land reform & rural development

Department:
Land Reform and Rural Development
REPUBLIC OF SOUTH AFRICA

Tender/Contract No.: SSC WC 01 (2026/2027) DLRRD

A Tender for Category 6CE or 6ME OR higher CIDB Registered Contractors

THE APPOINTMENT OF A CONTRACTOR FOR THE CONSTRUCTION OF A SEWER AND STORMWATER PIPE IN NDULI, CERES, UNDER WITZENBERG MUNICIPALITY, IN THE WESTERN CAPE PROVINCE

(VOLUME 2 OF 2)

Name of Tenderer (Bidding Entity): _____

Provide full name i.e. (CC, Pty Ltd, JV, Sole Proprietor): _____

Name of duly authorised person: _____

Address of Tenderer: _____

_____

Tel. Number: _____

Cell number: _____

Fax number: _____

E-mail : _____

Receipt number: _____

ISSUED BY:

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DEPARTMENT LAND REFORM AND RURAL DEVELOPMENT

CONTRACT NO.: SSC WC 01 (2026/2027) DLRRD

THE APPOINTMENT OF A CONTRACTOR FOR THE CONSTRUCTION OF A SEWER AND STORMWATER PIPE IN NDULI, CERES, UNDER WITZENBERG MUNICIPALITY, IN THE WESTERN CAPE PROVINCE

PART C3 PART 1: SCOPE OF WORK - CIVIL

C3.1: DESCRIPTION OF WORKS

PART C3.1: Description of Works

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C 3.1.1 Employer's Objectives

The objective of the Employer is to upgrade the bulk sewer for Nduli to prevent sewage spillages into the adjacent environment.

C 3.1.2 Overview of The Works

The work to be carried out includes the construction of a bulk sewer, stormwater pipes and the fitting of existing sewer manholes with lockable covers and frames.

C 3.1.3 Scope of Works

The work to be carried out under this contract consists mainly of the following:

(a) The construction of a bulk sewer of approximately 550 m length of 200 mm diameter uPVC pipes and manholes.

(b) Connections of existing sewers into the new bulk sewer.

(c) The construction of a stormwater pipe of approximately 505 m length of 600 mm diameter reinforced concrete pipes, manholes and outlet structures.

(d) The replacement of existing sewer manhole covers and frames with lockable covers and frames.

(e) The construction of syphon chambers.

(f) The erection of a security fence with height of 1.8 m and length of 900 m.

This description of the works is not necessarily complete and shall not limit the work to be carried out by the Contractor under this contract.

Approximate quantities of each type of work are given in the schedule of quantities.

C 3.1.4 Description of Site and Conditions

The following site conditions shall be taken into consideration:

- Altitude above sea level 485 m mean
- Operating Voltage – the site is not serviced with electricity supply
- Electrical Supply Frequency – the site is not serviced with electricity supply
- Maximum Temperature 45ºC
- Minimum Temperature 0ºC
- Maximum Relative Humidity 80 %
- Corrosion Conditions Moderate
- Lightning Moderate
- Rainfall Winter
- Flooding (means to prevent flooding is required)

C 3.1.5 Site Access

Access to the site may be gained from the R46 and the Onder-Swaarmoed Road.

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.

C 3.1.6 Nature of Ground and Subsoil Conditions

A geotechnical report is included in this document in Part C4.

C 3.1.7 Temporary Works

The Contractor shall be responsible for designing and providing any temporary works required. The Contractor shall allow for the cost of all temporary works, including design, provision and their removal, in his tendered rates.

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

C 3.1.8 Work to be carried out by others (under separate contracts)

The following works will be carried out under separate contracts by others:

- None

PART C3 PART 1: SCOPE OF WORK - CIVIL

C3.2: ENGINEERING

PART C3.2: Engineering

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C3.2.1 Design

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 and their compatibility with the permanent Works.

The design responsibility per stage is summarized as follows:

- Concept, feasibility and overall process: - Employer
- Basic Engineering and detail layouts to tender stage: - - Employer
- Final design to approved for construction stage: - Employer
- Temporary works: - Contractor
- Preparation of as built drawings: - Contractor

Amendments to the design, if necessary, will be issued during the construction phase.

C 3.2.2 Employer's Design

All work in this contract has been designed and is specified in the document. Some provisional sums have been allowed for, of which the works will be designed and quantities together with drawings will be provided to the successful Tenderer. These provisional sums include:

- Upgrading and Repairs to Mechanical Pumping Equipment to Existing Screening Facility
- Upgrade and Repairs to Screening Equipment to Existing Screening Facility
- Upgrade and Repairs to MCC and Electrical Equipment to Existing Screening Facility
- Upgrade and Repairs to Control and Instrumentation to Existing Screening Facility
- Upgrade and Repairs to Civil and Structureal Works to Existing Screening Facility
- Upgrade and Repairs to Fencing and Security to Existing Screening Facility

C 3.2.3 Contractor's Design

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.

The design of the temporary works shall be carried out in accordance with all relevant standards and codes of practice, with particular emphasis on the requirements of the OHS Act.

These drawings will have to be submitted for approval to the relevant authorities (Employer / Employer's Agent / H&S Agent/Local Authority) prior to commencement of the Works.

C 3.2.4 Drawings

Reduced drawings form part of the tender documents and shall be used for tender purposes only.

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 Employer's Agent. The Employer's Agent will, at 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 or relocated 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 Employer's Agent's Representative on a regular basis and at least on a monthly basis.

All information in possession of the Contractor, required by the Employer's Agent to verify the as-built/record drawings, must be submitted to the Employer's Agent before a Certificate of Practical Completion will be issued.

The Employer reserves the right to issue amended and/or additional drawings during the Contract.

Additional construction drawings will, in terms of the General Conditions of Contract, be issued to the Contractor by the Employer or the Employer's Agent on the commencement date and from time to time as required.

The following drawings are applicable to this contract and will form part of the contract documents.

DRAWING NUMBER	DRAWING TITLE
P1174-L01	Sewer Layout
P1174-L02	Sewer Long Section
P1174-L03	Stormwater Long Section
P1174-L04	Stormwater Long Section
P1174-L05	Detail of Flushing Syphon Chamber
P1174-L06	Detail of Steel Mesh Fencing
P1174-L07	Stormwater Details
P1174-L08	Sewer Details
P1174-L09	Traffic Accommodation
P1174-L010	Project Nameboard

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

PART C3 PART 1: SCOPE OF WORK - CIVIL

C3.3: PROCUREMENT

PART C3.3: Procurement

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C3.3.1 Preferential Procurement

Tenders will be evaluated in terms of the criteria and selected method included in Part T1.2: Tender Data.

C3.3.2 Subcontractors

The Contractor shall not subcontract more than 25 % of the value of the contract to subcontractors that do not have an equal or higher B-BBEE status level than the Contractor, unless such subcontractors are exempted micro enterprises that can demonstrate to the satisfaction of the Employer's Agent that they have the capability and ability to execute the subcontract works. The Contractor is encouraged to make use of local emerging subcontractors.

Where monetary allowances for provisional sums or prime cost items have been provided in the Bills of Quantities, and where the work is to be executed/supplied by sub-contractors/suppliers then the following selection process shall be followed in respect of the required sub-contractors/suppliers:

- Where monetary allowances for provisional sums or prime cost items allowed and the monetary allowance is less than R200 000.00, the Contractor shall invite three quotations from suitably qualified sub-contractors/suppliers, the selection of which shall be in consultation with, and to the approval of the Employer's Agent, for the required work or items.
- Where these monetary allowances exceed R200 000.00 an open tender process will have to be followed in respect of a subcontractor for this work, unless otherwise advised and approved by the Employer. In such cases where a tender process is to be followed, the tender will be issued by the Employer's Agent 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 Employer's Agent for approval.

The evaluation of the quotation received must include a preference points system as described in C3.11 of the Standard Conditions of Tender.

C3.3.3 Attendance on subcontractors

Approval given in terms of subcontracting shall not relieve the Contractor of any responsibility, duty or obligation imposed upon him by the Contract, and the Contractor shall in particular be and remain solely liable and responsible for all acts, omissions, negligence or breaches of contract on the part of the assignee or any of his employees, and for all acts, omissions or negligence of any Sub- Contractor or any of his employees.

PART C3 PART 1: SCOPE OF WORK - CIVIL

C3.4: CONSTRUCTION

PART C3.4: Construction

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C3.4.1 Works Specifications

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.

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

The specifications are included in Section C3.6.

C3.4.2 Site Establishment

Services and facilities provided by the Employer.

C3.4.2.1 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 Employer's Agent 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 Employer's Agent, 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.

3.4.2.2 Spoil Site

The Contractor shall provide his own spoil site for the disposal of spoil material from bulk and necessary excavations as indicated in the bill or as shown on the drawings. The Contractor is responsible for determining which registered sites he/she would like to use.

C3.4.3 Site Establishment

C3.4.3.1 Facilities for the Employer's Agent

The Contractor shall provide on site, for the duration of the Contract and for the exclusive use of the Employer's Agent 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 Employer's Agent 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. Alternatively if the facilities are not provided within 21 days of commencement of the contract the Employer's Agent may arrange for these services directly. The cost of arranging, maintaining and providing of such facilities arranged by the Employer's Agent due to failure by the Contractor will be deducted from payments due to the Contractor.

(i) Office accommodation

The Contractor shall supply and furnish two air-conditioned "Kwikjack" or similar approved (6 m x 3 m) site offices, internal size of at least 15 m² each, with a toilet for the exclusive use of the Employer's Agent and his staff. The Contractor must provide two suitable office desks with lockable drawers, four office chairs, two "Barhold" or similar wall-mounted racks with 6 clamps suitable for hanging A0 sized drawings, electric lighting, split air-conditioning unit (minimum 18 000 BTU for each unit), one plug per office (15 A each), one kettle, one 100 ℓ (minimum) fridge, a lockable plan cupboard in the office and windows fitted with blinds, burglar bars and fly screens over the openings, for the exclusive use of the Employer, Employer's Agent and assistant. A concrete floor will be permitted for the office provided that it is covered with linoleum. The roof and walls must be insulated.

The Employer, the Employer's Agent and assistant shall be allowed free use of all the Contractor's site

facilities.

The Employer, the Employer's Agent 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 Contractor shall arrange for the offices and facilities to be cleaned daily.

(ii) Carports

Two carports (6 m x 3 m 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 and the roof shall be impermeable.

(iii) Site meeting venue

The Contractor shall provide within his own site establishment facilities, a suitably furnished office or other venue capable of comfortably accommodating a minimum of fifteen (15) persons at site meetings. This is to include a large boardroom table with chairs, capable of seating these persons at site meetings. The table is to be large enough to accommodate these persons and also to display A1 sized drawings. In addition, one tea set comprising fifteen cups and saucers, fifteen teaspoons, two teapots, one sugar bowl and one milk jug shall be provided for use at these site meetings. The Employer's Agent shall be allowed free use of such venue for conducting any other meetings concerning the Contract at all reasonable times.

(iv) Contract nameboards

The Contractor shall provide, erect and maintain two (2) contract nameboards at such positions and locations directed by the Employer's Agent, which nameboards shall, unless otherwise specified elsewhere in the Contract, comply with the recommendations for the standard board of the Consulting Engineers South Africa of, with regard to size, painting, decorating and detail, and the requirements described hereunder. A typical detail drawing will be provided.

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 109.

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

(v) Survey equipment and assistants

- <u>Survey equipment</u>

  The Contractor shall, for the duration of the Contract, provide the following survey equipment for the use of the Employer's Agent and his staff:
  - 1 x 5 metre tape (Stallion or equivalent);
  - 1 x 1 metre spirit level;
  - 1 x 100 metre Stilon tape measure, with calibration certificate.

  Whenever reasonably required by the Employer's Agent, the Contractor shall make available to the Employer's Agent 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 ± 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 48 hours after notification by the Employer's Agent staff.

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

- Survey assistants

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

(vi) 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 Employer's Agent and his staff:

Cellular Telephones

The Contractor shall provide one cellular telephone and associated service contracts from a reputable cellular service provider. The Contractor shall further insure the cellular phones against loss or damage from whatever cause arising, and shall ensure that all cellular phone accounts are promptly paid on the dates of payment. The Contractor shall further, at its own cost, ensure the prompt repair of all cellular phones provided under this clause, when reasonably required by the Employer's Agent.

The Contractor shall, on submission and approval of an itemized statement by the Employer's Agent, be reimbursed only the cost of the Employer's Agent's cellular telephone calls.

(vii) Computer facilities

The Contractor shall, for the duration of the Contract at his own expense, provide the computer equipment together with the software specified hereunder, for the exclusive use of the Employer's Agent and his staff:

- 1 x Laptop computer
- 1 x Colour Printer with Scanner (including A3 and double sided printing capability) with WIFI/bluetooth connectivity functionality

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 computer shall comply with the following minimum specifications:

- INTEL Core i5 3360M (2.80 GHZ) with NVIDIA graphics
- 15.6"HD Widescreen
- Quadro NVS
- 8 Gig RAM
- 8 x DVD +/- RW Drive
- 3G card included (3G card-compatible)
- Carrying case included
- 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 licence agreements and disks shall be provided to the Employer's Agent for safekeeping:

(a) Microsoft Windows 10
(b) MS-Office Professional (2018)
(c) Internet connection with 2GB data per month package (3G)

All computer equipment provided shall be insured by the Contractor and 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 48 hours after notification by the Employer's Agent staff.
The computer equipment will revert to the Employer at the end of the Contract.

(viii) Electricity Supply for the Employer's Agent

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

The Contractor shall be liable for and pay to the Employer's Agent on demand, all costs which the Employer's Agent may incur in the repair or replacement of any electrical equipment provided by the Employer's Agent 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 its liabilities.

Other facilities and services

(ix) 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 necessaries 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 Employer's Agent, 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 Employer's Agent, 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 Employer's Agent, 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.

All water usage must be metered and reported at site meetings. The water supply is not guaranteed and no claims regarding insufficient supply of water will be considered. The contractor shall be held liable for any wastage of water due to negligence. Water usage will be charged for at the standard applicable tariff.

(x) 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.

(xi) Provision of Services, Metering and Reporting of Consumption

No separate payment will be made for the distribution and consumption of water and electricity, the cost of which will be deemed to be included in the tendered rates.

The Contractor must promptly provide the required services for the Employer's Agent not later than 21 days after the commencement date of the contract. In failing to do so, the Employer's Agent may arrange for these services directly. The cost of arranging, maintaining and providing of such facilities arranged by the Employer's Agent due to failure by the Contractor will be deducted from payments due to the Contractor.

The contractor shall pay a spot fine of R750.00 per service per occasion for failing to meter electricity and water consumption. The spot fine will be enforced by the Employer's Agent and will be deducted from

payments due to the contractor. The fine is payable whether the contractor is obliged to pay for services or not.

(xii) 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.

C3.4.4 Permits and Wayleaves

The Contractor shall be responsible for obtaining and renewing 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.

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.

C3.4.5 Site Maintenance

During the progress of the work and upon its completion, the site of the works shall be kept and left in a clean and orderly condition. The contractor shall at all times store materials and equipment for which he is responsible in an orderly manner and shall keep the site free from debris and obstruction.

Public roads affected by construction activities, shall be cleaned on a daily basis by means of suitable and appropriate techniques and equipment. Due care and preventative measures must be taken by the Contractor to prevent material falling or accumulating on roads and any ingress of materials into the storm water system. No additional payment will be made for maintaining the roads and storm water system in a clean and acceptable condition. The Contractor shall be held liable for any costs incurred resulting from the Contractor not complying with this requirement and such costs shall be deducted from payments due to the Contractor.

C3.4.6 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 tests are specified in, or reasonably to be inferred from the Contract, as to be taken into consideration by the Employer's Agent in deciding on whether the quality of materials utilised and workmanship achieved by the Contractor complies with the requirements of the specifications. The foregoing shall apply irrespective of whether the said testing is indicated in the specifications as to be carried out by the Employer's Agent 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 and arranging the test results in an orderly manner and indicating on a drawing the various test positions. The Contractor shall promptly provide the Employer's Agent 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 Sub-clause 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.

C3.4.7 Additional testing required by the Employer's Agent

In addition to the provisions of Sub-clause C3.4.6, the Employer's Agent 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 Sub-clause C3.4.6, at such times and at such locations in the Works as the

Employer's Agent shall prescribe. The Contractor shall promptly and without delay, arrange with the independent laboratory for the carrying out of all such additional testing as required by the Employer's Agent and copies of the test results shall be promptly provided to the Employer's Agent in an acceptable format and the test positions shall be indicated by the Contractor on a drawing.

C3.4.8 Cost of Testing and record keeping

The Contractor shall record all test results in tabular form in Excel which shall include a unique reference number, description of test, requirements/specified minimum, actual test result, date of test, position of test and Fail/Pass. Should a test indicate a failure the table shall include a reference to a further test of the rework indicating an acceptable test result (Pass).

The Contractor shall in addition on a continuous basis update a separate set of as built drawing(s) with all the test results. An updated table and drawing must be submitted the Employer's Agent on a monthly basis for approval. All actual test results shall also be submitted to the Employer's Agent (apart from the copy forwarded on receipt from the laboratory) with the unique reference number marked on the top right corner.

(a) Tests in Terms of Sub-clause C3.4.6

The costs of all testing carried out by the independent laboratory in accordance with the requirements of Sub-clause C3.4.6 above shall be born 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 Schedule 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 Sub-clause C3.4.6.

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.

Should the Contractor fail to timeously arrange or undertake the required test or fail to timeously present the test results and drawing with test positions, the Employer's Agent may proceed with arranging the testing and all costs related to the arrangement of the tests, the cost of testing and any other associated costs will be deducted from payments due to the Contractor.

(b) Additional Tests required by the Employer's Agent

The costs of any additional tests required by the Employer's Agent in terms of Sub-clause C3.4.7 shall be reimbursed to the Contractor against substitution of the Provisional Sum allowed therefore in the Schedule of Quantities; provided always that the costs of any such additional tests ordered by the Employer's Agent, the results of which indicate that the quality of the materials utilised and/or the standard of workmanship achieved is not in accordance with the specifications, shall not be reimbursable to the Contractor.

C3.4.9 Subcontractors

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

The Employer's Agent will not liaise directly with any subcontractors nor will he issue instructions concerning the subcontract works directly to any subcontractor.

All matters arising out of the subcontract agreements shall be dealt with directly between the Contractor and the subcontractors and the Employer's Agent will not become involved.

C3.4.10 Existing Services

Before the Contractor commences operations, he must discuss with and have the approval of the Employer, authority or owner concerned regarding the method he proposes to use for relocating or safe-guarding any services and existing works he may encounter during construction.

The positions of existing services shown on the Drawings are given in good faith and no guarantee can be given that:

(a) these services actually are in the approximate positions indicated.
(b) that these are the only services in the vicinity, and
(c) that the nature and description of these services are correct.

The Contractor shall be responsible to locate and safeguard any existing service or works he may encounter during construction and shall obtain clearance from the Employer, authority and the Employer's Agent before commencing work in the proximity of existing services or works.

The Contractor shall be responsible for any damage to such existing services and works in the execution of this contract and shall reimburse the Employer, authority or the owner concerned for any repairs required and for damages.

The Contractor shall be responsible for immediately notifying the Employer's Agent and the authorities concerned regarding any damage caused to public services and existing works.

Any alteration to public services shall be carried out by the Authority concerned unless the Contractor is instructed otherwise.

The Contractor shall provide the necessary assistance during any operations necessary in connection with the removal, alteration or safe-guarding of any public service.

C3.4.11 Access to And Construction in Restricted Areas

Working space and access to working areas are sometimes restricted. The construction method used in these restricted areas and accessing these areas largely depends on the Contractor's Equipment. 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 accessing and working in restricted areas. No extra payment nor any claim for payment due to these difficulties will be considered.

C3.4.12 Drawings

The reduced drawings that form part of the tender documents shall be used for tender purposes only.

The Contractor will be supplied with 3 sets of paper prints to scale of each of the drawings required for construction purposes. These copies are issued free of charge and the Contractor shall make any additional copies he may require at his own cost.

C3.4.12.1 Figured dimensions to be used

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 Employer's Agent. The Employer's Agent will, on the request of the Contractor in accordance with the provisions of clause 5.9 of the Conditions of Contract, provide such dimensions as may have been omitted from the Drawings.

C3.4.12.2 Drawings and As-Built / Record Drawings

The Contractor shall ensure that accurate as-built records and drawings are kept of all infrastructure installed, crossed, discovered or relocated 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. Levels of all services shall also be given. In addition the levels, coordinates, direction, size and type of existing services crossed or exposed must be recorded by the Contractor and be indicated on the as-built drawings. A marked-up set of drawings shall also be kept and updated by the Contractor on at least a weekly basis. This information shall be supplied to the Employer's Agent Representative on a regular basis in accordance with the Employer's Agent's requirements. Electrical services shall be indicated in red, water pipes in blue, sewers in green, storm water services in brown, Telkom services in orange, etc.

Any information in the possession of the Contractor, which the Employer's Agent requires to complete the record drawings shall be supplied to the Employer's Agent Representative before a Certificate of Practical Completion will be issued.

Should the Contractor fail to provide the information timeously, the Employer's Agent may arrange for additional surveys, exploratory holes, marking up of drawings, etc. to obtain and record the necessary information. All costs to obtain and record the information will be deducted from payments due to the Contractor.

C3.4.13 Information Supplied by The Employer

Certain information contained in these contract documents, or provided separately, is being offered in good faith. However, in the circumstances pertaining to the type of information supplied, no guarantee can be given that all the information is necessarily correct or representative. More specifically this applies to all material surveys and reports and similar information, the accuracy of which is necessarily subject to the limitation of testing, sampling, the natural variation of material or formations being investigated and the measure of confidence with which conclusions can be drawn from any investigations carried out. It also applies to the positions of existing services as indicated on the drawings.

The employer accepts no liability for the correctness or otherwise of the information supplied or for any resulting damages, whether direct or consequential, should it prove during the course of the contract that the information supplied is either incorrect or not representative. Any reliance placed by the tenderer on this information shall be at his own risk.

C3.4.14 Spoil Material

No indiscriminate spoiling of material will be allowed. All surplus material shall be spoiled at a site provided by the contractor, unless specifically scheduled otherwise in the schedule of quantities. The Contractor is responsible for determining which registered sites he/she would like to use.

All costs pertaining to removal and dumping of spoil are to be included in the Contractor's rates for the construction of the works.

The Employer will not accept spoiling on a third party property, regardless of arrangements concluded upon between the Contractor and such third party property owner, as spoiling needs to conform with legislative environmental requirements and short term arrangements do not see such requirements being met.

C3.4.15 Non-Working Days

The contractor shall not work on Sundays or on the following statutory Public Holidays: New Year's Day, Human Rights Day, Good Friday, Family Day, Freedom Day, Workers' Day, Youth Day, National Women's' Day, Heritage Day, Day of Reconciliation, Christmas Day and Day of Goodwill.

C3.4.16 Samples

The contractor shall at his own cost, supply all samples that may be required. Material or work not conforming to the approved samples shall be rejected. The Employer's Agent reserves to himself the right to submit samples to any tests to ensure that the material represented by the sample conforms to the requirements of the specifications.

C3.4.17 Manufacturer's Instructions

The recommendations of the manufacturers of patented materials must be strictly adhered to regarding the use, mixing, application, fastening, etc. thereof except when otherwise instructed in writing by the Employer's Agent.

C3.4.18 Proprietary Materials

Where proprietary materials are specified it is to indicate the quality or type of materials or articles required, and where the terms "or other approved" or "or approved equivalent" are used in connection with proprietary materials or articles, it is to be understood that the approval shall be at the sole discretion of the Employer's Agent.

C3.4.19 Notices, Signs, Barricades and Advertisements

The contractor shall erect the necessary signs, notices and barricades for the duration of the contract in order to safeguard both the works and the public.

Notices, signs and barricades as well as advertisements may be used only upon approval by the Employer's Agent, and the contractor shall be responsible for their supply, erection, maintenance and ultimate removal and shall make provision for this in his tendered rates.

The Employer's Agent shall have the right to have any sign, notice or advertisement moved to another position or to have it removed from the site of the works, should it in any way prove to be unsatisfactory, inconvenient or dangerous to the general public.

The standard name board of the South African Association of Consulting Engineers is specified, the cost of which shall be included in the rates tendered for items PSA 8.3.1 and 8.3.2 under section 1200 A of the schedule of quantities.

C3.4.20 Setting Out of Work

Reference and level beacons will be shown to the Contractor by the Employer's Agent at the commencement of the Contract and the Contractor will be responsible for transferring the datum to the Site of Works.

The Contractor shall check the condition and accuracy of all reference and level beacons and satisfy himself that they have not been disturbed and are true with regard to position and level. A beacon that has been disturbed shall not be used until its true position and level have been re-established and the new values have been certified by the Employer's Agent. The Contractor shall thereafter be held entirely responsible for the protection of all reference and level beacons.

The Contractor shall employ a capable surveyor to set out the Works to the required lines and levels. The Employer's Agent shall be informed immediately should any discrepancy be discovered between the levels or dimensions obtained by the Contractor and those shown on the drawings.

Where a beacon is likely to be disturbed during construction operations, the Contractor shall establish suitable reference beacons at locations where they will not be disturbed during construction. No beacons shall be covered over, disturbed or destroyed before accurate reference beacons have been established and details of the positions and levels of such beacons have been submitted to the Employer's Agent. The Contractor's reference beacons shall be of at least the same accuracy and sturdiness of construction as the existing beacons.

The Contractor shall submit the method of setting out he proposes to employ to the Employer's Agent. Accurate control off-line and level shall be provided by the Contractor at all stages of construction.

Work set out by the Contractor may be checked by the Employer's Agent and any errors found shall be rectified by the Contractor at his own expense. The Contractor shall supply any instrument, equipment, material and labour required by the Employer's Agent for this survey work. Any assistance, including checking given to the Contractor by the Employer's Agent or any setting out done by the Employer's Agent for Contractor shall not be held as relieving the Contractor of his responsibility for the accurate construction of the Works.

The Contractor's survey instruments and survey equipment shall be suitable for the accurate setting out of the Works and shall be subject to the approval of the Employer's Agent. They shall furthermore be checked and correctly adjusted by the authorized agents before the commencement of the contract and subsequently when required by the Employer's Agent and when otherwise necessary.

When required the Contractor shall, at his own expense, provide one labourer to assist the Employer's Agent. The Employer's Agent shall have the sole right of approving of such a labourer.

Survey work shall not be measured and paid for directly and compensation for the work involved in setting out shall be deemed to be covered by the rates tendered and paid for the various items of work included under the contract.

The Contractor must verify with the Employer's Agent prior to construction whether the coordinates shown on the drawings have reference to the Clarke 1880 or WGS 84 system.

C3.4.21 Control of Noise and Dust

All noise and dust to be kept to the lowest level possible.

C3.4.22 Source of Construction Material

The location and procurement of all imported material will be the responsibility of the Contractor. Rates tendered for all imported material shall include haulage. All manufactured materials shall carry the SABS mark.

C3.4.23 Freehaul

All tendered rates shall allow for all transport costs. The free haul distance for the purpose of this Contract will be unlimited unless otherwise indicated in the schedule of quantities.

C3.4.24 Drainage of Excavations and Trenches and Planning of Such Activities

The Contractor is responsible for the drainage of excavations and trenches and shall therefore provide, operate and maintain the pumps and other equipment required for this purpose. Drainage of trenches and excavations will not be measured and paid for separately and the cost thereof will be deemed to be covered by the prices tendered and paid for the various items of work included under this contract.

During the wet winter months, the extent of open trenches shall be limited to reduce the risk of any delays. The Contractor shall be responsible for planning the work accordingly.

The Contractor shall amend his preferred working method by for example opening up and immediately closing up of trenches once the short section of pipe is laid to prevent any material from becoming unsuitable or saturated.

Indiscriminate working methods, lack of proper planning and protection of the works during the winter months resulting in a delay shall not be considered a circumstance, event or act on which a claim may be based and such claim shall not be payable by the Employer.

No additional payment will be made for altering the working method.

C3.4.25 Safety of Trenches

The strutting and shoring of excavated faces, if necessary, will be the responsibility of the Contractor and will not

be measured and paid for separately. The Contractor, however, will be responsible to maintain and to keep all excavated faces in a safe condition to protect the Works and workers and to prevent delays caused by slope failures.

No trenches may be left open during the Contractor's holiday during December and January. All trenches which have been excavated but which have not been finally backfilled and compacted at the commencement of the said holiday period shall be temporarily fully backfilled and compacted to a standard which will:

(a) prevent damage occurring to the trenches or any other part of the Works;

(b) prevent damage to or physical loss of the property of any person;

(c) eliminate the risk of injury to any person;

during the said period.

All costs involved in the temporary backfilling and compaction of such trenches and the subsequent re-opening of the trenches after the holiday period shall be for the Contractor's account.

C3.4.26 Transport of Material

All costs of transporting material, including overhaul, shall be included in the applicable tendered rates. All references in the specifications to transport, overhaul and haul distances shall be deleted irrespective of whether or not the deletion is included in these project specifications.

C3.4.27 Security Control

The Contractor will be responsible for the safety and security of his personnel and the site in general all times. All laws, rules and regulations shall be strictly followed in this regard and all the necessary precautions and measures shall be taken to ensure the safety of personnel, the public and equipment. The safeguarding of excavations in particular shall be a priority.

The Contractor shall provide security watchmen for this contract, as he deems fit at no extra cost for the Employer.

C3.4.28 Testing of Water Pipes or Sewers

The Contractor shall carry out all control testing of materials and workmanship. The Employer's Agent must be notified well in advance of all final tests to be undertaken. No portion of pipe may be finally covered before the proper prescribed tests have been done and approved in writing by the Employer's Agent.

All test results must be tabulated and test sections described properly by the Contractor and must be submitted timeously by the Contractor. All test positions and pipe sections tested shall be indicated on a drawing provided by the Contractor.

C3.4.29 Materials Off Site

Should the Contractor claim payment of a portion of the value of some or all of the pipes, valves or any other material held in off-site stores the items concerned must be clearly marked as the property of the Employer. A certificate to this effect and confirmation that the relevant items have been paid for shall accompany his claim detailing the items and serial numbers as well as the street address of the store where the plant and equipment have been insured in terms of the general Conditions of Contract. The Contractor shall in writing provide documentary proof from the insurance company that these items are fully covered by the insurance policy concerned while the plant and equipment are stored away from the Site (street address of store to be stated).

C3.4.30 Photographs

The Employer, Employer's Agent and any of their agents shall at all times be allowed to photograph or film (video) any activities on site and the use of such shall be unlimited.

C3.4.31 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 burrow pits shall be adhered to.

C3.4.32 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, 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.

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

C3.4.33 Plant and Materials

C3.4.33.1 Plant and materials supplied by the Employer

The Employer shall not supply any plant or materials.

C3.4.33.2 Materials, samples and shop drawings

(a) Samples

Materials or work which does not conform to the approved samples submitted in terms of Subclause 7.4.1 of the Conditions of Contract will be rejected. The Employer's Agent 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 Employer's Agent, 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 Subclause 7.4.4 of the Conditions of Contract, be for the Contractor's account.

C3.4.34 Construction Equipment

C3.4.34.1 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 Regulations 2014.

C3.4.34.2 Equipment provided by the Employer

The Employer shall supply no plant, material or equipment.

C3.4.35 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 Employer's Agent of any breach of such rules. The site shall be managed and used for its intended purpose.

C3.4.36 Other Contractors

There will be no other Contractors on site.

C3.4.37 Construction Restrictions, Demolition and Diversion Works

As part of the civil construction process, the Contract will be subject to construction restrictions. The aforementioned will need to be considered for programming and planning requirements as stipulated.

The following restrictions will impact the construction process and the Contractor's proposed programme:

- None

C3.4.38 Access to Properties

The Contractor shall organize the work in such a manner as to cause the least possible inconvenience to the

public and to the property owners adjacent to or affected by the work included in this contract.

The Contractor shall provide access to the public and to the property owners and maintain the necessary access for the duration of the contract.

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

The Contractor may, with the approval of the Employer's Agent, make arrangements with the occupiers of the affected erven and properties to close off a portion of a street, road, footpath or entrance temporarily, provided the contractor duly notifies the occupiers of the intended closure and its probable duration and shall, as punctually as possible, re-open the route at the prescribed time. Where possible, the road shall be made safe and re-opened to traffic overnight. Any such closure shall be made by arrangement between the Contractor and the occupiers and shall not absolve the Contractor from his obligations under the contract to provide access at all times. The Employer's Agent shall be informed of such arrangements prior to implementation and it shall be subject to the approval by the Employer's Agent. Barricades, traffic signs and drums shall be provided by the Contractor to suit the specific conditions.

Note: No payment items have been scheduled separately for any work required to ensure compliance with the above-mentioned. The Contractor must note that the rates and prices tendered shall be deemed to include full compensation for any additional work required to construct the works as specified and to maintain access, and that no extra payment will be made, nor will any claim for payment for these difficulties be considered.

The arrangements made between the affected parties and the Contractor shall be confirmed in writing by the Contractor and submitted to the Employer's Agent for written approval by the Employer's Agent.

C3.4.39 Contractor's Vehicles

All equipment and vehicles used by the contractor shall be roadworthy at all times and all drivers and operators shall be in possession of valid drivers' licenses.

C3.4.40 Employment of Local Labour

It is the intention that the project, of which this contract is a part, should make the maximum possible use of the local labour force which is at present under employed.

To this end the Contractor is expected to limit non-local employees to key personnel only and to employ local labour on this contract.

The Contractor shall fill in Section T2.2.13: Form M: Key-Personnel and Non-Local Workers to be Employed and state how many non-local key personnel he intends to employ in the various categories. The Tenderer must also state on this form the number of local labourers he intends employing for this contract.

The numbers stated in the above-mentioned data sheet will be strictly controlled during the contract period and any increase in numbers shall be subject to the approval of the Employer.

The workforce utilized on the contract is to comprise only of local workers within the area of the jurisdiction of the client i.e. within municipal boundaries. The Employer's Agent may, at his discretion, upon receipt of a written and fully motivated application from the contractor and where he deems the circumstances so warrant, authorize in writing that non-local temporary works, not being his Key Personnel, be included in the workforce.

The Contractor shall pay to all temporary workers engaged in terms of this clause, not less than the minimum rate of remuneration as specified in the Government Gazette.

The Contractor must provide records of all labour employed including name, surname and ID number, differentiating between male, female, local or non-local key personnel, youth and handicapped on a monthly basis. This record must also indicate the total number of man-hours and total remuneration of labour. Monthly payment certificates will only be processed if they are accompanied by the completed reports.

All costs, relating to identification, acquisition, allocation, training, relieving labour of their duties, problem-solving and attending to any other matters in order that the employment of local labour proceeds smoothly, shall be included in the relevant rates.

C3.4.41 Community Liaison and Community Relations

In all dealings with the community and works employed from within the community, the Contractor shall take due cognizance of the character, culture and circumstances of the community involved and shall at all times use his best endeavours to avoid the development of disputes and to foster a spirit of cooperation and harmony towards

the project.

The Contractor shall at all times, keep the Employer's Agent fully informed on all matters affecting the Contractor and the community, and shall attend all community meetings relating to the project as may be reasonably required by the Employer's Agent. All matters concerning the community shall be discussed and where possible, resolved at such meetings.

Where any resolution of a community meeting shall be contrary to the terms and provisions of the Contract, the Contractor shall not give effect there-to without a prior written instruction from the Employer's Agent. Where the Contractor is of the opinion that any instruction of the Employer's Agent issued in terms of this clause will result in the incurring of additional costs which were not provided for in his tendered rated and/or that a delay in the progress of the works will result, he shall be entitled to submit a claim in terms of Clause 10.1 of the Conditions of Contract, provided always that the period of twenty-eight (28) days referred to in Clause 10.1.1.1 shall be reduced to five (5) normal working days in respect of all claims submitted in terms of this clause.

General:

The Community Liaison Officer (CLO) will be responsible to the Project Steering Committee (PSC), who will be involved in the appointment of the CLO. The CLO shall be a person with a good standing respect in the local community and would be selected according to the set criteria by the District Municipality. Inputs from the Ward Councilor, Ward Committee and other community structures will be instrumental in the appointment of the CLO.

The CLO is appointed for the period of physical construction, plus a period of 14 days prior to this period.
The period will end when no further work is required.

The contractor will provide office space and stationery for the CLO to carry out his / her duties.

The Contractor shall arrange and have available on site during normal working hours a cellphone for use by the CLO in carrying out his duties.

A CLO who fails in their responsibilities may be replaced in consultation with the Ward Councilor, Ward Committee and other community structures.

Duties and Responsibilities of the CLO:

- Represent the community and assist the Municipality, Contractor and the Engineer with communication between them and the community. Inform the community regarding the project, safety precautions and programme.
- Normal working hours will be from 07:00 am until 17:00.
- Assist with the relocation of people, where applicable.
- Maintain an up-to-date record of potential employees within the community and provide the contractor with copies of this information.
- Identify, screen and nominate labour from the community in accordance with the Contractor's requirements and determine, in consultation with the Contractor, the needs of local labour for employment and relevant technical training, where applicable.
- Liaise between Contractor and labour regarding wages and conditions of employment.
- Communicate daily with the Contractor on labour-related issues such as numbers and skills.
- Identify possible labour disputes, unrest, strikes, etc. in advance and assist with their resolution.
- Have a good working knowledge of the contents of the contract document regarding labour and training matters.
- Attend all meetings at which the community and/or labour is represented or discussed.
- Attend contract site meetings and report therein on community and labour issues.
- Co-ordinate and assist with obtaining information regarding the community's needs (questionnaires, etc.).
- Inform local labour of their conditions of temporary employment to ensure their availability and to inform them timeously of when they will no longer be required.
- Ensure that all labour involved in activities are fully informed of the principle of task-based work once tasks have been set.
- Attend disciplinary proceedings to ensure that hearings are fair and reasonable.
- Keep a daily written record of interviews and community liaison.
- Arrange venues for training if required.
- Assist with the training and education of the community regarding the correct usage of the services installed, where applicable.

- Any other duties that may become necessary as the works progress.

Duties and Responsibilities of the CLO:

- Communication function
    - Represent the community and assist the Municipality, Contractor and Engineer with communication between them and the community. Inform the community of the project details, safety issues and project plan.
- Attend all meetings at which the community and/or labour is represented or discussed.
- Inform employees of their temporary contract conditions to ensure their availability and to inform them timeously of when they will no longer be required on the project.
- Ensure that all temporary employees involved in activities are fully informed of the principle of the task-based work once tasks have been set.
- Availability - Be available 8 hrs per day as well as after hours when required.
- Physical Assistance - Assist with relocation of community.
- Administrative
- Maintain up to date records of potential employees for current and future projects.
- Co-ordinate and assist with obtaining information regarding needs of the community via questionnaires, etc.
- Keep a daily written record of interviews and any community liaison.
- Arrange venues for training when required.
- Complete all contractual documentation related to the employment contract of the temporary employees.
- Recruitment, Industrial Relations and Training Activities
- Identify, screen, and nominate labour in accordance with the requirements of the contract in conjunction with ward representative(s).
- Liaise between the contractor and employees regarding wages and conditions of employment.
- Communicate daily with the Contractor on labour issues, i.e. numbers and skills of the employees.
- Identify in advance potential labour disputes, unrest, strikes.
- Assist in resolving minor disputes.
- Attend contract site meetings and report on community and/or labour issues at these meetings. Be able to interpret labour relations dynamics amongst the workforce.
- Attend disciplinary hearings to ensure that hearings are fair and reasonable.
- Assist with training and education of the community regarding the correct usage of the services being installed /constructed.

PART C3: SCOPE OF WORK

C3.5: Management

PART C3.5: Management

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C3.5.1 Construction Programme and Planning

C3.5.1.1 Programme

The Contractor shall submit his programme of work to the Employer's Agent not later than 14 days after the Contractor has been notified of the acceptance of his tender and only after discussions with the Employer's Agent. The Contractor shall furthermore carefully consider the expected wet weather conditions during winter and plan the work and working methods to limit any possible standing time or delay. The Due Completion date and any "float" must be indicated by the Contractor on the programme. Should the Due Completion date not be indicated, the Due Completion date, in the opinion of the Employer's Agent, shall be accepted as correct and binding. If necessary, the Employer's Agent may instruct the Contractor to adjust his programme to suit other activities.

The Contractor shall deliver the programme to the Employer's Agent's offices and shall include:

- 2 colour paper copies
- In electronic MS Project format.

The programme shall not be in the form of a bar chart only, but shall clearly show the anticipated quantities and value of work to be performed each week.

If, during the progress of the work, the quantities of work performed per week fall below those shown on the programme, or if the sequence of operations is altered, or if the programme is deviated from in any other way, the Contractor shall, within one week of being notified by the Employer's Agent, submit a revised programme.

If the programme has to be revised by reason of the Contractor falling behind his programme, he shall produce a revised programme showing how he intends to regain lost time in order to ensure completion of the works within the time for completion as defined in clause 1.1.1.14 of the General Conditions of Contract or any granted extension of time. Any proposal to increase the tempo of work must be accompanied by positive steps to increase production by either providing more labour and equipment on site, or using the available labour and equipment in a more efficient manner.

Failure on the part of the contractor to submit or to work according to the programme or revised programmes shall be sufficient reason for the Employer's Agent to take steps as provided in clause 9.2 of the General Conditions of Contract.

The approval by the Employer's Agent of any programme shall have no contractual significance other than that the Employer's Agent will be satisfied if the work is carried out according to such programme and that the Contractor undertakes to carry out the work in accordance with the programme. It shall not limit the right of the Employer's Agent to instruct the contractor to vary the programme should circumstances make this necessary. The Contractor is also referred to clause PS 8 when drawing up his programme.

