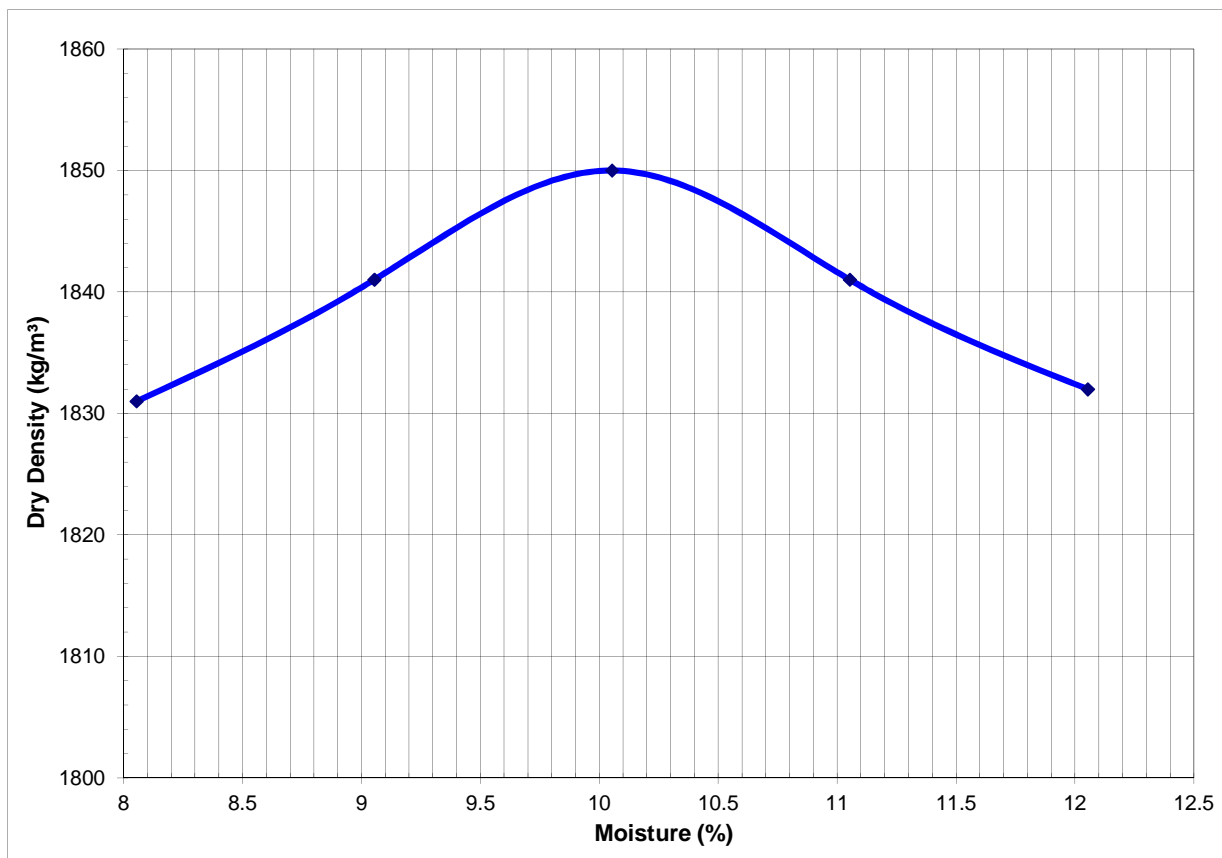
Compaction Effort : Mod AASHTO

**Maximum Dry Density (kg/m³)**      **1850**

**Optimum Moisture Content (%)**      **10.1**

Plotted Values:

Moisture (%)	8.1	9.1	10.1	11.1	12.1
Dry Density (kg/m³)	1831	1841	1850	1841	1832



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**Date Reported : 19.08.2024**