The Tenderer must make provision in his programme and tendered rates for the following constraints in working hours and working methods: (This list is not exhaustive and it is accepted that all other constraints were identified by the Contractor during the site inspection)

- All wayleaves must be obtained prior to construction.

The Contractor must submit on a monthly basis a progress report consisting of a short report on the progress, project constraint implications (Time, cost, quality, risks, resources) and progress shall be indicated on the approved programme for each activity.

The progress report must be submitted 2 Days before site meetings and must accompany payment certificates to ensure the processing of payment.

C3.5.1.2 General Allowances

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) the accommodation of public access and traffic,

(e) the provision and implementation of the health and safety plan in terms of the Construction Regulations 2014 of the Occupational Health and Safety Act, and

(f) the design, testing and approval of the concrete mixes.

C3.5.1.3 Reporting Requirements

The Contractor shall promptly submit the schedules and reports at Contract stage as requested by Employer's Agent. Updated reports must be submitted to the Employer's Agent two days before site meetings. Should the Contractor fail to provide the necessary documentation, the Employer's Agent may proceed to compile such documentation which costs will be deducted from payments due to the contractor. The report shall include the following:

- Bar chart or sloping bar chart schedule showing staff requirements by time interval and reflecting work planned by time interval.
- A monthly report showing planned progress versus actual progress giving details of how the Work will be completed in relation to the schedule.
- Daily major construction equipment report
- Daily staff report by crafts
- Procurement schedule for the procurement and receipt of materials, equipment and subcontract services by Contract and a monthly status report of all such materials and equipment
- MIG forms (approximately 5 pages) including employment details, expenditure and programme.

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 as amended.

The Contractor is referred to Part T1.2 Tender Data and the Health and Safety Specification (see Part C3.5.8 and P1 Particular Specification: Occupational Health and Safety Specifications) in this regard.

C3.5.3 Unauthorized Persons

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

C3.5.4 Management Meetings

C3.5.4.1 Technical Meetings

Technical meetings shall be held on an ad-hoc basis as required either by the Employer's Agent or the Contractor.

The Contractor shall arrange for the Contract Manager and the Construction Manager to attend these meetings and all Site meetings.

C3.5.4.2 Site Meetings

Site meetings shall be held monthly.

C3.5.4.3 Health and Safety Meetings

Health and Safety Meetings shall be held monthly.

C3.5.5 Format of Communications

Notices and other communications shall be in writing and delivered by hand with confirmation of receipt, or sent by mail or courier with confirmation of receipt, or transmitted by use of electronic transmission.

The format shall be:

(i) a paper-original signed by the Contractor's Representative, the Employer's Agent, or the authorised representative of the Employer's Agent;
or

(ii) an electronic original generated where the electronic original is transmitted by the electronic address uniquely assigned to each of such authorised representatives,

or both.

Notices and communication under this Contract shall comprise of the issue and receipt of the following:

	Type of Communication	Requirements	Pro-forma format
1	Official contractual correspondence issued under transmittal slip, which includes Claim and Dispute documentation as required by the Contractual processes.	Shall be signed by the person (Employer's Agent / Contractor's Authorised Signatory) officially appointed in terms of the Contract to be considered as official correspondence.	
2	Issue of Site Instructions (SI) in electronic format by the Employer's Agent or his representative.	All site instructions shall be in writing on the prescribed format and will not be an approved site instruction until the Employer's Agent or his representative has signed it.	
3	Variation Orders in electronic format issued by the Employer's Agent.	Will not be an approved variation order until the Employer's Agent has signed it.	
4	Requests for Information (RFI) notices submitted in electronic format by the Contractor to the Employer's Agent or his representative, in a pre-determined format.	RFI's shall be submitted in terms of GCC 2015 Clause 5.9.3. RFI's shall be used: • When further instructions, drawings, information, or clarifications are required. • When a substitution or alternative or alteration is proposed. • When a problem or deficiency needs to be identified.	Annexure A (end of Section C3.5)
5	Minutes of Meetings.	Signed off by the attending organisations' representatives.	

Where a Notice or other communication is to be delivered, given, issued, provided, sent, submitted or transmitted, it shall have effect when it is received (or deemed to have been received) at the recipient's current address. An electronically transmitted Notice or other communication is deemed to have been received on the day after transmission, provided no non-delivery notification was received by the sender.

NOTE: Random e-mail correspondence, text and whatsapp messages generated and distributed does not constitute official correspondence and communication under this Contract.

C3.5.6 Monthly Statements, Payment Certificates and Electronic Payments

The Contractor shall provide his banking details to enable electronic payments to be made for all payment certificates.

The statement to be submitted by the Contractor in terms of Clause 6.10 of the Conditions of Contract shall be prepared by the Contractor at its own cost, strictly in accordance with the standard payment certificate format prescribed by the Employer's Agent in digital electronic computer format. The Contractor shall, together with a copy of the digital electronic computer file of the statement, submit TWO (2) A4 sized paper copies of the statement. The Contractor must submit the payment certificate in Excel or Bill format as instructed by the Employer's Agent. All supporting calculations of each quantity must be submitted with each payment certificate, sufficiently broken down into various portions of the work to enable the Employer's Agent to verify the quantities.

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

The Contractor shall, at its own cost, make the said adjustments to the statement and return to the Employer's Agent within THREE (3) normal working days from the date on which the Employer's Agent communicated to the Contractor the adjustments which requires, FIVE (5) sets of A4-sized paper copies of such adjusted statement, together with a copy of the electronic digital computer file thereof.

Any delay by the Contractor in making the said adjustments and submitting to the Employer's Agent the requisite copies of the adjusted statement for the purposes of the Employer's Agent's payment certificate will be added to the times allowed in terms of Sub-clause 6.10.4 of the Conditions of Contract to the Employer's Agent for submission to the Employer and the Contractor of the signed payment certificate and to the period in which the Employer is required to make payment to the Contractor.

C3.5.7 Key Personnel

The Contractor shall provide a schedule of key personnel, with contact particulars and experience.

C3.5.8 Health and Safety

C3.5.8.1 Health and safety requirements and procedures

a) In terms of the provisions of Section 37(2) of the Occupational Health and Safety Amendment Act, 1993 (Act 85 of 1993), hereinafter referred to as the Act, the following arrangements and procedures shall apply between the Contractor and the Employer to ensure compliance by the Contractor with the provisions of the Act:

(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 Employer's Agent 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 Employer's Agent, of such investigation, complaint or criminal charge.

(vi) The Contractor shall furthermore, in compliance with Construction 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 Regulations 2014, and prepare a suitably and sufficiently documented health and safety plan as contemplated in regulation 7(1)(a) of the Construction Regulations 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 will be made under PSA 8.12 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.

The cost pertaining to this Health & Safety Plan is to be included under Item C3.5.8.1.

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.

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 gasses
- 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 aluminium 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 per

- cent 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 tool-box 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. during delivery, installation, testing and commissioning).

The cost pertaining to this Health & Safety specialist is to be included under Item C3.5.8.1.

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 Employer's Agent 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 summarising 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 Employer's Agent shall impose a fine of R5000.00 on the Contractor, in each instance.

The cost pertaining to these Health & Safety reports is to be included under Item C3.5.8.1.

C3.5.9 Environmental Management

The Contractor will be responsible for managing his activities so that damage to the environment is minimised, as per the specifications contained within the Particular Specification attached in Part C3.6.3.

C3.5.10 Forms for Contract Administration

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

- Project Labour Report
- HDI Contract Participation Expenditure Report
- Targeted Labour Contract Participation Expenditure Report

The Project Labour Report must include details of all labour (including that of sub-contractors) employed on this contract in the month in question.

ANNEXURE A

PRO-FORMA REQUEST FOR INFORMATION (RFI) FORMAT

REQUEST FOR INFORMATION

PROJECT: ..... RFI ref.no.

REQUEST DATE: .....

FROM: ..... **TO:** .....

COMPANY: ..... **COMPANY:** .....

Involved Disciplines		Reason for Request	Action Required
☐ Architect	☐ Fire Consultant	☐ Insufficient information	☐ Clarification
☐ Structural Engineer	☐ Telecommunication & Data	☐ Incorrect Information	☐ Direction
☐ Civil Engineer	☐ Project Manager	☐ Engineering Conflict	☐ Approval
☐ Electrical Engineer	☐ PQS	☐ Alternative Proposal	☐ Other: .....
☐ Mechanical Engineer		☐ Other:	
☐ Other:			

Probable Effect

☐ Additional time requested	☐ Decrease in time	☐ No time impact	☐ To be determined
☐ Additional Cost Impact	☐ Reduced Cost Impact	☐ No Cost Impact	☐ To be determined
☐ Other (specify):			

QUESTIONS / CONCERNS *(Requester)*

Detailed description of request:

Suggestion:

Respond not later than: .....

RESPONSE

☐ Approved ☐ Not approved ☐ Issue revised drawing(s) ☐ Issue Method Statement

☐ Cost Implication approved ☐ Cost Implication not approved ☐ Other: .....

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

PART C3: SCOPE OF WORK

C3.6: SPECIFICATIONS

PART C3.6: Specifications

CONTENTS

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PART C3: SCOPE OF WORK

C3.6.1: STANDARD SPECIFICATIONS

C3.6.1: **Standard Specifications**

APPLICABLE STANDARDIZED SPECIFICATIONS

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

SABS 1200	**A**	**:**	**General (1986)**
SABS 1200	**AB**	**:**	**Engineer's office**
SABS 1200	**C**	**:**	**Site clearance (1980) (As amended 1980)**
SABS 1200	**D**	**:**	**Earthworks (1988) (As amended 1990)**
SABS 1200	**DB**	**:**	**Earthworks (Pipe Trenches) (1989)**
SABS 1200	**DM**	**:**	**Earthworks (Roads, Subgrade)**
SABS 1200	**G**	**:**	**Concrete (Structural)**
SABS 1200	**LB**	**:**	**Bedding (pipes) (1983)**
SABS 1200	**LD**	**:**	**Sewers (1982)**
SABS 1200	**LE**	**:**	**Storm water drainage**
SABS 1200	**LF**	**:**	**Erf connections (water)**
SABS 1200	**M**	**:**	**Roads (General)**
SABS 1200	**ME**	**:**	**Subbase (1981)**
SABS 1200	**MF**	**:**	**Base (1981)**
SABS 1200	**MG**	**:**	**Bituminous Surface Treatment**
SABS 1200	**MH**	**:**	**Asphalt Base and Surfacing**

C3.6.2

VARIATIONS AND ADDITIONS TO THE SANS STANDARIZED SPECIFICATIONS

C3.6.2: VARIATIONS AND ADDITIONS TO THE SANS STANDARIZED SPECIFICATIONS

Each clause with the prefix PS shall refer to the congruent clause in the appropriate section of the standardised or particular specification. Such clause shall either substitute, or supplement, or amend the clause with the same number. Where there is no such congruent clause in the standardised or particular specification, the PS clause shall be a new clause in the project specification. Any clause that is referred to in the standardised specification will also include the appropriate project specification.

STATUS

In the event of any discrepancy between the project specifications and a part or parts of the SANS 1200 Standardized Specifications, the schedule of quantities or the drawings, the project specifications shall take precedence.

The following variations and additions to the following SANS 1200 standardized specifications listed in C3.6.1 are given as follows:

SABS 1200	**A**	**:**	**General (1986)**
SABS 1200	**AB**	**:**	**Engineer's office**
SABS 1200	**C**	**:**	**Site clearance (1980) (As amended 1980)**
SABS 1200	**D**	**:**	**Earthworks (1988) (As amended 1990)**
SABS 1200	**DB**	**:**	**Earthworks (Pipe Trenches) (1989)**
SABS 1200	**DM**	**:**	**Earthworks (Roads, Subgrade)**
SABS 1200	**G**	**:**	**Concrete (Structural)**
SABS 1200	**LB**	**:**	**Bedding (pipes) (1983)**
SABS 1200	**LD**	**:**	**Sewers (1982)**
SABS 1200	**LE**	**:**	**Storm water drainage**
SABS 1200	**LF**	**:**	**Erf connections (water)**
SABS 1200	**M**	**:**	**Roads (General)**
SABS 1200	**ME**	**:**	**Subbase (1981)**
SABS 1200	**MF**	**:**	**Base (1981)**
SABS 1200	**MG**	**:**	**Bituminous Surface Treatment**
SABS 1200	**MH**	**:**	**Asphalt Base and Surfacing**

PSA **GENERAL (1986)**

PSA 1 **SCOPE**

Replace subclause 1.1 with the following:

"1.1 This specification covers requirements, principles and responsibilities of a general nature which are normally applicable to all civil engineering contracts as well as the requirements for the contractor's establishment on site."

PSA 2 **INTERPRETATIONS**

PSA 2.3 **Definitions**

In the opening phrase between the words “specification” and “the following”, insert the words “the definitions given in the conditions of contract and “

(a) General

Add the following definitions:

“Employer’s Agent: All references in the SANS specifications referring to the Engineer shall also be deemed to refer to the Employer’s Agent in terms of the General Conditions of Contract.

General conditions: The general conditions of contract specified for use with this contract and 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."

(c) Measurement and payment

Replace the definitions for fixed charge and time-related charge with the following:

"Fixed charge: A charge that is not subject to adjustment on account of variation in the value of the contract amount or the contract time of completion.

Time-related charge: A charge, the amount of which is varied in accordance with the time for completion of the work as adjusted 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."

PSA 3 **MATERIALS**

PSA 3.1 **Quality**

Add the following:

"All manufactured materials supplied shall be new materials unless the contrary is specified. All materials specified in accordance with SABS specifications shall bear the SABS mark, whether so specified or not. Copies of SABS Certificates of all materials used must be submitted to the Employer’s Agent."

Add the following:
"The Contractor must provide the Employer’s Agent with at least 48 hours notice prior to control testing being required. Furthermore, the contractor must make provision in his programme for the undertaking, and calculation of results, of such testing. Construction of layer works over areas for which test results are not available will be undertaken at the Contractors own risk."

Add the following subclause(s)

"PSA 3.3 **Ordering of Materials**

The quantities set out in the schedule of quantities have been determined from calculations based on data available at the time and should therefore be considered to be only approximate quantities. The Contractor shall therefore, verify the quantities before ordering materials of any kind. No liability or responsibility whatsoever shall be attached to the Employer for materials ordered by the Contractor except if they have been ordered in accordance with written confirmation issued by the Employer's Agent.

PSA 4 **PLANT**

Replace the heading of PSA 4 with:

"PSA 4 Construction Equipment".

PSA 4.1 **Silencing of Plant**

Replace the heading of "PSA 4.1 Silencing of plant" with:

"PSA 4.1 Silencing of Construction Equipment".

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 Construction Equipment 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 first paragraph:

"The Contractor's construction camp shall be fenced off and shall contain all offices, stores, workshops, testing laboratories, toilet facilities, etc. The camp shall always be kept in a neat and tidy condition.

No personnel will be allowed to reside on the site. Only night-watchmen may be on the site after hours."
Add the following to the second paragraph:

"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."

"PSA 4.3 **Site Security**

The area within the area used by the Contractor for the establishment of his camp site may be subject to a security risk. 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 5.1.2 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 Employer’s Agent 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 those that 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 Employer’s Agent, 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. This, with the provision always that the Contractor shall not be 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 Employer’s Agent, were disturbed, damaged or destroyed by others beyond his control.”

PSA 5.3 **Protection of Existing 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 this subclause 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 Employer’s Agent, 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 Employer’s Agent 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 the 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 Employer’s Agent, 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 Sub-clauses 4.4 and 5.1.2.2 of SABS 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 Employer's Agent 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 Employer's Agent 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 Employer's Agent, 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 Employer's Agent 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 exercise all the necessary care to prevent damage to known services during construction operations. Major excavating equipment and other plant shall not be operated in dangerously close proximity of these services. Where necessary, excavation in close proximity of these services shall be carefully carried out by means of suitable hand tools, excluding picks wherever their use could cause damage to the services.

Services left exposed shall be suitably protected from damage.

PSA 5.4.3 Alterations and repairs to existing services

Unless the contrary is clearly specified or ordered, the contractor shall not carry out any alterations to existing services. Where this may be necessary, the contractor shall inform the Employer's Agent, 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.

Where existing services are damaged by the contractor, he shall immediately inform the Employer's Agent, or when this is not possible, the relevant authority, and shall obtain instructions as to who should carry out repairs. In urgent cases the contractor shall take all necessary steps to minimise damage to and the interruption of the service. No repairs shall be attempted to telecommunication cables or electric power lines and cables.

No liability for damages arising from any delay in having such alterations or repairs effected will be accepted by the employer. The contractor shall provide all reasonable opportunity, access and assistance to persons doing alterations or repairs to existing services."

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:

(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) and Construction Regulations 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 Employer's Agent 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 Employer's Agent Representative may reasonably require.

Where any such investigations reveal, or where it comes to the Employer's Agent'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 Employer's Agent shall, in accordance with the provisions of Clause 5.11 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 Employer's Agent, 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 Employer's Agent 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 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 Employer's Agent to act in terms of Sub-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.

Add the following subclause:

"PSA 5.9 **Site Meetings**

The Contractor or its authorised agent will be required to attend regular site meetings, which shall normally be held twice a month on dates and at times determined by the Employer's Agent, but in any case whenever reasonably required by the Employer's Agent. Unless otherwise indicated in the Contract or instructed by the Employer's Agent, 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 6 **TOLERANCES**

Add the following subclause:

PSA 6.2 **Degrees of Accuracy**

Add to the subclause:

"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."

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

"PSA 6.4 **General**

No guarantee is given that the full specified tolerances will be available independently of each other, and the contractor is cautioned in regard to the fact 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 shall for purpose of measurement and payment be determined from the 'authorised' dimensions. This shall be taken to mean the dimensions as specified or shown on the drawings or, if changed, as finally instructed by the Employer's Agent, without any allowance for the tolerances specified. Save as hereinafter specified to the contrary, all measurements for determining quantities for purposes of payment will be based on the "authorised" dimensions.

If the work is therefore constructed in compliance with the "authorised" dimensions plus or minus any tolerances allowed, 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 Employer's Agent 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 for 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 7.1.1 Checking

Replace the last sentence with the following:

"The contractor shall obtain the services of an independent testing laboratory at his own expense (Refer subclause C3.4.6) to carry out such checks as are prescribed in the various standardised specifications."

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 Employer's Agent's checks ..." in the first line of Subclause 7.1.2.

PSA 7.2 **Approved Laboratories**

REPLACE THE CONTENTS OF SUB-CLAUSE 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 Employer's Agent 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 Employer's Agent;

(c) any testing laboratory established and operated on the Site by or on behalf of the Employer or the Employer's Agent.

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".

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

PSA 8.1.2 Preliminary and general items or section

PSA 8.1.2.1 *Contents*

Delete item (c).

PSA 8.1.2.2 *Tendered sums*

Replace the contents of this subclause with the following:

"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 general conditions of contract and of this standardised specification, except to the extent that provision is made in these project specifications to cover compensation for any of these items of work.
- Cost of all wayleaves.
- 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 permanent or temporary work.
- Providing facilities on site for the contractor's personnel, including offices, storage facilities, workshops, ablutions, for providing services such as water, electricity, sewerage, 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 the cleaning-up of the camp site on completion of the works.
- Providing facilities for the Employer's Agent and his staff as specified in Part C3.4: Construction Site Establishment.
- Providing and erecting two new contract name boards as shown on the drawings.
- Providing all the required documentation described in Part C3.
- Adhering and complying with the client's Procurement requirements including the monthly completion of labour and remuneration records."

PSA 8.2 **Payment**

PSA 8.2.1 Fixed-charge and value-related items

Replace the contents of this subclause with the following:
"Payment of fixed charges in respect of item 8.3.1 will be made as follows:

Eighty per cent (80 %) of the sum tendered will be paid once the facilities have been provided and approved. The remaining twenty per cent (20 %) will be paid once the works have been completed, the facilities removed and the camp-site cleared and cleaned.

Payment for the sum tendered under item 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 met all his obligations to date under this specification, the general conditions of contract and the special conditions of contract, and where the value of work certified for payment, excluding materials on site and any payments under 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 moneys but excluding the second instalment referred to herein, exceeds 50 % of the tender 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 his 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 by more or less than the tender sum, then the sum tendered under item 8.3.2 will be adjusted pro rata up or down and this adjustment shall be applied to the third instalment. No adjustment will apply to item 8.3.1 in respect of variations in the value of work done or the time for completion finally authorised."

PSA 8.2.2 Time-related items

Replace the contents of this subclause with the following:

"Three time related items shall be scheduled and shall be full compensation for all time related preliminary and general costs and shall include the following:

- Public holidays
- Year-end break(s) not exceeding 15 working days in duration; and
- The contract period during the normal industry working period outside public holidays and outside the industry shutdown period during December and January.

Subject to the provisions of 8.2.3 and 8.2.4, payment under item 8.4.1 (time-related item) will be made as follows:

PSA 8.2.2.1 The contract period during the normal industry working period payment

Payment will be made monthly in equal amounts, calculated by dividing the sum tendered for the item by the tendered contract period in Days (excluding public holidays and the year-end break during December and January), provided always that the total of the monthly amounts so paid for the item is not more than in proportion to the progress of the work as a whole.

Should the Employer's Agent grant an extension of the time for completion of the works, the Contractor will be entitled to an increase in the sum tendered for the time-related item, which increase shall be in the same proportion to the original tendered sum as the extension of time is to the original time for completion of the works.

PSA 8.2.2.2 Public Holidays

The tendered amount per day will be payable for the number of statutory public holidays included in the contract period which replaces normal working days.

Should an extension of time be granted and a public holiday is within this period, the Contractor will be entitled to additional payment for each additional public holiday which replaces a working day.

PSA 8.2.2.3 Year-end break(s) not exceeding 15 working days in duration

The tendered sum will be payable for the year-end break(s) not exceeding 15 working days in duration which falls within the construction period. Should an extension of time be granted which extends the contract period beyond the year-end break, the Contractor will be entitled to payment as tendered for this item 8.2.2.3.

Payment for such increased amounts determined in accordance with PSA 8.2.2.1 to PSA 8.2.2.3 will be taken to be in full compensation for all additional time-related preliminary and general costs, that result from the circumstances pertaining to the extension of time granted."

PSA 8.3 **Scheduled Fixed-Charge and Value-Related Items**

Replace the items with the following:

"PSA 8.3.1 Fixed preliminary and general charges ..... **Unit : Sum**

PSA 8.3.2 Value-related preliminary and general charges ..... **Unit : Sum**

The sums tendered shall collectively include full compensation for all fixed and 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."

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 survey pegs during the duration of the contract and the reinstatement of all disturbed survey 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 items with the following:

"PSA 8.4.1 Time-related preliminary and general charges

PSA 8.4.1.1 The contract period during the normal industry working period payment..... **Unit : Sum**

PSA 8.4.1.2 Public Holidays..... **Unit : No of Statutory Public Holidays**

PSA 8.4.1.3 Year-end break(s) not exceeding 15 working days in duration..... **Unit : Sum**

The sums and rates tendered for items PSA 8.4.1.1 to PSA 8.4.1.3 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 Employer's Agent**

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 6.10 of the Conditions of Contract.

The Contractor shall be paid under sub-item (b), either:

(a) 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 Employer's Agent for payment under the related sub-item (a), all in accordance with the provisions of Subclause 6.10.1 of the Conditions of Contract, or

(b) where the unit of measurement of 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);

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."

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 8.6 **Prime Cost Items**

Replace 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 Employer's Agent 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 8.6.1 Community Liaison Officer (CLO)

Payment of the CLO shall be made on a monthly basis to the Contractor. The monthly amount for the cost of employment of the CLO shall be set by the Employer and the Contractor shall recover the actual cost thereof under the Provisional Sum allowed for. Proof of payment to the CLO shall be submitted with the payment certificates.

(a) Community Liaison Officer …… ..... **Unit : PC Sum**

(b) Overheads, charges and profit on item (a) above …… **Unit : %**

The Contractor shall be paid under sub-item (b), either:

(a) 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 Employer's Agent for payment under the related sub-item (a), all in accordance with the provisions of Subclause 6.10.1 of the Conditions of Contract, or

(b) where the unit of measurement of 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);

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 CLO and in fulfilling its obligations under the contract as the principal Contractor."

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**

Replace the contents of Subclause 8.7 with the following:

"Measurement and payment shall be in accordance with the provisions of Clause 6.5 of the General Conditions

of Contract for Construction Works Third Edition (2015)."

PSA 8.8 **Temporary Works**

PSA 8.8.1 Main Access Road to Works (construct and maintain) ..... **Unit : Sum**

The tendered rate shall include full compensation for the construction and maintenance of the temporary main access road to the works.

The tendered rate shall include all costs as described in PSA 8.3.2.

PSA 8.8.2 Accommodation of traffic ..... **Unit : Sum**

Add the following:

"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 item 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:

The tendered rate shall include full compensation to provide a scanner to detect steel pipes and a scanner to detect electrical cables and to mark the position of these services on site.

(a) Water and sewer pipes ..... **Unit : Sum**
(b) Electrical and other cables ..... **Unit : Sum**
(c) Other ..... **Unit : Sum**

PSA 8.8.4.2 Hand excavation necessary for locating and exposing existing services in all materials:

(a) In roadways ..... **Unit : m³**

(b) In all other areas ..... **Unit : m³**

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 SABS 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 items:

"PSA 8.8.7 Dealing with water ..... **Unit : Sum**

The sum shall cover the cost for the provision, operation, maintaining and removal of all equipment and materials required to deal with surface and subsurface water anywhere on the Site as required in terms of Subclause 5.1.3 of SABS 1200 D and Subclause 5.1.2 of SABS 1200 DB. No additional payment will be made

for “Special water hazards”.

The sum shall cover the cost of providing the necessary equipment 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.

Equal monthly payments will be made calculated by dividing the sum tendered for the item by the tendered contract period in months. The sum of the equal monthly payments shall not exceed the sum tendered for this item except where an extension of the contract period is approved by the Employer’s Agent in which case the monthly payments will be made pro rata to the extension of time only if dealing with water is required.”

PSA 8.8.8 Temporary fence minimum 1,2 m high ..... **Unit : m**

The tendered rate shall include full compensation for the supply and erection of the temporary fence, the maintenance of the fence and the dismantling of the fence.

The contractor shall erect a temporary high visibility barrier fence at the positions as shown on the drawings or as instructed. The tendered rate shall include full compensation for the supply, erection and maintenance of the fence and the removal thereof on completion of the civil contract. It shall at all times be kept in an upright and neat condition.

PSA 8.8.9 Dismantle and re-erect temporary 1,2 m high fence ..... **Unit : m**

The tendered rate shall include full compensation for the careful dismantling of the temporary high visibility barrier fence, the stacking, loading, transporting, off-loading and re-erection of the fence at a new required position. It will also include for the maintenance of the fence and the removal there-of at the end of the construction activities.

PSA 8.8.10 Dust control ..... **Unit : Sum**

The tendered rate shall include full compensation for the provision of a water truck on site on a continuous basis during the construction of earthworks and layerworks period and the regular wetting of the construction area to prevent any dust disturbance to adjacent areas.

PSA 8.8.11 Supply, erect and maintain temporary precast concrete or plastic water filled barriers (minimum 1 m high) ..... **Unit : m**

The tendered rate shall include full compensation for the supply and erecting of “New Jersey” type or Delta Bloc type or equivalent temporary precast concrete- or plastic water filled barriers in the road way, after the necessary temporary road signage has been erected. The barriers may only be erected over weekends to cause limited disruption to traffic. The tendered rate shall further include full compensation for the fixing of the individual barriers, maintaining the barriers, replacement of damaged barriers and the dismantling and removal of the barriers on completion of the work. The tendered rate for the supply and erecting the barriers must include the cost of traffic accommodation in these areas.

PSA 8.8.12 Relocate, erect and maintain precast concrete or plastic water filled barriers (minimum 1 m high)..... **Unit : m**

The tendered rate shall include full compensation for the relocation of the barriers within the site which shall include the dismantling, loading, transporting of loading the barriers and the re-erection in accordance with payment item PSA 8.8.11 above. The relocation and re-erection may only be done over weekends.”

Add the following:

"PSA 8.9 **Standing Time Cost**

(a) Equipment .... **Unit : Day**

(b) Labour .... **Unit : Day**

For purposes of calculating the standing time costs, a working week will be held to consist of five working days. Only that equipment and labour on site and in use shall be compensated. Equipment and labour on site and not required to complete the works at the time of the standing time event will not be included in the calculation of standing time cost.

The amount by which the standing time costs is adjusted shall only apply to delays which, in the opinion of the Employer's Agent, are incurred as a result of events entirely outside the Contractor's control.

Costs for delays incurred for all other circumstances shall be treated as provided for in the General Conditions of Contract.

The provision of this Clause shall in no way prejudice the right of either the Employer or the Contractor to terminate the Contract in terms of the provisions of Clause 9.1.2 of the General Conditions of Contract.

Variations in the Total Tender Sum resulting from payment for delays as a result of standing time costs as described herein shall be excluded from the total tender sum when Clause 6.4 of General Conditions of Contract is applied."

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 8.12 **Compliance with The Occupational Health and Safety Act (Act No 85 Of 1993) and Construction Regulations and Specifications Included in the Particular Specifications**..... **Unit : Sum**

The tendered rate shall include full compensation for compliance with the OHS Act and Construction Regulations and the Health and Safety requirements and specification included in this tender document. Refer to the Particular Specifications and Part C5.

It shall further include full compensation for the registration of the project with the Authorities (Department of Labour) and any delay in awaiting for approvals by the Authorities.

Temporary barriers and fences for deep or trench excavations required in terms of the contract shall not be paid for separately.

Payment under this item will be made as follows:

(a) The first instalment which is 30 % of the sum tendered, will be paid once the contractors Health and Safety Plan is approved by the Employer or the Employers Agent and the Contractor has met all his obligations to date under this specification.

(b) The remainder of the sum tendered will be paid in equal monthly amounts calculated by dividing the sum tendered (less 30 %) divided by the contract period in months.

No additional payment will be made should an extension of the contract period be granted. Penalties for non-compliance will be deducted from payments due to the Contractor.

PSA 8.13 Compliance with The Environmental Management Plan and Requirements Included in the Particular Specifications..... **Unit : Sum**

The tendered rate shall include full compensation for compliance with the environmental management requirements and specification included in this tender document. Refer to the Particular Specifications and Part C6.

Payment under this item will be made in equal monthly amounts calculated by dividing the sum tendered divided by the contract period in months.

No additional payment will be made should an extension of the contract period be granted. Penalties for non-compliance will be deducted from payments due to the Contractor.

PSA 8.16 **Supply and delivery of padlocks** ……..**Unit : No**
The tendered rate shall make full compensation for the supply and delivery of 40 mm Vitro locks with 8 sets of keys per lock and the delivery of these locks and keys to the Municipality.

PSA 8.17 **Photographic Record** ……..**Unit : Sum**
The Contractor must keep a photographic record of the condition of properties and structures within 30 m of the

proposed works. Photographs of every structure must be taken prior to construction and must be of high quality (3) mega pixel or higher to ascertain the condition of the property or structure. Structures will include (but are not limited to) boundary walls, fences, road surfaces, kerbing, stormwater structures and the surrounding area along the route of the pipeline. The preconstruction photographs must be handed to the Employer's Agent prior to any excavation is undertaken.

The structures and properties must again be photographed after construction to ascertain any possible damage to the structures or properties due to construction activities. This photographic record must be supplied to the Employer's Agent at the end of the contract and will form part of the record information to be provided by the Contractor.

The tendered sum shall include full compensation for the investigation and supply of the photographic record in electronic and colour hard copy format (standard photo size). Fifty percent of the sum tendered will be payable upon supply and approval by the Employer's Agent of the pre-construction photo record and the remaining 50% upon supply of the post-construction record.

PSA 8.19 **Liaison with residents and the local authority** .....**Unit : Sum**

The tendered rate shall include full compensation for all liaisons with the residents of each area and the Municipality regarding valve closures and issuing of public notices.

Residents must be informed of valve closures at least 48 hours prior to closing of valves.

The tendered rate must include:

- the preparation of an information page which must be delivered to each household to be affected, prior to working in the area.
- the delivery of a notice informing residents of a disruption in the water supply (three days prior to the disruption)
- obtaining a "happy letter" from all residents once the work is completed and gardens re-instated.
- direct liaison with residents should a complaint be received including a written account of the complaint and agreement reached with the resident.

No additional payment will be made for additional notices of disruption which must be issued as a result of failed connection attempts."

PSA 8.20 **Record of Test Results and Related Administration** ……...**Unit : Sum**

The tendered rate shall include full compensation for all the requirements stipulated in subclause C3.4.6, C3.4.7 and C3.4.8 for the record keeping, updating of test positions, recording the test results in tabular format and providing additional copies with the marked on reference number on a monthly basis.

Upon completion of the contract a separate full set of test results must also be submitted to the Employer's Agent before a Certificate of Practical Completion shall be issued.

Twenty percent of the Time Related P&G amount will be withheld should the required information not be provided in the correct format.

PSC **SITE CLEARANCE (1982)**

PSC 3 **MATERIALS**

PSC 3.1 **Disposal of Material**

Add the following:

"The Contractor shall obtain his own registered 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:

"Pipeline routes shall be cleared to a distance of 1,5 m on both sides of the pipeline centre line. Route pegs or markers shall not be destroyed or damaged during clearing operations."

PSC 5.2 **Cutting of Trees**

PSC 5.2.3 Preservation of trees

PSC 5.2.3.2 *Individual trees*

Replace the last sentence with the following:

"An amount of **R500-00** will be deducted from moneys due to the Contractor as a penalty for every tree that is damaged or removed unnecessarily."

PSC 5.3 **Clearing**

ADD THE FOLLOWING:

Add the following:

"The tenderers attention is drawn to the fact that all items described under subclause 5.3 which are not separately listed in the bill of quantities must be included in the price for item PSC 8.2.1."

PSC 5.5 **Reclearing of Vegetation**

Add the following:

"Where areas have to be re-cleared on the written instructions of the Employer's Agent, such re-clearing shall be carried out at the contractor's own cost and the contractor is advised therefore, not to clear areas at such an early stage that re-clearing may become necessary."

PSC 8 **MEASUREMENT AND PAYMENT**

PSC 8.1 **Basic Principles**

Add the following:

"Levels to be used for earthworks quantity calculations will be surveyed once the clearing operation have been completed."

PSC 8.2 **Scheduled Items**

PSC 8.2.1 Clear and Grub

Replace the first line with the following:

"The area designated by the Employer's Agent to be cleared and grubbed will be measured in m² to the nearest square metre or,"

PSC 8.2.5 Take down existing fences……..Unit: km

Delete the words 'at sites indicated by the Engineer' in the first paragraph.

Add the following:

Fencing material shall be spoiled at a registered site provided by the Contractor.

PSC 8.2.7 Dismantle and remove pipelines, electricity transmission lines, cables, etc. ……..**Unit : Sum**

Replace the contents of this Subclause with:

"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..... **Unit : Sum**

The Contractor shall ascertain the works necessary to remove the structures complete as given in the schedule of quantities and noted on the drawings.

"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 sand in layers of 300 mm including compaction to 100 % of MOD AASHTO."

Add the following payment clauses:

"PSC 8.2.11 Remove topsoil to spoil site furnished by contractor ……..... **Unit : m³**

The tendered rate shall include full compensation for removing topsoil to a depth of 150 mm and for loading and transporting the material to spoil sites furnished by the Contractor.

The Contractor shall confirm during the clear and grub and topsoil removal operation, in writing with the Employer's Agent any areas where the topsoil exceeds 150mm depth or where the roots of plant material requires deeper ripping for complete removal. The method and scope of additional work will then be confirmed by the Employer's Agent.

PSC 8.2.14 Demolish existing wall and discard off site ..... Unit : m

The rate shall cover the cost of demolishing existing walls including the concrete foundations, loading, transporting and offloading such material at a registered spoil site provided by the Contractor.

PSC 8.2.15 Remove and dispose of kerbing..... Unit : m

The rate shall cover the cost of the removal, transport and disposal of existing kerbs to a spoil site furnished by the Contractor, including all necessary excavation and backfill compacted to 100 % modified AASHTO density.

PSC 8.2.16 Remove unsuitable material from existing ponds..... Unit : m²

The tendered rate shall include full compensation for dewatering of the ponds, excavate unsuitable material and for loading and transporting the material to a registered spoil site provided by the Contractor.

PSC 8.2.17 Remove building rubble ..... Unit : m³

The rate shall include full compensation for the loading, transport and offloading of building rubble at a registered spoil site provided by the Contractor.

PSC 8.2.18 Remove concrete stormwater pipes …….. Unit : m

The rate shall include full compensation for the loading, transport and offloading of concrete pipes at a registered spoil site provided by the Contractor.

PSC 8.2.19 Remove and dispose of domestic waste……..Unit : m³

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

The rate shall include full compensation for the loading, transport and offloading of domestic waste at a registered spoil site provided by the Contractor.

PSD **EARTHWORKS (1988) AS AMENDED 1990**

PSD 2 **INTERPRETATIONS**

PSD 2.1 **Supporting Specifications**

Replace subclause 2.1.2 with the following:

"PSD 2.1.2 Any of the other SABS 1200 specifications may form part of the contract documents."

PSD 2.3 **Definitions**

Replace the definition "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 "Specified density" with the following:

"Specified density: The specified dry density expressed as a percentage of modified AASHTO dry density."

Replace the definition "Stockpile" with the following:

"Stockpile (Verb): The process of selecting and, as maybe necessary, loading, transporting and off-loading material in a designated area for later use and a specific purpose."

Add the following definitions:

"Fill: An embankment or terrace constructed from material obtained from excavations or borrow. In roads it includes the earthworks up to below the selected sub-grade level.

Fill (material): Material used for the construction of an embankment or terrace.

Roadbed: The in-situ material on which a fill is to be constructed.

Placing: Placing shall mean spreading of backfilling material, watering, mixing, compacting, final grading, complying with the required tolerances and providing for testing, all in accordance with the requirements of the specification."

PSD 3 **MATERIALS**

PSD 3.1 **Classification for Excavation Purposes**

PSD 3.1.1 Method of classifying

Add the following:

"Classification of material other than 'soft excavation' shall be agreed upon before excavation may be commenced. The contractor shall immediately inform the Employer's Agent if and when the nature of the material being excavated changes to the extent that a new classification for further excavation is warranted. Failure on the part of the contractor to advise the Employer's Agent thereof in good time shall entitle the Employer's Agent to classify, at his discretion, such excavation as may have been executed in material of a different nature."

PSD 3.2.3 Material suitable for backfill or fill against structures

Replace the contents of this sub-clause 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 50 mm sieve; and

(b) The material shall not contain large clay lumps that do not break up under the action of the compaction equipment; and

(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 95 %."

PSD 3.3 **Selection**

PSD 3.3.1 General

Replace the second paragraph 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."

Add the following subclause:

PSD 3.3.3 Selection in borrow pits

The approval of a borrow area for a certain purpose does not necessarily mean that all material within the area is suitable for the specified purpose. What it does mean, is that the borrow area contains some suitable material. The onus is on the Contractor to ensure that only material that is indeed suitable is removed and used for the specified purpose."

Where the Contractor is required to select material from excavations for a specific purpose, the above provisions relating to borrow areas shall apply *mutatus mutandis* to excavations.

The Contractor shall not waste or contaminate material that has been elected 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 SABS 1200 A and Subclause 5.1.2 of SABS 1200 D, at its own cost, provide and use detecting equipment which is suitable for the detection of underground cables and pipes."

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 "Occupational Health and Safety Act, 1993 (Act 85 of 1993."

PSD 5.1.1.2 Safeguarding of Excavations

REPLACE "Machinery and Occupational Safety Act" WITH "Occupational Health and Safety Act, 1993 (Act 85 of 1993)."

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 of trench may never be steeper than 60° to the horizontal and all costs incurred to slope the sides of an excavation or trench and the reinstatement thereof 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 this Subclause with the following:

"The use of explosives is prohibited on this project.

PSD 5 **CONSTRUCTION**

PSD 5.1 **Precautions**

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:

"Where no services are shown on the drawings, but the presence of such a service could be assumed within reason, the Contractor must in co-operation with the relevant authorities locate such a service before commencing construction. After locating such a service, it would be regarded as a noted service, and the Contractor will be responsible for any costs arising from damages to the service due to the construction activities of the contractor."

"The exposure by the Contractor of underground services, as required in terms of Subclause 5.4 of SABS 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 Employer's Agent.

Unless otherwise instructed or agreed by the Employer's Agent, 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 : 98 % 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 SABS 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 roadways will be made in accordance with Subclause 8.3.6.1 of SABS 1200DB (as amended).

PSD 5.1.2.3 Protection of cables

REPLACE SUBCLAUSE 5.1.2.3 WITH THE FOLLOWING:

"5.1.2.3 Protection during Construction

Further to the requirements of Subclause 5.4.2 of SABS 1200A (as amended), major excavating equipment and other Equipment 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 SABS 1200A (as amended), immediately notify the Employer's Agent 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 5.1.3 Stormwater and groundwater

Add the following:

"The contractor shall at the earliest practicable opportunity install the permanent drainage specified or shown on the drawings and shall at his own cost provide such further temporary drainage as may be necessary for the protection of the works, except where other specific items regarding drainage are provided."

PSD 5.2 **Methods and Procedures**

PSD 5.2.2 Excavation

PSD 5.2.2.1 Excavation for general earthworks and for structures

Add the following to paragraph (b):

"Where the nature of the material precludes the above procedure, additional excavations shall be made to provide working space for the erection of form work. In general payment will be made for a working width of 600 mm, but the contractor may excavate a greater working width at no additional cost to the employer. Excavation for structures shall be measured to vertical planes 0,6 m outside the concrete perimeter.

Immediately before any permanent construction is commenced, all loose material shall be removed or thoroughly compacted."

Replace paragraph (e) with the following:

"Where excavations have been carried out below the authorized levels, the contractor shall backfill such excavations to the correct level with approved gravel compacted to 95 % of modified AASHTO density or to the density of the surrounding material.

Where excavations for structures in hard material have been carried out, the Employer's Agent may however require the over-excavation to the backfilled with a weak concrete if there is a danger of settlement or differential settlement of the foundations.

Where the sides of excavations against which concrete is to be cast have been over-excavated or have collapsed partially, the contractor shall retrim in the excavations if necessary and, unless other remedial measures are agreed to by the Employer's Agent, shall cast the concrete for the structure, including any additional concrete which 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 5.2.2.2 Borrow pits

Add the following:

"A commercial source shall, for the purposes of this specification, mean a source of material provided by the Contractor, not the Employer.

Where it is specified that material shall be obtained from commercial sources, the Contractor shall be responsible and include in his prices for borrow to fill from commercial sources, for finding a source of suitable material, for making all arrangements for procuring the material with the owner of the source, for the payment of any royalties, charges or damages and, for transporting the material to the site regardless of the distance involved. No payment will be made for the removal of overburden or stockpiling at the commercial source and no extra over payment for excavating in intermediate, hard or boulder material shall apply."

"PSD 5.2.2.3 Disposal

Add the following:

"The Contractor shall provide the necessary spoil sites and shall make the necessary arrangements with the owner of the site where the material is disposed of and shall include in his rates for all charges in this regard and for transporting the material regardless of the distance involved."

Add the following subclause:

"PSD 5.2.2.4 Selection and stockpiling

The approval or designation of a particular borrow area for a particular purpose will not imply that all the material is suitable for the purpose or should be used for that purpose. The Contractor shall select suitable material from that source, discard unsuitable material and reserve material for other purposes as necessary. When required and as ordered by the Employer's Agent, material shall be stockpiled for later use when the excavation thereof is unavoidable in order to excavate the material required at the time.

PSD 5.2.3 Placing and Compaction

PSD 5.2.3.1 Embankments

Delete the word "90 %" and replace with "93 %".

Delete "98 % in the case of non-cohesive soil" and substitute "100 % in the case of non-cohesive soil".

Add the following:

Before any placing of fill commences, preparatory work such as site clearing, fencing (where required), and the removal of topsoil and unsuitable ground shall be completed. All drainage structures and culverts shall also be installed unless agreed otherwise by the Employer's Agent. The top 150 mm of natural ground (subgrade) shall be compacted to at least 93 % Mod. AASHTO before the filling operation commences.

Bonding

- If the natural ground crossfall is greater than 5 % the entire interface between the embankment and the natural ground shall be bonded by scarifying to a depth of 150 mm.
- The thickness of any one layer of fill up to 1 m below formation level shall not exceed 150 mm after compaction using static rollers, or 300 mm using vibrating rollers.
- The top 1 m layer of fill below formation shall be carried out in layers not exceeding 150 mm thickness.

The standard of compaction required shall be:

- up to 1 m below formation level, 95 % Mod. AASHTO density.
- the top 1 m layer below formation, 95 % Mod. AASHTO density.
- The moisture content during compaction of the top 1m layer below formation as determined by the Modified AASHTO compaction test shall be optimum +/-2 %.
- After compaction, the layer shall be proof-rolled with a vehicle having a minimum wheel load of 20 kN in order to determine any soft spots.
- Any layer which becomes soft after being compacted and tested, shall be recompacted to the specified density at the Contractor's expense.
- All stones, lumps, etc. shall be broken down to conform to a maximum dimension not exceeding two-thirds of the specified compacted thickness of the layer.
- Placing of Fill on Swampy Ground – On swampy ground and at other problem areas but not around structures, the Employer's Representative may permit the pioneering of the embankment by end dumping or bulldozing, but only to the minimum extent necessary to develop adequate facilities for normal placing.
- The side slopes shall be trimmed to a plane surface free from loose material and stones larger than 100 mm maximum dimension and having no local humps or depressions greater than 150 mm. Where the embankment slope is not to receive topsoil, it shall be compacted to provide a stable slope. Where the surface is to receive topsoil it shall be left with a semi-rough finish free from loose material.

Item coverage shall include for:

- Compacting of natural ground before forming embankments to 95 % Mod. AASHTO to a depth of at least 150 mm; and
- Allowing for shrinkage and wastage of material.

PSD 5.2.4.3 Grass or other vegetation

Add the following subclause:

"Hydroseeding

The following materials shall be used in hydroseeding:

(a) Fertiliser

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
45 kg	**per hectare**

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.

The work shall be executed in May, which falls in the 12-month maintenance period.

Straw stabilisation

One bale of hay per 20 m² shall be rotivated or harrowed into the sand. Harrowing or rotivation shall be done in an east-west direction, i.e. across the direction of the prevailing winds."

PSD 5.2.5 Transport for Earthworks

PSD 5.2.5.2 Overhaul

Replace the contents of this subclause with the following:

"No overhaul will be paid under sections 1200 D, 1200 DM, 1200 DK or 1200 DB or any other sections. All transport costs irrespective of distance, source and material must be included in the relevant payment clauses."

PSD 7 **TESTING**

PSD 7.2 **Taking and Testing of Samples**

Replace the heading and contents of this subclause with the following:

Taking and Testing of Samples and Compaction Frequencies

The following are the minimum test frequencies to be executed by the Contractor at his own expense, regardless of whether the tests pass or not:

a) Material imported from commercial sources for fill material:

One CBR and indicator test per 200 m³ of compacted material brought on to site. A sample and one CBR and indicator test of the material proposed for importation shall be submitted to the Employer's Agent for approval prior to the commencement of importation. The testing requirements shall be repeated when the source of commercial supply change.

b) Fill material (insitu and commercial sources):

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

One density test and moisture content per 100 m³ of compacted fill. Tests shall be distributed evenly throughout full depth and area. Areas with less than 100 m³ of compacted fill requires one density test and moisture content. Density requirements of the fill shall be met when verified by nuclear density meter (NDM) in accordance with SANS 3001: NG5, GR20 and GR30. Test positions shall be agreed with the Employer's Agent Representative. DCP tests can be undertaken to demonstrate consistency, but it shall not be accepted to demonstrate that the compaction requirements have been verified. All test positions must be recorded by the Contractor and submitted with test results to the Employer's Agent within 5 Days of placing the fill.

c) Compacted subgrade (areas in cut):

One density test and moisture content per 200 m² of compacted surface area. Tests shall be distributed evenly throughout the cut area. One density test and moisture content is required where cut areas are less than 200 m³. Density requirements of the subgrade shall be met when verified by nuclear density meter (NDM) in accordance with SANS 3001: NG5, GR20 and GR30. Test positions shall be agreed with the Employer's Agent Representative. DCP tests can be undertaken to demonstrate consistency, but it shall not be accepted to demonstrate that the compaction requirements have been verified. All test positions must be recorded by the Contractor and submitted with test results to the Employer's Agent within 5 Days.

Should any of the above density tests fail to comply with the specified requirements, the Contractor shall at his own expense remedy the failure and submit a new test to the Employer's Agent.

PSD 8 **MEASUREMENT AND PAYMENT**

PSD 8.1 **Basic Principles**

Add the following paragraph:

"PSD 8.1.4 Where backfilling is part of the activities described under a payment clause, the word backfilling includes the supply of the approved backfilling (regardless of the source and distance), as well as the placing of the material as described under subclause PSD 2.3."

PSD 8.1.5 Watering or harrowing of material and allowing it to dry out to obtain optimum moisture content before backfilling and compaction of fill material (whether obtained from site or commercial sources) will not be paid for separately and shall be deemed to be included in the tendered rates for Bulk Excavation or Restricted Excavation.

PSD 8.2 **Computation of Quantities**

PSD 8.2.1(a)(2) Add "or residential houses", after "…. rail embankment".

PSD 8.3 **Scheduled Items**

PSD 8.3.2 Bulk Excavation:

Add the words "temporary stockpiling, harrowing or drying the material" after the words "…….. basic selection, loading ……." in the second sentence of paragraph (a).

Add the following:

"PSD 8.3.2(c) Excavate in all materials, temporary stockpile and maintain ..... **Unit : m³**

The rate shall cover the cost of complying with all precautions required in terms of SABS 1200 D subclause 5.1 in addition to the cost of excavation, basic selection, loading, transportation within freehaul distance, off-loading, temporary stockpiling, spreading or backfilling, watering, harrowing and drying the material, compacting, final grading complying with the requirements for tolerances, and maintaining of the stockpile, all in accordance with the requirements of the specifications."

PSD 8.3.2.2 Cut to spoil ..... **Unit : m³**

The unit measurement shall be the cubic metre of material measured in-situ before excavation or measured in accordance with the provisions of 8.2.2 by taking a percentage of the loose volume in trucks. Where material from an excavation is used in fill, as well as taken to spoil the provisions of 8.2.1 shall be strictly adhered to for purposes of measurement.

The tendered rates shall include full compensation for excavating as if in soft excavation, loading, transporting for the free-haul distance and for off-loading, spreading and trimming the spoil material at sites provided by the

Contractor.

PSD 8.3.2.3 Extra over sub-items 8.3.2, PSD 8.3.2 (c) and PSD 8.3.2.2 for excavating in:

(a) Intermediate excavation ..... **Unit : m³**
(b) Hard rock excavation ..... **Unit : m³**
(c) Boulder excavation class A ..... **Unit : m³**
(d) Boulder excavation class B ..... **Unit : m³**

The tendered rates shall include full compensation for the additional cost of excavating and processing material in the classes specified (see drawing D-1)."

PSD 8.3.3 Restricted excavation

Add the words "harrowing or drying the material" after the words "….. material separate (where relevant)" in the fourth sentence of paragraph (a).

Add the following sub-sub-item:

" (c) Extra over item 8.3.3 (a) for hand excavation ..... **Unit : m³**

This item shall apply to hand excavation ordered by the Employer's Agent or where the Employer's Agent considers that, owing to circumstances, excavation by mechanical excavators is not practicable. It shall not apply to hand excavation for the purpose of trimming or finishing excavation made by mechanical means.

The tendered rate shall include full compensation for the additional cost of excavating by means of hand tools."

PSD 8.3.4 Importing of Materials

Amend subclause '(a)' as follows:

Delete the words "Extra over for" from the heading. Delete the words "additional to 8.3.2 and 8.3.3" and replace with "of the work and items described in payment items 8.3.2 or 8.3.3 and including the cost of".

PSD 8.3.6 Overhaul

Add the following:

"No overhaul shall apply to material from commercial sources or to material disposed of to sites provided by the Contractor or by other means employed by the Contractor."

PSD 8.3.8 Existing services (see 5.1.2.2)

PSD 8.3.8.1 Location

REPLACE ITEM 8.3.8.1 WITH THE FOLLOWING:

"*Hand Excavation for Locating and Exposing Existing Services*:

(a) In roadways ..... **Unit : m³**

(b) In all other areas ..... **Unit : m³**

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 Employer's Agent 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 SABS 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 SABS 1200DB."

PSD 8.3.10 Topsoiling ……**Unit : m³**
Change the unit to "m^3" and replace the contents of this item with the following:

"The unit of measurement shall be the cubic metre and the quantity shall be calculated from the authorized dimensions.

The tendered rate shall include for loading the topsoil from stockpiles, transporting it for the free-haul distance, off-loading, spreading, shaping and lightly compacting."

PSD 8.3.11 Grassing or other vegetation cover

Replace the contents with the following:

"PSD 8.3.11.1 Planting of grass cuttings..... **Unit : m²**

Only special type of grass with a short root system is to be used.

PSD 8.3.11.2 Planting of grass sods…… **Unit : m²**

Only special type of grass with a short root system is to be used.

PSD 8.3.11.3 Hydroseeding …… …….. **Unit : m²**

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, rehydroseeding 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 : m²**

The tendered rate shall include all costs to supply, spread and rotivate or harrow the straw 100 mm deep into the sand. One straw bale will be used for every 25 m^2.

ADD THE FOLLOWING ITEMS IN SUBCLAUSE 8.3:

"PSD 8.3.14 Extra over items 8.3.2 and PSD 8.3.3 for temporary stockpiling .....**Unit : m³**

The unit of measurement shall be the cubic metre of material from necessary excavations, temporarily stockpiled by the Contractor on the instructions of the Employer's Agent, 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 8.3.2 and PSD 8.3.3 of off-loading, forming and maintaining the stockpile for as long as is required, reloading and transporting within the applicable freehaul distance from the stockpile.

Payments to the Contractor under this item will only be made in respect of that material stockpiled on the instructions of the Employer's Agent (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 its 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 8.3.16 Extra over items 8.3.2 and 8.3.3 for disposing of spoil material on a site provided by the contractor .....**Unit : m³**

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 any charges for taking such material and for all other incidentals necessary to dispose of the spoil material. No overhaul shall apply.

PSD 8.3.17 Variations in compactive effort: (use in conjunction with PSD 8.3.2.1(b))

(a) Vibrator roller ..... **Unit : m²-pass**
(b) Heavy grid roller ..... **Unit : m²-pass**
(c) Tamping roller ..... **Unit : m²-pass**
(d) Flat wheel roller ..... **Unit : m²-pass**
(e) Pneumatic roller ..... **Unit : m²-pass**

The unit of measurement shall be the square-metre-pass and shall be computed by multiplying the number of square metres to which the changed pass efforts apply by the increased or decreased number of roller passes, computed on the basis of a 200 mm layer thickness.

Where a change in the compaction effort is requested, the contractor will be compensated at the tendered rates for the above items in respect of the increased number of square-metre roller passes of each type of roller required over and above that specified in the relevant standard effort. His compensation will be decreased simultaneously, at the applicable rates, by the number of square-metre roller passes of each type of roller which is either decreased or completely left out.

The tendered rate for each additional square-metre-pass ordered by the Employer's Agent over and above the specified number of passes, shall include full compensation for all supervision, labour, plant, equipment, fuel, materials and incidentals necessary for completing the work. The same rates shall be accepted by the contractor during computation of a decrease in his compensation where the number of roller passes for each specific type or roller is decreased.

PSD 8.3.18 Selection, transportation and placement of boulders for rip rap ..... **Unit : m²**

Various positions and slopes for construction of the rip rap shall be scheduled.

The tendered rate shall include full compensation for the selection of boulders between 200 mm dia and 300 mm dia from stockpiles, loading, transporting and offloading of the boulders and careful placement of boulders by hand to construct the rip rap.

PSD 8.3.19 Compaction of In-situ Material to a depth of 300 mm

a) 93 % modified AASHTO density ..... **Unit : m²**

The unit of measurement shall be the square metre.

The tendered rate shall include full compensation for scarifying, watering, shaping and compacting the in-situ material to 93 % modified AASHTO density to a depth of 300 mm."

PSD 8.3.20 Supply and install Geosynthetic Clay Liners (Bentonite) ..... **Unit : m²**

The tendered rate shall include full compensation for the supply and lay of a needle punched reinforced composite and heat treated Geosynthetic Clay Liner comprising of two geotextile outer layers with a uniform core of natural sodium bentonite clay to form a hydraulic barrier.

The tendered rate shall include for all costs including all materials, labour, plant and supervision and for the supply and installation of Kaytech's Envirofix ® Thermal Lock ™ GCL.

PSDB EARTHWORKS (PIPE TRENCHES) (1989(b))

PSDB 3 **MATERIALS**

PSDB 3.5 **Backfill Materials**

Add the following paragraphs:

"(c) Cement stabilised backfilling

Backfilling shall be stabilised with 5 % cement where directed by the Employer's Agent. 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

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 such a consistency that the mixture can 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 4 **PLANT**

PSDB 4.1 **Excavation Equipment**

Add the following paragraph:

"All excavations in excess of the specified depth and width, must be backfilled with approved backfilling material. No additional payment regarding this will be made, it will be assumed that payment is included in the tendered rates for the applicable items.

Compaction of sand must be to 100 % of modified AASHTO maximum density."

PSDB 5 **CONSTRUCTION**

PSDB 5.1 **Precautions**

PSDB 5.1.3 Accommodation of traffic and access to properties

Replace the semicolon and the word "and" at the end of subclause 5.1.3(a) with a full stop and replace item (b) with the following:

"(b) Where necessary to achieve compliance by the Contractor with his obligations in terms of subclause C3.4.38 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 Employer's Agent, 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 Employer's Agent has included in the Schedule of Quantities, particular payment items specifically therefore, 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:

"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 300 mm above the pipes after which the whole pipe shall be fully exposed by means of hand excavation. The excavation width shall comply with Subclause 8.2.3.

The pipes shall be removed from the trench in a manner approved by the Employer's Agent, and brought to the surface for inspection by the Employer's Agent.

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 Employer's Agent's instructions, as relevant."

PSDB 5.2 **Minimum Base Widths**

Add the following above the table.

"No allowance shall be made for the extra thickness of the collars or couplings."

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 Employer's Agent."

PSDB 5.4 **Excavation**

Add the following:

"All excavation for pipes must be done according to the trench excavation method, and not to the fill method. No additional payment extra over to that listed under item 8.3.3 will be made for pipes, culverts or any other structure that falls within the road or fill layers. Except where otherwise specified, trenches shall be of such a depth that the minimum cover over the pipes shall be 700 mm except at road-crossings where the minimum cover shall be 1 000 mm."

PSDB 5.6 **Backfilling**

PSDB 5.6.3 Disposal of soft Excavation Material

Replace the contents of the subclause with the following:

"Excavated material from the trench that has become surplus because of bulking, displacement by the pipe, and importation, shall be disposed of outside the site boundaries at a spoil site provided by the contractor. No additional payment will be made, and all costs related to the disposal of this surplus or unsuitable material will be deemed to be included in the tendered rates for the applicable items."

PSDB 5.7 **Compaction**

PSDB 5.7.1 Areas not Subject to Traffic Loads

Replace "90 %" with "95 %".

Add the following sentence: -

"All non-cohesive material shall be compacted to 100 % MOD AASHTO density."

PSDB 5.7.2 Areas Subject to Traffic Loads:

Replace "93 %" with "95 %".

Delete "98 %" and substitute "100 %".

Add the following:

"All pipe trenches that fall within the road reserves shall be regarded as areas subject to traffic loads."

"PSDB 5.11 **Removal of Existing Pipes**

PSDB 5.11.1 Where shown on the drawings or where so instructed by the Employer's Agent, the Contractor shall excavate, expose and remove from the ground, existing water pipelines.

PSDB 5.11.2 If instructed by the Employer's Agent, 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 Employer's Agent, in accordance with the requirements of Subclause PSA 5.4.1. Measurement and payment for locating the exact positions of the pipelines where required by the Employer's Agent, 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 Employer's Agent, cleaned sufficiently as to allow inspection of the pipes and specials by the Employer's Agent and stacked in such a manner as will facilitate the inspection of each pipe and special by the Employer's Agent.

PSDB 5.11.5 Pipes and specials that are declared by the Employer's Agent as suitable for re-use shall be transported to the Employer's storeyard; where it shall be off-loaded and neatly stacked to the satisfaction of the Employer's Agent and in accordance to the manufacturer's instructions. The Contractor shall be responsible for obtaining a written receipt of all pipes so delivered to the Employer's storeyard.

PSDB 5.11.6 Pipes and specials which are declared by the Employer's Agent 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 7 **TESTING**

PSDB 7.1 Replace the contents of the subclause with the following:

The following are the minimum test frequencies to be executed by the Contractor at his own expense, regardless of whether the tests indicate acceptable compaction or not:

(a) Pipe bedding: one density test on the bedding cradle and/or blanket for every 100 m of pipe trench. A minimum of 2 density tests for continuous pipe trenches between 50 m to 100 m and a minimum of 1 density test for pipe trenches less than 50 m are required.

(b) Normal trench backfilling (areas not subject to traffic loads): one density test on every second 300 mm thick layer after compaction for every 100 m of pipe trench. A minimum of 2 density tests for continuous pipe trenches between 50 m to 100 m and a minimum of 1 density test for pipe trenches less than 50 m are required.

(a) Backfilling in areas subject to traffic loads: one test on each layer of 300 mm thickness after compaction for every 100 m of pipe trench. A minimum of 2 density tests for continuous pipe trenches between 50 m to 100 m and a minimum of 1 density test for pipe trenches less than 50 m are required.

Density requirements of the bedding and backfill shall be met when verified by nuclear density meter (NDM) in accordance with SANS 3001: NG5, GR20 and GR30. The above applicable to all types of civil services installed. All test positions must be recorded by the Contractor and submitted with test results to the Employer's Agent within 5 Days of placing the bedding and backfill. Bedding and backfill installed without the requirements described above will be for the Contractors risk and may be rejected by the Employers Agent.

PSDB 8 **MEASUREMENT AND PAYMENT**

PSDB 8.1 **Basic Principles**

PSDB 8.1.1 Replace the last section of subclause 8.1.1 ".... surplus material along the route of the pipeline within 0,5 km of the source", with ".... surplus material within the freehaul distance of the site boundaries."

PSDB 8.1.2 Add the following:

"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 Add the following to subclause 8.2.3.

"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."

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 8.3.2 (a) with "as scheduled in the schedule of quantities."
Replace the words "measured to the bottom of the bedding layer" with "measured from the final road layer or surface to the pipe invert level".

Replace the phrase "within freehaul distances"
with:

"at a spoil site provided by the contractor or municipal dumpsite unless scheduled otherwise"
Add the following after the last sentence and before paragraph (b).

"The tendered rate for excavation of trenches for electrical cables to be supplied and installed by the Electrical Contractor shall include full compensation for liaising with the Electrical Contractor, maintaining the trenches to allow the installation of the cables, supply and installation of warning tape and backfilling once the Electrical Contractor completed the installation of cables."

Add the following after the third paragraph:

"The rate shall also cover the cost of the additional compactive effort required as specified in 5.7.2 (as amended) and the additional selection of materials as specified in 5.6.2 to comply with the requirements for areas subject to road traffic loads. No additional payment will therefore be made under item 8.3.3.3."

(b) Extra-over item (a) above for; and (c) excavate and dispose of unsuitable material from trench bottom

Replace the phrase "within freehaul distances"
with:

"at a spoil site provided by the Contractor or municipal dumpsite unless scheduled otherwise"

PSDB 8.3.2 (b) Extra over item (a) for :

Add the following at the end of the existing sub-item 2:

"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 new sub-items in 8.3.2(b):

"(3) Hand excavation and backfill where ordered by the Employer's Agent:

(a) Soft material ..... **Unit : m³**
(b) Intermediate material..... **Unit : m³**

The unit of measurement shall be the cubic metre of material, measured in place according to the authorised dimensions, or the lesser dimension excavated, which was excavated by hand on the specific prior written instructions of the Employer's Agent; provided always that the Employer's Agent'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 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:

(i) utilise construction appropriate to the nature of the specific parts of the Work 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 Employer's Agent..... **Unit : m³**

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's Agent's instructions in accordance with Sub-clause 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 Employer's Agent..... **Unit : m³**

The unit of measurement shall be the cubic metre of soilcrete placed on the Employer's Agent's instruction in accordance with Sub-clause 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) Mass concrete Class 15 MPa/19 mm in encasing around pipes where directed by the Employer's Agent **Unit : m³**

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 for subitem (6) 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.

(7) Excavation is marshy areas irrespective of depth ..... **Unit : m³**

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 for subitem (7) 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.

(8) Backfill with clean sand compacted to 100 % modified AASHTO density ..... **Unit : m³**

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 for subitem (8) shall include full compensation for all additional cost to dispose of excess excavated material at a spoil site provided by the Contractor and to import clean sand from

commercial sources to backfill and to compact the clean sand backfill to 100 % Mod AAHSTO.

(9) Boulder Excavation

The unit of measurement shall be the cubic metre of boulder material excavated.
(Refer to SANS 1200D, 3.1.2d)

Add the following sub-items in 8.3.2 after sub-item 8.3.2) (c):

(10) 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^3**

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 freehaul distance and where applicable, selecting and keeping separate, excavated material suitable for use as backfill.

(11) Excavate open drains in all materials ..... **Unit : m^3**

The tendered rates shall include full compensation for excavating in all materials within the dimensions specified or authorised by the Employer's Agent 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 93 % of modified AASHTO density around the structures.

(12) Extra-over sub-items (10) and (11) for excavating in :

(1) Intermediate material..... **Unit : m^3**

(2) Hard rock material..... **Unit : m^3**

Measurement and payment shall be in accordance with the provisions of 8.3.2(b) of SABS 1200D (as amended)."

PSDB 8.3.3 Excavation ancillaries

PSDB 8.3.3.1 Add the following to the last paragraph:

"The freehaul distance is unlimited and no additional payment will be made for the transport of the material".

PSDB 8.3.3.3 Compaction in road reserves

Replace the heading of this subitem with the following:

"PSDB 8.3.3.3 Compaction in road crossings"

And 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, unless a selected layer is specified then it will be measured from the bottom of the selected layer. The length of the trench used for compacting the quantity for payment will be the actual length under the road."

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*

Delete this item.

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.

PSDB 8.3.4 Particular Items

PSDB 8.3.4(a) Shore trench opposite structure or service

Replace the heading of this subitem with the following:

"PSDB 8.3.4(a) Shore trench opposite structure or service or in restricted work space

Add 'of the approved design, presentation of method statement' after 'if necessary', in the second sentence.

"Add the following after the last sentence:

The Contractor shall be responsible for the design of all lateral support and shoring. Designs certified by a Registered Professional Engineer including all design assumptions, calculations, drawings and method statements must be submitted to the Employer's Agent for acceptance prior to ordering material and prior to any excavation work commences.

Add the following after the last sentence:

"Separate items will be measured for depths of trenches in increments of 1,0 m. The rate for each stated category shall cover the cost of shoring from ground level up to the full depth of the stated category, both sides of the trench. Payment for this item will only be made if written instructions were issued by the Employer's Agent."

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.

Add the following:

"(v) This rate shall also cover the additional cost of detection, exposure, hand excavation, protection, alteration and backfill material (the last if outside trench dimensions).

(vi) An existing service which has been abandoned at the time it is crossed, will not be measured.

PSDB 8.3.6 Finishing

Add the following:

"Different items will be scheduled for materials stockpiled and materials imported from commercial sources".

"PSDB 8.3.7 Accommodation of traffic..... **Unit : sum**

The tendered rate for the accommodation of traffic shall include full compensation for all items of cost necessary for the accommodation of traffic and the construction and maintenance of bypasses, including existing roads used as bypasses, during the construction period. It shall also include full compensation for traffic control, the provision of traffic signs and, where necessary, communications equipment required for traffic control, the provision of traffic signs and, where necessary, communications equipment required to regulate traffic, for the construction of temporary drainage works, and for the maintenance of all drainage works, arranging for the moving of services, attending to traffic problems, complying with the requirements of the Road Traffic Ordinance and of the relevant local authorities.

Payment shall be made in equal monthly instalments."

"PSDB 8.3.8 Removal of existing pipes:

(a) Excavate in all materials to 300 mm above the pipelines ..... **Unit : m^3**

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**

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 Sub-clause 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 Employer's Agent's inspection and recording the Employer's Agent'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 Employer's Agent and delivered to the address specified in Sub-clause 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 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 Employer's Agent in accordance with Sub-clause PSDB 5.11 above, irrespective of the type or diameter of the special, delivered to the address specified in Sub-clause 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 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 Employer's Agent 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 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 PSDB 5.11.5.

(ii) Specials ..... **Unit : No.**

The unit of measurement shall be the number of specials declared by the Employer's Agent 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^3**

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.

(g) Make up deficiency in backfill material ..... **Unit : m^3**

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 SABS 1200DB.

PSDB 8.3.9 Provision of temporary bridges for maintaining access to properties:

(a) Temporary pedestrian bridges..... **Unit : No.**

(b) Temporary vehicular bridges ..... **Unit : No.**

The unit of measurement shall be the number of temporary pedestrian and vehicular bridges actually provided in accordance with the Specifications.

The tendered rates shall include full compensation for the supply, first installation, maintenance and final dismantling and removal of the temporary access bridges when no longer required, as specified in Subclause PSDB 5.1.3.

PSDB 8.3.10 Moving of temporary bridges to and their re-erection in new positions:

(a) Temporary pedestrian bridges..... **Unit : No.**

(b) Temporary vehicular bridges ..... **Unit : No.**

The unit of measurement shall be the number of times each temporary bridge is moved to and re-erected in an entirely new position, excluding its first erection in the position where it was originally installed. No payment shall be made without the Employer's Agent's prior approval for the moving and re-erection of a temporary bridge.

The tendered rates shall include full compensation for taking down, transporting, handling, re-erecting and maintaining of the temporary bridges in the new positions."

Add the following payment clauses:

"PSDB 8.3.12 Excavate in all materials to expose danger tape on 11 kV cable and backfill trench to invert ..... **Unit : m**

The rate shall cover the cost of complying with the requirements of 5.1, (except where particular items are scheduled to cover particular costs (see 5.1.2.2)), excavation (including hand excavation) to above the danger tape, backfilling the trench once the Local Council has removed the cable, compacting and disposing of surplus material as specified in 5.6.3 and 5.6.4.

The rate shall also cover the cost of liaison with and accommodation of the Local Council.

The volume measured for payment shall be taken as 0,42 m³/m from ground surface to above danger tape and 0,54 m³/m from ground surface to invert.

PSDB 8.3.13 Excavate in all materials and backfill later from above danger tape ..... **Unit : m**

The rate shall cover the cost of complying with the requirements of 5.1 (except where particular items are scheduled to cover particular costs (see 5.1.2.2)), excavation to invert, backfilling at a later stage from above danger tape, compacting, and disposing of surplus material as specified in 5.6.3 and 5.6.4.

The rate shall also cover the cost of liaison with and accommodation of the Local Council.

The volume measured for payment shall be taken as 0,42 m³/m from ground surface to above danger tape and 0,54 m³/m from ground surface to invert.

PSDB 8.3.14 Removal and Reinstatement of the following:

Various items shall be scheduled. The rates shall include full compensation for the careful removal, transport, stockpiling, maintenance and reinstatement, to at least the original condition, of various items. No additional payment shall be made for the crossing of these items under clause PSDB 8.3.5.

PSDB 8.3.15 Supply and install danger/warning tape ..... **Unit : m**

The tendered rate shall include full compensation for the supply and installation of 300mm wide orange warning tape within new trenches, 300 mm from the final ground layer where directed by the Employer's Agent or as indicated on the drawings.

PSDB 8.3.16 Compaction of trench invert in situ material to a depth of 300 mm..... **Unit : m³**

(a) 93 % modified AASHTO density

The unit of measurement shall be the cubic metre compacted, 300 mm deep across the authorized trench width.

The tendered rate shall include full compensation for scarifying (if necessary), watering, shaping and comparing the in situ material to 93 % Mod AASHTO density to a depth of 300 mm below the trench invert.

SABS 1200DM EARTHWORKS (ROADS: SUBGRADE)

PSDM 3 **MATERIALS**

PSDM 3.1 **Classification for Excavation Purposes**

Clause PSD 3.1 will apply for this clause.

PSDM 3.2 **Classification for Placing Purposes**

PSDM 3.2.3 Selected layer

Replace the contents of this sub-clause with the requirements of SABS 1200 M:1996 Sub-clause 3.3.3: "Aggregates for pavement layers". The requirements for G7 or G8 quality as indicated on drawings or specified elsewhere will normally apply.

If the term selected only is used, the requirements of G7 quality shall apply.

Add:

G8 quality material, is similar to the requirements for G7 quality material as per SABS 1200M:1996 Table 3B except for the following relaxations:

Strength: CBR at 93 % of Mod. AASHTO max. density shall be at least 10 %;

Atterberg limits: In the case of calcretes the limit placed on the product of the LS and the percentage passing the 0,425 mm sieve, does not apply;

Size: The nominal maximum size shall not exceed two thirds of the compacted layer thickness

PSDM 3.2.4 Gravel surfacing

Replace (a), (b) and (c) with the following:

''The material used for the gravel wearing course shall comply with the following parameters as defined in TRH 20; subject to such other requirements involving future upgrading, where so indicated on drawings or directed by the Employer's Agent:

Maximum Size: 37.5 mm
Oversize Index: 0 (unless otherwise specified in Project Specifications)
Shrinkage Product: 100 to 240 based on linear shrinkage x per cent passing 0.425 mm sieve
Grading Coefficient: 16 to 34 based on (% passing 26, 5mm - % passing 2,0 mm) x % passing 4.75 mrn/ 100
CBR: 15 % at 95 % of Mod AASHTO density (soaked)"

Add the following new subclauses:

PSDM 3.2.5 Geotextiles for sub-surface drains

Should the use of synthetic-fibre filter fabric in subsoil drainage, or as filter blankets, or for any other purposes, be specified, it shall comply with the requirements as specified hereinafter.

(1) Composition and manufacturing

The synthetic-fibre fabric, or geotextile, shall be manufactured from a synthetic polymer processed into a permeable, homogeneous sheet. The sheet shall be either of a woven, non-woven or knitted construction. On account of the temperature and moisture susceptibility of polyarnide, this synthetic product is not considered acceptable.

(2) Classification

The geotextile 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. The table shall be used for determining the grade of a geotextile.

Table PSDM1

GRADE			
PROPERTY	2	3	TEST METHOD
Penetration load (minimum), N	2400	1500	*3.5* of SABS 0221 -1988
Puncture resistance (maximum),	26	32	Clause B8116 COLTO (1989)

mm Water percolation (minimum), $l/m^2/s$	20	20	3.7 to SABS 022 1-1988

Notes: -

– The standard atmosphere for testing and the preconditioning atmosphere for all geotextile tests (SABS tests and other) shall have relative humidity falling within the range of 0 to 80 per cent and a temperature within the rage of 15°C to 35°C.

– The resistance of a geotextile to puncture is the average diameter of the hole formed when a 45° cone with a mass of 1 kg is dropped through 500mm onto the geotextile fixed in the holding device.

(3) Durability

A geotextile is required to comply with the following specification:

– Resistance to chemical attack

The geotextile 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). Soil (as paste) and ground water containing salts with a conductance of up to 1.0 S/m (conductivity to be determined by Method A2 1 T, TMH 1, 1986)

- Resistance of ultra-violet light

The geotextile shall be at least 80% of its original strength after direct exposure to sunlight of 1 500 hours.

- Resistance to rot

The geotextile shall be entirely rot-proof and shall not support the growth of algae.

(4) Selection

The geotextile required shall satisfy the criteria for a grade 2 and 3 geotextile as specified in the schedule of quantities or project specifications. The contractor shall, at least 45 days before the installation of the geotextile, submit to the Employer's Agent samples of the geotextiles he proposes to use, so that the Employer's Agent may test the geotextile, and confirm the use thereof if he is satisfied that it meets the specified functional requirements as per COLTO Standard Specifications for Road and Bridge Works, Clause 8.1.14(b). No extra payment shall be made for providing the samples for testing.

PSDM 3.2.6 Pipes for sub-surface drains

Pipes for subsoil drainage shall have the specified internal diameter, which shall be not less than 100 mm, and shall be one of the following types: Perforated or slotted unplasticized PVC pipes complying with SABS 791; Perforated high-density polyethylene pressure pipes complying with the requirements of SABS 533, Part II. The size of perforations in perforated pipes shall in all cases be 8mm in diameter ± 1,5 mm and the number of perforations per metre shall be not less than 26 for 100 mm diameter pipes and 52 for 150 mm diameter pipes. Perforations shall be spaced in two rows for 100 mm diameter pipes and as shown on the drawings for 150 mm diameter pipes.

Slotted pipes shall have a slot width of 8 mm ± 1,5 mm. The arrangement of slots shall he subject to the Employer's Agent's approval, but the total slot area shall be not less than that presented for perforations.

Pipes without slots or perforations required for conveying ground from the subsoil drainage proper to the point of discharge, shall be un-perforated, PVC or polyethylene pipes of the types specified above, or concrete pipes complying with the requirements of SABS 677.

PSDM 5 CONSTRUCTION

PSDM 5.1 Precautions

Add the following:

PSDM 5.1.3.4 Negligence.

Where a service is damaged because of the Contractor's negligence the Contractor shall make good such damage or bear the cost of the repairs."

PSDM 5.2 Methods and Procedures

PSDM 5.2.2 Cut and borrow

PSDM 5.2.2.2 Dimensions of cuts

Replace the sub-subclause (except for Note) with the following:

"The dimensions of cuts (including rock cuts) shall be in accordance with the details of the typical cross-sections shown on the drawings and as may be further defined or amended by the Employer's Agent during construction.

The cost for shaping cuttings to the required levels and tolerances will be deemed to be included in the relevant pay items. No separate payment will be made for any operation the contractor may require to meet the required level and tolerance, except where confined to hard and/or boulder material and specifically provided for in Schedule items 8.3.3(b) and 8.3.9 "

PSDM 5.2.2.3 Use of material

(d) Borrow

Replace second paragraph with the following:

"Where borrow pits are not designated, the Contractor shall locate approved suitable sources of material. Where it is specified that material shall be obtained from commercial sources, the contractor shall be responsible and include in his prices for borrow to fill from commercial sources, for finding a source of suitable material, for making all arrangements for procuring the material with the owner of the source, for the payment of any royalties, charges or damages and, for transporting the material to the site regardless of the distance involved No payment will be made for the removal of overburden or stockpiling at the commercial source and no extra over payment for excavating in intermediate, hard or boulder material shall apply. The Employer's Agent may order which of the sources of approved material shall be used by the Contractor at any particular time"

PSDM 5.2.3 Treatment of Road-bed

PSDM 5.2.3.2 *Removal of unsuitable ground*

Replace the second sentence of paragraph (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 paragraph (b):

"Unsuitable material excavated will be paid for as cut to spoil"

.

PSDM 5.2.3.3 *Treatment of road-bed*

(a) Preparation and Compaction of Road Bed

Add the following:

"Where road bed preparation takes place in sand the in-situ sand layer is to be watered and compacted to 100 % Mod. AASHTO density. The surface of the in-situ sand layer is to be firm and smooth in order to receive the subsequent selected subgrade or subbase layer, as the case may be. To this end the Employer's Agent may order that unnecessary construction traffic remain off the finished in-situ sand layer until the subsequent layer has been completed."

PSDM 5.2.4.2 *Placing and Compaction*

(c) Breaking down of material

Add the following after last sentence:

"In addition, where grid rolling is ordered or used to attain the required maximum size, the following procedure shall apply for normal grid-rolling:

(1) The material shall be placed or bladed to the one side of the road to provide working space for breaking down the material.

(2) Subject to the approval of the Employer's Agent a portion of the material shall be spread in a thin layer on a compacted surface to promote effective breaking-down of the material, and to a width which the grid roller shall be able to cover in a single pass.

(3) The grid roller, which shall proceed at a speed of at least 12 km/h and shall have a minimum mass of 13.5 tons, shall do four complete roller passes over the material.

(4) Any oversized material shall be removed by hand, and/or constructional plant as provided in SABS 1200DM Clause 8.3.8.

(5) The broken-down material shall be placed in a windrow to the opposite side of the material still to be broken-down.

(6) Repeat steps (2) to (5), but place the second windrow next to the first.

(7) To mix the material, the two windrows formed in steps (2) to (6) shall then be bladed into a single windrow to the side of the road.

(8) If so ordered by the Employer's Agent repeat steps (2) to (7) until all the material that needs to be broken-down has been treated.

(9) However, should too much oversize material continue to be produced by normal grid-rolling, the Employer's Agent may instruct that any one of the following be done:

- That additional normal grid-rolling or its equivalent be done;
- That, instead of attempting to break down the material on the road, it be crushed as described in project specifications; or
- That the contractor and Employer's Agent agree on the use of any other methods and equipment which may be more suitable, and determine compensation for such work in terms of clause 36 of the General Conditions of Contract.

(10) Any oversize material still remaining after processing accordance with any of the processes described above shall be removed from the road as provided for in clause 5.2.4.2(c) or payment where appropriate as per clause 8.3.8.

Research has shown that grid rolling is only effective for material where the Treton impact value is in excess of twenty (20).

(f) Compaction

Add to (1) the following: "--and at least 93 % of modified AASHTO density for road widening operations:"

(g) Backfill and compaction at structures

Add after"…….compacted to at least 90 % of modified AASHTO density", *the following :* "or such higher compaction requirement for the adjoining earthworks; and 95 % of modified AASHTO density within the width of selected material behind the structure where so indicated in SABS 1200D clause 3.2.3 or otherwise shown on drawings"

(*WCPA Roads Infrastructure Branch e.g. shows HH as width of zone requiring selected compacted material behind portal culverts)*

PSDM 5.2.5 Selected layer

Amend (a) to read:

"(a) for material other than sand--------at least 93% of modified AASHTO density; and for top selected layer 95 % of modified AASHTO density; and"

PSDM 5.2.6 Gravel surfacing

Add after "95 %" in text "-- or 97 % of modified AASHTO density, as shown on drawings and/or scheduled, or otherwise directed by the Employer's Agent."

PSDM 5.2.8 Transport

PSDM 5.2.8.1 *Freehaul*

Replace the contents of this sub-sub-clause with the following:

"All transport within the site boundaries, will be regarded as freehaul.'

PSDM 5.8.2.1 *Overhaul*

Replace the contents of this sub-sub-clause with the following:

"All transport within the site boundaries, will be regarded as freehaul.'

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 surfacing, 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 excavations, 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 or where the Employer's Agent deems it necessary to spread topsoil, he may instruct the Contractor at the stage of the major earthworks operation to work to levels altered from those shown on the drawings.

Topsoil may be provided from stockpiles on site in which case the Contractor shall load, transport and spread as ordered by the Employer's Agent. In the case of topsoil being 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. A sample form can be obtained from the Employer's Agent.

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.