### SANS 3001 Moisture/Density Relationship

Sample No. : T53077

Method of preparation : N/A

Natural/Stabilised : Natural

Material Description : Dk.Rd.SAND with occasional Gravel

Field No. : IP6

Depth (m) : 0.03-0.17

Origin : -

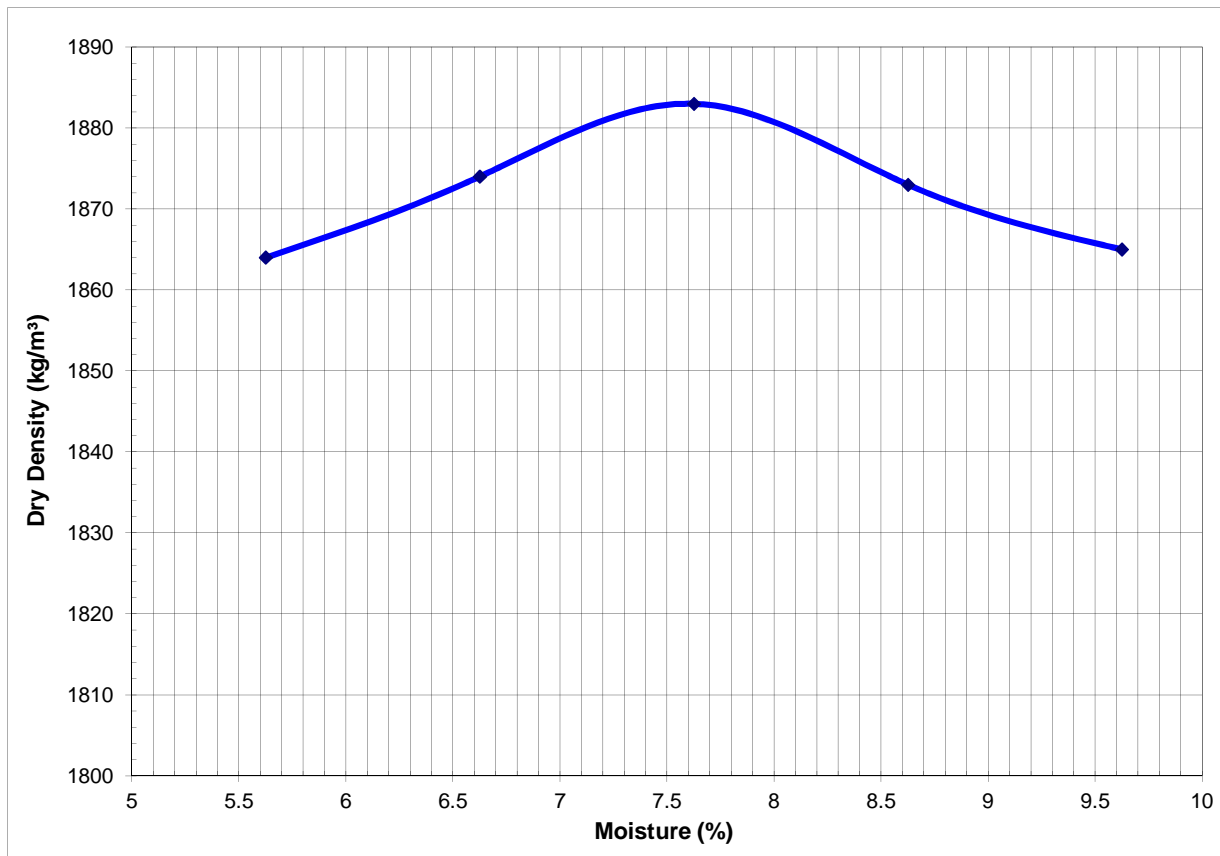
Compaction Effort : Mod AASHTO

**Maximum Dry Density (kg/m<sup>3</sup>) 1883**

**Optimum Moisture Content (%) 7.6**

Plotted Values:

Moisture (%)	5.6	6.6	7.6	8.6	9.6
Dry Density (kg/m <sup>3</sup> )	1864	1874	1883	1873	1865



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**Project : Ispingo WWTW**

**Attention : Mrs R. Naidoo**

**Your Ref No. : -**

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**Date Reported : 19.08.2024**