PSDM 7 **TESTING**

PSDM 7.3 **Routine Inspection and Testing**

PSDM 7.3.2 Table 2-Densities: Replace the required values in columns 3,4,5 with the requirements of PSM 7.4 Table 10

Add footnote 1 to fill: Where indicated in Project Specifications and/or Schedule or on drawings, 93 % modified AASHTO density shall apply *(This higher value is normally specified for fill for road widening projects to minimize differential settlement which is bound to result in longitudinal cracking or even slip circles forming)*

Add footnote 2 to fill: Where indicated in Project Specifications and/or Schedule or on drawings, 95 % modified AASHTO density shall apply for backfilling behind structures to a specified width (refer SABS 1200D clause 3.2.3 or applicable drawings) up to the level of and including selected layers

Add footnote 3 to selected layer: Where indicated in Project Specifications and/or Schedule or on drawings, 95 % modified AASHTO density (100 % for sand) shall apply. *(This higher value is normally specified for top selected layer or for one or more selected layers for road widening projects to minimize differential settlement which is bound to result in longitudinal cracking)*

Add footnote 4 to gravel surfacing: Where indicated in Project Specifications and/or Schedule or on drawings, 97 % modified AASHTO density shall apply. *(This is currently the requirements of the WCPA Roads Infrastructure Branch. Research has shown that the higher densities minimizes maintenance blading frequencies and are easily attained in practice)*

PSDM 8 **MEASUREMENT AND PAYMENT**

PSDM 8.2 **Computation of Quantities**

Replace sub-subclause 8.2.1 to 8.2.3 (inclusive) with the following:

PSDM 8.2.1 The provisions of sub-subclause 8.2.1 of SABS 1200 D shall apply

In addition, for SABS 1200 D 8.2.1(a) (2) add "or residential houses" , after "---rail embankment."

PSDM 8.2.2 The provisions of sub-subclause 8.2.2 of SABS 1200 D shall apply

PSDM 8.2.3 The provisions of sub-subclause 8.2.3 of SABS 1200 D shall apply

PSDM 8.2.5 Verifying quantities

Replace the first sentence 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 the design cross-sections for the purpose of measurement of earthworks quantities. The Contractor shall survey the actual cross-sections of the excavations and shall submit the survey information, drawings of the actual cross-sections and calculation of actual quantities to the Employer's Agent for confirmation of the quantities for the preparation of payment certificates."

PSDM 8.3 **Scheduled Items**

PSDM 8.3.3 Road-bed preparation and compaction of material to

Add:

"(4) minimum of 95 % modified AASHTO density
(often a requirement for road widening or upgrading operations)
The unit of measurement shall be the cubic metre of roadbed material prepared and compacted as specified. The quantity shall be computed in accordance with the authorized dimensions of the completed layers."

PSDM 8.3.4 Cut to Fill, Borrow to Fill

Amend heading as follows:

PSDM 8.3.4 Cut to Fill, Borrow to Fill, Commercial source to Fill (schedule separately)

Add to Sub-clause 8.3.4 the following:

(c) Compact to 93 % of modified AASHTO density ..... **Unit:m^3**
(*Typically applicable to road widening projects)*

Cut to Fill, Borrow to Fill and Commercial Source to Fill will be scheduled separately.

Also add:

"Where fill material is borrowed from trench excavations the rate shall include the selection from the sides of trenches, transporting, if necessary, stockpiling, preparing, processing, shaping (including forming side channels and benching if applicable), watering, mixing, compacting to the densities specified and finishing the slopes of fills."

PSDM 8.3.5 Selected layer compacted to 93 % of modified AASHTO maximum density

Amend title and numbering to read:

PSDM 8.3.5 Selected layer (schedule separately: From designated borrowpits or Approved commercial source/s)

(a) Selected layer compacted to 93 % of modified AASHTO density (specify compacted layer thickness) **Unit:m^3**

(b) Selected layer compacted to 95 % of modified AASHTO density (specify compacted layer

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

thickness)..... **Unit:m^3**

(Note: this item is often required when widening roads and minimize the risk of differential settlement, or for the top selected layer of higher order roads)

(c) Sand (as per SABS 1200M:1996 and project specifications) selected layer compacted to 100 % of modified AASHTO density (specify compacted layer thickness) ..... **Unit: m^3**

PSDM 8.3.7 Cut to spoil or stockpile from

Replace the wording 'to a site as directed' in the last paragraph with 'to a site provided by the Contractor'.

PSDM 8.3.12 Overhaul

Replace this sub-subclause with:

"No overhaul will be paid on material for the purpose of this contract, and all costs for transporting materials shall be included in the applicable tendered rates and amounts.'

PSDM 8.3.13 Surface Finishes

Add to Sub-Subclause 8.3.13 the following subclause:

(c) Trimming and grading of verges ..... **Unit: m^2**.

The unit of measurement for trimming and grading of verges shall be per square metre. The rate tendered for the above item shall include for all things necessary to complete the work as specified. However, the major earthworks required to bring the verge to the required level and the additional depth of excavation or reduction in fill height as ordered for the topsoil operation shall be measured and paid for under the appropriate excavation item.

PSDM 8.3.14 Borrow pits*:*

Replace the contents of this item as follows:

"(a) Opening up and closing down of borrow pit .....**Unit : Sum**

(b) Dealing with overburden .....**Unit : m^3**

The provisions of Subclauses 8.3.4(b) and 8.3.4(c) of SABS 1200 D shall apply respectively to items (a) and (b) above."

PSDM 8.3.16 Gravel surface layer **(**schedule separately**:** From designated borrowpits or

Approved commercial source/s)..... **Unit: m^3**

Add:

(a) Compacted to 95 % modified AASHTO density

(b) Compacted to 97 % modified AASHTO density

Add the following new subclause:

PSDM 8.3.17 Provide sub-surface drainage system .....**Unit: m**

The unit rate for a sub-surface drainage system shall include full compensation for all excavation; for procuring, furnishing and transporting to the site of the works and installing in accordance with the working drawings and to authorised dimensions, Grade 2 geotextile to PSDM 3.2.5, surrounding lightly compacted 19 mm crushed aggregated to SABS 1083, serviced by a proven and approved high density polyethylene perforated pipe (to PSDM 3.2.6) of nominal diameter 100 mm or more as shown on the detail drawing and protected against infiltration of mortar from above during construction of the paved side drain/or earth-blanket/or precast paving blocks, using a 150 micron polyethylene sheeting which sheeting shall be removed once the backfilling with approved material commences. The rate shall in addition fully compensate for any other material, plant and equipment, and labour required and incidental to the successful installation of the sub-drain including the required excavation. The trench shall be specially protected against the ingress of water as far as practically feasible during the installation process (refer to SABS 1200A schedule item 8.8.6

where required)

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 Sidewalks:

(a) Fill compacted to 90 % of modified AASHTO density and obtained from:

(i) Designated borrow pits..... **Unit : m³**

(ii) Commercial sources..... **Unit : m³**

(iii) Excavations ..... **Unit : m³**

(b) Scarify in situ material to a depth of 150 mm and compact to 90 % of modified AASHTO density..... **Unit : m³**

(c) Excavated material removed to spoil..... **Unit : m³**

The tendered rates shall include full compensation for constructing the sidewalks to the profiles indicated either on the Drawings or by the Employer's Agent, for working in restricted areas, for using material classified as soft material with a maximum particle size of 60 mm, and for carrying out the work in accordance with the Specifications.

Additional payment will be made under item PSDM 8.3.12 if overhaul is applicable to subitems (a)(i), (a)(iii) and (c) above.

PSDM 8.3.20 Scarify, mix and compact existing layerworks (top 150 mm) ..... **Unit : m³**

This item applies to areas where the new road levels will be higher than the existing. The rate shall cover the cost to scarify the existing tar and base to a depth of 150 mm, mixing it with some of the new material (base or subbase), shaping it to the new levels and lines and compacting the layer to 98% of the MOD AASHTO density.

PSDM 8.3.21 Benching into existing layerworks ..... **Unit : m**

The rate shall cover the cost for neatly cutting through the existing tar and benching into the existing road layers as shown on the drawings.

PSDM 8.3.22 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 tying the new layerworks to the existing.

PSDM 8.3.23 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 8.3.24 Extra over item PSDM 8.3.5 for soilcrete backfill ..... **Unit : m³**

The unit of measurement shall be the cubic metre of soilcrete place where so ordered by the Employer's Agent.

The tendered rate shall include full compensation for selecting, mixing and placing of the soilcrete as well as for the cost of shuttering that may be required all in accordance with the specifications of PSDB 3.5.

PSG CONCRETE (STRUCTURAL)

PSG 2 INTERPRETATIONS

PSG 2.4 **Explanation of Terms**

Add the following:

"PSG 2.4.4 Precast concrete

Concrete components of the general quality described in this specification, which have been cast and cured either elsewhere or on the site and placed in position to form an integral part of the structure."

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 ordinary Portland cement, CEM 1 42,5 according to SABS ENV 197-1, may be used.

Should the contractor wish to use any other type of cement he shall obtain the Employer's Agent's prior written approval (see 8.1.3.2 and 8.1.3.3)."

PSG 3.2.3 Storage of cement

Add the following:

"Cement shall not be stored for longer than 12 weeks without the permission of the Employer's Agent."

PSG 3.4 **Aggregates**

PSG 3.4.3 Storage of aggregates

Add the following:

"Where aggregates of differing chloride content are stored on the site, the use thereof in the various classes of concrete, shall be strictly controlled."

Add the following subclauses:

"PSG 3.9 **Waterstops**

PVC waterstops shall comply with the requirements of CKS 389."

PSG 3.10 Roofing Felt

Three-ply roofing felt shall comply with the requirements of SABS 92 for type 40 felt.

PSG 3.11 Butyl Rubber Sealing Strips

The dimensions of the sealing strip for use in the reservoir are shown on the drawings. The strips shall have a factory-applied bonding layer on one side.

The strip shall have an elongation at break of not less than 300 % and a tensile strength of 8,0 MPa. The sealing strip shall be permanently bonded to the prepared concrete surface, in accordance with the manufacturer's instructions.

The completed joint shall be guaranteed to be 100 % watertight and to be resistant to the long term effects of chemically treated water.

PSG 3.12 Alkali-Aggregate Reaction

Malmesbury hornfels (shale) or other potentially reactive aggregate shall not be used in conjunction with a high alkali cement in concrete in any part of the Works. For the purposes of this clause, a high alkali cement is one in which the equivalent alkali content (Na_2 O equivalent) exceeds 0,60 % by mass of cement.

In order to ensure that the above requirement is met, the Contractor may elect to use a non-reactive aggregate, that complies with the requirements of SABS 1083. Alternatively, if the Contractor chooses to use Malmesbury hornfels or other potentially reactive aggregate, he shall comply with the following requirements regarding the cement:

a) Before commencing any particular section of the structure, the Contractor shall ensure that he has enough cement that is not a high alkali cement to complete the section.
b) Certificates stating the alkali content of each delivery of cement to the Site shall be supplied by the Contractor. These certificates shall be based on tests carried out at a laboratory approved by the Employer's Agent. The cost of testing, including sampling, transporting of samples, and issuing of certificates, shall be borne by the Contractor.
c) The Contractor shall be entitled to use an approved brand of cement as a means for ensuring that the permissible alkali content is not exceeded. The Contractor shall make allowance for the higher price of such brand, if he chooses to use this method.
d) High alkali cement delivered to the Site shall be rejected, and the cost of its removal and replacement with cement with an acceptable alkali content shall be borne by the Contractor.

PSG 4 PLANT

PSG 4.1 **General**

Add the following subclause:

"PSG 4.1.1 Minimum plant

The Contractor shall have available and in sound working order the following minimum plant for the construction of the concrete reservoir:

(a) Two concrete mixers each of sufficient capacity to complete a circular 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 of which at least one 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 the 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 the commencement of every major concrete-placing operation.

Should the plant used for placing concrete for the reservoirs be electrically or mechanically powered, then he shall also provide some other approved, non-electrically powered standby means for the placing of concrete at an adequate rate in the event of a power or mechanical failure of the main plant.

Where the Contractor elects to place a crane inside the circumference of the reservoir wall for the duration of the period of construction, he shall communicate with the Employer's Agent in good time to ensure that the design and layout of the panels which form the roof slab and floor allow for such positioning of the crane. Where sections of the roof and floor have to be redesigned to accommodate the crane, the costs of such redesign shall be borne by the Contractor."

PSG 4.5 **Formwork**

PSG 4.5.1 Design

Add the following:

"Any or all formwork or scaffolding required for any part of the works shall be designed by the Contractor, and before commencing with the erection of any formwork or scaffolding, the Contractor shall submit to the Employer's Agent, for approval, the methods which he proposes to use. The Employer's Agent shall have the authority to order any alterations to the design or in the sizes of any part of the formwork or scaffolding which he may consider necessary. The fact that the Employer's Agent approved or has altered any part shall not be construed as to relieve the Contractor of his responsibility with regard to the strength and stability of the formwork or scaffolding."

PSG 4.5.3 Ties

Add the following:

"No plugs, bolts, ties or clamps of any description used for the purpose of holding the formwork will be allowed to project into or through the concrete unless with the express permission of the Employer's Agent.

Only approved tie-rods which consist of solid rods (which remain embedded in the concrete) and have removable ends shall be used to hold the formwork of the reservoir walls. The removable tie-rod ends shall be such that they can be removed without damaging the concrete, and no permanently embedded parts of such tie-rods shall have less than 50 mm cover to the finished concrete surface.

The cavities left in the concrete after the tie-rod end cones have been removed shall be soundly caulked with 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 the special tie-rods as well as filling the cavities left by the tie-rod cones shall be included in the rates tendered for formwork under the appropriate pay items.

On no account shall formwork be secured to reinforcing bars."

PSG 5 CONSTRUCTION

PSG 5.1 **Reinforcement**

PSG 5.1.2 Fixing

Add the following:

"The Employer's Agent will inspect the reinforcing after it has been fixed in place, the formwork has been cleaned, cover blocks have been positioned, and before concreting commences. Welding of reinforcing steel will not be permitted."

PSG 5.1.3 Cover

Add the following:

"The distance between pipes cast into the concrete and the reinforcing shall nowhere be less than:

(a) 40 mm or

(a) 5 mm plus the maximum size of the coarse aggregate, whichever is the largest."

Add the following:

"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, slabs, etc. The propping may be required simultaneously on more than one level directly underneath one another. The requirements for continuous propping and/or backpropping shall be calculated to a theoretical model that is acceptable to the Employer's Agent, and details shall be submitted for the Employer's Agent's approval. Data required for such calculations, eg design loads and structural dimensions, will be supplied by the Employer's Agent on request."

PSG 5.3 **Holes, Chases and Fixing Blocks**

Add the following:

"Spacer blocks for reinforcing and fixtures may be cast into the concrete provided the strength or any other desirable characteristic (such as the appearance) of the concrete section is, in the opinion of the Employer's Agent, not affected or impaired. Spacers required for ensuring that the specified cover is obtained shall be of a suitable material, shape and design. Spacers shall be durable, shall not lead to corrosion of the reinforcement and shall not cause spalling of the concrete cover.

Only approved concrete spacer blocks may be used in the permanent works. Concrete spacer blocks made on the construction site shall not be used unless they are made and suitably cured under strictly controlled conditions. Ties cast into spacer blocks shall not extend deeper into the spacer block than half the depth of the spacer block. The concrete cover over the projecting ends of ties or clamps shall comply with the

concrete cover requirements for reinforcement.

Concrete spacer blocks shall be of similar concrete grade to the parent concrete. The smallest concrete spacer block dimension must not be less than the specified concrete cover, and the largest dimension must not exceed 1.8 times the cover.

Spacer blocks shall be spaced sufficiently closed together to ensure that the specified cover is maintained during concrete placement.

Plastic spacer blocks shall only be permitted with the approval of the Employer's Agent.

Stones, clay bricks, wood blocks, pieces of broken concrete or bricks shall not be used as spacer blocks to support reinforcing steel."

PSG 5.5 **Concrete**

PSG 5.5.1.5 *Durability*

The exposure conditions for concrete are classified as "very severe".

Add the following values to table 5:

"The maximum water/cement ratio for moderate sections, general reinforced concrete, exterior portions of mass concrete, as well as for internal concrete in buildings under conditions of very severe exposure, is 0,45".

Notwithstanding the aforementioned, the cement content may under no circumstances be less than:

Structural concrete of ≥ 25 MPa - 265 kg/m^3
Exposed concrete and trafficable surfaces - 280 kg/m^3

PSG 5.5.1.7 *Strength Concrete*

Add the following:

"The concrete mixes shall be designed by the Portland Cement Institute or similar approved laboratory.

The shrinkage of concrete to be cast in floor systems, shall not exceed 0,02 % tested as per SABS 1085. Three tests shall be conducted on the mix design to confirm compliance. Test results shall be made available before the concrete is used on site."

PSG 5.5.3.2 *Ready-mixed concrete*

Add the following:

"The Contractor shall confirm that sufficient continuous supply of concrete is secured to complete the portion of concrete work in one continuous pour."

PSG 5.5.7 Construction joints

Add the following:

"Horizontal construction joints are permitted in the reservoir walls, but must be clarified with the Employer's Agent in advance."

The wall shall be cast in lifts of such height that each lift can be poured without interruption in one continuous operation during normal working hours.

A payment item is provided to cover the costs (if any) of ensuring the watertightness of construction joints. It is the contractor's responsibility to ensure that such joints are watertight. The contractor's proposed method for ensuring the watertightness of such joints shall be submitted to the Employer's Agent for his approval."

PSG 5.5.8 Curing and protection

Add the following:

"Should a curing compound be allowed by the Employer's Agent then it shall be a resin based curing compound. Curing of columns, shafts and walls shall be done by either retaining the formwork for the

required period of time or covering with plastic sheeting. On lesser shafts and walls the Employer's Agent may allow a curing compound for curing."

PSG 5.5.11 *Watertight concrete*

Add the following:

"The minimum cement content for OPC in water-retaining structures shall be 325 kg/m3, while the maximum shall be 400 kg/m3 in reinforced concrete, or 500 kg/m3 in prestressed concrete. Where OPC blended with PFA is permitted, the maximum cement content shall be 450 kg/m3 for reinforced concrete, and 550 kg/m3 for prestressed concrete.

The maximum water:cement ratio for water-retaining structures shall be 0,53 for OPC."

PSG 6 TOLERANCES

PSG 6.2 **Permissible Deviations**

PSG 6.2.3 Specified permissible deviations

Add the following:

"Degree of accuracy II is applicable.

Every permissible deviation is binding on its own. The accumulative effect of permissible deviations will not be considered. The maximum permissible vertical deviation is subject to the other permissible deviations."

Replace subclause 6.2.3(d)(5) with the following:

	Permissible deviation Degree of accuracy		
	III	II	I
	mm	mm	mm
"Vertically, per metre height	5	3	2
subject to a maximum of	50	30	10

None of the prescribed permissible deviations will be taken as permission for violating any legal boundaries of properties by any part of a structure.

The above permissible deviations also apply to slip-form concrete, unless another set of permissible deviations have first been accepted by the Employer's Agent, in writing. Such amended permissible deviations shall clearly make provision for interfaces between structures erected with the aid of slip-form concrete and those erected with the aid of conventional concrete.

The maximum permissible deviation from a 3 m long straight line connecting two points on the surface of a finished floor is 5 mm."

PSG 7 TESTS

PSG 7.1 **Facilities and Frequency of Sampling**

PSG 7.1.1 Facilities

Add the following:

"The contractor shall provide the facilities necessary to test the concrete cubes made at the frequency specified in subclause 7.1.2.

The facilities shall consist of sufficient storage capacity and the testing of cubes:

(a) by means of an approved, calibrated cube testing press installed on site in a manner approved by the Employer's Agent, or
(b) by an approved laboratory.

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

PSG 7.1.2.1 Replace the wording 'each sample being sufficient for 3 cubes' in the first paragraph with the following:

'each sample being sufficient for 6 cubes'

PSG 7.2.4 Early-Strength Testing

Add the following:

Three cubes of each sample shall be tested at the age of 7 days.

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."

Add the following acceptance test for watertightness of the tank:

"TESTING FOR WATERTIGHTNESS

The structure shall be filled with water being gradually let in until the top water level has been reached. The water level will then be carefully noted and recorded by the Employer's Agent in relation to a fixed bench-mark, and the structure shall be allowed to remain filled for a period of two weeks to permit complete absorption of water by the concrete. This period may obviously be shorter should an earlier test prove to be successful.

Any loss of water which may have occurred shall then be made up by again filling the structure to the top water level and by allowing to be watertight if the drop in level in 96 hours (less the drop caused by evaporation) does to represent more than 0,06 % of the volume of the reservoir.

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.

The Contractor may attend the taking of all measurements by the Employer's Agent.

In the event of an appreciable leakage being evident or visible at any stage of the filling or testing, or in the event of the final degree of watertightness being unsatisfactory, the contractor shall, when so ordered by the Employer's Agent, discontinue such filling or testing and shall, at his own expense, take approved steps to rectify the leakage, until a test proves that a sufficient degree of watertightness has been obtained.

The costs of retesting the reservoir for watertightness shall be borne by the Contractor."

PSG 8 MEASUREMENT AND PAYMENT

PSG 8.3 **Measurement and Rates**

PSG 8.3.1 & PSG 8.3.2 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 authorized by the Employer's Agent.

The unit of measurement for welded steel fabric shall be the kilogram of fabric reinforcement in place and the quantity shall be calculated from the netto area covered by the mesh, excluding laps.

Clips, ties, separators, stools and other steel used for positioning reinforcement shall not be measured, unless shown on the bending schedules.

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 8.9 **Apply Sika Mono Top -620 to channel wall and floor** ..... **Unit : m^2**

The tendered rate shall make full compensation for all labour and materials and the preparation of the concrete surface for application of the Sika product. The application of the product shall be strictly according

to the manufacturer's specifications.

PSG 8.10 **Testing for water tightness**.....**Unit : No**

Various structures will be scheduled. The rate will include full compensation for the successful water tightness test in accordance with PSG 7.3.

The water tightness test will be paid by a lump sum separately for each structure.

The tendered sum shall make full compensation for all labour, equipment, water and materials to carry out the tests as specified in PSG 7.3, to rectify faults and to achieve a test result to the satisfaction of the Employer's Agent.

The sum shall include for all water required for the successful watertight testing of the structure.

PSG 8.11 **Brickwork and Plasterworks**.....**Unit : m^2**

Building work shall be carried out in accordance with SANS 2001-CM1 and the specification and drawings.

8.11.1 Bricks

Bricks shall comply with SABS 227:2007 and shall be of the class scheduled or shown on the Drawings.

Satisfactory proof of the load-bearing capacity of the bricks offered shall be submitted before deliveries are made to the Site.

Three samples of each type of brick shall be submitted to the Employer's Agent for approval. All subsequent deliveries shall be of a standard equal to or better than that of the approved samples.

Wall ties shall be of the galvanised, crimped, single-wire type with a 3,15 mm diameter, and shall comply with the requirements of SABS 2001-CM1.

8.11.2 Construction of Brickwork and Plasterwork

8.11.2(a) Cement mortar

Cement mortar shall, unless otherwise specified, consist of 1 part of Portland cement to 4 parts of sand by volume for normal brickwork and 1 part of Portland cement to 3 parts of sand by volume for reinforced 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.

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 until it is used to prevent it from setting.

8.11.2(b) Brickwork

Dimensions of all the brickwork shall be set out and built as shown on the Drawings. 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.

Brickwork shall be carried up in a uniform manner with no portion being raised more than 1 m above an adjacent portion. All perpends, quoins, etc, shall be kept strictly true and square and the whole properly bonded together.

Brickwork shall be built in stretcher bond or english bond as shown on the Drawings, and bats shall not be used except where required for the bond. All joints shall be 10 mm wide and four courses shall measure 320 mm.

Brickwork for cavity walls and solid walls built in stretcher bond shall be tied with wall ties placed not more than one metre apart in every third course, 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 Employer's Agent.

8.11.2(c) Reinforced brickwork

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 4 courses or as shown on the Drawings. Reinforced brickwork shall continue at least 300 mm on each side of the openings.

Brick lintels shall be built upon rigid temporary supports left in position for not less than 7 days after brick-laying. Prestressed concrete lintels may be used where approved by the Employer's Agent.

8.11.2(d) 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.

8.11.2(e) Damp-proofing

A damp-proof course shall be 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.

8.11.2(f) 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.

8.11.2(g) Plaster coats

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.

8.11.2(h) Thickness

The total thickness of the plaster finish shall be 13 mm minimum and 20 mm maximum.

8.11.2(i) Workmanship

All plaster work shall be finished smooth and ready to receive paint. Plaster shall be flush with the faces of all switch 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.

The plasterer shall cut out and make good all cracks, blisters and other defects and leave the plaster work, on completion, in a state which is acceptable to the Employer's Agent.

8.11.2(j) Measurement and payment for brickwork and plaster work will be as follows:

a) Brickwork:

(i) (Thickness, type and class indicated) ..... **Unit : m²**

(ii) Etc for other thicknesses, types and classes

The unit of measurement shall be the square metre of each type of brickwork built, calculated from the leading dimensions of the brickwork. Areas of pipes, etc, built into brickwork shall not be included in the areas measured. 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, the building-in of conduits, beams, lintels, pipe sleeves, doors, windows, the raking-out of joints, damp-proof course, brickforce reinforced as specified, etc.

b) Plaster Work:

(i) (Thickness of plaster and finish indicated) ..... **Unit : m²**

(ii) 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 plaster work, including the supply of all materials, mixing, applying, finishing, forming reveals, joints, narrow widths, rounded angles, v-joints, etc, complete as specified.

PSG 8.12 **Break into existing concrete channel wall**

Various items will be measured.

The tendered rate shall include full compensation for all excavation, labour and material to break into the existing channel wall and the disposal of the surplus material. The tendered rate shall also include the placing of sand bags to divert the flow if necessary.

PSG 8.13 **Break into existing channel inlet, modify channel and make good** ..... **Unit : Sum**

The tendered rate shall include full compensation for all labour and material to break into the existing channel inlet, all excavation, the disposal of all surplus material, the modification of the channel inlet to accommodate the new 825 mm dia pipeline into the new concrete wall, all formwork, concrete (reinforcement measured elsewhere) and the casting of the new pipeline into the new channel wall. The tendered rate shall also include the application of Sika Grout 121 around the pipeline before casting the pipeline into the channel wall.

PSG 8.14 **Preparation of existing concrete surface (top of channel)**..... **Unit : m²**

The tendered rate shall include full compensation for the delivery and supply of all material and labour to scabble the top of the existing channel wall and to apply a wet to dry epoxy to the top of the scabbled surface. The bonding agent shall be SikaTop-Armatec 110 EpoCem (or similar approved).

PSG 8.15 **Sand blasting of channel wall and floor to expose aggregate** ..... **Unit : m²**

The tendered rate shall include full compensation for the supply and delivery of all material and labour to sandblast the channel walls and floors before the application of Sika MonoTop-620.

PSG 8.17 **Cast in pipes with or without puddle flanges** ..... **Unit : No**

Various pipe diameters and wall thicknesses will be measured.

The tendered rate shall make full compensation for casting the pipe into the wall including grouting (if necessary), supplying and installing joints as per the detail drawing, adapting of formwork around the pipe and ensuring a watertight seal. Puddle flanges and other couplings are measured elsewhere.

PSG 8.22 **Dowels** .....**Unit : No**

Installation of dowels will be measured by number.

The Contractor shall prepare the existing surface where the concrete joins as follows:

(i) Scabble the entire area thoroughly, to expose the coarse aggregate or rock.
(ii) Install galvanised steel dowels along the length of the joint.
(iii) The dowels shall be installed minimum of 450 mm deep into the existing concrete or rock using Sika AnchorFix-2 or Hilti-HIT-HY150, or equal, approved epoxy grout approved by the Engineer and 800 mm deep into the new concrete area.
(iv) Wash and clean the entire contact area.
(v) Immediately before casting, and in accordance with manufacturer's instructions, apply wet to dry epoxy to the entire contact area.

The rate shall cover the cost of all materials, including the dowels and epoxy grout and all labour and plant to execute the work as specified.

PSG 8.23 **Preparation of existing concrete or rock surface** .....**Unit : m²**

The tendered rate shall include full compensation for the delivery and supply of all material and labour to scabble the top of the existing rock or weir and to apply a wet to dry epoxy to the top of the scabbled surface. The bonding agent shall be SikaTop Armatec 110 EC (or similar approved).

PSG 8.24 **Benching in large manholes**.....**Unit : No**

The tendered rate shall include full compensation for supplying, mixing, placing, forming to the required shape and slope as shown on the drawings, including all labour required to construct the benching of 25 MPa concrete with 20 mm 1:3 cement mortar finished with 3 mm thick layer of Sikagard-720 EpoCem and 2 No coats of Sikagard 63 N or similar approved for large diameter manholes. Materials shall also comply with the requirements of SABS 1200 LD and sand shall be of dolomitic origin.

PSLB BEDDING (PIPES) (1983)

PSLB 3.1 **Selected Granular Material**

Replace the contents of this subclause with the following:

Selected granular material shall be an aggregate, sand or granular material, all of a non-cohesive nature (Non Plastic (NP)) and free from any organic material, of which the grading analysis shows 100 % passing a 13,2 mm sieve and not more than 5 % passing a 0,075 mm sieve.

PSLB 3.2 **Selected Fill Material**

Replace the contents of this subclause with the following:

The requirements of PSLB 3.1 shall apply mutatis mutandis.

PSLB 3.3 **Bedding**

Add the following:

"PVC-U, PVC-O, GRP and HDPE pipes are considered to be flexible pipes for the purpose of this subclause."

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 3.4.3 Samples (new clause)

The Contractor shall deliver samples of materials as described in subclause 3.1 and 3.2 from sources as described in subclause 3.4.1 and 3.4.2 to an approved laboratory as defined in subclause PSA 7.2 for testing. Testing shall be done in accordance with TMH5 and SANS 3001. The following tests are required:

- TMH5 – MD1 and MD2
- SANS 3001 – GR1, GR10, GR12, GR20, GR30, GR40 and PR5

PSLB 5 **CONSTRUCTION**

PSLB 5.1 **General**

PSLB 5.1.2 Details of bedding

Add the following paragraph.

"The dimension "X" for flexible and rigid pipes as indicated on drawing LB-1 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 Replace "90 %"

with:

"90 % (100 % for sand)".

PSLB 7 **TESTING**

PSLB 7.1 **DENSITY**

Replace the contents of this subclause with the following:

Density testing shall be done in accordance with subclause PS DB 7.1.

PSLB 7.3 SAMPLES (new clause)

Prior to delivery of any bedding material to site, the Contractor shall submit a representative sample with the tests results as specified in subclause PSLB 3.4.3 of the material to the Employer's Agent for acceptance at least 14 days prior to the commencement of bedding operations.

The Contractor shall at his own cost, take another sample of the bedding material and shall arrange for the

testing thereof in accordance with subclause PSLB 3.4.3 when the material is delivered to site. Further sampling and testing shall be done in accordance with subclause PSLB 3.4.3 for every 200 m³ of material from each source described in subclause 3.4.1 and 3.4.2.

PSLB 8 **MEASUREMENT AND PAYMENT**

PSLB 8.1 **Principles**

PSLB 8.1.1 Supply of Bedding Materials Measured Separately

Add the following after the first sentence:

The rate for supply of bedding materials measured separately shall include the requirements and testing costs as described in Clauses 3, 4, 5, 6, 7 in the Standard Specifications and as amended in the Project Specifications.

Insert the following words after the word “placing” in the last sentence: “density testing and grading analysis as per the frequency specified,”.

PSLB 8.1.3 Volume of Bedding Materials

Add the following to paragraph (b):

"The depth of bedding as specified in PSLB 5.1.2 is applicable. The volume of bedding material displaced by the pipeline shall not be included in the calculation of the volume of bedding material."

PSLB 8.1.5 Disposal of Displaced Material

Replace the contents of this subclause with the following: -

"Material displaced by the pipeline and by importation of material from sources other than trench excavation, shall be disposed of outside the boundaries of the site."

PSLB 8.1.6 Freehaul

Notwithstanding what is specified in subclauses 8.2.1, 8.2.2.2, 8.2.2.3, 8.2.4 and 8.2.5, the freehaul distance for disposal of all displaced (surplus) material, shall be unlimited."

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 specification, of delivering it to points alongside the trench spaced to suit the Contractor's methods of working, and of disposing of displaced material outside the site boundaries."

Add the following after the note:

“Bedding material excavated as part of the trench excavation, placed adjacent to the trench and used at the same point as bedding material will therefore not be measured separately, but will be deemed to be included in the rates for trench excavation and the supply, lay and bed of pipelines.”

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:

"Payment for opening up borrow pits and for removal of overburden shall be made under subclause 8.3.4 of SABS 1200 D."

PSLB 8.2.5 Overhaul of Material for Bedding Cradle and Selected Fill Blanket

Delete the contents of this Subclause.

"PSLB 8.2.6 Extra over items 8.2.1 and 8.2.2 for bedding stabilised with 5 % cement ..... **Unit : m³**

The tendered rate shall include full compensation for selecting, mixing, backfilling and compacting the stabilised material to 90 % of modified AASHTO density."

ADD THE FOLLOWING:

"PSLB 8.2.7 Provision of stone/geofabric to deal with water ..... **Unit : m3/m²**

If in the opinion of the Employer's Agent, the Contractor complied with the requirements for dealing with water as specified in PSA 8.8.7, the Employer's Agent 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 Employer's Agent.

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 Employer's Agent.

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."

PSLB 8.2.8 Wrap damp proof course around selected fill blanket.

The tendered rate shall include full compensation for construction of the damp proof course around the fill blanket as shown on the drawings.

PSLD **SEWERS (1982)**

PSLD 3 **MATERIALS**

PSLD 3.1 **Pipes, Fittings and Pipe Joints**

PSLD 3.1.2 Reinforced Concrete Pipes

Replace the contents of this subclause with the following:

Reinforced concrete pipes must be manufactured in accordance with SANS 677 and in accordance with a certified ISO 9001: 2000 quality management system.

Reinforced Concrete pipes shall be of the spigot and socket type, bitumen coated outside with 3 mm thick HDPE lining and shall have watertight socket seals. The minimum class pipe to be used shall be 100 D unless otherwise shown on the drawings or scheduled. The HDPE lining shall comply with SANS 10409:2005: Design, selection and installation of geomembranes. The HDPE lining shall be a cast in liner, Anchor Knob Sheet (AKS), and 1230 knob/m^2 must be cast into the concrete pipe. The knobs must be homogeneously formed with the HDPE liner during the extrusion manufacturing process. The concrete cover of reinforcement on the inside shall be at least 20 mm. Watertight rubber rings or other approved flexible joints must be provided.

The concrete for the reinforced concrete pipes shall be manufactured from dolomitic aggregate. For pipe jacking the pipe shall be purpose made and shall be Class 200 D, and have steel guidance rings, steel collars, pressure distribution rings of medium density fibre and all other required accessories. The Contractor shall supply the detailed design of the pipes for pipe jacking to the Employer's Agent including load strength of the pipe and joint detail prior to construction.

Pipes and manholes shall be handled and stored strictly in accordance with the manufacturer's instructions.

PSLD 3.1.3 AC Pipes

Add the following:

"All AC pipes (FC pipes) shall be double bitumen dipped."

PSLD 3.1.8 Weholite Pipes

Weholite pipes must be manufactured in accordance with EN 13476-1 and SANS 21138 and must form part of an ISO 9001: 2008 quality management system.

Weholite pipes shall be of the structured wall type, 6 m or 12 m long as scheduled and shall have a "watertight" socket seal for diameters up to 500 mm. For diameters 600 mm and greater all pipes shall be extrusion welded in situ by qualified personnel who are PFSA certified with valid PFSA certificates and IFPA welder cards in accordance with the manufacturer's specifications. Acceptance testing of test weld sections will be undertaken in accordance with SANS 10270.

Furthermore, rubber sleeve couplings (Weholite LP couplings) shall also be installed after in situ welding extrusion.

The minimum ring stiffness shall be 4 kN/m² unless otherwise scheduled.

Pipes and manholes shall be handled and stored strictly in accordance with the manufacturer's instructions.

PSLD 3.5 **Manholes, Chambers, Etc.**

PSLD 3.5.1 Bricks

ADD THE FOLLOWING:

"Bricks shall be burnt clay masonry units as per the table below complying with the requirements of SANS 227:2007."

Attribute	**Underground Infrastructure (manholes, catchpits, etc.)**	**Surface Infrastructure (wing walls, headwalls, etc.)**
Class	NFXE (Engineering unit)	FBXE (Engineering unit)
Type	Solid (un-perforated)	Solid (un-perforated)

Nominal Compressive Strength	14 MPa	14 MPa
Dimensions	222 x 106 x 73 mm	222 x 106 x 73 mm
Limits of cold water absorption	Not more than 12 %	Not more than 12 %
Efflorescence	Special grade	Uniform

PSLD 3.5.2 Pre-cast concrete sections

Replace “Drawing LD-5” in the last sentence with “drawings”.

Add the following:

"Sectional spun concrete cylinders shall be manufactured from dolomitic aggregate.

Precast concrete sections with an inside diameter of at least 1 000 mm shall be used for manholes.

The soffits of all inlet pipes in a manhole shall be on the same level unless different levels are shown on the drawings. If the outlet pipe is bigger than all the inlet pipes, it shall have the same soffit level as the inlet pipes. To counteract the effects of buoyancy, all manholes deeper than 2,0 m shall be bedded in Grade 20 MPa/19 mm concrete to dimensions as specified on the drawings. The concrete bases may be partly precast, subject to approval by the Employer’s Agent.”

PSLD 3.5.4 Concrete

Add the following:

“Only dolomitic aggregate shall be used for all concrete items”.

PSLD 3.5.5 Sand

Add the following:

“Only dolomitic sand shall be used for all concrete items”.

PSLD 3.5.7 Step Irons

Delete the contents of this subclause and substitute the following:

"Step irons in AC, concrete ring and brick manholes shall be of the copolymer polypropylene type, such as Calcamite or similar, with a 12 mm dia. high tensile steel reinforced core and shall be of length suitable for fixing in brick, pre-cast concrete or reinforced fibre cement as applicable.

A purpose made HDPE step ladder must be manufactured for Weholite/HDPE manholes in lieu of the normal step irons used in other types of manholes.”

PSLD 3.5.8 Manhole covers and frames

Notwithstanding the requirements of Subclause 3.5.8 all heavy duty manhole covers shall be cast iron (or Securex) as shown on the drawings in accordance with SABS 558.

Add the following:

PSLD 3.5.9 Channels and benching in manholes

“Round and half round AC or vitrified clay pipe fittings must be placed in the manholes as channels when the benching is constructed”.

PSLD 3.6 **Marker Posts**

Replace the words "project specification" with "drawings."

PSLD 5 **CONSTRUCTION**

PSLD 5.2 **Laying and Bedding**

PSLD 5.9.2 Marker Posts

Delete the contents of this subclause and substitute the following:

"Sewer connection ends shall be marked as shown on the drawings."

Add the following clause:

"PSLD 5.11 **Backfilling Around Manholes**

"Material used to backfill around manholes that fall within the road reserve must comply with SABS 1200 LB subclause 3.1. Material used to backfill around other manholes must comply with SABS 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 5.12 **Special water hazards**

The Contractor shall, by means of pumping or any other approved method, deal with the flow effluent in the sewer mains. Any water extracted from domestic sewer shall be piped and discharged back into the sewer system - either into the industrial sewer or the domestic sewer.

PSLD 6 **TOLERANCES**

PSLD 6.1 **General**

Add the following:

“Due to the flat gradients of the sewer all levels shall be set out at least by means of a laser level. For sewer pipes of diameter 600mm and larger, the Contractor must provide the level and position (xyz coordinate) of each pipe laid to the Employer’s Agent within 24 hours of the specific pipe being laid. The deviation must also be recorded and submitted. Under no circumstances may any deviation exceed the maximum allowable angular deflection at a joint specified by the manufacturer.”

PSLD 7 **TESTING**

PSLD 7.2 **Tests and Acceptance/Rejection Criteria**

PSLD 7.2.6 Water-tightness of Manholes

Add the following:

Manholes must be tested for watertightness. 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."

PSLD 7.2.7 Capping strip welding (HDPE lined pipes)

Each capping strip weld must be tested and certified by a certified welder who shall only use appropriate calibrated tools and machinery. A copy of the spark and any other test must be submitted to the Employer’s Agent. All welding and testing to be done in accordance with SANS 10409:2005 and in accordance with the manufacturer’s instructions.

PSLD 8 **MEASUREMENT AND PAYMENT**

PSLD 8.2 **Scheduled Items**

PSLD 8.2.1 Supply, Lay, Joint, Bed (Class…), and Test Pipeline

Add the following word after “bedding,” in the last paragraph: “cutting”.

PSLD 8.2.3 Manholes

Replace the contents of this subclause 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 and 1,0 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 SABS 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

Replace the contents of this subclause with the following:

“Separate items will be listed for connections of different lengths 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.

Connections to sewer pipes and sewer manholes shall be measured separately.

a) Connections to sewer .....**Unit : No**

The rate shall cover the cost for excavation in all materials, supply of and construction of suitable bedding in accordance with SABS 1200 LB 3.1, backfilling, disposal of surplus material, 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, the end cap and the erf connection pipe.”

b) Connections to sewer manhole .....**Unit : No**

The rate shall cover the cost for adapting a standard manhole to accommodate the erf connection pipe, excavation in all materials, supply of and construction suitable bedding in accordance with SABS 1200 LB 3.1, backfilling, disposal of surplus material, supply and installation of the erf connection pipe including the end cap".

PSLD 8.2.11 Connection to existing sewer at:

Replace with the following:

“PSLD 8.2.11 Connection to existing sewer by:

a) Breaking into existing manhole …….. ..... **Unit : No**

Various depth categories shall be scheduled.

The tendered rate shall include full compensation for excavation, breaking into existing manhole, modifying of the benching inside the manhole, dealing with sewage in the live sewer, ensuring the water tightness of the new connection, ensuring that no rubble or soil enter the system and backfilling in accordance with PSLD 5.11.

The contractor shall at no additional cost to the employer execute the work in such a manner that no rubble, soil or water shall enter the existing sewer system, failing by which he shall be held responsible for the resulting remedial work.

Excavation shall be carried out in a manner to avoid uneven side forces.

b) Breaking into existing sewer and building a new manhole …… ..... **Unit : No**

The tendered rate shall include full compensation for locating the existing sewer pipeline, excavating in all materials down to its level and around it, protecting the pipe, disposing of unsuitable and surplus material, shoring and dealing with water if necessary, over-pumping of sewage if necessary to facilitate breaking in, breaking into the pipeline by means of machine cutting, constructing the manhole in accordance with the drawings, connecting the new pipeline to the manhole, importing backfill material and backfill to the provision of all materials, labour and equipment required.

The contractor shall at no additional cost to the employer execute the work in such a manner that no

rubble, soil or water shall enter the existing sewer system, failing by which he shall be held responsible for the resulting remedial work.

Excavation shall be carried out in a manner to avoid uneven side forces.

c) Demolish existing manhole and construct new manhole as per detail drawing ……. .....**Unit : No**

Various depth categories shall be scheduled.

The tendered rate shall include full compensation for demolishing the existing manhole and removal of rubble off site, over-pumping of sewage until the new manhole is constructed, excavating in all materials to the correct level, protecting the existing pipe, disposing of unsuitable and surplus material, shoring and dealing with water if necessary, breaking into the pipeline by means of machine cutting, constructing the manhole in accordance with the drawings, connecting the new pipeline to the manhole, importing backfill material and backfill to the provision of all materials, labour and equipment required.

The contractor shall at no additional cost to the employer execute the work in such a manner that no rubble, soil or water shall enter the existing sewer system, failing by which he shall be held responsible for the resulting remedial work.

Excavation shall be carried out in a manner to avoid uneven side forces.

PSLD 8.2.13 Dealing with sewage.....**Unit : Sum**

The tendered rate shall include full compensation for dealing with sewage in the existing sewers during all connections, crossings and breaking into the pipeline. The tendered rate shall include full compensation for all temporary pipe work, deviations or over pumping as may be required during the construction of the new sewer.

Payment will be made in equal monthly (calculated by dealing the sum tendered by the contract period) intervals for the duration of the contract period.

PSLE STORMWATER DRAINAGE

PSLE 3 MATERIALS

PSLE 3.1 **Culvert Units and Pipes**

(d) Skewed ends

ADD THE FOLLOWING:

*"*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:

"Bricks shall be burnt clay masonry units as per the table below complying with the requirements of SANS 227:2007."

Attribute	**Underground Infrastructure (manholes, catchpits, etc.)**	**Surface Infrastructure (wing walls, headwalls, etc.)**
Class	NFXE (Engineering unit)	FBXE (Engineering unit)
Type	Solid (un-perforated)	Solid (un-perforated)
Nominal Compressive Strength	14 MPa	14 MPa
Dimensions	222 x 106 x 73 mm	222 x 106 x 73 mm
Limits of cold water absorption	Not more than 12 %	Not more than 12 %
Efflorescence	Special grade	Uniform

ADD THE FOLLOWING SUBCLAUSE:

PSLE 3.5 **Geotextiles**

The filter fabric to be used below the gabions and mattresses, as well as for subdrainage, shall comply with the following requirements:

(a) Composition and manufacturing

The synthetic-fibre filter fabric, or geotextile, shall be manufactured from a synthetic polymer processed into a permeable, homogeneous sheet. On account of the temperature and moisture susceptibility of polyamide, this synthetic product is not considered acceptable

(b) Classification:

The geotextile 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. The table below gives the values for the properties:

PROPERTY	GRADE 1	GRADE 2	GRADE 3	TEST METHOD
Penetration Load (minimum), N	3800	2400	1500	3.5 of SABS 0221-1988
Puncture Resistance (maximum), mm	14	26	32	Clause 8114 of COLTO Standard Specifications Standard Specifications
Water Percolation (minimum), $l/m^2/s$	20	20	20	3.7 of SABS 0221-1988
Mass per unit area (minimum), g/m^2	320			3.4 of SABS 0221-1988

Notes: - The standard atmosphere for testing and the preconditioning atmosphere for all geotextile tests

(SABS tests and others) shall have a relative humidity falling within the range of 0 to 80 per cent and a temperature within the range of 15 °C to 35 °C.

The resistance of a geotextile 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 onto the geotextile fixed in the holding device.

(c) Durability

A geotextile is required to comply with the following specifications:

- Resistance to chemical attack

The geotextile 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)

- Resistance to ultra-violet light

  The geotextile shall maintain at least 80% of its original strength after direct exposure to sunlight of 1 500 hours.
- Resistance to rot. The geotextile shall be entirely rot proof and shall not support the growth of algae.

(d) Geotextile evaluation and selection

The Contractor shall, at least 45 days before the installation of the geotextile, submit to the Employer's Agent samples of the geotextile(s) he proposes to use, together with the relevant test results produced by an approved laboratory.

The Employer's Agent may require additional samples and have these tested by another laboratory at his discretion. Such tests will be paid for under the provisional item allowed for, but only if compliance with the requirements of this specification is confirmed.
No extra payment shall be made for providing the samples

(i) ***For river/ erosion protection works underlying gabions and gabion mattresses***
The requirements for Grade 1 geotextile shall apply.

Geotextile of non-woven construction is preferred, and woven geotextiles will be considered only if published data can be provided which show the satisfactory long-term performance of these geotextiles in an environment similar to that in which they are to be used.

Geotextiles, other than non-woven needle-punched material, will be considered only if actual field performance data for geotextiles which have been in use in river protection works for 15 years or longer, can be supplied.

(A typical product with the required track record is Kaytech's Bidim Grade A6)

(ii) ***For subdrainage***

The requirements for Grade 2 and Grade 3 geotextiles shall apply.

A functional evaluation shall be done of the permeability reduction (flow test) after 400 hours by an approved laboratory as per test method described in COLTO Standard Specifications for Road and Bridge Works: 1998 Clause 8114 (b).

The test is conducted on the geotextile in combination with the characteristic soil sample obtained from the site where the geotextile is required.

The permeability coefficient K_{400} of the geotextile-soil system shall be classified according to the following criteria:

SOIL	P (%)	P< = 1,0	1,0 < P < = 7,0	7,0 < P < = 50	P > 50
	D_{10} (mm)	D_{10}> = 0,150	0,095 < = D_{10} < 0,150	0, 007 < = D_{10} <0,095	D_{10} < 0,007
K_{400}	HIGH	K_{400} > = 46,0	K_{400} . > = 19,0	K_{400} . > = 9,0	K_{400} > = 6,0
	MEDIUM	K_{400}< 46,0 AND $K_{400.}$ > = 15,0	K_{400} < 19,0 AND K_{400} > = 6,0	K_{400} < 9,0 AND K_{400} > = 3,0	K_{400} < 6,0 AND K_{400} > = 2,0

K_{400} = permeability coefficient after 400 hours of testing expressed as a percentage of the permeability coefficient at the start of the test.

P = percentage passing through 0,075 mm sieve

D_{10} = the diameter of the grain size, such that 10 per cent by mass is smaller

The geotextile-soil system shall either fall in either the medium or high range of $K_{400.}$ In general the geotextile with the highest value of K_{400} will be specified for use with the particular geotextile-soil combination. In addition, actual experience of field performance will also be considered during the selection process.

Installation conditions with regard to depth, nature of sides of excavation, degree of sharpness of drainage stone, and compactive effort used, shall also be taken into account when the final selection is made. (Typically Kaytech's Bidim Grade A4 should satisfy the Grade 2 requirements of this specification, and is suitable for trench depth less than 2 m, with rough sides or sharp drainage stone, placed with moderate compaction.)

"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 SABS 791. Fittings shall be class 34 heavy duty and shall also comply with SABS 791.

The size of the perforations in perforated pipes shall in all cases be 8 mm in diameter ± 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 SABS 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 5.2 **Bedding and Laying**

PSLE 5.2.2 Pipe culverts

ADD THE FOLLOWING:

"The class of bedding required for the various pipe culverts is shown on the Drawings."

ADD THE FOLLOWING SUBCLAUSES:

"PSLE 5.8 **Construction of Subsurface Drains**

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 be sealed off with a loose concrete cap of class 20/19 concrete, 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 stormwater pipes or culverts.

After all the crushed stone 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 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 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.

PSLE 5.9 **Backfilling Around Structures**

Material used to backfill around manholes that fall within the road reserve must comply with SABS 1200 LB subclause 3.1. Material used to backfill around other manholes must comply with SABS 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 8 MEASUREMENT AND PAYMENT

PSLE 8.2 **Scheduled Items**

PSLE 8.2.1 Supply and lay Concrete Pipe Culverts

Add the following at the end of Subclause 8.2.1:

"The pipe culvert will be measured linearly on slopes overall as laid, with the internal lengths of manholes and the like being deducted. Separate items will be scheduled for pipes of different materials, diameters and, where

relevant, classes and for different classes of bedding and types of joint. The rates shall cover the cost of providing the pipes and jointing materials, and the cost of transporting, laying, bedding, jointing, wrapping joints with geotextile filter blanket, if required, cutting on site, waste and building into manholes, catchpits and headwalls".

PSLE 8.2.2 Supply and lay Portal and Rectangular Culverts

(a) Complete with precast invert slabs

Add the following after the second sentence.

"The tendered rate shall include full compensation for the supply, shaping and compaction of G5 subbase to 97 % Mod AASHTO, 200 mm thick below the invert slab."

PSLE 8.2.8 Supply and installation of manholes, catchpits and the like:

REPLACE THE CONTENTS OF THE ITEM WITH THE FOLLOWING:

"Separate items are listed for manholes and catchpits etc. with reference to depths (increments of 1,0 m) and type. The rate shall cover the cost of any excavation in all material (including disposal of surplus) and backfilling with suitable material in accordance with PSLE 5.9 (including importation of material if required) additional to what is measured under the relevant pipe trench item (refer to SABS 1200 DB 8.2.2 and 8.2.3). The rate shall further cover the cost for building the manholes and catchpits complete as shown on the relevant drawings including manhole covers and frames and grids".

The depth category of manholes and catchpits shall be measured as the difference between the cover level and the deepest invert level."

ADD THE FOLLOWING ITEMS:

"PSLE 8.2.14 Pipes in subsurface drains:

(a) Normal duty uPVC pipes complete with couplings:

(i) (Diameter and whether perforated or not, indicated) ..... **Unit : m**

(ii) Etc for other diameters

(b) Heavy duty fittings:

(i) (Type and diameter indicated) ..... **Unit : No.**

(ii) Etc for other types and diameters

The tendered rates per metre of pipe measured in place along its centre line including the length of fittings shall include full compensation for procuring, furnishing, laying and jointing the pipes as specified.

The tendered rates for fittings shall include full compensation for procuring, furnishing, laying and jointing the fittings as specified, irrespective of the type of fitting.

PSLE 8.2.15 Geofabric (description of type, grade, etc)..... **Unit : m^2**

The filter fabric will be measured in place after installation.

The tendered rate shall include full compensation for procuring, supplying, cutting, overlap, jointing, placing and protecting the filter fabric as specified, as well as for wastage.

PSLE 8.2.16 Crushed stone in subsurface drains: ..... **Unit : m^3**

The tendered rate shall include full compensation for procuring, supplying, transporting and placing the material as specified. The quantity shall be calculated from the authorised dimensions.

Impermeable material will be paid under SABS 1200 DB.

PSLE 8.2.17 Grade 20 MPa/19 mm concrete outlet structures for subsurface drains (including formwork) ..... **Unit : m³**

The tendered rate shall include full compensation for procuring and supplying of all materials, the provision and erection of formwork, reinforcing and the mixing, transporting and placing of concrete.

PSLE 8.2.18 Concrete caps for subsurface drain pipes ..... **Unit : No.**

The tendered rate shall include full compensation for supplying and installing the concrete caps.

PSLE 8.2.19 Jointing with existing network ..... **Unit : Sum**

The tendered sum shall include full compensation for the cost of all labour, plant, materials, excavation, backfilling, compaction and overheads to join the subsurface drains to the existing stormwater network.

PSLE 8.2.20 Break into existing manhole and install:

(a) (State pipe diameter and type) ..... **Unit : Sum**
(b) Etc for other diameters and types

The tendered rates shall include full compensation for the supply of all labour, equipment and materials, for making an opening in the existing manhole, for installing the new pipe in the new opening, for sealing around the pipe, for breaking out the existing benching and channels where required and reconstructing them complete with rendering to suite the new pipe arrangement, for disposal of all debris to the dumping site and for backfilling around the manhole with selected material.

PSLE 8.2.21 Break into existing stormwater pipe, install new pipe and build new manhole:

(a) (State new pipe diameter and type) ..... **Unit : No.**

(b) Etc for other new pipe diameters and types

The tendered rates shall include full compensation for the supply of all labour, equipment and materials, for removing a section of the existing stormwater pipe, for installing the new pipe, for the complete construction of the new manhole, for sealing around the pipes, for disposal of all debris to the dumping site and for backfilling around the manhole with selected material."

PSLE 8.2.22 Brick stormwater canal as per drawings ..... **Unit : m**

The rate shall cover the cost for supply of all materials for the brick canal and bedding, and for bedding, jointing, excavation, compacting, testing for leakage of water, all labour in laying and jointing, together with all backfilling, compacting and removal of excess material. After construction, the canal must be cleaned and tested with water to ensure that no water is standing in any part of it.

The complete cost for the supply and installation of sluice gates as per detail drawings will be measured separately.

PSLE 8.2.23 Supply and install subsurface drains complete ..... **Unit : m**

The unit rate for a sub-surface drainage system shall include full compensation for all excavation; for procuring, furnishing and transporting to the site of the works and installing in accordance with the working drawings and to authorised dimensions, Grade 2 geotextile to PSDM 3.2.5, surrounding lightly compacted 19 mm crushed aggregated to SABS 1083, serviced by a proven and approved high density polyethylene perforated pipe (to PSDM 3.2.6) of nominal diameter 100 mm or more as shown on the detail drawing and protected against infiltration of mortar from above during construction of the paved side drain/or earth-blanket/or precast paving blocks, using a 150 micron polyethylene sheeting which sheeting shall be removed once the backfilling with approved material commences. The rate shall in addition fully compensate for any other material, plant and equipment, and labour required and incidental to the successful installation of the sub-drain including the required excavation. The trench shall be specially protected against the ingress of water as far as practically feasible during the installation process.

PSLE 8.2.24 Pipes in subsurface drains ..... **Unit : m**

The tendered rate by metre of pipe measured in place along its centre line including the length of fittings shall include full compensation for procuring, furnishing, laying and jointing the pipes as specified.

PSLE 8.2.25 Polyethylene sheeting 0,15 mm thick ..... **Unit : m²**

The sheeting shall be measured net within the specified dimensions.

The tendered rate shall include full compensation for furnishing, procuring, cutting, overlap, jointing, placing and protecting the sheeting as specified, as well as for wastage.

PSLE 8.2.26 Geofabric (description of type, grade, etc) ..... **Unit : m²**

The filter fabric shall be measured in place after installation.

The tendered rate shall include full compensation for furnishing, procuring, cutting, overlap, jointing, placing and protecting the filter fabric as specified, as well as for wastage.

PSLE 8.2.27 Permeable material in subsurface drains:

(a) Crushed stone ..... **Unit : m³**

(b) Filter sand obtained from borrow areas ..... **Unit : m³**

(c) Filter sand obtained from commercial sources ..... **Unit : m³**

The tendered rate shall include full compensation for procuring, furnishing and transporting, placing and compacting the material as specified. The quantity shall be calculated from the authorized dimensions.

For payment purposes a distinction shall be made between the difference classes of permeable material.

PSLE 8.2.28 Recover existing spigot and socket concrete pipe ..... **Unit : m**

The rate shall cover the cost of careful excavation to expose the pipe completely, removal of the pipes and transport to new position, cleaning the pipes and backfilling the trench with sand in layers not exceeding 300 mm thickness, including compaction to 100 % of MOD AASHTO density.

PSLE 8.2.29 Relay recovered pipes ..... **Unit : m**

The rate shall cover the cost of handling, laying and bedding, as well as the provision of new rubber rings or insertions, as the case may be.

PSLE 8.2.30 Construct new manhole on existing pipe ..... **Unit : No.**

The tendered rate shall include full compensation for locating the existing stormwater pipeline, excavating in all materials down to its level and around it, protecting the pipe, disposing of unsuitable and surplus material, shoring and dealing with water if necessary, breaking into the pipeline by means of machine cutting, constructing the manhole in accordance with the drawings, connecting the new pipeline to the manhole, importing backfill material and backfill to the provision of all materials, labour and equipment required, as well as costs related to liaison with the relevant authorities.

The contractor shall at no additional cost to the employer execute the work in such a manner that no rubble, soil or water shall enter the existing stormwater system, failing by which he shall be held responsible for the resulting remedial work.

Excavation shall be carried out in a manner to avoid uneven side forces.

PSLE 8.2.31 Modify grid inlets to catchpits with side inlets ..... **Unit : No.**

The tendered rates shall cover all costs to modify existing catchpits with grid inlets in order to also have side inlets. The rate will further include all excavation and backfilling required.

PSLE 8.2.32 Improvements to existing manholes/catchpits ..... **Unit : No.**

The tendered rates shall cover all costs (excluding excavation and backfilling) related to improvements to these structures. Where applicable, specifications will conform to those stipulated on the standard details.

PSLE 8.2.33 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."

PSLE 8.2.34 Brick up pipes ..... **Unit : No**

The tendered rate shall include full compensation for the construction of a double brick wall within the pipe end in a manhole to re-direct stormwater. The rate shall include full compensation for the supply of all materials and labour to construct the wall.

PSLE 8.2.35 Connect subsurface drain to manhole or catchpit ..... **Unit : No**

The tendered rate shall include full compensation for the cost of all materials, labour, compaction and overheads to join the subsurface drains to the new catchpits or manholes.

PSLF ERF CONNECTION (WATER)

PSLF 3 **MATERIALS**

PSLF 3.1 **Pipes, Fittings and Couplings**

PSLF 3.1.4 Polyethylene

Replace the contents of this subclause with PSL 3.7.2

PSLF 3.1.7 Saddles

Replace the contents of sub-item a) and b) with the following:

a) be of a heavy duty Magnum Class 16 Polypropylene saddle with brass DZR insert.
b) be fitted with M10 grade 316 stainless steel nuts and bolts wrapped with two layers densotape.

ADD THE FOLLOWING SUBCLAUSE:

"PSLF 3.1.8 Ferrule

A bronze or galvanised ferrule that can be closed off similar to the "Talbot" standard pattern and in accordance with BS 1400 must be supplied."

PSLF 3.4 BEDDING

Replace the contents of this clause with the following:

Bedding shall be in accordance with SABS 1200 LB 3.1.

PSLF 8 **MEASUREMENT AND PAYMENT**

PSLF 8.2 **Scheduled Items**

PSLF 8.2.1 Provide erf connections complete ..... **Unit : No.**

ADD THE FOLLOWING:

"The length of erf connection will be taken as the shortest distance between the watermain and the erf boundary."

"The rate shall also include for the excavation, backfilling and disposal of the surplus material as well as for the supply and construction of bedding. The rate shall also include the supply and installation of the saddle."

PSLF 8.2.2 Supply, install and test erf connection..... **Unit : m**

ADD THE FOLLOWING:

"The rate shall also include for the excavation, backfilling and disposal of the surplus material as well as for the supply and construction of sand bedding."

PSLF 8.2.3 Supply and installation of specials ..... **Unit : No.**

REPLACE THE CONTENTS OF THE SUBCLAUSE WITH THE FOLLOWING:

"Separate items are listed for specials of each type and size.

The rate shall cover the cost of excavating in all material (including disposal of surplus or unsuitable material), the supply of sand bedding, the supply and installation of specials, the connection to the watermain including all jointing material and testing, as well as backfilling with suitable material including the supply thereof."

PSLF 8.2.8 Marker posts

Replace the contents of this subclause with the following:

The Item will differentiate between marker posts to be placed at newly constructed house connections and marker posts to be provided at existing house connections.

a) At new house connections .....**Unit : No**

The rate for new house connections shall include full compensation for painting identification marks, for manufacturing, installing, and painting marker posts and, in both cases, the cost of listing and submitting a record of the installations to the Employer's Agent.

a) At existing house connections .....**Unit : No**

The rate for marker blocks to be placed at existing house connections shall cover the costs of everything mentioned under (a) above, but also the cost for locating and exposing the end points of the existing house connections.

PSLF 8.2.9 Supply only of water meters with couplings.....**Unit : No**

The tendered rate shall include full compensation for supplying and delivering the following items per connection to the Municipality.

- one meter and strainer as specified
- one stopcock as specified
- two meters length of copper pipe as specified
- all other dezinctified fittings necessary to install the water meter in the meter box as shown on the drawings.

PSLF 8.2.10 Installation of water meters by the Municipality .....**Prov Sum**

The Contractor will pay the Municipality for all work related to the installation of water meters. The stated provisional sum will be used in part to remunerate the contractor for the exact amount paid to the Municipality. No additional payments will be made and all cost incurred by the contractor related to the payment will be deemed to be included in the tendered rate for item PSL 8.2.2."

PSM **ROADS (GENERAL) (1996)**

PSM 2 **INTERPRETATION**

PSM 2.2 **Definitions**

PSM 2.2.45 Sand (cohesionless and non-cohesive)

Replace not more than 10 % (by mass) of nominal aperture size 0,075 mm with "—not more than 20 % (by mass) of nominal aperture size 0,075 mm"
(*COLTO 1998 requirement)*

PSM 6 **TOLERANCES**

Add the following new subclause after 6.3:

PSM 6.4 **Level Control of Road Layers**

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 metreage intervals to coincide with the level pegs or at least every 10m.

PSM 7 **TESTING**

PSM 7.1 **General**

Add the following:

"The random sampling method of TMH *5,* for the spotting of positions, for field density testing will normally be applied by the Employer's Agent Representative. Where an area is obviously of a different quality (such as suspect density), such areas shall be assessed separately by the Employer's Agent. The Contractor shall present the full width of the layer, between the stated linear stake values, for acceptance. Only in exceptional cases will partial widths of layer be accepted for testing."

PSM 7.3 **Routine Inspection and Testing**

PSM 7.3.1 Add the following:

"The request for acceptance of a layer shall be submitted in writing, specifying the exact location of the section and type of layer as well as the Contractor's quality control results. On receipt of all these details the Employer's Agent will arrange for the necessary inspections and appropriate tests to satisfy himself that the road layer complies. Testing will be carried out as expeditiously as possible. The Contractor shall backfill the test holes left in the layer with a similar material to that of the layer tested and compact the material to a similar density. Concrete shall not be used."

PSM 7.3.2 Replace "respective values given in Clause 7"

with:

"respective values given in PSM 7.4 Table 10"

PSM 7.4 **Compaction Control**

Add the following:

"All field-density determinations shall be done in accordance with method C (direct transmission) of method A10(b). Method A10(a) may be used where so instructed by the Employer's Agent. Unless otherwise directed by the Employer's Agent, density testing for layer works shall be carried out within 24 hours of compaction having been completed. For the determination of the dry density the moisture content shall he determined by means of a gravimetric method. Method A10(b) will be the reference method, except where in the opinion of the Employer's Agent the material is of such a nature that, when the method is applied, disturbances will occur which will affect the results. The apparatus shall be properly calibrated, and a valid calibration certificate by a recognised laboratory shall be submitted to the Employer's Agent on demand. The Employer's Agent may insist on recalibration at any stage."

If the Project Specification does not require the Statistical Judgement Plan in respect of compaction, then the Table 10 requirements shall be satisfied for the specified layer and prescribed compaction:

PSM 8 **MEASUREMENT AND PAYMENT**

Add the following new subclause:

PSM 8.2 **Inspection and Testing of a Road Layer**

The cost of refilling and compacting the test holes shall be included in the rate tendered for the construction of that layer.

TABLE 10 ACCEPTANCE LIMITS IN RESPECT OF COMPACTION

			Minimum average relative compaction for the following sample sizes						Minimum value for any single test for the following sample sizes					
Layer	Prescribed Compaction	Unit of measurement for density	4	5	6	7	8	9	4	5	6	7	8	9
Selected layer	90%	Mod. AASHTO density	90.1	90.4	90.6	90.7	90.9	91.0	86.4	86.2	86.0	85.9	85.8	85.7
	93%	Mod. AASHTO density	93.1	93.4	93.6	93.7	93.9	94.0	89.4	89.2	89.0	88.9	88.8	88.7
	95%	Mod. AASHTO density	95.1	95.4	95.6	95.7	95.9	96.0	91.4	91.2	91.0	90.9	90.8	90.7
	100%	Mod. AASHTO density	100.1	100.4	100.6	100.8	100.9	101 0	96.4	96.2	96.0	95.9	95.8	95.7
Subbase *	95%	Mod. AASHTO density	95.1	95.4	95.6	95.7	95.9	96.0	91.4	91.2	91.0	90.9	90.8	90.7
	96%	Mod. AASHTO density	96.1	96.4	96.6	96.7	96.9	97.0	92.4	92.2	92.0	91.9	91.8	91.7
	97%	Mod. AASHTO density	97.1	97.4	97.6	97.7	97.9	98.0	93.4	93.2	93.0	92.9	92.8	92.7
Gravel base	100%	Mod. AASHTO density	100.1	100.4	100.6	100.8	100.9	101.0	96.4	96.2	96.0	95.9	95.8	95.7
	98%	Mod. AASHTO density	98.1	98.4	98.6	98.7	98.9	99.0	94.4	94.2	94.0	93.9	93.8	93.7
	97%	Mod. AASHTO density	97.1	97.4	97.6	97.7	97.9	98.0	93.4	93.2	93.0	92,9	92.8	92.7
Crushed-stone base G1**	88%	Apparent relative dens.	88.1	88.4	88.5	88.7	88.8	88.9	84.7	84.6	84.4	84.3	84.2	84.1
G2 **	85%	Bulk relative density	85.1	85.4	85.6	85.7	85.9	86.0	81.4	81.2	81.0	80.9	80.8	80.7
G3	98%	Mod. AASHTO density	98.1	98.4	98.6	98.7	98.9	99.0	94.4	94.2	94.0	93.9	93.8	93.7
G3	100%	Mod. AASHTO density	100.1	100.4	100.6	100.8	100.9	101.0	96.4	96.2	96.0	95.9	95.8	95.7

Source: COLTO Standard Specifications for Roads and Bridge Works:1998 Table 8305/1

Note:* Applicable to unstabilised and stabilized subbase *(stabilized typically set at 96 %)*
** Where higher values are specified, Appendix B Statistical judgement plan will become mandatory

PSME **SUBBASE (1981)**

PSME 3 **MATERIALS**

PSME 3.2 **Physical Properties**

PSME 3.2.1(d) Regional factor

The regional factor for the area is 0.60.

PSME 3.2.2 Gravel shoulder and gravel wearing course material

Replace the contents of this subclause with the following:

‘‘The material used for the gravel wearing course shall comply with the following parameters as defined in TRH 20; subject to such other requirements involving future upgrading, where so indicated on drawings or directed by the Employer’s Agent:

Maximum Size: 37.5 mm
Oversize Index: 0
Shrinkage Product: 100 to 240 based on linear shrinkage x per cent passing 0.425 mm sieve
Grading Coefficient: 16 to 34 based on (% passing 26,5 mm - % passing 2,0 mm) x % passing 4.75 mm/ 100
CBR: 15 % at 95 % of Mod AASHTO density (soaked)

Where gravel shoulders or staged construction is contemplated for low volume roads (lightly trafficked), a base material as specified in PSMFL 3.2 and PSMFL 3.3 may be required to function as a gravel shoulder and/or wearing course.”

PSME 5 **CONSTRUCTION**

PSME 5.3 **Processing**

b) Heavy grid rolling

Insert the following after the first sentence:

“Research has shown that grid rolling is only effective for material where the Treton impact value is in excess of twenty (20).”

PSME 5.4 **Placing and Compaction**

PSME 5.4.1 Placing

Substitute “the project specification” in the second paragraph of ME 5.4.1 with “ME 6.1.4”

Add the following:

”Where size reduction is required to comply with the specifications, and grid rolling is required to attain such requirements, the process shall be carried out as outlined in PSME 5.3(b) “

PSME 5.4.4 Compaction

Replace the sub-subclause with:

“The sub-base shall be compacted to a density of at least 97 % of modified AASHTO density (or 100 % of modified AASHTO density in the case of sand complying with subclause 2.2 of SABS 1200M and deemed suitable as a subbase under very specific circumstances), unless otherwise specifically indicated on drawings. Gravel shoulders and any gravel wearing course shall be compacted to a density of at least 97 % of modified AASHTO density unless otherwise specified and/or indicated on drawings. “

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."

PSME 7.2.2 Routine Inspection and Testing

Replace the values in Table 3 with the applicable criteria for minimum average density and minimum density value for any single test, for the specified density, based on the number of tests per lot as specified in PSM 7.4.

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 paragraph (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 unless otherwise specified in the project specification."

PSME 8.3 **Scheduled Items**

PSME 8.3.3 Construct the sub-base course/shoulders/gravel wearing course with material from commercial sources or designated borrow areas

Replace the heading of this item with the following:

"PSME 8.3.3 Construct the sub-base course/shoulders/gravel wearing course with material from commercial sources"

Add the following to the payment description paragraph:

"This item shall also be applicable to the construction of sub-base course/ shoulders/gravel wearing course with material from borrow pits selected by the contractor."

PSME 8.3.9 Overhaul (haul exceeding 2 km)

Delete this item.

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^2**

(b) Insecticide ..... **Unit : m^2**

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 Employer's Agent will be measured for payment."

PSMF **BASE**

PSMF 3 **MATERIALS**

PSMF 3.3 **Physical and Chemical Propertiesre**

PSMF 3.3.1 Natural Gravel (Unstabilised or Stabilised)

Substitute the requirements of MF 3.3.1 for unstabilised natural gravel with the following:

Natural gravel, of G4 quality, which is placed in the base shall, after compaction, comply with the requirements of SABS 1200 M 3.3.3.

PSMF 3.3.2 Graded Crushed Stone

Substitute the requirements of MF 3.3.2 with the following:

Graded crushed stone placed in the base shall, after compaction, comply with the requirements for type G1 as specified in 3.3.3 in SABS 1200 M.

PSMF 3.3.3 Graded Crushed Stone and Soil Fines

Substitute the requirements of MF 3.3.3 with the following:

Graded crushed stone that is admixed with soil fines, placed in the base shall comply with the requirements for type G2 or G3 as specified in 3.3.3 in SABS 1200 M.

PSMF 5.4 **Placing and Compaction of a Base other than a Water Bound Macadam Base**

PSMF 5.4.6 Work In Restricted Areas

No additional payment shall be made for work in restricted areas and any relevant costs shall be deemed to be included in the tendered rates.

PSMF 5.9 **Transport**

PSMF 5.9.1 Free-haul

Substitute MF 5.9.1 with the following:

An unlimited free-haul distance shall apply to basecourse material.

PSMF 6 **TOLERANCES**

PSMF 6.1 **Dimensions, Levels, Etc**

PSMF 6.1.2 Grade

Add the following to MF 6.1.2:

In addition to the above-mentioned requirements the surface shall be of such a grade that all surface water shall drain freely to the adjacent kerbs and/or channels, and all subsequent costs to rectify the surface to comply hereto shall be borne by the Contractor.

PSMF 7 **TESTING**

PSMF 7.2 **Process Control**

Substitute "1 500 m^2" with "1 200 m^2", "1 500 m^3" with "1 200 m^3" and "5 000 m^2" with "3 000 m^2" in Table 3 of MF 7.2.

PSMF 7.3 **Routine Inspection and Testing**

Substitute MF 7.3.2 with the following:

No density shall be less than the specified minimum density for the relevant layer.

PSMF 8 **MEASUREMENT AND PAYMENT**

PSMF 8.2 **Computation of Quantities**

Substitute MF 8.2 with the following:

PSME 8.2 shall apply mutatis mutandis.

PSMG **BITUMINOUS SURFACE TREATMENT**

PSMG 3.2 **CURING COAT**

The bituminous membrane shall comprise an invert bitumen emulsion complying with SABS 1260 (eg MSP 1™ or equivalent).

PSMG 3.3 **Bituminous Binder for Double Surface Treatment**

PSMG 3.3.1 Add:

(h) A 5 % SBR modified cationic emulsion using 80/100 penetration grade base bitumen, and of 70 % modified binder content, and conforming to SC-E2 specification for modified emulsions for surface seal (Rubspray 70/5™ or equivalent), shall be used (note: no precoating of aggregate required). Refer to TG1 October 2001, published by the Asphalt Academy c/o Transportek CSIR for details of specification.

(i) An 80/100-penetration grade bitumen modified with SBS polymer and conforming to S-E2 specification for polymer modified binders for sealing applications (COLFLEX S™ or equivalent), shall be used (Note: precoating of aggregate is required).

PS MG 8.1.3 Curing coat

Amend to read:

The nominal rate of curing coat shall be 0,4 litres per square metre net cold bitumen, using an Invert emulsion.

PSMG 8.1.4 Double surface treatment

Amend Table 4 to read:

for nominal size 13,2 mm First coat application 0,8 litres net cold bitumen per square metre;

and Table 5 to read:

for nominal size 6,7 mm Second application 0,8 litres net cold bitumen per square metre.

PSMH ASPHALT BASE AND SURFACING

PSMH 2 **INTERPRETATIONS**

PSMH 2.3 **Definitions and Abbreviations**

Add the following subclause:

PSMH 2.3.18 "Thin Layer Asphalt

Irrespective of mix type or usage, asphalt layers of specified thickness less than 30 mm are considered to serve predominantly functional requirements and fall within the ambit of thin layer asphalt."

PSMH 3 **MATERIALS**

PSMH 3.4.2 Surfacing

Add the following paragraph (a)

"Use 60/70 penetration grade, unless otherwise specified"

Delete paragraph (b) and replace with the following:

"All to comply with appropriate specifications as published in The Technical Guideline: The use of Modified Bituminous Binders in Road Construction, TG1 prepared by the Asphalt Academy of South Africa, and details of appropriate mix provided in suitable project specifications.

(b) Using homogenous polymer modifiers
(i) Styrene-butadienne-sturene (SBS) block copolymers (elastomeric)
(ii) Ethylene-vinyl acetate (EVA) block copolymers (plastomeric)

(c) Using non-homogenous binders
(i) Bitumen rubber (wet method)

(d) High molecular weight waxes from Fischer-Tropsch (F-T) process used in conjunction with (a) or (b) where so specified.

PSMH 3.5.6 Grading

Add the following after first paragraph**:**

"For thin layer asphalt (<=30 mm), use the continuously graded fine mix or such parameters as provided for in Sabita Manual 27 "Guideline for thin layer asphalt wearing courses on residential streets" and/or in project specifications, provided the nominal maximum aggregate size (NMAS) complies with the following requirements:

Layer thickness (mm)	NMAS (mm)
>20<30	9.5 or 6.7
<or = 20	6.7

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. It shall contain no clay, loam or other deleterious matter."

PSMH 5 **CONSTRUCTION**

Add the following to MH 5.1.1:

The application of the prime-coat may only proceed after the written approval of the base by the Employer's Agent and only if the moisture content of the upper 50 mm of the base is lower than 50 % of the optimum moisture content.

PSMH 5.5 **Design of Asphalt**

PSMH 5.5.1 General

Replace the contents with the following:

"The design of the asphalt mixes shall be in accordance with the design guidelines of TRH 8 and relevant guidelines based on recent appropriate research findings."

"For thin layer asphalt implement the requirements of Sabita Manual 27 "Guideline for thin layer hot mix asphalt wearing courses on residential streets" (eg voids in mix (VIMS 3 % to 4,5 %)

PSMH 5.5.2 Marshall criteria

Delete the subclause

PSMH 5.5.6 Mineral Filler Contents

Add the following to MH 5.5.6:

"An active filler content of 0.5 % to 1.5 % by mass shall be used in asphalt base and shall be introduced to the mix prior to wetting with the binder. The use of hydrated lime filler is a prerequisite for use with quartzitic sandstone and where the clay content value of the minus 0.075 mm fraction of the aggregate, approaches 20, (potential for stripping) as determined with the International Slurry Association Methylene Blue Test (also termed "French Test"). This value reflects mg. of solution per gram of the minus 0.075 mm material required to form a blue halo."

PSMH 5.5.7 Approval of Mix

Add the following:

"PSMH 5.5.7.4 Notwithstanding the above, the composition of the mix shall be as follows:

(a) Continuously graded surfacing (percentages by mass) (coarse and medium):

Bitumen Binder content (nominal) 5.7%
Active Mineral filler (nominal) 1.0%
Aggregate..... 93%

(b) Continuously graded fine (nominal 6.7 mm) (islands and sidewalk)

Bitumen Binder content (nominal) ..... 6 %
Active Mineral filler (nominal) 1.0%
Aggregate..... 93%

PSMH 5.6 **Proportioning, Mixing and Transportation of the Asphalt**

PSMH 5.8 **Compaction**

Replace the contents of the second paragraph with the following:

"The asphalt shall be compacted to 93 % of the Theoretical Maximum Density (Rice's Density)".

And

For thin layer asphalt, where cores have been found unreliable, use the Marvil Permeability test to assess level of compaction. A permeability value of less than 3 litres per hour is required for layer thickness >20 mm <30 mm. For layer thickness 20 mm or less apply 1 litre/hour criteria. (test method as per Sabita Manuel 27: Appendix E)

PSMH 5.9 **Joints**

Add the following:

"The paved width shall be such that an allowance is made for up to seventy-five millimeter (75 mm) to be cut

back for the longitudinal point.
Transverse joints shall be cut back in a neat straight line by approximately zero comma three meter (0.3 m) to the full depth and over the full paved width of the layer. The zero comma three meter (0.3 m) shall be measured back from the full depth edge/end of the tapering asphalt layer.

There shall be no deduction in payment for the asphalt removed and spoiled when forming transverse joints at the end of a day's work or longitudinal joints or trimming the outside edge of the complete asphalt course along the kerbs, unless the Employer's Agent considers the wastage to be excessive. Asphalt removed and spoiled at other transverse joints shall be regarded as excessive wastage."

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^3/m^2. '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 6.3.6 Smoothness

"Degree of accuracy 1 is applicable."

PSMH 7 **TESTING**

PSMH 7.2.1.2.3 Asphalt bases and surfacing

In Table 11: Add after Density: (or permeability for thin layer asphalt).

Increase the number of tests per lot (minimum) for aggregate grading, bitumen content Table 11 from 3 to 4 and for density (or permeability in the case of thin layer asphalt) to 6, in order to facilitate a statistical analysis approach.

PSMH 7.2.4 Density testing

Test locations shall be applied in a stratified random sampling manner.

Density tests shall normally be carried out on cores cut from the road. However, for thin layer asphalt, only Marvil permeability tests will be used to assess density. Acceptance will be adjudicated in the following manner:

- If test results indicate "satisfactory" permeability - accept;
- If results yield uncertainty — the layer should be monitored during the maintenance period and retested at the end thereof; and/or implement mineral filled emulsion treatment
- If results indicate unsatisfactory permeability, remedial measures should be considered such as applying a mineral-filled anionic stable mix emulsion (with or without SBR latex as directed by the Employer's Agent- for sidewalks the SBR latex should preferably be excluded if pedestrian traffic cannot be controlled during the curing period), diluted for the correct consistency, and placed by hand squeegee/soft broom. If this is not viable the work should either be accepted with an extended guarantee, or it should be rejected**.**

The cores representing a lot, shall be assessed using statistical methods with the specified lower limit being 93 % of theoretical maximum density, maximum percentage defectives in an acceptable product being 15 % (and using single limits for the constants), unless SANS requirements are re-introduced in the project specifications

All holes left by the coring machine shall be neatly repaired by the Contractor.

PSMH 8 **MEASUREMENT AND PAYMENT**

PSMH 8.1 **Rates of Application and Bituminous Binder Content**

PSMH 8.1.4 Tack coat

Replace the contents of this subclause with the following:

"The tack coat shall be a 30 % spray grade emulsion applied at a rate of 0,55 litre/m^2 for conventional asphalt, or further increased by 0.1 to 0.2 litre/m^2 for thin layer asphalt (tendered rate to be based on 0,7 litre/m^2 "

PSMH 8.1.5 Bituminous Binder Content

Substitute 'nominal' in the first sentence with "net".

Amend MH 8 1 5(a) as follows:
(a) Base 1) Continuously graded (Max. aggregate size 26.5 mm) 4,25 %

Amend MH 8 1 5(b) as follows:

(b) Surfacing 1) Medium continuously graded 4,8 %

PSMH 8.1.6 Mineral Filler

Add the following:

"Only active filler added on the instructions of the Employer's Agent, for the purpose of improving adhesion, preventing stripping or otherwise, will be paid for. No payment will be made for filler added to improve the grading."

PSMH 8.4 **Computation of Quantities**

Delete the first paragraph of subclause 8.4.2 and substitute the following:

"Asphalt surfacings will be measured by area in m²".

Replace the last two paragraphs of subclause 8.4.2 with the following:

"No payment will be made for excess width, wastage, or for asphalt laid in excess of the specified thickness."