### SANS 3001 Moisture/Density Relationship

Sample No. : T53078

Method of preparation : Scalped

Natural/Stabilised : Natural

Material Description : Dk.Yel.Clayey silty gravelly SAND

Field No. : IP6

Depth (m) : 0.40-0.55

Origin : -

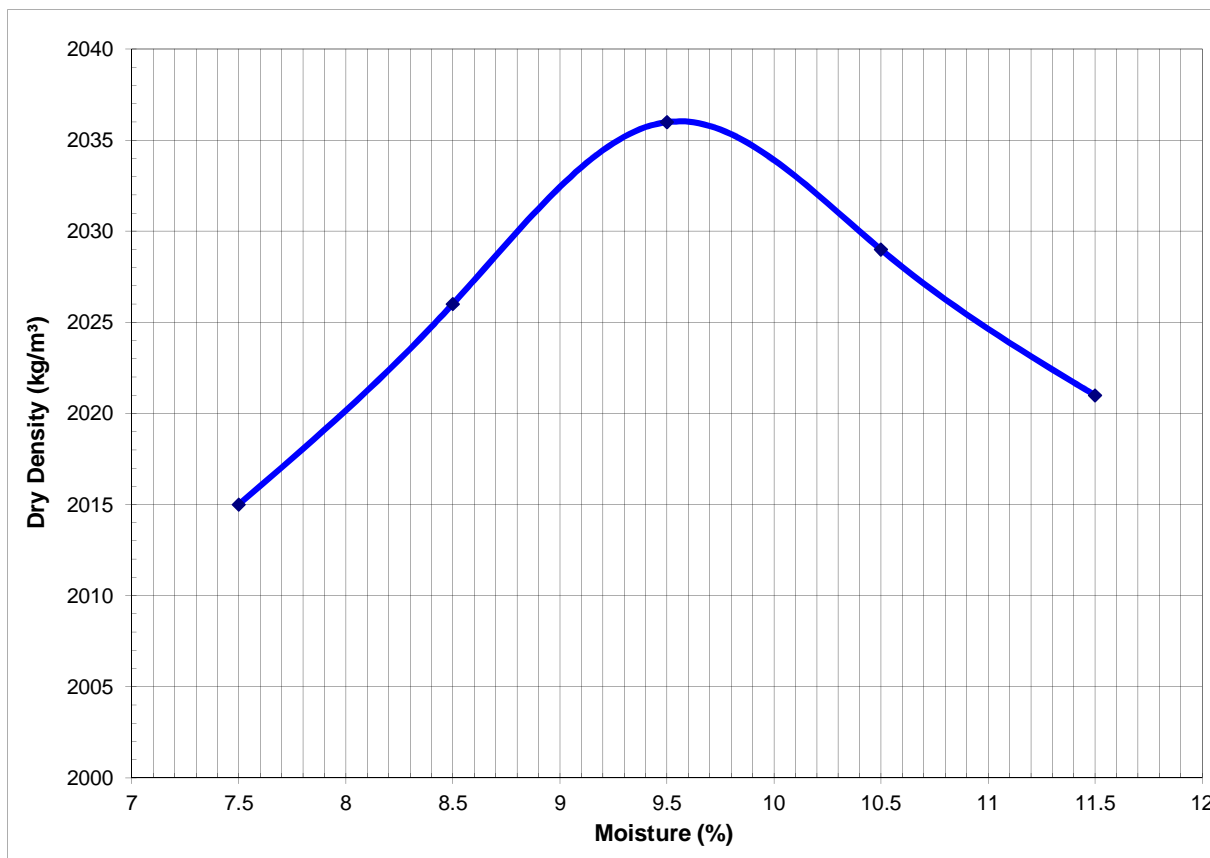
Compaction Effort : Mod AASHTO

**Maximum Dry Density (kg/m<sup>3</sup>) 2036**

**Optimum Moisture Content (%) 9.6**

Plotted Values:

Moisture (%)	7.5	8.5	9.5	10.5	11.5
Dry Density (kg/m <sup>3</sup> )	2015	2026	2036	2029	2021



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**Date Reported** : 19.08.2024

### SANS 3001 Moisture/Density Relationship

Sample No. : T53079  
 Method of preparation : N/A  
 Natural/Stabilised : Natural  
 Material Description : Pal.Rd.Sandy GRAVEL