PSMH 8.5 **Scheduled Items**

PSMH 8.5.3 Tack coat (state thickness of asphalt to be accommodated)

Add at end:

As per PSMH 8.1.4, different application rates apply when thin layer asphalt is introduced

PSMH 8.5.4 Asphalt (nominal thickness indicated)……**Unit : m²**

Replace unit: t with unit: m^2

Replace first sentence with:

The type of asphalt and the type and grade of bituminous binder will be stated. In addition, where the nominal thickness indicated, is less than 30 mm, it will imply that thin layer asphalt requirements are applicable.

Add at end:

"The tendered rate shall also include full compensation for any wastage."

Add the following items:

PSMH 8.5.9 Asphalt additive –extra-over PSMH 8.5.4……**Unit:m^2**

The type/make of additive and percentage by mass of bituminous binder content required, will be stated

The Extra-over rate to PSMH 8.5.4 tendered, shall include the cost of supplying, hauling and blending of aliphatic synthetic wax modifier at the prescribed percentage by mass.

Where alternative makes to the specified make, and which is capable of meeting the same end result, is permissible, this should be stated in project specifications

Add the following items:

PSMH 8.5.10 Cut existing asphalt and base to a depth of 150 mm..... **Unit : m**

The unit of measurement shall be the metre of asphalt and base cut as instructed by the Employer's Agent. The tendered rate shall include full compensation for all labour, equipment and material to cut the existing asphalt to a depth of 150 mm complete, as shown on the drawings, and to dispose of all debris at a spoil site provided by the Contractor.

PSMH 8.5.14 Extra over item PSMH 8.5.4 for the use of bitumen binder supplied by a refineries outside of the Western Cape Province

(a) Supplying from Kwazulu Natal .....ton (t)
(b) Supplying from the Free State.....ton (t)

The unit of measurement shall be the ton of bitumen imported from the specified province and used on the road as determined and agreed on site with the Employer's Agent, based on the average approved tested binder content of the asphalt mixes as determined on a lot for lot basis.

The tendered rate shall include full compensation for all transportation costs for importing the binder from the specified province. No additional cost for bitumen importation shall be paid and no claims for increased transport costs during the project duration shall be considered."

PSMK KERBING AND CHANNELLING (1983)

PSMK 3 **MATERIALS**

PSMK 3.1 **Concrete**

Add the following:

"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:

"The profile/dimensions of pre-cast kerbs and channels must be in accordance with the details shown on the drawing."

PSMK 3.9 **Bedding Material**

Replace the contents with the following:

"The concrete on which the kerbing and channelling will be placed must be a minimum strength of 15 MPa and thickness specified in the drawings."

PSMK 5 **CONSTRUCTION**

PSMK 5.1 EXCAVATION AND BEDDING

Replace "90 %"

with:

"93 % (100 % for sand)"

PSMK 5.2 **Kerbing and Channeling of Precast Concrete**

Replace the first sentence with:

"Kerbing and Channelling of pre-cast concrete must be placed on a concrete bedding as required in PSMK 3.9".

Add the following subclauses:

PSMK 5.13 **Streetname Kerbing**

Street names must be cast into a full length barrier kerb. The street name must be painted white on a green background and positioned as shown on the drawings or as indicated by the Employer's Agent."

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 7 **TESTING**

PSMK 7.2.1 General tests

Delete this subclause.

PSMK 7.2.2 Alternative tests

Replace the heading and contents of this subclause with the following:

"PSMK 7.2.2 Tests

The Contractor shall carry out a minimum of 3 cube crushing tests per 500 m of kerbing placed. The cost of such tests shall be deemed to be included in the rates tendered for kerbing.

One test shall consist of a set of 6 cubes made with concrete taken from the mixer, the kerbing machine or from any part of the work as ordered.

If, after three cubes of any set of six cubes have been tested after 28 days in an approved laboratory, the average crushing strength is found to be more than 3 MPa less than the specified strength, the kerbing represented by the cubes, will be rejected.

The Contractor may apply for resubmission of the rejected section on the basis of cores drilled from the section and tested for estimated actual crushing strength in accordance with SABS method 865 (excluding Appendix A). The cost of drilling and testing the cores will be for the Contractor's account, regardless 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 8.2 **Scheduled Items**

PSMK 8.2.1 Concrete kerbing

Replace the contents of subclause (b) with the following:

"The unit rate for pre-cast kerbing shall cover the cost of supply of all kerbing, material for jointing (including expansion joints), bedding and backfilling, as well as the cost of all excavating, compacting, testing in terms of 7.2, laying, jointing (including expansion joints), backfilling and the removal of excess material."

Replace "5.8.2" in the third line of paragraph (e) with "5.8.3".

Add the following items:

"PSMK 8.2.14 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 x 100 mm wide). The following saw cut notation and colour shall be used.

Valve	WV	White
Hydrant	WH	Yellow
Electricity	E	Red
Telkom	T	Green"

"PSMK 8.2.15 Remove existing kerbing and:

(a) Dispose of them off Site ..... Unit : m

(b) Re-use them elsewhere on the Site ..... 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 Brick kerbing and channelling bedded in concrete as shown on the drawings:

(a) Radius over 11 m and straight sections ..... Unit : m

(b) Radius up to 11 m ..... Unit : m

(c) Dropped sections for entrances ..... Unit : m

(d) 800 mm long transition sections between brickwork channelling and side inlets ..... Unit : No

The unit rate for brick kerbing shall cover the cost for supply of all materials for the kerbing and bedding, and for bedding, jointing (including expansion joints), excavation, compacting, testing in terms of 7.2, and for all labour in laying and jointing (including expansion joints), together with all backfilling, compacting and removal of excess material."

C3.6.3

PARTICULAR SPECIFICATIONS

C3.6.3: **PARTICULAR SPECIFICATIONS**

The following Particular Specifications are included and forms part of the contract.

TA	**:**	**Fencing**
P1	**:**	**Occupational Health and Safety Specifications (Part C5)**
P2	**:**	**Environmental Management Specifications (Part C6)**

TA FENCING

CONTENTS

PS-TA-1 SCOPE

PS-TA-2 TYPE OF FENCE

PS-TA-3 MATERIALS

PS-TA-4 CLEARING OF FENCE LINE

PS-TA-5 INSTALLING POSTS AND STANDARDS

PS-TA-6 INSTALLING WIRE

PS-TA-7 INSTALLING DIAMOND MESH

PS-TA-8 INSTALLING BARBED-TAPE CONCERTINAS

PS-TA-9 CLOSING OPENINGS UNDER FENCES

PS-TA-10 INSTALLING GATES

PS-TA-11 GENERAL REQUIREMENTS AND TOLERANCES

PS-TA-12 MEASUREMENT AND PAYMENT

PS-TA 01 SCOPE

This is a Particular Specification and covers the erection of new fences, gates etc. All erection of fences gates etc. shall be completed by an accredited and approved installer. The Engineer and Client to approve the installer prior to commencement. The manufacturer shall supply and manufacture fences, gates etc. Only manufacture approved construction material shall be used. Note that the manufacturer of the access gates and gate panels are to be the same.

PS-TA 02 TYPE OF FENCE

The fence shall be a security fence and shall be erected in accordance with the dimensions shown on the Drawings.

PS-TA 03 MATERIALS

PS-TA 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 SABS 280. "Acceptable" in CKS 82 means "acceptable to the Engineer".

Tubular posts, standards and stays shall be hot dipped galvanised in accordance with SANS 32:1997 Table 1 for Type A.1 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 drilled for stay bolts or gate fittings as indicated on the Drawings.

PS-TA 03.2 BOLTS FOR STAYS

Bolts, nuts and washers shall be of mild steel and hot dipped galvanised in accordance with SANS 121:2011 Table 4. 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.

PS-TA 03.3 WIRE

All wire shall conform to the requirements of SABS 675:2009 and shall be class A galvanised, except where otherwise specified below.

(a) Barbed wire

Barbed wire shall be one or both of the following types:

(i) High-tensile grade, oval shaped, single-strand wire, 2,60 mm x 2,00 mm.

(ii) Mild-steel grade, double strand, uni-directional twist wire, each strand 2,50 mm in diameter.

Barbs shall be spaced at not more than 150 mm intervals.

(b) Smooth wire

Smooth wire shall be of the types specified below:

(i) Straining wire shall be mild-steel wire, 4,00 mm in diameter.

(ii) Fencing wire shall be high-tensile-grade 2,24 mm diameter wire.

(iii) Tying wire or binding wire shall be 2,50 mm diameter, mild-steel, class A hot dipped galvanised wire for tying fencing wire to standards and 1,60 mm diameter, mild-steel, class A hot dipped galvanised wire for tying wire mesh to fencing wire.

(c) 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 together 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 barbed tape shall be made of cold-rolled carbon steel hot dipped galvanised to class Z600 (SANS 3575:2008). The concertina clips shall be manufactured from steel strip hot dip galvanised to class Z600.

PS-TA 03.4 DIAMOND MESH

Diamond mesh (chain-link fencing) shall comply with the requirements of SABS 1373. The width shall be as shown on the Drawings, and both edges shall be clinched.

The diameter of the wire shall be 2,5 mm and the mesh size shall be as shown on the Drawings and the wire shall be class A galvanised.

PS-TA 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.

PS-TA 03.6 CONCRETE

Concrete used for fencing shall comply with the requirements of SABS 1200 G.

PS-TA 03.7 WELDED COMPONENTS

Should items be made up of smaller components, welded together, all hot dipped galvanising shall be performed after items have been welded together. No welding shall be permitted on site.

PA 03.8 MOUNTING BRACKETS FOR BARBED-TAPE CONCERTINAS AND COILS

All material such as angle irons and steel flats shall be heavy duty hot dipped galvanised to SANS 121.

PS-TA 04 CLEARING OF 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.

PS-TA 05 INSTALLING POSTS AND STANDARDS

Straining posts shall be erected at all ends, corners and bends in the line of fencing and at all junctions with other fences. Straining posts shall not be spaced further apart than shown on the Drawings. The

height of the posts above the ground shall be such that the correct clearance between the lowest wire and the ground can be obtained.

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 explosives, he will be paid separately for the drilling and blasting operations required.

Corner, gate, end and straining posts shall be braced by means of stays or anchors, as shown on the Drawings. Pipe stays shall be bolted to the posts. Gate posts shall not be used as straining posts, but at each gate post a straining post shall be placed as shown on the Drawings and stayed by means of an anchor consisting of six strands of wire.

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 and shall be planted with the overhang as shown on the Drawings and at right angles to the direction of the fence. After posts and standards have been firmly set in accordance with the foregoing requirements, the fencing wire shall be attached thereto as described below.

PS-TA 06 INSTALLING WIRE

All fencing wire shall be carefully stretched and hung without sag and with true alignment, and care shall be taken not to stretch the wire so tightly as to cause breaking, to pull up straining posts, or to be easily damaged during veld fires.

Each strand of fencing wire shall be securely fastened in the correct position to each standard with galvanised binding wire. The binding wire for each horizontal fence wire shall pass through a hole or notch in the standard, and the ends of the wire shall be wound at least four times around the fencing wire.

At the end, corner, straining and gate posts the fencing wire shall be securely wrapped twice around the post and secured against slipping by tying the end tightly around the wire by means of at least six snug, tight twists. In the case of high-tensile wire, two long windings must first be made before the six tight twists, to prevent the wire from breaking at the first twist. Where smooth wire is used, the loose end shall be bent back and hooked into the opening between the fencing wire and the first winding.
Splices in the fencing wire will be permitted if made in the following manner with the use of a splice tool: The end of each wire at the splice shall be carried at least 75 mm past the splice tool and wrapped snugly around the other wire for not less than six complete turns, after which the two separate wire ends shall be wound in opposite directions. After the splice tool has been removed, the space left by it in the splice wire shall be closed by pulling together the wire ends. The unused ends of wire shall be cut close, to leave a neat splice.

The gaps between gate posts and the adjacent straining posts shall be fenced off with short fencing wires.

PS-TA 07 INSTALLING DIAMOND MESH

Where indicated on the Drawings, diamond mesh shall be stretched against the fence and properly tied to the fencing wire. The diamond mesh shall be secured by means of binding wire at 1,2 m centres along the top and bottom wires and at 3 m centres along each of the other fencing wires, unless shown otherwise on the Drawings.

PS-TA 08 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 0.5m maximum intervals between standards.

Rolls of barbed-tape concertinas shall be joined with 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.

PS-TA 09 CLOSING OPENINGS UNDER FENCES

At ditches, streams, drainage channels or other hollows where the fence cannot follow the general ground contour, the Contractor shall close the opening under the fence by means of horizontal barbed wires 150 mm apart and stretched between additional straining posts as shown on the Drawings. The opening shall be covered with strips of diamond mesh, 1 000 mm wide, fixed to the barbed wires.

In the case of larger streams, the opening below the lower fencing wire shall be closed by means of loose-hanging wire nets as shown on the Drawings. These mats shall be erected at streams only on the instructions of the Engineer.

PS-TA 10 INSTALLING GATES

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.

PS-TA 11 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.

PS-TA 12 MEASUREMENT AND PAYMENT

All measurement and payment items shall include the installation of fences, gates and royalties by an accredited and approved installer. The Engineer and Client to approve the installer prior to the erection of fences, gates etc. The manufacturer shall supply and manufacture fences, gates etc. Only manufacture approved construction material shall be used.

PS-TA 12.01 ERECTION ONLY OF NEW FENCING MATERIAL:

(a) Barbed wire (grade, size and type of wire indicated)..... Unit : m

(b) Smooth wire (grade and size indicated)..... Unit : m

(c) Barbed tape concertinas (coil diameter indicated)..... Unit : m

The unit of measurement shall be the metre of each type of fencing wire and barbed-tape concertinas measured between end posts. Binding wire and wire used for the bracing and anchoring of posts shall not be measured for payment.

(d) Diamond mesh (mesh size indicated)..... Unit : m^2

The unit of measurement shall be the square metre of diamond mesh and the quantity shall be calculated on the prescribed width and the length between straining posts or gate posts, or the length of strips for covering openings under fences, or the length used for the covering of gates.

(e) Corner, end, and straining posts, including anchors
(Type, size and length indicated)..... Unit: number

The unit of measurement shall be the number of posts erected in accordance with the maximum specified spacing or such lesser spacing as authorised by the Engineer.

(f) Standards (length and type indicated)..... Unit : number

The unit of measurement shall be the number of standards erected in accordance with the maximum specified spacing or such lesser spacing as authorised by the Engineer.

(g) Droppers (length and type indicated)..... Unit : number

The unit of measurement shall be the number of droppers erected in accordance with the maximum specified spacing or such lesser spacing as authorised by the Engineer.

The tendered rates shall include full compensation for all excavations, concrete, for the drilling of holes for standards, and for the complete erection of the fence as specified and as shown on the Drawings. The tendered rate for posts shall make provision for the construction of the stays of the types shown on the Drawings.

The quantity of material used shall be determined by measuring the quantities of individual items of material installed in the completed fence. No linear measure of completed fence shall be applicable.

PS-TA 12.02 INSTALLATION ONLY OF NEW GATES:

(a) Single leaf (size and type indicated)..... Unit : number

(b) Double leaf (size and type indicated)..... Unit : number

The unit of measurement shall be the number of new gates erected. A pair of gates shall be measured as one.

The tendered rate shall include full compensation for concrete, locking mechanism and for the erection of the gates complete as specified and as shown on the Drawings. It shall not include compensation for any fencing wire or mesh used on the gate.

PS-TA 12.03 THE DRILLING AND BLASTING OF HOLES FOR POSTS AND ANCHORS:……..Unit: No

The unit of measurement shall be the number of holes for posts and anchors made, in accordance with the relevant detail drawings, by drilling and blasting where excavation by hand tools or pneumatic tools cannot be done economically and only upon approval by the Engineer.

The tendered rate shall include full compensation for drilling and blasting the holes and for all other expenses in connection with the provision, storage, transportation and use of explosives.

PS-TA 12.04 INSTALLATION ONLY OF NEW WIRE MESH FENCE AS PER THE DETAIL DRAWINGS:…Unit: m

The unit of measurement shall be meter in linear length of fence completed as specified by the relevant detail drawings, including standard and intermediate posts but excluding any special posts required. (Refer to PS-TA 12.06 below).

The tendered rates shall include full compensation for all excavations, concrete, anchoring, for the drilling of holes for standards, and for the complete erection of the fence as specified and as shown on the drawings.

PS-TA 12.05 INSTALLATION ONLY EXTRA OVER FOR NEW GALVANISED SECURITY WIRING AS PER THE DETAIL DRAWINGS: ……..Unit: m

The unit of measurement shall be meter in linear length of security wiring completed as specified by the relevant detail drawings.

The tendered rates shall include full compensation for all labour required to construct the security wiring, including supplying and installing all mounting brackets and binding wiring to connect the security wiring to the top of the fence, including all required grouting, if applicable, to fix the units in place.

PS-TA 12.06 EXTRA OVER FOR ERECTION ONLY OF SPECIAL POSTS

(a) Straining posts.....Unit : number
(b) Corner posts.....Unit : number
(c) Etc. .....Unit : number

The unit of measurement shall be the number of similar posts erected in accordance with the maximum specified spacing as indicated on the relevant drawings or such lesser spacing as authorised by the Engineer.

The tendered rates shall include full compensation for all excavations, concrete, for the drilling of holes for standards, and for the complete erection of the posts as specified and as shown on the Drawings. The tendered rate for posts shall make provision for the construction of the stays of the types shown on the Drawings.

The tendered rate shall be for the additional costs, over and above the linear rates tendered in accordance with PA 12.04 above.

PS-TA 12.07 INSTALLATION ONLY OF NEW SECURITY GATES:

(a) Single leaf (size and type indicated)..... Unit : number

(b) Double leaf (size and type indicated)..... Unit : number

The unit of measurement shall be the number of new gates erected. A pair of gates shall be measured as one.

The tendered rate shall include full compensation for erecting and securing the gates, and to complete all work as per the manufacturer's specifications.

PS-TA 12.08 CONSTRUCTION ONLY OF NEW SECURITY FENCE AS PER THE DRAWINGS: ……Unit: m

The unit of measurement shall be meter in linear length of security fencing completed as specified by the relevant detail drawings and manufacturer's specifications.

The tendered rates shall include full compensation for all labour and equipment required to construct, erect & secure the security fence and posts, including supplying and installing additional items such as electrified coils, brackets, etc., to the manufacturer's specifications.

PS-TA 12.09 SUPPLY ONLY OF NEW SECURITY FENCING MATERIAL: ……. Unit **:** as scheduled

The rate shall compensate for the supply only of the fencing materials and delivery to the proposed site of works/Witzenberg Municipal stores.

DEPARTMENT LAND REFORM AND RURAL DEVELOPMENT

CONTRACT NO.: SSC WC 01 (2026/2027) DLRRD

THE APPOINTMENT OF A CONTRACTOR FOR THE CONSTRUCTION OF A SEWER AND STORMWATER PIPE IN NDULI, CERES, UNDER WITZENBERG MUNICIPALITY, IN THE WESTERN CAPE PROVINCE

PART C3 PART 2:

SCOPE OF WORK: MECHANICAL AND ELECTRICAL

PART C3.1: Description of Works

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Section 1: General

1. OVERVIEW

1.1 GENERAL REQUIREMENTS

The following scope of works pertains to the design, procurement, delivery, erection, installation, testing, commissioning, taking-over and closing-out of a holistic and complete project of works by the Contractor, and associated sub-contractors.

All material and labour items required to ensure a complete, functional and compliant project must be provided as part of the tender offer.

1.2 BROAD PROJECT SCOPE

The existing Nduli Screenings Facility needs to be refurbished/repaired with new mechanical and electrical equipment due to vandalism of the existing equipment. This project will be conducted as a subcontract to the main appointed civil contractor responsible for installing a new sewer gravity main in Nduli, that feeds the Nduli Screenings Facility. The broad overall scope for the mechanical and electrical contract, but not limited to, is as follows:

- One (1) automated mechanical front rake screen, complete with ancillary equipment
- Two (2) manual hand rake bar screen, complete with ancillary equipment
- One (1) washer / compactor unit, including ancillary equipment
- One (1) paddle stirrers to fit the vortex grit chambers, complete with submersible grit extraction pumps and associated pipework, complete with ancillary equipment
- One (1) grit classifier, complete with ancillary equipment
- Five (5) handstops to fit in to the specified channels, complete with frames and ancillary equipment
- Associated electrical control (MCC) and instrumentation equipment.
- All other equipment required to link associated systems or equipment for a fully functional installation.

The specifications for each component of the scope of work is detailed below and itemised in the pricing schedule accordingly.

All building work required, including cable trenching and backfilling, specifically by the successful tenderer will be executed by the Main Civil Contractor to maintain a consistent standard of workmanship across the site for civil works. The mechanical contractor must allow for the associated costs and will be required to co-ordinate these requirements within reasonable time to the Main Contractor as not to adversely affect the execution of the civil contract in any way. As indicated in the datasheets, delivery periods of all respective materials shall be indicated for

evaluation in accordance with the expected completion time of the project. Should this negatively affect the completion period, it must so be indicated.

All costs associated with liaison, attendance upon and co-operation with other contractors on the site must be allowed for in the tendered rate in the Pricing Data – Schedule of Prices, and no additional payments will be made on this matter.

2. SITE

The site is located on the edge of Nduli, Ceres, in the Western Cape, at the intersection of the R46 - and Chris Hani Avenue.

Note: The summer temperatures in the area can reach up to 45°C as well as an 75% maximum relative humidity. Equipment must be rated and supplied to suite.

2.1 APPLICABLE STANDARDS

All work carried out, as well as equipment supplied, must fully meet and be in compliance with the requirements of the Occupational Health and Safety Act (Act 85 of 1993) and the Construction Regulations (2014) issued in terms of Section 43 of the Act.

In addition, the latest revisions of the following statutory regulations, laws and obligations as pertaining specifically to any and all electrical work applicable to this specific project are applicable:

- The regulations of the local Supply Authority
- The regulations of the Client, being either Governmental, Municipal, Parastatal or Private
- Local fire regulations
- SANS 10400-A: 2010 – The application of the national building regulations, Part A: General principles and requirements

All references to "SABS" specifications shall be read as "SANS" in light of the recent changes by the South African Bureau of Standards. Where a SANS Standard does not exist or if not applicable, the relevant IEC or BS Standard shall be applicable.

In the event of discrepancy between any of the specifications, regulations and codes of practice, the SANS 10142-1 Code of Practice for Wiring of Premises shall take precedence.

Additionally, the following specifications, whether specifically mentioned, or not, within this document, shall also apply:

SANS 1091: 2012	National colour standards
SANS 10140 :2008	Identification colour marking
SANS 156:2007	Moulded case circuit breakers

SANS 60269-1:2010	Low-voltage fuses, Part 1: General
SANS 60269-4:2012	Low-voltage fuses, Part 4: Supplementary requirements for fuse-link for the protection of semiconductor devices
SANS 1507-1:2007	Electrical cables with extruded solid dielectric insulation for fixed installations (300/500V to 1900/3300V), Part 1: General
SANS 60439-1:2004	Low voltage switchgear and controlgear assemblies, Part 1: Type-tested and partially type-tested assemblies
SANS 60439-2:2006	Low voltage switchgear and controlgear assemblies, Part 2: Particular requirements for busbar trunking systems (busways)
SANS 1973-1:2007	Low voltage switchgear and controlgear assemblies, Part 1: Type-tested assemblies with stated deviation and a short-circuit withstand strength above 10kA
SANS 1973-3:2008	Low voltage switchgear and controlgear assemblies, Part 1: Safety of assemblies with a rated protective short-circuits up to and including 10kA
SANS 60947:2012	Low voltage switchgear and controlgear assemblies
SANS 475:2013	Luminaires for interior lighting, streetlighting and floodlighting – Performance requirements
SANS 10114-1:2005	Interior lighting, Part 1: Artificial lighting of interiors
SANS 10222-5-1-3:2007	Electrical security installations, Part 5-1-3: CCTV installations - CCTV surveillance systems for use in security applications - Installation, planning and implementation requirements
SANS 60793-1-1:2008	Optical fibres, Part 1-1: Measurement methods and test procedures - General and guidance
SANS 10131:2004	Above-ground storage tanks for petroleum products
SANS 780:2009	Transformer Testing
SANS 1084-1/2 : 2014	Electric Motor Standards
SANS 10131:2004	Fuel Tank Design and Construction
SANS 10198:2014	Cable Trenching
SANS 1804:2007	Induction Motors

SANS 62: 2013	Steel pipes
SANS 719: 2011	Electric welded low carbon steel pipes for aqueous fluids (large bore)
SANS 10044: 2004	Welding
SANS 2001 (collection)	Construction works
ISO 12944: 2017	Paints and Varnishes: Corrosion protection of steel structures by protective paint systems
ISO 8501:2007	Preparation of steel substrates before application of paints and related products -- Visual assessment of surface cleanliness
SANS 121:2011	Hot dip galvanized coatings on fabricated iron and steel articles – Specifications and test methods
SANS 32: 1997	Internal and/or external protective coatings for steel tubes - Specification for hot dip galvanized coatings applied in automatic plants
SANS 1123: 2015	Pipe flanges
ISO 4014: 2011	Hexagon head bolts – Product grades A and B
ISO 4032: 2012	Hexagon regular nuts (style 1) – Product grade A and B
ISO 7089: 2012	Plain washers – normal series – Product grade A
SANS 1200 (collection)	Standardized specification for civil engineering construction
SANS 664: 2011	Wedge gate and resilient seal valves for waterworks
BS EN 593: 2017	Industrial Valves. Metallic butterfly valves for general purposes
SANS 1551:2008	Check valves (flanged and wafer types)
ISO 9906: 2012	Rotodynamic pumps -- Hydraulic performance acceptance tests - Grades 1, 2 and 3
ISO 9905: 1994	Technical specifications for centrifugal pumps -- Class I
ISO 5199: 2002	Technical specifications for centrifugal pumps -- Class II
ISO 9908: 1993	Technical specifications for centrifugal pumps -- Class III

ISO 2585: 1975	End-suction centrifugal pumps (rating 16 bar) — Designation, nominal duty point and dimensions
ISO 3661: 1977	End-suction centrifugal pumps -- Baseplate and installation dimensions
BS EN 12756: 2001	Mechanical seals. Principal dimensions, designation and material codes

3. HEALTH AND SAFETY

All work carried out, as well as equipment supplied, must fully meet and be in compliance with the requirements of the Occupational Health and Safety Act (Act 85 of 1993) and the Construction Regulations (2014) issued in terms of Section 43 of the Act.

Refer Appendix A for a detailed health and safety specification.

Please note that the requirements of the new construction regulations 2014 have been in effect from February 2014. The new regulations place additional legal duties upon contractors and sub-contractors. Although this health and safety specification includes much of the content of these new requirements, the contractor will be deemed to be familiar with the requirements of these regulations, and to have factored in all the duties placed upon contractors and sub-contractors in the tender.

A copy of the regulations can be viewed on the Department of Labour's website.

The contractor shall allow for all costs involved, including but not limited to the initial documentation and contracts, compilation of the Health and Safety plan and file, all site inspections and reporting, attendance of site meetings, close out report, etc..

4. PROGRAMME

The required completion date of the project is as soon as possible after appointment and/or as stipulated in the contract conditions. The program must be broken down into various applicable tasks, indicating inter-dependencies with one another, with the critical path clearly highlighted within the program. The program must be submitted within the contractual timeframe with the necessary approval procedure to be followed as well. All sub-contractor work, lead times and deliverables must be included into the program so as to determine the critical path items.

The various tasks must include the periods in which they undertake to effect complete delivery of all material under the contract from the date of placing the order. Tenderers are also to state the period in which they undertake to complete all erection, adjustment, putting into proper working order and testing of all plant and material after receipt of the order from the Engineer to commence erection or after the date of final delivery of material, whichever is later.

When the work must be carried out in conjunction with the work of other Contractors or with that of the Employer, it shall be co-ordinated and arranged in such a manner so as to interfere as

little as possible with the progress of such other work, and so as to offer every reasonable facility to other Contractors or to departmental employees of the Employer.

5. INFORMATION AND DRAWINGS

For the mechanical process equipment, the Contractor shall supply the following information for all equipment prior to procuring to the Engineer for approval:

1. Product Data: Include the following:
    i. Descriptive literature, brochures, and/or catalogs of the equipment
    ii. Motor characteristics and performance information
    iii. Gear reducer data including service factor, efficiency, torque rating, and materials
    iv. Parts list including a list of recommended spare parts
2. Shop Drawings: Include the following:
    i. Manufacturer's installation drawings
    ii. Layout drawings
    iii. Wiring and schematic diagrams
3. Operations and maintenance manual
4. Installation reference list
5. Detailed installation instructions
6. Equipment weights and lifting points.
7. Recommendations for short and long term storage
8. A copy of the manufacturer's warranty
9. A copy of documents proving certification of the Manufacturer's Quality Management System according to ISO 9001 and Environmental Protection Management System according to ISO 14001

Within three (3) weeks after receiving written acceptance of the tender, the Contractor shall supply the following information in duplicate for approval before commencing manufacturing:

1. Working or "Shop" drawings of mechanical process equipment / installation including main and ancillary items of equipment to be installed, as well as all cable and wiring diagrams

2. Working or "Shop" drawings of the indicating the layout of the mechanical equipment at the relevant locations, showing how the equipment is linked to other associated equipment or how it interacts with the other associated equipment
3. MCC layout and single line diagrams detailing all control metering and indication circuits inclusive of a description of circuit operation
4. First round SCADA screenshots

NOTE:

Drawings must be neat and clearly legible. Circuit diagrams must be done on a grid system with elements of control equipment referred to applicable (grid) line numbers in a schedule directly below the relevant control device.

The Contractor shall supply neat and clearly legible As-Built drawings for all mechanical and electrical installations, including mechanical pipework workshop drawings, electrical circuit single line diagrams, solar array installation, MV or LV bulk line (including coordinates). All drawing shall be included in the O&M Manuals.

6. ENGINEERING RESPONSIBILITIES

6.1 Design Services and Activity Matrix

The responsibility for design of the works, per design stage:

- Concept, feasibility and overall process : Employer (Engineer)
- Basic engineering and detail layout to tender stage : Employer (Engineer)
- Final design to be approved for construction stage : Contractor
- Temporary works : Contractor
- Preparation of As-Built drawings : Contractor

6.2 Employer's design

The Employer, through the services of the Engineer, designed the process layout and civil structures required to produce treated effluent that complies with the Water use License for the release of treated effluent to a watercourse as published by the Department of Water Affairs.

Any changes to the process or civil design that the mechanical tenderer may require to suit his particular equipment must be submitted with the tender document. Full details of the changes. Including cost implications (where applicable), must be provided at the time of tender.

6.3 Design brief

The mechanical contractor shall be responsible for the design of his own propriety equipment and systems. All designs shall be done in accordance with good engineering practise, based on the specifications and types of materials specified in the tender document. The Contractor shall

ensure that all equipment designed and/or provided and installed by him shall be of robust construction capable of performing the desired work/duty in an efficient manner.

Although the Engineer may approve drawings and designs of the Contractor, this does not exempt the Contractor from this responsibility. The professional responsibility for such designs shall remain with the Contractor and his Engineer.

6.4 Data submitted at Tender Stage and Preliminary Design Basis

The information called for in this section "C3 Specifications" and/or the Data Sheets and any approved alterations by the Tenderer, as well as the Tender drawings, in the form of diagrams and bound into this document shall form the basis of the final approved design under this section. It is assumed that the Contractor have visited the Site of Works and have satisfied himself as to the means of access and everything affecting the delivery, storage, handling and complete erection and installation of the plant. Preliminary drawings and tender data to be supplied by the tenderer (at tender stage) typically consist of the following:

- Dimensioned scale drawings of the layout of all the plant with information regarding space requirements, loading on supporting structures and major openings to be left in the structure etc;
- Full and detailed description and illustrations or drawings of the plant and ancillaries and of materials used in the construction thereof.

6.5 Construction stage data and drawing

This section shall be governed by the requirements of the Conditions of Contract as defined and amended in "Part C1: Agreement and Contract Data". In addition to this, the Contractor shall supply the Engineer, in triplicate, with the following information within four (4) weeks of the acceptance of his tender for any portion of the Contract:

- Fully dimensioned drawings of the plant;
- The necessary data concerning the geometry of structures housing the plant;
- The positions and sizes of all foundations, bolt holes, openings in walls or floors and all other special features affecting the design and construction of the Works.

This information will be used by the Employer to arrange for the necessary concrete work, foundations, bolt holes, openings for pipes, cable ducts, etc. for the proper erection and installation of the plant under this contract. Any cutting or alteration of structural work arising from inadequate or incorrect dimensions and particulars provided by the Contractor, or through late receipt of such particulars, will be arranged by the Engineer to be carried out at his discretion at the expense of the Contractor under this Contract.

6.6 Guarantee

The Tenderer shall submit performance details of the plant, where called for in the information sheets and these details shall be taken as the guaranteed figures of the performance of the plant.

Should the overall performance of the plant fail to comply with these figures by more than five per cent (5 %), then the Engineer shall have the right to reject the plant, to recover all monies paid to the Contractor under the contract for such plant and to confiscate the surety by way of liquidated damages, whereupon the Contractor at his own expenses shall remove all rejected plant when ordered to do so by the Engineer.

All equipment shall be guaranteed against faulty design, materials and workmanship for a period of twelve (12) months from the date of commissioning. During this period the Contractor shall rectify, at this own cost, any defect which can be attributed to faulty design, materials and workmanship. Normal wear and tear shall be excluded.

7. FACTORY TESTING

The following equipment must be demonstrated in the factory to the Engineer and all equipment necessary to test the performance and operation of said equipment must be provided:

1. Electrical Distribution Boards, if and where applicable.
2. Motor Control Centres (MCCs),
3. Miniature Substations (M/Ss), Ring Main Units (RMUs) and transformers
4. Power Factor Correction Equipment (PFC)
5. Telemetry outstations and programmed SCADA layouts, in conjunction with the MCCs

Before the Engineer is called to witness any testing, the Contractor must test the equipment and integrated control system on his own and confirm in writing to the Engineer that the equipment conforms to specification. Refer to each section of equipment with the project specification for detailed testing requirements.

8. SITE TESTING AND COMMISSIONING

The complete plant as installed must be functionally tested by the Contractor, and thereafter commissioned and optimised to ensure a fully functioning and compliant installation. Due to the nature of the project and the implementation of the installations, multiple commissioning and testing sessions will be held. The Contractor shall allow for all costs involved for such cases, including have all the relevant sub-contractors on site for this.

No section of the plant may be made 'live' until a valid and complete Certificate of Compliance (COC) has been issued for said section of plant.

8.1 Functional tests that must be carried out and recorded must include:

- Phase rotations
- Insulation tests
- Continuity paths
- Routine tests as required per manufacturer equipment
- Energy meter calibration and integration with Client and Supply Authority, where required, including energy meter orientation and functional operation

- Measuring of voltages and currents, including overload protection settings
- Phase balancing for as even distribution as possible
- Site specific levels, pressures, flows
- Performance test of equipment
- All final system setpoints, values, protection settings and other applicable data must be compiled into a singular tabular format and included into the manuals to act as a basis for any further changes in the future.

8.2 **Plant Commissioning and Optimisation:**

It is required that the functional plant be run and further monitored to ensure that it runs at its most efficient point. Setpoint adjustments, protection settings, energy meter analysis and small system changes must all be implemented as part of the Contractor's commissioning responsibility.

Only once the Contractor confirms in writing that both the functional tests and commissioning optimisation exercises have successfully been conducted and that their performance and results are in line with the specification requirements, including providing the relevant data as requested above, can a date be set for the site inspection by the Engineer.

Due to the nature of the project, it is envisioned that multiple testing and commissioning sessions will be done to test and inspect an area's or individual system, by the Contractor. The Contractor shall therefore allow for multiple trips, sessions and inspections, with the relevant personnel present. The work and sites will not all be ready at the same time, and will follow both the final civil program as well as Client spend requirements. Adequate provision must be made in the P&Gs BOQ components to cater for this phased implementation approach and no additional claims in this regard will be entertained.

8.3 **Trail and Operational Period**

Once the plant was commissioned to the satisfaction of the Engineer, the Trial Operational Period shall start and shall consist out of continuous period of operation, free of any troubles, for 28 days. For the entire duration of this period, the Contractor shall have a competent person on site for to operate the installation, make fine adjustments and train the Employer's staff for the operation and maintenance of the plant. With the occurrence of any alarm of fault, the Trial Operational Period shall re-start. No additional costs will be granted to the Contractor for extended operational periods, and all cost involved, including possible penalties, shall be for the account of the Contractor.

At the end of the Trial Operational Period, the Engineer shall inspect the plant in conjunction with the Contractor and Employer, with the purpose of taking over of the works in terms of Clause 10 of the Conditions of Contract for Construction. The Engineer shall only be requested for inspection of the installation once the operational acceptance period is successfully completed without any alarms or faults.

9. **OPERATIONAL AND MAINTENANCE MANUALS**

The Contractor must prepare and supply manuals for the successful operation and maintenance of the installation. A draft of the manual must be submitted before commissioning for approval. The draft must then be corrected, if required, and three sets of the manual must be submitted before first acceptance of the plant will be taken.

A commissioning inspection on-site will not be arranged if a first round of manuals has not been provided and commented on by the Engineer. Note that the Taking-Over Certificate will not be issued unless the final three copies of the operation and maintenance manuals including any amendments have been submitted to the Engineer.

These manuals must contain the following information as a minimum:

Section 1 : System description

A comprehensive description of the system including schematic diagrams, where required for clarification.

Section 2 : Commissioning data

The results of all checks and measurements as recorded during the commissioning period must be included and be compiled in such a manner that every check and measurement is clearly defined.

Section 3 : Operating instructions

3.1 Pre-start checklist for each individual plant.

3.2 Starting and stopping instructions.

3.3 Plant running checklist.

3.4 Safety precautions to be taken.

3.5 Manual operation.

3.6 Operator's duties.

Section 4 : Maintenance instructions

4.1 Schedule of maintenance particulars.

4.2 Part numbers of all replacement items.

4.3 Serial numbers of principal pieces of equipment.

Section 5: Mechanical equipment

The following information shall be provided for all Mechanical equipment:

5.1 Mechanical equipment schedule with make, model number, rating, commissioning setting and name, address and telephone number of the supplier.

5.2 Operating instructions.

5.3 Maintenance instructions.

5.4 Manufacturer's brochures and pamphlets.

Section 6 : Electrical equipment

The following information shall be provided for all electrical equipment whether MV, MCC, PFC or field mounted.

6.1 Electrical equipment schedule with make, model number, rating, commissioning setting and name, address and telephone number of the supplier.

6.2 Operating instructions.

6.3 Maintenance instructions.

6.4 Manufacturer's brochures and pamphlets.

Section 7 : Instrumentation, control and energy system

7.1 Description of each individual control system.

7.2 Control equipment schedule with make, model number, rating, commissioning setting and name, address and telephone number of supplier.

7.3 Manufacturer's brochures and pamphlets.

7.4 Maintenance instructions.

7.5 All setpoints, system settings and protection values in tabular format as per final installed system

Section 8 : Telemetry and SCADA

8.1 Description of each individual outstation including make, model number, rating, commissioning settings and name, address and telephone number of supplier.

8.2 SCADA screenshots, parameter setpoints and basic control functionality.

8.3 Manufacturer's brochures and pamphlets.

8.4 Maintenance instructions.

Section 9 : Drawings

Paper prints or reduced sized prints of all Contractor's drawings for all project components update to "as built" drawings. All drawings shall be formal CAD drawings with all information, dimensions and coordinates (if applicable) indicated on it.

The contract will be considered incomplete until all tests have been conducted to the satisfaction of the Engineer and all drawings and manuals have been handed over to the Engineer.

10. **TRAINING**

The contractor must allow for and include any respective operation and maintenance training required for key management and operations personnel of the client of all components covered in the scope of contract and installation. Allowance shall be made for all critical subcontractor(s) to be part of the presenting team in order to do training on their scope of works.

The training must be conducted for a minimum of five days during the commissioning of the installations, and repeated once more after taking-over for another training session to reinforce the training done. The trainees shall be present for the full 8 hours working day during the train, under supervision of a certified Class V operator and a representative of the Contractor. The Operation and Maintenance Manuals must be used as the basis for the training and the training shall include both theoretical and on-site practical training. An attendance register must be provided and signed at each training session, by all required and present members. It must be included into the O&M Manuals.

As a minimum, the training shall cover the following aspects:

- Theoretical training, including lectures in the theory of sewage treatment, biological nutrient removal technology as implemented in this Contract, and operation of the various configurations.
    - Provision of A0 size laminated, full colour posters of:
        - Layout drawing of the installation;
        - Process flow diagram of the entire facility;
        - P&ID diagram;
        - MV switchgear single line diagram and switching procedures for start-up, shut-down and operation;
        - Separate MCC single line diagrams for each MCC with start-up, shut-down and operating instructions for all operational modes of the relevant equipment;
    - Provision of lecture materials (5 sets) including the above diagrams and procedures in a smaller format;
    - Training of operational staff in the adjustment and determination of the correct setting of the sluice gates, weirs and recycle pumps for the various process configurations.
- Training of the operators in the determination and setting of:
    - bypass facilities;
    - process configurations;
    - structure isolation;
- Training of operators in emergency procedures:

- Power failures;

- Training of operators and maintenance personnel in the operation of MCCs:
  - Control system software and/or timer setting;
  - Alarm conditions and basic fault finding;
  - Motor protection relay and settings.

- Training of operators and maintenance staff in the inspection and maintenance procedures required for all mechanical and electrical equipment:
  - Routine inspection and logging of data;
  - Greasing and oil changes;
  - Planned preventative maintenance.

All associated costs involved with the training sessions must be allowed for, including the time and cost of the persons presenting, the training material etc.