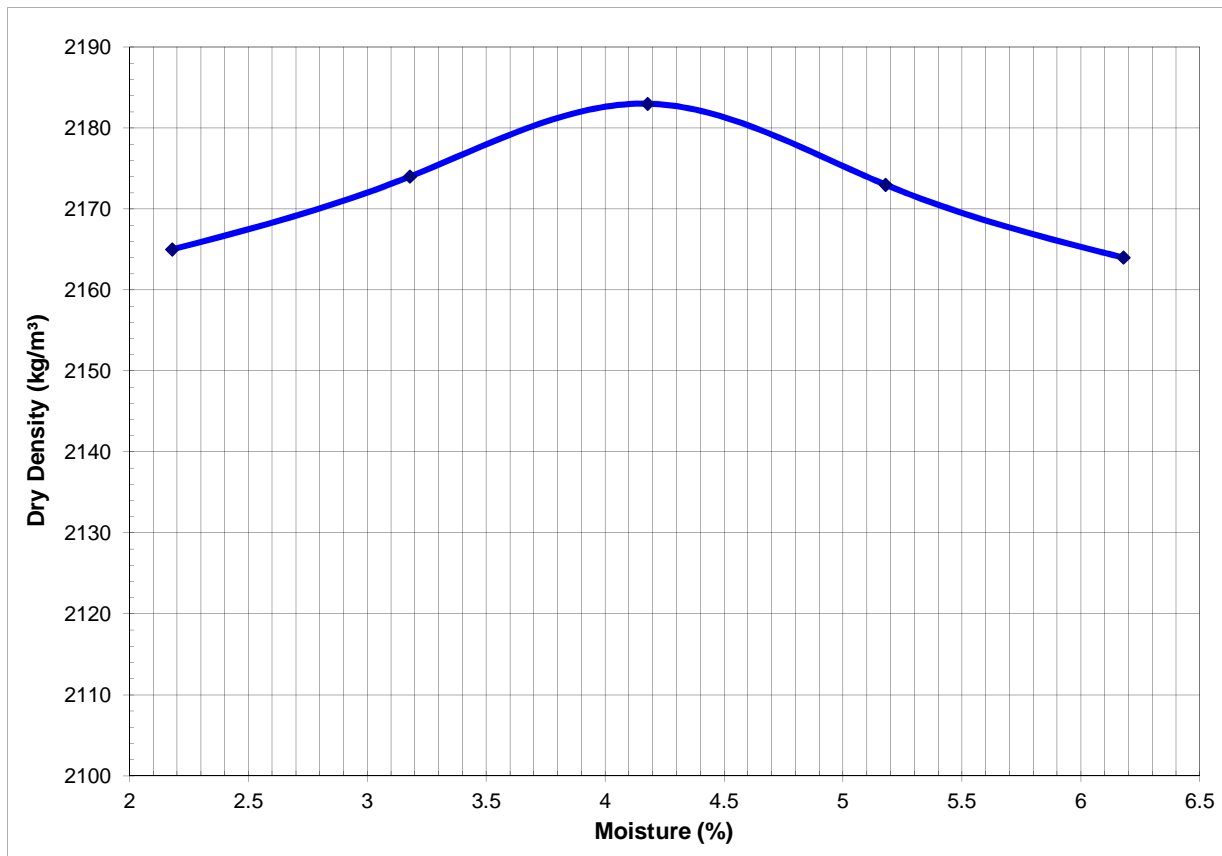
Field No. : IP8  
 Depth (m) : 0.1-0.25  
 Origin : -  
 Compaction Effort : Mod AASHTO

**Maximum Dry Density (kg/m³) 2183**

**Optimum Moisture Content (%) 4.2**

**Plotted Values:**

Moisture (%)	2.2	3.2	4.2	5.2	6.2
Dry Density (kg/m³)	2165	2174	2183	2173	2164



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**Date Reported : 19.08.2024**

### SANS 3001 Moisture/Density Relationship

Sample No. : T53080

Method of preparation : N/A

Natural/Stabilised : Natural

Material Description : Dk.Yel.Silty gravelly SAND

Field No. : IP8

Depth (m) : 0.25-0.55

Origin : -

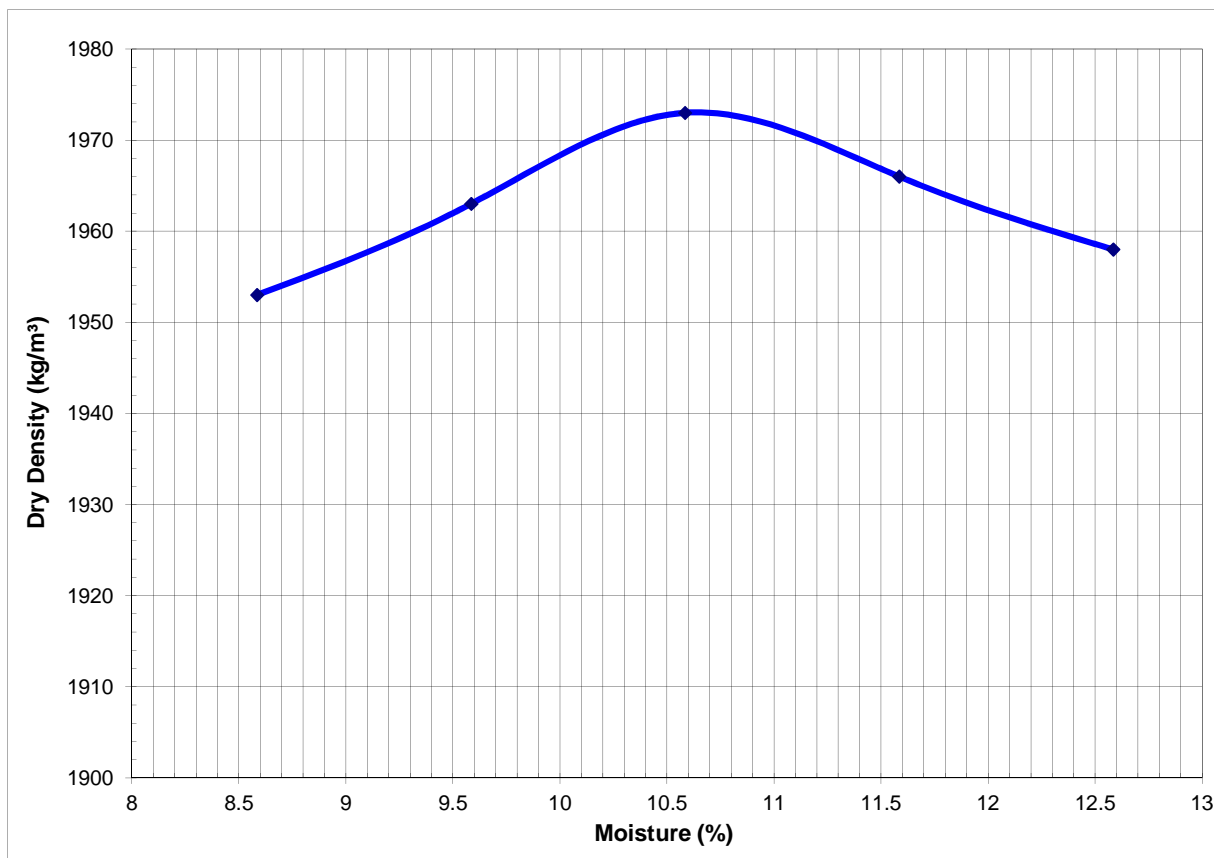
Compaction Effort : Mod AASHTO

**Maximum Dry Density (kg/m³) 1973**

**Optimum Moisture Content (%) 10.7**

Plotted Values:

Moisture (%)	8.6	9.6	10.6	11.6	12.6
Dry Density (kg/m³)	1953	1963	1973	1966	1958



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### SANS 3001 Moisture/Density Relationship