11. TAKING-OVER TESTS

Only on successful completion of the 28 day trial period and the Contractor has confirmed in writing that the functional plant testing and commissioning optimisation has been done, including the first round of Client and operator training, as well as approved manuals are in place, can a date be set for the final taking-over inspection.

Due to the nature of the project, it is envisioned that multiple testing and taking-over test sessions will be done to test and inspect an area's or individual system. The Contractor shall therefore allow for multiple inspections, with the relevant personnel present. The work and sites will not all be ready at the same time, and will follow both the final civil program. Adequate provision must be made in the P&Gs BOQ components to cater for this phased implementation approach and no additional claims in this regard will be entertained.

The Contractor will be required to make suitable arrangements for demonstrating the plant and equipment supplied under this contract in the presence of the Engineer or his representative, to prove it fully complies with the specification. Any or all of the test results must be demonstrated to the Engineer at his request.

A competent person per applicable discipline, fully conversant with all aspects of operation, must be present to carry out the demonstration.

12. DEFECTS LIABILITY PERIOD AND FINAL INSPECTION

After the 1 year/12 month defects liability/warranty period, a final meeting and equipment inspection will be held. Should all inspections prove successful, a final completion certificate will be issued to the contractor and any retention money will be approved and released for payment, the original guarantee returned, culminating in the successful completion of the project.

Section 2: MECHANICAL

1. **GENERAL SCOPE**

The mechanical scope of works consists of the design, supply, transport to site, erection and installation, commissioning and performance testing of the following main components:

- One (1) automated mechanical bar screen, complete with ancillary equipment
- Two (2) manual hand rake bar screen, complete with ancillary equipment
- One (1) washer / compactor unit, including ancillary equipment
- One (1) paddle stirrers to fit the vortex grit chambers, complete with submersible grit extraction pumps and associated pipework, complete with ancillary equipment
- One (1) grit classifier, complete with ancillary equipment
- Five (5) handstops to fit in to the specified channels, complete with frames and ancillary equipment
- All equipment required to link associated systems or equipment for a fully functional installation.

2. **REFERENCE TO STANDARD SPECIFICATIONS:**

The Mechanical Project Specification shall be read in conjunction with the following Mechanical Standard Specifications:

MSS01	Pumping Equipment	Rev 05
MSS02	Pipework and Valves	Rev 06
MSS03	Materials and Coatings	Rev 02
MSS04	Ancillary Equipment	Rev 04
MSS05	Mechanical Equipment for Wastewater Treatment Works	Rev 04

The Mechanical Project Specification shall take preference over the Mechanical Standard Specifications should there be contradictions. The Mechanical Specification shall also be read in conjunction with the Electrical Project Specification and Electrical Standard Specification(s) to ensure integration and allowance made for interfaces that may be required for instrumentation and other electrical equipment.

3. FRONT RAKE FINE MECHANICAL MULTIPLE BAR SCREEN:

3.1 Specific requirements for Front Rake Fine Mechanical Multiple Bar Screens

One new fine, front rake, mechanical bar screen shall be supplied and installed in the existing inlet works. Such screenings would comprise of general gross solids, rags, paper, plastic and organic matter. Refer to the applicable drawings included for the layout of the screenings facility.

The current average flow through the screen will be about 10 l/s and the peak ultimate flow will be 50 l/s. The screen shall be designed to handle a peak flow of 50 l/s of municipal wastewater with no less than 50 mm of freeboard when installed in an 500 mm wide and 800 mm deep concrete channel. Inclination of the bar rack shall be approximately 15° to the vertical. Effective screen area shall have a minimum of 75% free open-area for water flow. The screenings discharge chute shall be above the upper slab level and shall be designed to accommodate the screenings wash press, complete with mounting frame located on the upper level. The screen shall lift and discharge screenings directly into a screening wash press downstream of the screen without use of brushes or spray washers. The bar gaps shall not be more than 6.0mm for the fine screens.

The travel speed of the rakes shall be between 8 and 12 meter per minute.

All parts shall be designed and manufactured to handle the forces that may be exerted on the screen during fabrication, shipping, erection, and proper operation according to the O&M manual.

All components shall be so designed that jamming at any point will not result in structural failure but will cause the drive motor to stall. All components, including the gear reducer, shall be designed to withstand, without damage or permanent distortion, the full stalling torque of the drive motor and/or the maximum differential head at any channel water depth.

Allowance shall be made for all ancillary equipment required for a fully functional system, including all ancillary equipment required. This shall include for all wash water pipework and connections including solenoid valves required.

3.2 General requirements for Front Rake Fine Mechanical Multiple Bar Screens

3.2.1 *Scope of Works*

This part of the specifications covers the design, supply, delivery to site, installation and commissioning of the main and ancillary equipment required for the automated, channel fitted, multiple bar, front rake, fine mechanical screens designed to remove floating or suspended debris from the raw incoming sewage. The screenings would generally consist out of rags, paper, plastics, organic matter, large solids, etc.

The screen shall comprise of (but not limited to) the following basic components:

a) A framework to which all components are attached.
b) A sole plate at the base of the framework.
c) A flat bar rack that will accumulate the screenings.
d) A flat bar dead plate which extends above the bar rack to the discharge chute.

e) An endless chain conveyer system, comprising of two chains and sprocket assemblies, one at each side of the frame.
f) Multiple rakes, attached to the chain conveyer system, to clean the bar rack of accumulated screenings.
g) A pivoting scraper for discharging the screenings from the raking tines.
h) A chute for discharging screenings from the assembly.
i) A drive assembly, which will provide motive power to the chain assemblies for screen operation.
j) The control and instrumentation required for automated operation (as described in the Electrical Specification).

A screen system that requires periodic manual cleaning of the bar rack shall not be accepted. The screen construction shall be robust and simple. The design shall be such that it does not require regular maintenance and only screen of proven ability shall be provided.

The Contractor shall ensure that the equipment offered comply or exceed the requirements set out in the specification and that it is suitable for the application. The Contractor shall make allowance for a fully functional and integrated system, including all interconnecting systems that may be required. This specification shall be read in conjunction with the other Mechanical Standard Specifications whether there are specific references or not.

3.2.2 *General Design Criteria*

The equipment shall meet the following requirements:

a) It shall be designed to facilitate the efficient manufacture, inspection, transportation, installation, maintenance, cleaning and repairs.
b) It shall be designed with a minimum expected life of 20 years of safe and satisfactory operation under the conditions prevailing at the site
c) The design shall prevent undue stresses caused the expansion and contractions due to temperature changes and other local natural manmade conditions.
d) The design shall keep maintenance costs to a minimum
e) It shall be designed to comply completely with the legal requirements in respect of safety and the prevention of environmental pollution.
f) It shall satisfy any specific requirements contained in the relevant statutory codes and legislation.
g) The design shall allow for 24-hour operation, 365 days a year under the specific design conditions.
h) The equipment installed shall be complete and fully operational as per the requirements set out in the Scope of Works.
i) All material used for the equipment shall be suitable for the operation and environment and compatible with the intended use.
j) The design shall allow for suitable treatment to prevent corrosion and erosion of the materials and equipment.
k) After approval by the Engineer, at the time of award of the Contract, the information stated in the Data Sheets shall be fully complied with, notwithstanding the specified scope of the Contract.

l) All electrical equipment, forming part of the specified equipment, as described in the Electrical Specification, shall be sealed against penetration by hose cleaning operations as well as being accessible for repairs and maintenance.

3.2.3 *Materials*

The screen shall be manufactured from at least 304L Stainless Steel (or higher grades) shapes (rods, angles, and channels), pipes, and sheets. All side frames and guides, bar rack, rake assembly, scraper assembly, shafting, discharge chute, fasteners and anchor bolts shall be made of this material. 304 Stainless Steel and lower grade Stainless Steel shall not be accepted. Screen shall be manufactured in a Stainless Steel only factory to prevent contamination of the Stainless Steel with rusty dust.

All Stainless Steel components and structures shall be submersed in a chemical bath of nitric acid and hydrofluoric acid (pickling bath) to remove any residues that may be present on the material as a result of forming, manufacture, or handling. After removal from the pickling bath, the equipment must be washed with a high-pressure wash of cold water to remove any remaining surface debris and promote the formation of an oxidized passive layer which is critical to the long life of the Stainless Steel.

Chains and sprockets shall be made of 316L Stainless Steel. Chain rollers shall be made of polyamide RCH1000.

Lower sprocket bearings shall have a Stainless Steel casing, including a shaft made of white cast iron and a ceramic (silicium carbide) friction bushing. The design shall be as such to prevent grit from entering the bushing system. Proof of such a design shall be furnished on request of the Engineers. Grease lubricated bushes or bearings will not be accepted. Screens utilizing bottom guides or tracks to guide the chain shall not be accepted.

Upper sprocket bearings shall have a paint coated cast iron casing and include ball bearings that are greased for life and shall be double-sealed with Nilos rings.

3.2.4 *Construction*

The bar screen shall remove debris (screenings) from the incoming wastewater by means of a positively cleaned bar rack that is installed in a concrete channel. The screen shall retain debris at the bar rack. A multitude of rake blades shall remove and lift the debris to a discharge mechanism. The bar rack shall be cleaned by a series of rakes engaging the bar rack from the upstream side (front) at the bottom of the channel and then moving up along the bar rack. The debris shall be lifted above the channel and dropped on a discharge chute at the downstream side (back) of the screen. Screens with single rakes engaging in the screenings field at any time shall not be approved. Screens employing brushes and spray water for screenings removal shall not be approved.

The bar rack shall consist of equally spaced, straight tear drop design bars that are inclined from the horizontal with the inclination angle specified above. The bars shall have a minimum thickness of 8 mm on the widest section of the bar. The lower ends of the bars shall match the pattern of the rotating assembly / rake by being curved around the lower rotating assembly shall end parallel

with the channel floor. It shall be provided with a minimum 4 mm thick curved base plate such that the rakes positively remove all screenings from the bottom of the bar rack. The depth of the bars shall be 60 mm. The bar rack shall be securely fastened to the frame of the screen and be readily removable. Trapezoidal or tapered bars shall not be accepted.

The bar screen shall be provided with a dead plate extending from the bar rack to the discharge chute. The dead plate shall be made of a minimum 4 mm thick Stainless Steel plate and shall be stiffened by structural members so that it is flat without undulation so that the tips of the rake's teeth ride at a distance between 1 to 2 mm over the dead plate. The dead plate shall be securely fastened to the side frames.

A discharge chute shall be provided that fully encloses the discharge section of the screen. An access hatch with hinges and a handle shall be provided in the chute permitting easy access. The discharge chute shall be mounted to direct screenings into the appropriate receiving container or conveyor. The chute shall have a slope of minimum 60° to the horizontal. The discharge chute shall be made of a minimum 4 mm thick Stainless Steel plate.

A frame shall be provided supporting all required loads. Side frames shall be made of minimum 4 mm thick 304L Stainless Steel plates with a minimum of four axial edges and shall have a minimum width of 600 mm. The side frames shall be connected with each other through channels having a minimum thickness of 4 mm and a minimum cross section of 100 x 50 mm. The side frames shall be connected to support frames. The support frames shall be securely anchored onto the operating floor. The maximum allowable deflection of the frame at 50 kN at 3000 mm length shall be no more than 1.0 mm.

The screen shall be provided with easily removable, sufficiently stiffened covers made of 1.5 mm thick Stainless Steel plates with edges on all sided. The covers shall be provided with turn locks and handles.

4 mm thick neoprene strips shall be fastened to the side frames to seal the lateral gaps between the side frames and the channel walls.

Each side frame shall include separate roller tracks to guide the rakes. The roller tracks shall be bolted to the frame so that they can easily be replaced. The roller tracks shall be made of 4 mm thick L-profiles.

Drive chains for the rakes shall be roller type chains and shall have links made from 316 stainless steel. The chain bushes and pins shall be made from Duplex Stainless Steel. Each chain shall be rated for a maximum load of 56000N. Drive chains, chain guides, sprockets and their bearings shall be replaceable without the need for removing the screen from the channel. Chain pitch shall be no less than 160mm. Screens utilizing drive chains constructed from alternative materials will not be acceptable for this project due to the corrosive nature of waste-water.

Chain rollers shall be made of polyamide and shall have a minimum diameter of 60 mm and shall be a minimum of 32 mm wide.

Each screen shall be provided with four identical sprockets with a reference diameter larger than 300 mm. The sprockets shall be made of minimum 29 mm thick and as a minimum 304L Stainless

Steel plates. Each sprocket shall be made of two pieces that are flanged to the shaft or bearing. Screens utilizing different materials for the sprocket assemblies will not be acceptable.

Stainless Steel guards shall be provided to partially cover the lower sprockets to provide protection from debris. These guards shall be bolted to the frame.

Upper bearings shall be of the ball bearing type, it shall be greased for life or shall be equipped with grease nipples for lubrication and shall be double-sealed with Nilos rings. Their diameter shall be a minimum of 50mm. The casing shall be made of paint coated cast iron.

Lower bearings shall be of the slide bearing type in a Stainless Steel casing. They shall include white cast iron shafts and silicium carbide slide bushings with a length of 50 mm and an internal diameter of minimum 59 mm. Bearings employing slide bushings made of plastic or metal material and requires greasing shall not be accepted.

Rakes shall include rake bars made of 6 mm thick channel profile having a cross section of 105 x 60 mm. Rake blades with a thickness of 8 mm and a depth of minimum 170 mm shall be bolted on the rake bars. The rake blades shall have teeth matching and engaging the bars of the bar rack. The rake blades shall each consist of several pieces with teeth such that only one of the pieces needs to be replaced in case that a tooth should be damaged.

A pivoting scraper mechanism shall be positioned at the point of discharge and shall be attached to the side frames. The scraper shall clean the rake on each pass and return to its rest position with minimal shock. The scraper shall be designed such that screenings do not wrap around the rake or scraper. The scraper shall be provided with a scraper bar made 4 mm thick channel profile with a minimum cross section of 39 mm x 68 mm and an adjustable 10 mm thick wiper made of Polyethylene. The scraper shall be connected with the frame through a pair of minimum 500 mm long scraper arms that shall be made of 4 mm thick channel profile with a minimum cross section of 68 mm x 59 mm. A pair of shock absorber elements made of neoprene shall be provided.

The drive shaft shall have a diameter of minimum 80mm and a wall thickness of minimum 5 mm. It shall include an integral rocker arm assembly on the drive end that flexes if the screen rakes get jammed.

The rocker arm assembly shall consist of a drive unit mounted to a Stainless Steel arm. The Stainless Steel arm will be held in place by a flanged roller bearing connected to the drive shaft and two heavy duty tension springs. The flange bearing shall be connected to the rocker arm by four bolts. The rocker arm shall be maintained in the standard operating position by the two tension springs. If the screen rakes experience a jam, the force will cause the rocker arm to rotate around the drive shaft, compressing one of the tension springs. This motion shall be limited by a rocker guide. When the rocker arm rotates out of the normal operating position a proximity sensor will send a signal to the PLC causing the motor to enter a self-clearing mode. If the self-clearing mode should prove unsuccessful then the system shall initiate an alarm signal. Screens depending on electronic overload protection devices to safeguard the screen will not be accepted.

The drive unit shall be designed for continuous service and intermittent spray water contact.

The bevel gear reducer shall be a totally enclosed unit. Gear reducer shall have ball or roller bearings throughout with all moving parts immersed in oil. Gear reducers which require periodic disassembly of the unit and manual re-greasing of bearings are not acceptable. The nominal input power rating of the gear reducer shall be at least equal to the nominal horsepower of the drive motor. Gear reducer shall be designed and manufactured in compliance with applicable AGMA or equivalent standards. During continuous operation the oil temperature shall not exceed 95 degrees C.

The rake assembly shall be driven by an electric motor. The motor shall be UL rated for operation in Class 1, Div 2 environment. The motor shall be rated for operation from a -5°C to 40 °C environment, with a humidity up to 95%. It shall be able to operate in both directions of rotation and shall conform to the relevant Standard Specifications.

The equipment shall include all limit switches and protection instrumentation, seen necessary by the Manufacturer to ensure the validity of the warrantee, to prevent damage to the equipment in overloading, etc conditions. The equipment shall have the functionality to operate in forward / reverse to try and dislodge blockages.

3.2.5 *Spare Parts*

The following Spare Parts shall be included and supplied together with the equipment:

- 2 set of rake plates
- 4 upper bearings assemblies
- 4 lower bearings assemblies
- 2 wipers for scraper
- 4 shock absorbers for scraper
- 2 proximity switches

Spare parts shall be packaged with labels indicating the contents of each package, and shall be delivered to Owner as directed.

3.2.6 *Installation and Testing*

The Contractor shall verify all dimensions in the field to ensure compliance of equipment dimensions with the drawings. Contractor shall notify the Engineer of significant deviations.

Installation of the equipment shall be in strict accordance with the contract documents and the manufacturer's instructions and shop drawings. Manufacturer shall supply equipment, including anchor bolts for the equipment. Contractors shall install the equipment in accordance with the manufacturer's recommendations.

Supplier shall furnish the services of a factory-trained Service Engineer for one (1) trip including a total of eight (8) days to inspect the installation, observe start up, and provide operator training.

Equipment shall not be energized, or "bumped" to check the electrical connection for motor rotation without the Service Engineer present.

The Service Engineer shall make all necessary adjustments and settings to the controls.

The Service Engineer shall demonstrate proper and sequential operation of the screen and demonstrate that the equipment achieved the requirements set out in the Specifications. The screen shall operate automatically based on the differential water levels and on a timer basis.

4. CHANNEL MOUNTED HAND STOPS:

4.1 Specific requirements for Channel Mounted Hand Stops:

This specification covers the requirements for channel mounted, manually operated hand stops.

The requirements set out herewith are minimum anticipated and the Contractor shall be responsible to ensure that the equipment proposed is suitable in all respects for the equipment specified herein. This specification shall be read in conjunction with the applicable standard specifications.

Table of Handstop Sizes

Handstops	Location	Channel Width (m)	Channel Depth (m)	Height of Handstops (m)
1	Upstream of mechanical screen	0.5	0.8	0.7
2	Downstream of mechanical screen	0.5	0.8	0.7
3	Main channel between degritter	0.5	0.8	0.6
4	Inlet of degritter	0.4	0.8	0.6
5	Outlet of degritter	0.5	0.8	0.6

The hand stop inverts shall be flush with the cannel invert and the guide frames shall recess in the channel walls.

The handstops shall be locked in open and closed positions.

Materials:

The frames of the handstops shall be Aluminium or 304L S/S, with the handstops being GRP.

5. SCREENINGS WASHER / COMPACTOR:

5.1 Specific requirements for the Washer / Compactor of the screenings

Provision shall be made for the supply and installation of one (1) screenings washer / compactor unit. The washer / compactor shall receive screenings from the one mechanical bar type screen.

The press equipment shall be designed to remove organic matter and moisture from the screenings to produce a relatively clean product, which is easy to handle and dispose of to landfill or incineration. The equipment shall be located on the upper slab.

The press shall be capable of washing, dewatering and compacting wet screenings from a screen with 6.0 mm bar gaps. The screenings will contain faecal matter.

The top of the inlet hopper shall be wide enough to collect the screenings from the screen.

The size of the press and chute assembly shall be designed to suit the installation and shall be such that compacted screenings are discharged into bags that can be handled manually and sealed to prevent foul odours.

The compactor's discharge height shall be sufficient to provide at least 1m height above the required discharge point.

The screenings wash press shall operate independently of the screen and the washing and pressing operation sequences shall be provided by the contractor.

The requirements set out herewith are the minimum anticipated and the Contractor shall be responsible to ensure that the equipment proposed is suitable in all respects for the duties specified herein.

Allowance shall be made for all ancillary equipment required for a fully functional system, including all ancillary equipment required. This shall include for all wash water pipework and connections including solenoid valves required.

5.2 General requirements for the Washer / Compactor of the screenings

5.2.1 *Scope of works*

This part of the specifications covers the design, supply, delivery to site, installation and commissioning of the main and ancillary equipment required for the mechanical washer and screw type screening press for the washing, compaction and removal of moisture from the wet screenings received from the mechanical screens. The press equipment shall be designed to remove organic matter, by means of a mechanical washing action, and removing moisture from the screenings to produce a relatively clean product, which is suitable for disposal at a Municipal landfill.

The Contractor shall ensure that the equipment offered comply or exceed the requirements set out in the specification and that it is suitable for the application. The Contractor shall make allowance for a fully functional and integrated system, including all interconnecting systems that may be required. This specification shall be read in conjunction with the other Mechanical Standard Specifications whether there are specific references or not.

The press shall be of the progressive screw type, incorporating a gravity inlet hopper and a positive method of forcing all accumulating screening solids into a compression chamber for dewatering and compaction of wet screenings by the back pressure created by a venturi or propelling the product up a discharge chute.

Screenings shall derive mainly from domestic sewerage and shall contain items like paper, rages, plastic, faecal and other organic matter, etc. Other items may also include pieces of wood, metal cans, bottles etc.

The press shall be sized for the duties as specified in the specific requirements.

The wet screenings shall have an anticipated moisture content of between 90% and 95% and after dewatering and compacting, the discharge product shall have a moisture content of not more than 50% by weight.

Each Washer Compactor shall comprise of the following basic components:

a) A screw chamber and inlet hopper with agitator and level control.
b) A compression chamber.
c) A conveying and compressing screw.
d) A discharge chute.
e) A venturi tube (If required).
f) A drainage trough.
g) A support frame.
h) A drive assembly, which will provide motive power to the screw
i) A set of wheels or a pivoting retraction device

Presses that requires manual cleaning will not be acceptable. The press construction shall be robust and simple. The design shall be such that it does not require regular maintenance and only press of proven ability shall be provided.

The Contractor shall ensure that the equipment offered comply or exceed the requirements set out in the specification and that it is suitable for the application. This specification shall be read in conjunction with the other Mechanical Standard Specifications whether there are specific references or not.

5.2.2 *General Design Criteria*

The screenings shall be deposited cleanly into a receiving hopper of the press directly from the mechanical screen.

In the hopper the screenings will accumulate and be washed by agitation and the addition ow final water. Excess water will be drained from the hopper by the operation of the drain and screw rotation.

From the hopper screenings shall gravitate into the screw chamber of the press where initial dewatering shall take place as the horizontal screw slowly rotates within the chamber.

Narrow slots or small holes in the lower portion of the chamber shall allow the liquid to flow into the collection trough below, where it is then flushed by the sprays and piped away for dispense back into the main screen channel upstream of the screen.

From the open screw chamber, the screenings shall be propelled by the horizontal screw into the compression chamber where the final dewatering takes place. Compression shall be achieved by forcing the screenings through a venturi or a pipe placed at the end of the compression chamber, pressure being built up by the venturi or by friction in the discharge pipe

and chute. The displaced liquid and soft organic matter shall be forced through the small slots or holes in the compression chamber and collected in the trough.

From the compression chamber the dewatered screenings shall be forced into the discharge tube and chute where they are slowly conveyed to the discharge point. The chute shall be inclined to the required discharge height as required by the discharge bin.

The screenings washer / compactor shall operate independently of the screen and the washing and pressing operation sequences shall be provided by the Contractor.

The equipment shall meet the following requirements:

a) It shall be designed to facilitate the efficient manufacture, inspection, transportation, installation, maintenance, cleaning and repairs.
b) It shall be designed with a minimum expected life of 20 years of safe and satisfactory operation under the conditions prevailing at the site
c) The design shall prevent undue stresses caused the expansion and contractions due to temperature changes and other local natural manmade conditions.
d) The design shall keep maintenance costs to a minimum
e) It shall be designed to comply completely with the legal requirements in respect of safety and the prevention of environmental pollution.
f) It shall satisfy any specific requirements contained in the relevant statutory codes and legislation.
g) The design shall allow for 24-hour operation, 365 days a year under the specific design conditions.
h) The equipment installed shall be complete and fully operational as per the requirements set out in the Scope of Works.
i) All material used for the equipment shall be suitable for the operation and environment and compatible with the intended use.
j) The design shall allow for suitable treatment to prevent corrosion and erosion of the materials and equipment.
k) After approval by the Engineer, at the time of award of the Contract, the information stated in the Data Sheets shall be fully complied with, notwithstanding the specified scope of the Contract.
l) All electrical equipment, forming part of the specified equipment, as described in the Electrical Specification, shall be sealed against penetration by hose cleaning operations as well as being accessible for repairs and maintenance.

5.2.3 *Materials*

The complete washer / compactor shall be manufactured from at least 304 Stainless Steel (or higher grades) shapes (rods, angles, and channels), pipes, and sheets. It shall be manufactured in a Stainless Steel only factory to prevent contamination of the Stainless Steel with rusty dust.

All Stainless Steel components and structures shall be submersed in a chemical bath of nitric acid and hydrofluoric acid (pickling bath) to remove any residues that may be present on the material as a result of forming, manufacture, or handling. After removal from the pickling bath,

the equipment must be washed with a high-pressure wash of cold water to remove any remaining surface debris and promote the formation of an oxidized passive layer which is critical to the long life of the Stainless Steel.

5.2.4 *Construction*

Screw Chamber and Inlet Hopper:

The horizontal inclined screw chamber shall be of a heavy duty tubular construction and flanged at either end to suite the geared motor lantern housing on the inlet side, and the discharge chute on the outside.

The top side of the inlet end of the chamber shall be open and flanged to affix the inlet hopper. This hopper shall be made to suit the discharge of the screen and covers shall be provided that enable the contents to be inspected but prevent any water from escaping during the washing cycle. The hooper cover will also be relatively air tight as odours will be extracted from the interconnected screen.

The lower portion of the chamber shall incorporate radial slots or holes to allow liquid and soft material drainage, and in the design of these slots consideration shall be given to the high stress created in the tube of the compression zone.

The compression chamber shall be designed to withstand the highest pressures required to achieve the dewatering specified, without any deformation taking place.

The hopper shall be rectangular flanged connected to the screw chamber utilising a gasket to prevent leakage at the joint. The hopper shall be sized with walls steep enough to prevent the hanging up of screenings, either on top of the edges or on the walls, and provision shall be made to be able to install effective washing sprays, either at the time of supply, or at a later date.

Conveying and Compressing Screw

The screw shall be of an extremely robust construction and incorporate heavy steel welded to a solid steel shaft. The single start screw pitch shall be approximately 70% of the screw outside diameter, and the blade thickness not less than 7% of the screw diameter. The diameter of the solid centre shaft shall be not less than 35% of the outside diameter.

The screw shaft shall be cantilevered from the gearbox output shaft where it shall be fixed. It shall propel the screenings away from the gearbox to the compression end of the chamber, and shall not deflect to touch the chamber walls, even under maximum conditions. A bearing shall not be incorporated at the discharge end of the screw compact chamber where it would be subject to wear and the ingress of liquid due to the compression action. The tips of the screw blades shall be hard faced to minimize wear.

The drive shaft shall pass through the drive end plate, which shall incorporate a mechanical seal, or gland packed type seal to prevent the leakage of any liquid from the chamber into the lantern housing.

Discharge Chute

The discharge chute shall be flange connected to the end of the compression chamber. It shall be inclined and of the required length to suit the required discharge point and elevation. Any bends shall be of the long radius type.

Venturi Tube

When considered necessary, a venturi tube shall be positioned at the exit from the compression chamber, located between the chamber and chute flanges, to achieve the needed pressure for screenings dewatering. The venturi may be omitted if sufficient backpressure is achieved for dewatering purposes in the discharge chute. It shall be possible to easily remove or replace the venturi to change the backpressure to be generated.

Drainage Trough

A drainage trough shall be situated underneath the screw chamber and shall be easily accessible for hosing and cleaning purposes. The trough shall be inclined to one end such that the liquid will drain to the outlet where it shall be piped away in a large diameter pipe and gravity back to the screenings channel. The pipe shall be at least DN 80 mm.

A wash pipe incorporating spray nozzles shall be situated at the upper end of the trough such that the trough can be cleaned by introducing high pressure clean water into the pipework spraying the bottom of the trough towards the outlet end. The wash water spray shall be controlled by a spool type solenoid valve, which shall open when the press starts and close at a preset time of the press stopping. The solenoid valve shall be protected by an in line filter and be complete with manual isolating valve and unions for easy removal.

Support Steelwork

All the necessary support steelwork for the screenings press shall be provided to securely support the press which will be positioned above and straddled in the inlet channel

Drive Unit:

Rotational power to the press screw shall be delivered from a flange mounted geared motor unit situated at the inlet end of the press. The geared motor shall provide a high rotational torque to the screw and also resist the high thrust generated by the screw in the compression chamber, and shall be able to operate in both directions.

A double flanged lantern type housing shall be incorporated between the screw chamber and the gearbox so that any liquid passing the shaft seal at the chamber will escape from the lantern housing and cannot pass the geared motor output shaft seal and enter the gearbox.

The drive motor, gearbox and bearings shall be of the totally enclosed type suitable for regular hosing down operations.

The speed reducers shall be of the helical or bevel gear type geared motor, selected for continuous operation in outdoor conditions and subject to torrential downpours and direct sunlight with temperatures ranging from -5°C to 40°C. They must be able to operate in both directions of rotation.

The gearbox shall be rated with a service factor of at least 3 : 1 based on the maximum absorbed power and in accordance with the method laid down by the ISO.

All bearings shall be rated with an L10 life of at least 100 000 hours, and the output shaft bearing shall be specially selected to accommodate the thrust load created by the screw.

Bearings shall be of the heavy-duty deep groove ball, cylindrical or spherical roller type, and oil bath splash lubricated.

The gearbox casing shall be constructed of high-grade grey cast iron.

Shafts shall be manufactured from high carbon steel suitably precision machined and heat-treated.

Gears shall be of the helical or bevel type manufactured from the highest quality alloy steel, gas carburized and accurately ground.

Shaft seals shall be of the lip type.

Lubrication shall be by oil bath and splash to all bearings and gears. The drive to the gearbox may be by a direct coupled motor as in the 'geared motor' type.

The gearbox shall incorporate a moisture proof breather plug.

An easily accessible oil plug shall be incorporated to measure the oil level in the gearbox.

An oil drain plug shall be fitted in an easily accessible attitude for draining of the oil.

Motor

The motor shall be selected for continuous operation in outdoor conditions and subject to torrential downpours and direct sunlight with temperatures ranging from -5°C to 40°C and humidity up to 95%. It shall be able to operate in both directions of rotation and shall conform to the relevant standard specification.

Controls and instrumentation:

The equipment shall include all limit switches and protection instrumentation, seen necessary by the Manufacturer to ensure the validity of the warrantee, to prevent damage to the equipment in overloading, etc conditions. The equipment shall have the functionality to operate in forward / reverse to try and dislodge blockages.

5.2.5 *Walkways, Platforms and Staircases*

Walkways, platforms and staircases shall be provided for all equipment that require operators to work (for operating or maintenance purposes) at heights higher than 1.2 m above the NGL. These platforms, walkways, staircases and their respective support structures shall be constructed from GRP or epoxy coated hot dipped galvanised.

All walkways, platforms and staircases shall be equipped with suitable hand railings and all equipment and structures shall be in accordance with the applicable Standards and the Health and Safety Act.

5.2.6 *Spare Parts*

The following Spare Parts shall be included and supplied together with the equipment:

- One set of brushes
- One set of wear bars
- Any other parts deemed critical by the manufacturer.

Spare parts shall be packaged with labels indicating the contents of each package, and shall be delivered to Owner as directed.

5.2.7 ***Installation and Testing***

The Contractor shall verify all dimensions in the field to ensure compliance of equipment dimensions with the drawings. Contractor shall notify the Engineer of significant deviations.

Installation of the equipment shall be in strict accordance with the contract documents, and the manufacturer's instructions and shop drawings. The manufacturer shall supply equipment, including anchor bolts for the equipment. Contractors shall install the equipment in accordance with the manufacturer's recommendations.

Supplier shall furnish the services of a factory-trained Service Engineer for one (1) trip including a total of three (3) days to inspect the installation, observe start up, and provide operator training.

Equipment shall not be energized, or "bumped" to check the electrical connection for motor rotation without the Service Engineer present.

The Service Engineer shall make all necessary adjustments and settings to the controls.

The Service Engineer shall demonstrate proper and sequential operation of the equipment and demonstrate that the equipment achieved the requirements set out in the Specifications. The washer / compactor shall operate automatically based on the mechanical bar screen(s) and conveyer operation.

6. VORTEX GRIT REMOVER:

6.1 Specific Requirements for the Vortex Grit Remover

Provision shall be made for the supply and installation of a grit removal system.

The primary grit removal mechanism shall comprise of a circular tank with floor sloping towards the centre and grit collecting hopper. The contents of the tank shall be kept in motion by means of a tangential inlet to the tank and also by means of rotating paddles when the minimum inlet flow is inadequate to maintain the optimum velocity to keep the organic matter present in suspension.

Water pipes shall be routed to the bottom of the grit sump for the purpose of fluidising and washing the accumulated grit. Once the grit has been washed, grit pumps shall then be used to pump the grit up the vertical discharge pipe, which passes through the centre tube of the paddle drive unit. After passing up the vertical pipe, the fluidised grit shall then pass along the horizontal

discharge pipe, where it shall be deposited into a Grit Classifier for further washing and elevating for discharge into a collection bin.

The grit will derive mainly from domestic sewage with some wash off from roads, and blown sand.

The equipment shall comprise of the following basic mechanical components:

a) One (1) paddle drive assembly
b) Two (2) grit pump suitably coated to prevent internal wear and external corrosion.
c) One (1) lifting davit and socket.
d) All required wash water pipes and valves.
e) A complete set of all necessary piping and supports from the pump to the classifier.

The equipment shall be rated and designed for the removal of grit from raw, screen sewage. Equipment requiring manual cleaning of the tank hopper will not be acceptable.

The equipment provided shall be simple and robust and designed for a long life without the requirement of regular maintenance. Only equipment of proven ability shall be provided.

Degritting Tank:

The degritter tank will be capable of passing an average dry weather flow (ADWF) of 20 l/s, and a peak wet weather flow (PWWF) of 50 l/s of screened sewage. The sewage will contain large amounts of grit and large amounts of organic matter.

The tank will have an internal diameter of 2.0 m and a side water depth of up to 1.3 m, with a slope towards the central grit hopper of 30° to the horizontal. The grit hopper will have a diameter of 1.0 m and a depth of 1.3 m to the top of the base. Refer to the applicable drawings.

Paddle Drive System:

A paddle drive system shall be provided for the degritter tank.

The paddle shall rotate at a speed of approximately 12 rpm, and the gearbox / slew ring have a service factor of at least 3:0:1 on the maximum absorbed power.

The drive slew ring assembly shall be contained in a sealed housing such that the unit be lubricated and be designed so that the grit pump can be lifted out of the tank through the centre of the paddle drive unit.

Grit Pumps:

Two grit pumps shall be provided. One will be installed and the second will be a spare. The pump impellers and volutes shall be hard faced and details shall be furnished with the tender. The approximate duty of each pump will be 8 l/s at 6m. The duty is to be confirmed by the Contractor with final design.

6.2 General requirements for the Vortex Grit Remover

6.2.1 *Scope of works*

This part of the specifications covers the design, supply, delivery to site, installation and commissioning of the main and ancillary equipment required for the rotating paddle system the promotes the settling of grit from the screened sewage stream and removal pumping equipment for extraction of the settled grid from the cylindrical chambers / hoppers.

The primary means of grit removal shall comprise of a circular tank with a sloping floor towards the centre and a grit collecting hopper. The contents of the tanks shall be kept in motion by means of a tangential inlet to the tank and by means of a rotating paddle system when the minimum inlet flow is inadequate to maintain the optimum velocity to keep the organic matter present in suspension. The construction of the concrete tank and hopper falls outside the scope of the mechanical and electrical project.

The Contractor shall supply and install a complete, functional paddle system, designed to operate in raw, screened sewage, in the constructed concrete tank / hopper. This will include a grit extraction pumping system.

Water pipes shall be routed to the bottom of the grit sump for purposes of fluidising and washing the accumulated grit. The water supply for this process shall either be provided from jockey pumps or Municipal supply. Refer the project Specific Requirements for the project specific fluidisation requirements.

The settled grit shall be removed as a slurry from the chamber by means of a submersible pump situated in the hopper. The grit slurry shall be pumped to the grit washer / classifier.

The discharged product from the grit chambers shall have a dry organic content of not more than 5% by weight.

The Contractor shall ensure that the equipment offered comply or exceed the requirements set out in the specification and that it is suitable for the application. The Contractor shall make allowance for a fully functional and integrated system, including all interconnecting systems that may be required. This specification shall be read in conjunction with the other Mechanical Standard Specifications whether there are specific references or not.

The grit will derive mainly from domestic sewage with some wash off from roads and blown sand.

The paddle system and extraction pumps shall be sized for the duties as specified in the specific requirements. All dimensions must be confirmed on site prior to procurement of equipment.

Each Grit removal system shall comprise of the following basic components:

a) Electrically driven paddle system, including mechanical drives, gearbox, supporting structure, etc.
b) Submersible grit pump, including pipework and valves.
c) A complete set of all necessary piping and valves.
d) Transfer pipework to the grit washer / clarifier.

Equipment requiring manual clearing of grit from the tank hopper will not be acceptable. The screen construction shall be robust and simple. The design shall be such that it does not require regular maintenance and only screen of proven ability shall be provided.

6.2.2 ***General Design Criteria***

The vortex degritters shall operate continuously, and will be designed such that the tangential inlet creates a rotary motion to the tank contents of such a velocity that will keep the organic particles in suspension while settling of the grit particles are achieved. When the difference between the PWWF and the ADWF is generally more than 2 : 1, the ideal tank velocity range shall be maintained by a series of rotating paddles.

The settled grit particles shall be washed into the central collection hopper where it shall be temporarily stored prior to washing and removal by means of pumps.

The equipment shall meet the following requirements:

a) It shall be designed to facilitate the efficient manufacture, inspection, transportation, installation, maintenance, cleaning and repairs.
b) It shall be designed with a minimum expected life of 20 years of safe and satisfactory operation under the conditions prevailing at the site
c) The design shall prevent undue stresses caused the expansion and contractions due to temperature changes and other local natural manmade conditions.
d) The design shall keep maintenance costs to a minimum
e) It shall be designed to comply completely with the legal requirements in respect of safety and the prevention of environmental pollution.
f) It shall satisfy any specific requirements contained in the relevant statutory codes and legislation.
g) The design shall allow for 24-hour operation, 365 days a year under the specific design conditions.
h) The equipment installed shall be complete and fully operational as per the requirements set out in the Scope of Works.
i) All material used for the equipment shall be suitable for the operation and environment and compatible with the intended use.
j) The design shall allow for suitable treatment to prevent corrosion and erosion of the materials and equipment.
k) After approval by the Engineer, at the time of award of the Contract, the information stated in the Data Sheets shall be fully complied with, notwithstanding the specified scope of the Contract.
l) All electrical equipment, forming part of the specified equipment, as described in the Electrical Specification, shall be sealed against penetration by hose cleaning operations as well as being accessible for repairs and maintenance.

6.2.3 ***Materials***

The complete paddle and drive system (paddle drive tube, paddle arms and paddles, pipework, submerged steelwork and brackets, pipework, fasteners etc) shall be manufactured from at least 304L Stainless Steel shapes (rods, angles, and channels), pipes, and sheets. It shall be manufactured in a Stainless Steel only factory to prevent contamination of the Stainless Steel with rusty dust. The paddle drive housing may be manufactured from hot dipped galvanised mild steel.

All pipework, including the extraction from the hopper and delivery pipework to the grit washer / clarifier shall be manufactured from 304L Stainless Steel.

The material for the pump sets shall be according to the applicable Standard Specification.

All Stainless Steel components and structures shall be submersed in a chemical bath of nitric acid and hydrofluoric acid (pickling bath) to remove any residues that may be present on the material as a result of forming, manufacture, or handling. After removal from the pickling bath, the equipment must be washed with a high-pressure wash of cold water to remove any remaining surface debris and promote the formation of an oxidized passive layer which is critical to the long life of the Stainless Steel.

Materials of Construction:

Paddle Drive Housing	Mild Steel
Paddle Drive Tube	304L Stainless Steel
Paddle Arms and Paddles	304L Stainless Steel
Flexible Piping	Rubber / Polyurethane
Steelwork & Brackets above Channel	Mild Steel
Steelwork & Brackets in Channel	304L Stainless Steel
All Steel Pipework	304L Stainless Steel
Fasteners and Concrete Anchors	316L Stainless Steel

Corrosion Protection:

Paddle Drive Housing	Hot Dip Galvanised
Paddle Drive Tube	Grit Blast and Pickle & Passivate
Paddle Arms and Paddles	Grit Blast and Pickle & Passivate
Steelwork & Brackets above Channel	Hot Dip Galvanised
Other Pipework	Grit Blast and Pickle & Passivate
Any Submerged Steelwork & Brackets	Grit Blast and Pickle & Passivate

6.2.4 ***Construction***

Design and operation:

The optimum velocity within the body of the tank shall be between 0.3 to 0.4 m/s, equating to a tangential inlet velocity upwards of 0.6 m/s, to remove grit particles with sizes larger than 0.2 mm.

Grit shall not accumulate on the conical sloping floor but shall deposit in the central sump of the tank due to the scour velocity caused by the paddles and / or the tangential inlet flow velocity. Certain organic matter of similar size the grit and may be settled together to the bottom of the hopper. Prior to extracting the settled grit from the bottom of the hopper, it shall be fluidised by a counter flow of air and then washed with water under pressure. The fluidisation and wash water shall be controlled on a timer basis in conjunction with the washing and extraction operation.

The source of the wash – and fluidisation water shall be indicated in the Specific Requirements. A diaphragm valve shall automatically open to supply fluidising and wash water to the selected

vortex degritters tank, prior to one of the extraction pumps starting. The washing action shall be timer based controlled in conjunction with the degritting system.