Sample No. : T53082

Method of preparation : Scalped

Natural/Stabilised : Natural

Material Description : Dk.Rd.Or.Silty clayey sandy GRAVEL

Field No. : IP11

Depth (m) : 0.20-0.50

Origin : -

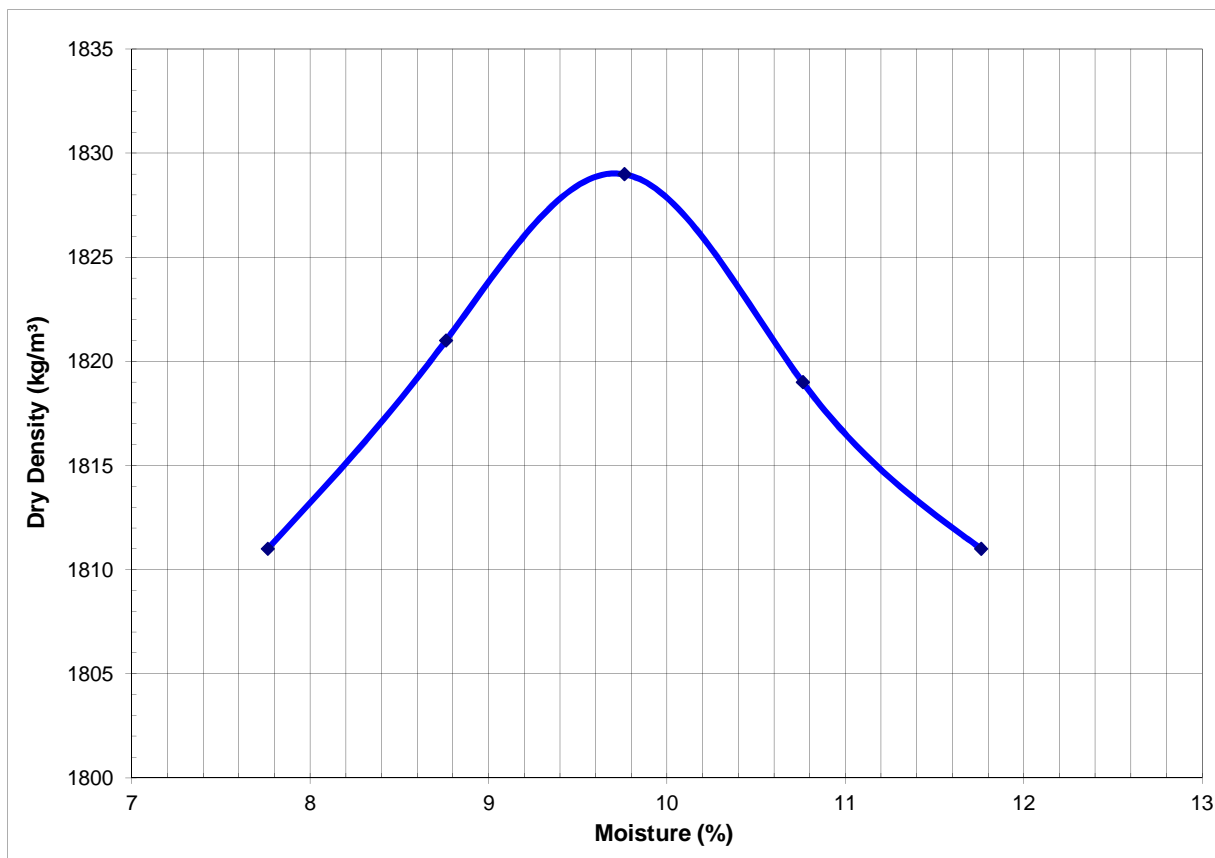
Compaction Effort : Mod AASHTO

**Maximum Dry Density (kg/m<sup>3</sup>)**      **1829**

**Optimum Moisture Content (%)**      **9.7**

Plotted Values:

Moisture (%)	7.8	8.8	9.8	10.8	11.8
Dry Density (kg/m <sup>3</sup> )	1811	1821	1829	1819	1811



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### SANS 3001 Moisture/Density Relationship

Sample No. : T53083

Method of preparation : N/A

Natural/Stabilised : Natural

Material Description : Dk.Yel.Br.Silty SAND

Field No. : IP11

Depth (m) : 0.50-0.70

Origin : -

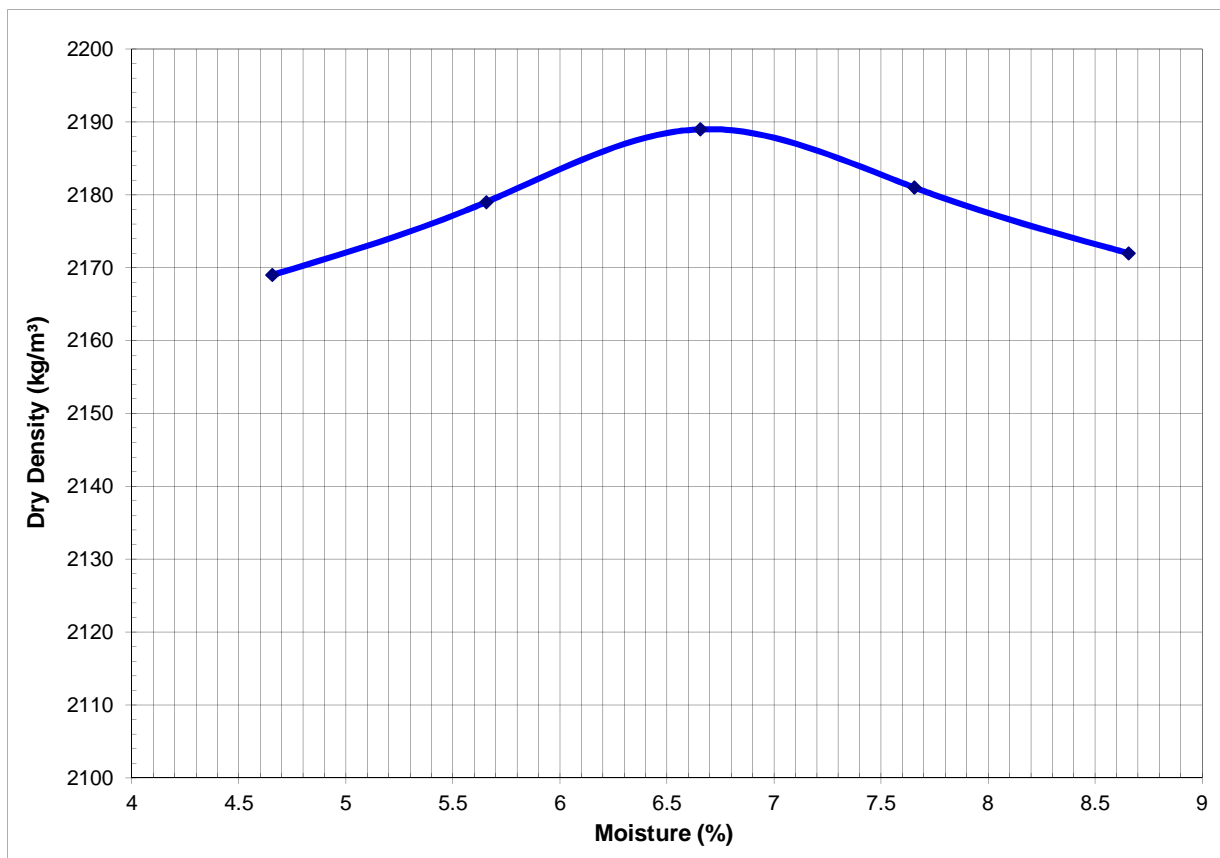
Compaction Effort : Mod AASHTO

**Maximum Dry Density (kg/m³) 2189**

**Optimum Moisture Content (%) 6.7**

Plotted Values:

Moisture (%)	4.7	5.7	6.7	7.7	8.7
Dry Density (kg/m³)	2169	2179	2189	2181	2172



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### SANS 3001 Moisture/Density Relationship

Sample No. : T53088

Method of preparation : N/A

Natural/Stabilised : Natural

Material Description : Dk.Rd.Or.Gravelly SAND

Field No. : IP15

Depth (m) : 0.20-0.40

Origin : -

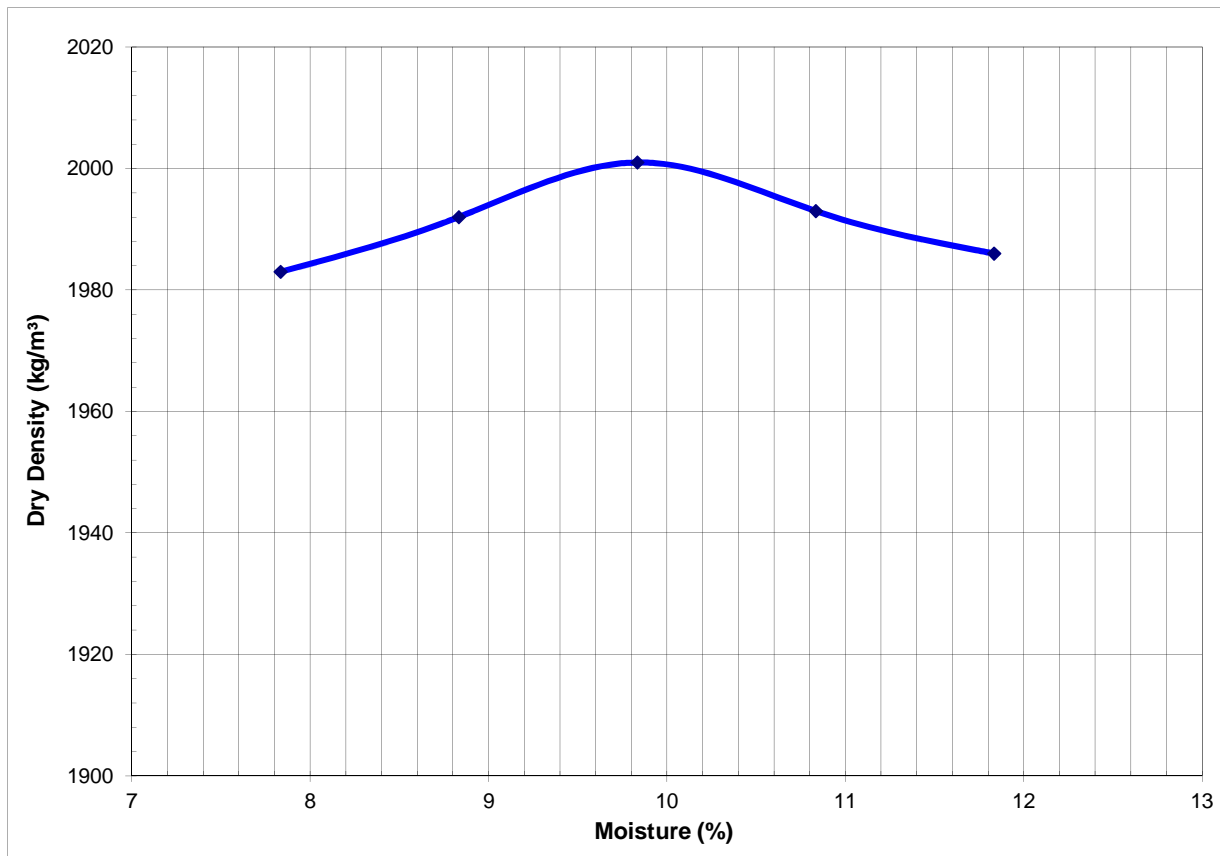
Compaction Effort : Mod AASHTO

**Maximum Dry Density (kg/m³)**      **2001**

**Optimum Moisture Content (%)**      **9.8**

Plotted Values:

Moisture (%)	7.8	8.8	9.8	10.8	11.8
Dry Density (kg/m³)	1983	1992	2001	1993	1986



**Remarks:** This report relates only to sample(s) received. This report shall not be reproduced, except in full, without the prior consent of GEOSURE (Pty) Ltd.

# APPENDIX A

## UNCERTAINTY OF MEASUREMENT AND DECISION RULE

### Notes on Uncertainty:

1. ABBREVIATIONS: UoM = Uncertainty of Measurement; E.UoM = Expanded Uncertainty of Measurement
2. UoM for gravels, sands, cohesive materials and asphalt was determined from a reproducibility study
2. UoM for aggregates and concrete was determined from a repeatability study

### Notes on Decision Rule:

1. The decision rule employed by this laboratory is based on ILAC-G9:03/2009
2. Decision rules are only applicable to classification of gravels, sands and cohesive materials
3. Contact GEOSURE for further information related to the decision rule

MATERIAL TYPE		GRAVELS AND CRUSHED STONE (G1 - G5)	SANDS (G8-G9)	COHESIVE MATERIALS (G5 - G9)
PROPERTY		E.UoM (K=2)	E.UoM (K=2)	E.UoM (K=2)
% Passing Sieve Aperture	100.0 mm	0.00	0.00	0.00
	75.0 mm	0.00	0.00	2.56
	63.0 mm	0.00	0.00	1.48
	50.0 mm	0.00	0.00	1.56
	37.5 mm	0.36	0.00	1.32
	28.0 mm	2.08	0.00	0.98
	20.0 mm	0.78	0.00	0.98
	14.0 mm	0.38	0.00	1.82
	5.00 mm	1.94	0.44	1.10
	2.00 mm	2.44	0.56	0.90
	0.425 mm	1.42	1.40	1.42
Mechanical Analysis (%)	0.075 mm	0.38	0.72	0.98
	CS	1.32	1.08	0.98
	CFS	1.32	0.66	0.00
	MFS	0.00	1.56	0.00
	FFS	0.74	0.92	1.02
Grading Modulus	S+C	1.36	0.36	0.00
	LL	0.04	0.02	0.06
	PI	0.00	0.00	1.60
Atterberg Limits (%)	LS	0.00	0.00	0.64
	LL	0.00	0.00	0.22
	PI	0.00	0.00	0.64
CBR (%)	100% Comp.	18.36	8.24	2.70
	98% Comp.	9.24	7.50	1.10
	97% Comp.	5.84	6.82	0.62
	95% Comp.	1.32	3.04	0.40
	93% Comp.	1.94	2.44	0.66
	90% Comp.	3.54	1.50	0.66
MOD	Swell @ 100%	0.04	0.00	0.92
	MDD (kg/m <sup>3</sup> )	5.74	3.42	7.76
	O.M.C (%)	0.08	0.12	0.50

AGGREGATE (SINGLE SIZED CRUSHED STONE)		
PROPERTY		E.UoM (K=2)
% Passing Sieve Aperture	100.0 mm	0.00
	75.0 mm	0.00
	63.0 mm	0.00
	50.0 mm	0.00
	37.5 mm	0.00
	28.0 mm	0.00
	20.0 mm	0.16
	14.0 mm	0.14
	10.0 mm	0.32
	7.1 mm	0.18
	5.0 mm	0.20
	2.0 mm	0.08
	1.0 mm	0.18
	0.600 mm	0.20
	0.425 mm	0.20
	0.300 mm	0.16
	0.150 mm	0.04
	0.075 mm	0.12
	Fineness Mod.	0.00
Flak. Index	%	0.22
ALD	mm	0.12
ALD Comp.	mm	0.10
Sand Equiv		0.54
ACV (AG10)	%	0.10
10% FACT(AG10)	kN	1.08
ACV (AG15)	%	0.00
10% FACT(AG15)	kN	1.00
BD (AG20)	kg/m <sup>3</sup>	0.38
AD (AG20)	kg/m <sup>3</sup>	0.44
WA (AG20)	%	0.00
BD (AG21)	kg/m <sup>3</sup>	22.76
AG (AG21)	kg/m <sup>3</sup>	27.04
WA (AG21)	%	0.00
ARD (AG22)	kg/m <sup>3</sup>	1.92
RD (AG23)	kg/m <sup>3</sup>	2.04
PD (AG23)	kg/m <sup>3</sup>	0.00

CONCRETE		
AGE		E.UoM (K=2)
7 Day Results		
Strength( MPa)		2.30
28 Day Results		
Strength( MPa)		1.26

Nuclear Density	
Property	E.UoM (K=2)
Wet Density (kg/m <sup>3</sup> )	8.88
Dry Density (kg/m <sup>3</sup> )	11.36
Moisture Content (%)	0.38





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**Your Ref.No.: -**

**Date Reported: 12.09.2024**

**Date Received: 14.08.2024**

[illegible]

**UNITS of measurement**

S/m	-	Siemens / metre
ppm	-	parts per million
mg/L	-	milligram / Litre
°C	-	Degrees Celsius

Darren Samuel for Geosure (Pty) Ltd.  
Technical Signatory



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