The hydraulic flow and the expected variation in flow, the volume of grit, including the nature of the raw sewage to be screened and pressed are described in the Specific Requirements.

Paddle Mechanism:

Where required as indicated in the Specific Requirements, a constant velocity condition shall be achieved by means of slow rotating paddle system, operating in the same direction of the sewage flow.

The drive tube shall allow for sufficient internal diameter to allow for the grit extraction delivery pipework to be route through the centre of the drive tube. The drive tube shall be directly connected to the reduction gearbox.

Four paddles shall be installed, fixed onto the drive tube. The paddles shall be adjustable in all directions and locked into place by means of counter screws. The complete unit shall be manufactured from Stainless Steel and designed to operate in raw screened sewage.

Paddle Drive Unit:

The paddle drive unit shall be driven by an electrical motor connected to reduction gearbox. A suitable slew ring gear arrangement shall be provided to drive the centre tube. No water submerged gears, bearings, drive wheels or guides will be accepted. A method of easily varying the output speed shall be provided.

The geared slewing ring bearings shall have a safety factor of at least 5 : 1 based on the permissible axial loading and safety factor of at least 5 : 1 based on the permissible gear loading at the driving spur - or slew gear interface. The geared slewing ring shall be oil bath lubricated, with facilities to check, maintain and drain the oil, on tanks in excess of 5.0 m in diameter. The oil bath shall be contained in a sealed and weatherproof enclosure. Grease lubricated slewing rings will only be accepted on tanks up to and including 5.0m in diameter.

The drive motor, gearbox and bearings shall be of the totally enclosed type suitable for regular hosing down operations.

Speed reducers shall be of the helical of bevel gear type geared motor, suitable for continuous operation in outdoor conditions and subject to torrential downpours and direct sunlight with temperature ranging between -5°C and 40°C. It must be able to operate in both directions of rotation.

The gearbox shall be rated with a service factor of at least 3 : 1 based on the maximum absorbed power and in accordance with the method laid down by the I.S.O. Gearbox casings shall be constructed of high-grade grey cast iron.

All gearbox bearings shall be rated with an L10 life of at least 100 000 hours. Bearings shall be of the heavy-duty deep groove ball, cylindrical or spherical roller type, and oil bath splash lubricated.

All gearbox shafts shall be manufactured from high carbon steel suitably precision machined and heat-treated. Gears shall be of the helical or bevel type manufactured from the highest quality alloy steel, gas carburized and accurately ground.

The gearbox shaft seals shall be of the lip type. Lubrication shall be by oil bath and splash to all bearings and gears. An easily accessible oil level plug shall be incorporated to measure the oil level in the gearbox. An oil drain plug shall be fitted in an easily accessible attitude for draining of the oil.

The drive to the gearbox may be by a direct coupled motor as in the 'geared motor' type. The gearbox shall incorporate a moisture proof breather plug.

Drive Motor:

The motor shall be selected for continuous operation in outdoor conditions and subject to torrential downpours and direct sunlight with temperatures ranging from -5°C to 40°C and humidity up to 95%. It shall be rated for 400V, 50hz electrical supply. It shall be able to operate in both directions of rotation and shall conform to the relevant Standard Specification.

The motor shall be rated with at least a 2 : 1 service factor on the absorbed power at the maximum speed.

Floor plate:

Floor plates shall be supplied and installed to cover the opening(s) to the grit chamber. The plates shall be suited to the specific paddle and pumping system and it shall be constructed in two sections with lifting lugs to easy handling. The plate thickness shall not be thinner than 10mm and shall be from similar material than that of the paddle drive.

Grit Extraction Pump:

Extraction pump sets shall be supplied and installed for the extraction of the settled grit from the hoppers. The extraction pumps shall pump via a dedicated delivery pipe to the grit washer / clarifier.

The pump shall be of the submersible type, with a vortex impeller, with suitably protected volute and impeller using hardwearing coating.

The pump discharge and vertical discharge piping shall be at least 100 mm diameter.

The pump will be lifted out of the degritter by a davit and winch and shall pass through the centre of the paddle drive. The discharge piping will be flexible to facilitate the removal of the pump and shall be of heavy duty design to resist wear and tear.

Wash Water Piping and Valves:

All piping and valves shall be provided from the supply point at the screenings structure. Piping shall be DN40 stainless steel 304 and will be surface run from the supply point to the bottom of each degritter.

A nozzle is to be provided on the end of each pipe to ensure the settled grit in the hopper is fluidized so that it can be extracted by the pump.

Pipe Supports:

Pipe supports and brackets shall be provided where necessary to support the weight of all pipes and valves etc. All pipework shall be adequately supported from the floor on tubular or other approved supports with jacking bolts for height adjustment on the base and U bolts or other approved method for fixing to the pipe. These supports shall ensure that minimal stresses are imposed on the pump and valve castings etc.

Davit and Sockets:

One socket shall be installed at the degritter. A davit with winch shall be used to raise and lower the pump out of the degritter. The design of the davit and winch shall be in accordance with the Standard Specification.

Sockets that fill with rainwater when not in use will not be acceptable.

Controls and instrumentation:

The equipment shall include all limit switches and protection instrumentation, seen necessary by the Manufacturer to ensure the validity of the warrantee, to prevent damage to the equipment in overloading, etc conditions. The equipment shall have the functionality to operate in forward / reverse to try and dislodge blockages.

6.2.5 *Walkways, Platforms and Staircases*

Walkways, platforms and staircases shall be provided for all equipment that require operators to work (for operating or maintenance purposes) at heights higher than 1.2 m above the NGL. These platforms, walkways, staircases and their respective support structures shall be constructed from GRP or epoxy coated hot dipped galvanised.

All walkways, platforms and staircases shall be equipped with suitable hand railings and all equipment and structures shall be in accordance with the applicable Standards and the Health and Safety Act.

6.2.6 ***Spare Parts***

The following Spare Parts shall be included and supplied together with the equipment:

- A set of special tools (if required)
- Any other parts deemed critical by the manufacturer.

Spare parts shall be packaged with labels indicating the contents of each package, and shall be delivered to Owner as directed.

6.2.7 ***Installation and Testing***

The Contractor shall verify all dimensions in the field to ensure compliance of equipment dimensions with the drawings. Contractor shall notify the Engineer of significant deviations.

Installation of the equipment shall be in strict accordance with the contract documents and the manufacturer's instructions and shop drawings. Manufacturer shall supply equipment, including anchor bolts for the equipment. Contractors shall install the equipment in accordance with the manufacturer's recommendations.

Supplier shall furnish the services of a factory-trained Service Engineer for one (1) trip including a total of five (5) days to inspect the installation, observe start up, and provide operator training.

Equipment shall not be energized, or "bumped" to check the electrical connection for motor rotation without the Service Engineer present.

The Service Engineer shall make all necessary adjustments and settings to the controls.

The Service Engineer shall demonstrate proper and sequential operation of the equipment and demonstrate that the equipment achieved the requirements set out in the Specifications. The paddle system and grit removal pumps shall operate automatically based on a timer basis.

7. GRIT CLASSIFIER:

7.1 Specific requirements for the Grit Classifier

Provision shall be made for the supply and installation of one (1) grit classifier, designed for a flow of 10 l/s of grit slurry pumped by the submersible grit pump.

The maximum water content in the washed grit shall be 10%, while the maximum volatile solids content in the dried grit processed shall not be more than 3%. The minimum capture rate of 200 microns quartz at the design flow shall be 95%.

The grit shall be deposited into a bin and the chute shall be designed and sized to reach the location where the bin is located.

The Contractor shall allow for all ancillary equipment and pipework required for a fully functional system. This shall include for all wash water connections and solenoid valves required.

7.2 General requirements for the Grit Classifier

7.2.1 *Scope of works*

This specification covers the requirements for a screw type grit classifier for the dewatering and removal of organic matter from grit extracted from sewage. The classifier equipment shall be designed to remove organic matter and moisture from the grit to produce a relatively clean product, which is easy to handle and dispose of by burial.

The requirements set out herewith are the minimum anticipated and the Contractor shall be responsible to ensure that the equipment proposed is suitable in all respects for the duties specified herein.

One screw type grit classifier shall be provided. The classifier shall be capable of treating at least 10 l/s of fluidised grit pumped by the submersible grit pump.

The total volume of the hopper, above the screw, shall suit the system offered.

The height from the concrete floor to the underside of the chute at the discharge point shall be suitable for discharge of grit into a bin. The applicable drawing indicates the required positioning of the grit classifier.

Each Grit removal system shall comprise of the following basic components:

a) A grit washer tank / hopper and screw trough
b) An inlet pipe nozzle
c) A stilling baffle
d) An overflow weir
e) An outlet pipe connection
f) A discharge chute, including inclined elevating screw
g) A cover with airvents
h) A drive assembly, which will drive the screw
i) A stirring device with gear motor (if required)
j) Electrical control and instrumentation

The grit classifier shall be complete, free standing unit, used for the separation of grit from any organic material present. The unit shall comprise of an Archimedean screw contained within an inclined trough and a lower hopper section. The machine shall be contained in a robust steel fabrication suitable for mounting on a flat concrete slab. Concrete plinths will be provided where required.

The grit to be treated will derive from domestic sewage and will contain mainly particulate matter with some other less dense and larger particles such as corn, cigarette ends and other organic matter, The grit to be treated will have been subject to a primary grit removal process and, in this instance; a vortex type degritter tank will be used. The grit will have an anticipated organic content of between 20% and 10% by dry weight, and after classifying, the discharged product shall have organic content of not more than 5% by dry weight. The product shall be discharged into a bin.

The classifier construction shall be simple and robust and designed for a long life without the requirement for regular maintenance. Only classifiers of proven ability shall be provided.

The classifier shall be silent in operation.

The water, grit and organic mixture shall be introduced into the hopper over the inclined screw, where grit solids settle and are slowly propelled up the inclined trough.

Water, grit and organics will enter the unit in a turbulent condition. A baffle shall deflect the liquid phase down into the well, whilst any air shall be allowed to escape through a vent pipe in the cover, when applicable.

A critically positioned weir shall allow organic material washed from the inlet flow, to return to the main sewage flow upstream at the degritter whilst the grit is gradually elevated along the

inclined trough out of the water to be discharged in a relatively dry and clean condition at the top of the trough.

The rotating inclined screw, within the lower part of the hopper and below water, shall maintain controlled liquid velocity conditions, which shall keep the grit solids at the lower part of the trough and at the same time release any organic material.

The rotating screw shall progressively elevate and deposit the grit cleanly at the upper end of the trough into a bin.

The liquid containing the suspended organic matter shall be piped back into the main channel flow for further treatment.

7.2.2 ***General Design Criteria***

The equipment shall meet the following requirements:

a) It shall be designed to facilitate the efficient manufacture, inspection, transportation, installation, maintenance, cleaning and repairs.
b) It shall be designed with a minimum expected life of 20 years of safe and satisfactory operation under the conditions prevailing at the site
c) The design shall prevent undue stresses caused the expansion and contractions due to temperature changes and other local natural manmade conditions.
d) The design shall keep maintenance costs to a minimum
e) It shall be designed to comply completely with the legal requirements in respect of safety and the prevention of environmental pollution.
f) It shall satisfy any specific requirements contained in the relevant statutory codes and legislation.
g) The design shall allow for 24-hour operation, 365 days a year under the specific design conditions.
h) The equipment installed shall be complete and fully operational as per the requirements set out in the Scope of Works.
i) All material used for the equipment shall be suitable for the operation and environment and compatible with the intended use.
j) The design shall allow for suitable treatment to prevent corrosion and erosion of the materials and equipment.
k) After approval by the Engineer, at the time of award of the Contract, the information stated in the Data Sheets shall be fully complied with, notwithstanding the specified scope of the Contract.
l) All electrical equipment, forming part of the specified equipment, as described in the Electrical Specification, shall be sealed against penetration by hose cleaning operations as well as being accessible for repairs and maintenance.

The pumped entry into the inlet chamber of the hopper shall wash the grit, causing the organic matter to separate from the grit particles, prior to settling. The large grits shall settle into the intermediate portion of the screw length just prior to elevating above the water surface. After washing, the flow shall enter the quiescent zone, where smaller grits shall settle, and the organic

fraction shall be discharged over the weir. The heavier organic fraction, which has settled initially with the grit, shall be slowly released by the rotating action of the screw.

7.2.3 ***Materials***

The complete grit classifier system (washer tank including internal, stirrer, screw, conveyer chute, fasteners, etc) shall be manufactured from at least 304L Stainless Steel shapes (rods, angles, and channels), pipes, and sheets. It shall be manufactured in a Stainless Steel only factory to prevent contamination of the Stainless Steel with rusty dust. The paddle drive housing may be manufactured from hot dipped galvanised mild steel. All pipework, including the extraction from the hopper and delivery pipework to the grit washer / clarifier shall be manufactured from 304L Stainless Steel.

The material for the pump sets shall be according to the applicable Standard Specification.

All Stainless Steel components and structures shall be submersed in a chemical bath of nitric acid and hydrofluoric acid (pickling bath) to remove any residues that may be present on the material as a result of forming, manufacture, or handling. After removal from the pickling bath, the equipment must be washed with a high-pressure wash of cold water to remove any remaining surface debris and promote the formation of an oxidized passive layer which is critical to the long life of the Stainless Steel.

7.2.4 ***Construction***

<u>Trough & Washing Hopper</u>

The inclined trough and hopper shall be a specially shaped fabricated to container, which contains the screw, the outlet weir and the baffle, which separates the turbulent zone from the quiescent zone. The hopper shall have sides inclined at more than 60° to the horizontal and it shall be complete with feet, legs and pipe nozzles for mounting onto a level concrete floor or plinth.

Base plates shall be shimmed at least 25 mm above the floor of plinth and grouted after anchoring.

A cover shall be incorporated over the wet area to contain any splashing and odours when necessary and when specified.

<u>Screw Shaft</u>

The screw and shaft assembly shall mount within the length of the inclined through and hopper. It shall be inclined at approximately 30° and mounted at each end between special bearings which take all axial and radial thrusts.

The screw flights shall be welded to a central tubular, heavy wall shaft to which it shall be fixed to the upper and lower end shafts.

The flights of the screw shall be welded securely to the central tube to form a continuous helix. No intermediate bearings shall be employed.

A specially selected clearance (± 10 mm) shall be allowed between the screw flights and the inner wall of the trough to ensure adequate grit movement and still allow drainage as the grit is elevated up the trough.

The single start screw pitch shall be approximately 50% of the screw outside diameter, and the blade thickness not less than 2% of the screw outside diameter.

The hollow centre shaft shall be not less than 35% of the screw outside diameter, with a wall thickness of not less than Schedule 80.

The top and bottom shafts shall be machined truly concentric with the screw assembly.

Centreless screws, without a centre tube and bottom bearing, and running liners with the trough, will not be permitted.

The drive shaft shall pass through the drive end plate, to which is bolted a self aligning ball bearing in a flanged housing with grease seals.

Bottom Bearing

The bottom bearing shall comprise of a solid stainless steel stub shaft fixed to the inside of the trough at the lower end. A vesconite bush fitted within the end of the tubular screw shaft shall rotate on the stub shaft. All surfaces shall be accurately machined to be truly axial and give the correct running clearance. In this manner no leaks shall occur to the outside of the trough and hopper.

The bottom bearing assembly shall be subject to radial loads only. The bush which may eventually be subject to some wear shall rotate on the shaft and therefore any such wear will be equal around the inside of the bush and not in one place as with a stationary bush.

The bottom bearing assembly shall be grease lubricated from the outside of the housing by a continuous grease supply from an automatic motorised lubricator.

It shall be possible to remove the bottom bearing assembly from the trough end for repair or replacement without removing the screw from the classifier.

Top Bearing

The top bearing shall be of the self aligning ball bearing type in a flanged cast iron housing . This bearing shall be well above water level and situated on the top end plate outside the trough. Grease seals shall be fitted to the bearing and the bearing shall incorporate a grease lubrication pipe and grease nipple so that the bearing can lubricated from the floor level.

The top bearing shall be subject to both axial and radial loading. It shall be designed for an L10 life of at least 100 000 hours.

Outlet Weir:

An adjustable outlet weir plate shall be incorporated within the hopper. Water containing the organic matter will pass over this weir prior to leaving the classifier and returning to the main sewage flow.

Screw Drive Unit:

The screw shaft drive unit shall comprise of a hollow shaft geared motor which mounts directly on the screw top shaft. It shall be mounted outside of the trough and shall be prevented from rotating by a torque arm and bracket fixed to the trough end.

The drive motor, gearbox and bearings shall be of the totally enclosed type suitable for regular hosing down operations.

Speed reducers shall be of the helical of bevel gear type geared motor, suitable for continuous operation in outdoor conditions and subject to torrential downpours and direct sunlight with temperature ranging between -5°C and 40°C. It must be able to operate in both directions of rotation.

The gearbox shall be rated with a service factor of at least 3 : 1 based on the maximum absorbed power and in accordance with the method laid down by the I.S.O. Gearbox casings shall be constructed of high-grade grey cast iron.

All gearbox bearings shall be rated with an L10 life of at least 100 000 hours. Bearings shall be of the heavy-duty deep groove ball, cylindrical or spherical roller type, and oil bath splash lubricated.

All gearbox shafts shall be manufactured from high carbon steel suitably precision machined and heat-treated. Gears shall be of the helical or bevel type manufactured from the highest quality alloy steel, gas carburized and accurately ground.

The gearbox shaft seals shall be of the lip type. Lubrication shall be by oil bath and splash to all bearings and gears. An easily accessible oil level plug shall be incorporated to measure the oil level in the gearbox. An oil drain plug shall be fitted in an easily accessible attitude for draining of the oil.

The drive to the gearbox may be by a direct coupled motor as in the ‘geared motor’ type. The gearbox shall incorporate a moisture proof breather plug.

Drive Motor:

The motor shall be selected for continuous operation in outdoor conditions and subject to torrential downpours and direct sunlight with temperatures ranging from -5°C to 40°C and humidity up to 95%. It shall be rated for 400V, 50hz electrical supply. It shall be able to operate in both directions of rotation and shall conform to the relevant Standard Specification.

The motor shall be rated with at least a 2 : 1 service factor on the absorbed power at the maximum speed.

Piping and Valves:

All piping shall be of flanged, Stainless Steel pipework in accordance with the specific Standard Specification, utilising flanged connections and valves etc.

All pipework and isolating valves required to transfer the wastewater containing organic matter back to the main screened sewage channel shall be allowed for. The configuration of the pipework

will be such to ensure all water are able to feed back into the channel under gravity alone, and it shall not be pumped.

Each pump shall be equipped with a suitably sized and pressure rated flanged gate valve and flanged single door swing type non-return valve on the delivery. All valves shall be in accordance with the applicable Standard Specifications.

All pipework and valves shall be properly supported and anchored by means of suitable supports / anchors designed to handle both static and dynamic forces. All supports and anchors shall be constructed from hot dipped galvanised mild steel. Steps shall be taken to prevent galvanic corrosion between the pipework and supports.

All fasteners shall be Stainless Steel.

Controls and instrumentation:

The equipment shall include all limit switches and protection instrumentation, seen necessary by the Manufacturer to ensure the validity of the warrantee, to prevent damage to the equipment in overloading, etc conditions. The equipment shall have the functionality to operate in forward / reverse to try and dislodge blockages.

7.2.5 *Walkways, Platforms and Staircases*

Walkways, platforms and staircases shall be provided for all equipment that require operators to work (for operating or maintenance purposes) at heights higher than 1.2 m above the NGL. These platforms, walkways, staircases and their respective support structures shall be constructed from GRP or epoxy coated hot dipped galvanised.

All walkways, platforms and staircases shall be equipped with suitable hand railings and all equipment and structures shall be in accordance with the applicable Standards and the Health and Safety Act.

7.2.6 ***Spare Parts***

The following Spare Parts shall be included and supplied together with the equipment:

- A set of special tools (if required)
- Any other parts deemed critical by the manufacturer.

Spare parts shall be packaged with labels indicating the contents of each package, and shall be delivered to Owner as directed.

7.2.7 ***Installation and Testing***

The Contractor shall verify all dimensions in the field to ensure compliance of equipment dimensions with the drawings. Contractor shall notify the Engineer of significant deviations.

Installation of the equipment shall be in strict accordance with the contract documents and the manufacturer's instructions and shop drawings. Manufacturer shall supply equipment, including anchor bolts for the equipment. Contractors shall install the equipment in accordance with the manufacturer's recommendations.

Supplier shall furnish the services of a factory-trained Service Engineer for one (1) trip including a total of five (5) days to inspect the installation, observe start up, and provide operator training.

Equipment shall not be energized, or "bumped" to check the electrical connection for motor rotation without the Service Engineer present.

The Service Engineer shall make all necessary adjustments and settings to the controls.

The Service Engineer shall demonstrate proper and sequential operation of the grit classifier and demonstrate that the equipment achieved the requirements set out in the Specifications. It shall operate automatically based on a batch system.

8. MANUAL RAKE BAR SCREEN:

8.1 Specific requirements for Manual Rake Bar Screen

Two (2) manual rake bar screen shall be supplied and installed in the inlet and overflow/bypass channel. The purpose of the screen in the mechanical screen channel is to remove all large objects before sewage reaches the mechanical screen. The purpose for the screen in the bypass channel is for the times that the mechanical screen is bypassed due to maintenance. Refer to the drawings included for the layout of the screening facility.

The screens shall be designed to handle an ultimate flow of 50 l/s of municipal wastewater with no less than 50 mm of freeboard when installed in a 500 mm wide channel, 800 mm deep. Inclination of the bar rack shall be 45°. Effective screen area shall have a minimum of 75% free open-area for water flow. The bar gaps shall not be more than 10.0mm for the fine screen, and 50.00 mm for the coarse screen.

The maximum upstream water level shall not exceed 450 mm above channel bottom. The screen shall be capable of processing the peak flow without exceeding the maximum upstream water level based on a 35% reduction of the screen's free open area. The head loss through the screen shall not exceed 160 mm with a 35% reduction of the screen's free open area.

All parts shall be designed and manufactured to handle the forces that may be exerted on the screen during fabrication, shipping, erection, and proper operation according to the O&M manual.

Allowance shall be made for all ancillary equipment required for a fully functional system, including all ancillary equipment required. This shall include for all wash water pipework and connections including solenoid valves required.

8.2 General requirements for Manual Rake Bar Screen

8.2.1 *Scope of Works*

This part of the specifications covers the design, supply, delivery to site, installation and commissioning of the main and ancillary equipment required for the, channel fitted, manual rake bar screens designed to remove floating or suspended debris from the raw incoming sewage. The screenings would generally consist out of rags, paper, plastics, organic matter, large solids, etc.

Each screen shall comprise of (but not limited to) the following basic components:

a) A framework to which all components are attached.
b) A flat bar rack that will accumulate the screenings.
c) A drainage platform onto which screenings will be scraped to be dewatered.

The design shall be such that it does not require regular maintenance and only screen of proven ability shall be provided.

The Contractor shall ensure that the equipment offered comply or exceed the requirements set out in the specification and that it is suitable for the application. The Contractor shall make allowance for a fully functional and integrated system, including all interconnecting systems that may be required. This specification shall be read in conjunction with the other Mechanical Standard Specifications whether there are specific references or not.

8.2.2 *General Design Criteria*

The equipment shall meet the following requirements:

m) It shall be designed to facilitate the efficient manufacture, inspection, transportation, installation, maintenance, cleaning and repairs.
n) It shall be designed with a minimum expected life of 20 years of safe and satisfactory operation under the conditions prevailing at the site
o) The design shall prevent undue stresses caused the expansion and contractions due to temperature changes and other local natural manmade conditions.
p) The design shall keep maintenance costs to a minimum
q) It shall be designed to comply completely with the legal requirements in respect of safety and the prevention of environmental pollution.
r) It shall satisfy any specific requirements contained in the relevant statutory codes and legislation.
s) The design shall allow for 24-hour operation, 365 days a year under the specific design conditions.
t) The equipment installed shall be complete and fully operational as per the requirements set out in the Scope of Works.
u) All material used for the equipment shall be suitable for the operation and environment and compatible with the intended use.
v) The design shall allow for suitable treatment to prevent corrosion and erosion of the materials and equipment.
w) After approval by the Engineer, at the time of award of the Contract, the information stated in the Data Sheets shall be fully complied with, notwithstanding the specified scope of the Contract.
x) All electrical equipment, forming part of the specified equipment, as described in the Electrical Specification, shall be sealed against penetration by hose cleaning operations as well as being accessible for repairs and maintenance.

8.2.3 *Materials*

The screen shall be manufactured from at least 304L Stainless Steel (or higher grades) shapes (rods, angles, and channels), pipes, and sheets. All side frames and guides, bar rack, discharge chute, drainage platform, fasteners and anchor bolts shall be made of this material. 304 Stainless Steel and lower grade Stainless Steel shall not be accepted. Screen shall be manufactured in a Stainless Steel only factory to prevent contamination of the Stainless Steel with rusty dust.

All Stainless Steel components and structures shall be submersed in a chemical bath of nitric acid and hydrofluoric acid (pickling bath) to remove any residues that may be present on the material as a result of forming, manufacture, or handling. After removal from the pickling bath, the equipment must be washed with a high-pressure wash of cold water to remove any remaining surface debris and promote the formation of an oxidized passive layer which is critical to the long life of the Stainless Steel.

8.2.4 *Construction*

The bar screen shall remove debris (screenings) from the incoming wastewater by means of a positively cleaned bar rack that is installed in a concrete channel. The screen shall retain debris at the bar rack. The screenings shall be manually removed by the operator by means of a hand rake. The debris shall be lifted above the channel and dropped on a drainage platform at the downstream side (back) of the screen.

The bar rack shall consist of equally spaced, straight flat bars that are inclined from the horizontal with the inclination angle specified above. The bars shall have a minimum thickness of 8 mm. The top and lower ends of the bars shall end parallel with the channel floor. It shall be provided with a minimum 8 mm thick base plate such that the rakes positively remove all screenings from the bottom of the bar rack. The depth of the bars shall be a minimum of 60 mm. The bar rack shall be securely fastened to the frame of the screen and shall be removable.

The drainage platform shall be constructed from perforated Stainless Steel plate with a minimum of 8mm thick. It shall be profiled to allow for water to drain towards the centre of the channel, and not allow water to run towards the channel walls. The platform shall be supported by means of cross members and shall be suitable design to carry the weight of an operator as well as wet screenings. The minimum loading shall be 200 kg. The platform support structure shall be manufactured from Stainless Steel profiles and suitable fastened to the channel walls by means of Stainless Steel anchor bolts. The perforated plate shall be secured to the support structure.

A suitable rake shall be supplied that suits the rack spacing to allow for easy cleaning and operation.

8.2.5 *Spare Parts*

The following Spare Parts shall be included and supplied together with the equipment:

- None

Spare parts shall be packaged with labels indicating the contents of each package, and shall be delivered to Owner as directed.

8.2.6 *Installation and Testing*

The Contractor shall verify all dimensions in the field to ensure compliance of equipment dimensions with the drawings. Contractor shall notify the Engineer of significant deviations.

Installation of the equipment shall be in strict accordance with the contract documents and the manufacturer's instructions and shop drawings. Manufacturer shall supply equipment, including anchor bolts for the equipment. Contractors shall install the equipment in accordance with the manufacturer's recommendations.

The Service Engineer shall demonstrate proper and sequential operation of the screen and demonstrate that the equipment achieved the requirements set out in the Specifications. The screen shall operate automatically based on the differential water levels and on a timer basis.

9. FASTENERS (NUTS, BOLTS, READY-BAR, ANCHORS) – WHERE APPLICABLE

Nuts, bolts, washers (2 per bolt set), ready-bar (threaded rod) shall be manufactured in accordance with the specific requirements. Where bolts and ready-bar is cut, the ends must be treated with an anti-corrosion coating. Bolts and ready-bar lengths shall allow for at least two screw threads to be visible when tightened.

Where applicable, all mounted into concrete shall be done with chemical anchors suited to the application, considering all respective forces and stresses applicable.

10. INSTALLATION AND REMOVALS

The sum tendered for shall include for all arrangements for handling, transport, crainage/rigging, erection, adjustment and commissioning of all potential phases of the project and installation.

The Contractor shall provide for all interconnection pipework / chutes / etc, required for the separate system to ensure that all systems are fully functional and operational as it is intended.

The contractor shall allow for all costs involved for the removal of all existing mechanical equipment at the existing inlet works and one of the existing clarifiers (where the new rotating bridge are to be installed). The contractor shall make allowance for the transport of the redundant equipment to the Municipal store Ceres.

Alternative offers proposals will only be considered if the main/specified offer is priced and that it is offered apart from the main proposal and in attached covering letter.

Section 3: Electrical

1. **GENERAL SCOPE**

The electrical scope of works consists of the following main components for the Nduli Inlet Works project:

- One new Outdoor Motor Control Centre (MCC) for:
    - **Inlet Works MCC** consisting of:
        - One mechanical screen
        - One screenings washer/compactor
        - One grit paddle drive
        - One grit pump
        - One grit classifier
        - Small lighting and power supplies
        - Site lighting
        - Other small existing feeds supplies
- One new kiosk for:
    - **Electric Fencing Kiosk** consisting of:
        - One energizer unit
        - One GSM telemetry transmitter
- New control instrumentation for suction control, pump and motor protection as well as system monitoring
- Removal of existing equipment to the Municipal stores
- Cable installation to all required points of supply, including excavations, restoring surfaces and pavements to original finishes and all required ancillaries

2. REFERENCED STANDARD SPECIFICATIONS

This Electrical, Control and Instrumentation (E, C&I) Project Specification must be read in conjunction with the following Electrical Standard Specifications:

SSE01	Medium Voltage	Rev 1
SSE02	LV and Control	Rev 1
SSE03	Instrumentation and Control Devices	Rev 1
SSE04	Telemetry and SCADA	Rev 2

The E,C&I Project Specification takes preference over the Electrical Standard Specifications should there be contradictions. The E,C&I Specification must also be read in conjunction with the Mechanical Project Specification and Mechanical Standard Specification(s) to ensure integration and allowance made for interfaces that may be required for pump, motors and other mechanical equipment.

3. BULK ELECTRICAL SUPPLY TO SITE

The site has an existing 50kVA pole-mounted transformer transmits via a 25mm^2 x 4 core cable to a municipal supply kiosk located outside of the site. A new supply cable and metering kiosk needs to be supplied and installed under this contract.

3.1 Distribution Kiosks

The new site metering kiosk must be supplied and installed, in line with the requirements below. The outdoor kiosk must be of the 3CR12 type, with front and back access allowance made. Allowance must be made for adequate cable bending radii throughout, with adequate cable support, busbar tails on the CBs, pre-drilled copper busbars and cables.

As part of the kiosk cost, a suitably sized plinth as well as all required sleeves, excavations, vermin-proofing, expandable foam and compaction must be allowed for. Any plinth sizing, weight and reinforcement design must also be allowed for.

The kiosk must consist of the following equipment:

Kiosk Requirements:

- Front:
  - Main CB : 60A TP
- Back:
  - Metering of the Landis & Gyr E650 and/or similar type, complete with integrated remote modem

4. MOTOR CONTROL CENTRES (MCCs)

4.1 STATUTORY REQUIREMENTS

MCCs must be provided as detailed below and fully conform to the requirements of SANS 10142-1 (latest edition). All material, components and equipment installed within the respective MCCs must also comply with SANS 10142-1, specifically Section 4.3, which details further specific compliance requirements per specific item.

Specific SANS standards such as 1973-1 and 1973-3 are applicable for MCCs above and below a 10kA fault rating. For SANS 1973-1 (MCCs above 10kA), a Type-Tested Assembly (TTA) must be provided and the populator of the assembly (if different entity from the one providing the TTA) must complete the work in strict accordance with the required standards of the TTA design. MCCs equal to or less than 10kA must strictly comply with SANS 1973-3.

Note that the specifications and requirements in the document act as guidelines only in terms of legislative compliance. Final legislative compliance, in terms of the Act, remains that of the Contractor and in case of a conflict, the SANS requirements shall apply.

During the tender stage, the relevant tendering party must specify in the data sheets whether and how the MCCs and equipment offered comply with the legislative requirements. Note this is a legal requirement and the tenderer must categorically acknowledge that they have acquainted themselves fully with the applicable SANS standards and that the offered equipment will comply as such.

4.2 GENERAL

4.2.7 Ratings

The MCCs and associated equipment and switchgear must be rated for the applicable fault levels as indicated in each MCC's section below.

CB and busbar sizes are only provisional during tender stage, as some of the plant and field equipment could change in sizing, depending on the final equipment offering by the tenderer.

MCCs must be rated to operate under at least a maximum ambient temperature of 50°C and a minimum of -1°C, in relative humidity of 90%.

MCCs must be rated to a minimum protection degree of IP44 within buildings and IP54 for outdoor installations.

All MCC distribution sections must allow for 30% physical spare capacity in their design, for future expansions or changes during construction.

As such, any and all ratings provided for the MCCs must be seen as applicable for tender (quotation) stage only. All sizes must therefore be confirmed with the Engineer, before construction commences. Any changes during construction stage, due to a lack of compliance in this regard, will be for the Contractor's account.

4.2.8 General Construction

4.2.8.1 *Material and Configuration*

The MCCs are intended for bulk industrial application, with loads such as compressors, motors and conveyors being fed from it or from other various sub-DBs and dedicated control panels provided by others.

The MCCs must be floor-standing units, manufactured from 3CR-12 sheet steel, not less than 1.5mm thick. Where trenches are provided over which the MCCs must be installed, and all required plinths (minimum 50mm x 100mm hot-dipped galvanized U-Channel) and supports to stabilize and install the MCC over the trench must be provided as part of the MCC pricing.

Painting of the complete unit must be done strictly in compliance with the manufacturer's recommendations, with uniform thickness without. The final coat must be avocado green enamel baked or powder epoxy, to be confirmed by the Client and Engineer before manufacturing.

MCCs must be constructed in tiers, with all tiers and panels compartmentalized (above and equal to 10kA). All required doors must be hinged and fitted with rubber door seals, so as to provide a continuous sealing edge along the gasket. All panels and doors must be removable with square-key locks used for securing them and a minimum of two per door.

The grouping of the MCC and associated equipment and feeds must be structured in a logical way, taking both the process flow of the feeds into account, as well as the grouping of respective and associated equipment. The following main components are required for the general MCC layout:

- Incoming section, with main incoming Circuit Breaker (CB), separate brass neutral and earth bars, metering, E-Stop and indication light (I/L), surge arresters, phase failure relay and main incoming cable access.
- Dedicated and enclosed air-insulated busbar chamber (both vertical and horizontal, where required by the MCC manufacturer design philosophy), running the length of the MCC
- Outgoing feeds to motor driven equipment and various other sub-DBs, each with dedicated door-interlock handle
- Local lighting and power sub-DB section, with dedicated CB feeds.
- Dedicated power and control terminal compartments for field-cable connections

All live parts must be arranged to allow for front-access only.

Note that all internal busbars, including the neutral, must be of solid copper. These busbars assemblies must be fully type tested and compliant along with the steelwork configuration, to form one fully compliant TTA. A dedicated brass earth bar must run the length of the MCC, with pre-drilled holes at each tier/panel section.

The MCC must be designed that for the purpose of transport, it would be easy to disassemble the unit into moveable parts. This includes providing multi-pin sockets at each panel split for control wiring between two sections.

4.2.8.2 *Field and Cable Accommodation*

Adequate space must be provided between the MCC base, gland plate and main incoming CB terminals to accommodate the main supply incoming cable. The permissible bending radius of the cable must never be exceeded. The minimum distance between the base and glanding plate may never be less than 300mm though. Further note that the glanding plate must be suited for the type of main supply cable being installed, with a non-ferrous metal glanding plate to be used for single-core cables. In the case of parallel cables, or where required for the glanding of a large incoming cable, then adequately pre-drilled busbar extension stubs must be provided, securely fastened to the CB. These stubs must be 'flaired', so as to provide adequate space between them and allowing adequate space to install and fasten the cables and all requirements as such must be provided as part of the tender offer.

Each additional tier must be provided with a dedicated terminal compartment at the bottom off the tier, fitted with terminals above the gland plate (unless the tier is a dedicated feed for one piece of equipment). The terminals must be suitably sized for the equipment fed, and adequately labelled on the backplane and terminal itself. All cable connections from the field may be done in this terminal compartment only, with all wiring from the terminals to the respective CBs and other feeds done in the factory. All other spatial, height and material requirements as per the incoming section are also applicable here.

Wireways may also be utilised, but then these must be dedicated wireways the fully height of the MCC, with a minimum of 250mm wide. Note that for fully compartmentalized MCCs wireways are a requirement as no through-wiring from one compartment to another is permitted. Should field terminals be installed within these wireways, then dedicated supports must be provided for securing the cables. No cable may simply 'hang' on its terminals, regardless of being glanded in the bottom. Terminals must further be staggered in the horizontal, so as to prevent cables lapping over one another when being installed from the field.

All wiring must be installed within PVC trunking throughout the MCC, including the wireways. Trunking must run neatly in vertical and horizontal sections where required and must laced together by means of 'Helen strap' or other similar and equal material. Note that wiring not installed in trunking must be installed in wire looms and fixed to dedicated rails, with the rails being part of the steelwork design and construction. Note that no self-adhesive straps will be allowed within the panel and it is therefore critical that any potential support rails be accommodated during the design stage.

4.2.8.3 *Labelling*

Each MCC must be clearly labelled and fastened to the panel by means of screws. In addition, each section must be labelled with externally mounted labels, below the equipment served. All CBs (incoming and outgoing) and other plant feeds must be provided with labels depicting either where they are fed from or what loads they are feeding, and what the applicable supply and cable earth size is.

All internal equipment and switchgear must be labelled with plastic engraved labels in clearly identifiable positions, and not on the trunking itself.

The main point of isolation must be provided with adequate 'Main Point of Isolation' labels as well as required 'in case of emergency' label.

Note that all internal wiring, cables, terminals and relays must be numbered, with the numbering to match the final As-Built documentation.

4.2.9 **Outdoor MCCs**

4.2.9.1 *General Construction*

In addition to the requirements above, MCCs intended for outdoor installation must further be installed on a hot-dipped galvanized angle-iron stand bolted to the concrete plinth, enclosed with wire mesh, with a minimum height of 300mm above FFL.

MCCs within residential areas must be painted avocado-green and outside off-white. This must be confirmed with the Client and Engineer before construction and failure to do so will be for the Contractor's account.

Outdoor MCCs must be provided with a double-sloped roof, with a minimum overhang of 50mm on all four sides.

A double-door construction must be provided on the outside, with door seals provided for both the inner and outer doors. The inner doors must be provided with square key locks and all required indication and control equipment must be flush-mounted on the inner doors. The outer doors must be provided with lockable (suitably sized for large Municipal padlock) rotary handles operating a stainless steel slide locking rod.

Stays to hold open an outer door must further be provided for each door, to prevent the wind from blowing around an open door.

All handles, hinges, nuts, bolts and sliding rod must be made of stainless steel.

Note that the plinth orientation must be designed as such that the front control section of the MCC faces South, and all required sleeve configurations included into this design requirement.

4.2.9.2 *Additional Telemetry Requirements*

Where a telemetry outstation is specified, it must be installed in a dedicated compartment at the back of the MCC. All normal control, monitoring and power equipment must be remain in the front section(s) of the MCC.

This back section compartment need not be provided with inner doors and the required voltage free contacts can be installed in this compartment. A dedicated backplane for the telemetry enclosure mounting must be provided, as well as the necessary gland plate for any external cable entries (as well as antenna cable).

Note that the spatial requirements must be clearly coordinated, including MCC depth, between the MCC and telemetry suppliers and no claims in this regard will be entertained. The compartment must be equipped with all required wireways, backplanes, supports and earthing points.

4.2.9.3 *Coordination and Pricing*

The coordination relating to the plinth size, amount and position of sleeves as well as plinth orientation remains that of the Contractor and all required coordination with either civil contractor, or if required, provided as part of this contract, must be included in the tender pricing.

Where specified, the stand, canopy, supports, coordination and any other material and labour required for a fully compliant installation must be included as part of the MCC price for the tender offer.

4.2.10 ***Switchgear and Equipment***

4.2.10.1 *Phase-Failure Protection*

A suitable phase-failure relay (with adjustable switching points and sensitivity) must be installed within the incoming section, for the protection of the equipment. The relay must be provided with an additional dedicated and adjustable delay-on timer. After the identification of a phase failure condition, and after the condition has fallen away, the power onto the MC may not be energised until this dedicated timer has timed out.

The relay must provide protection against phase loss, phase rotation and under/over voltage.

4.2.10.2 *Surge Protection*

The incoming section of the MCC must be equipped with surge protection in accordance with SANS 10142-1. Both Class 1 and Class2 coordinated protection must be provided, adjacent to one another. Curve C backup protection CBs must be provided, with final ratings and positions to be determined by the supplier of the surge arresters.

Note that Surgetek, ABB or similar and equal equipment must be provided, being of the clip-in type and having visual displays and contacts for remote monitoring. The arresters must be mounted in a vented, see-through enclosure.

4.2.10.3 *Circuit Breakers*

As this application is industrial by nature, circuit breakers must be rated accordingly (moulded case type), with sizing, tripping curves and protections taking into account for the applicable motors. Residential type equipment is therefore not accepted, except within the dedicated small lighting and power distribution feeds.

All CBs must carry the SABS mark.

CBs must be equipped with thermal devices for tripping in over-current situations and magnetic devices for instantaneous tripping in fault current conditions.

Single and double pole CBs may be rated at no less than 240V, with 420V the minimum voltage for three-pole CBs.

4.2.10.4 *Current Transformers (CTs)*

CTs must have Class C accuracy, suitable for a 10VA secondary load and comply with SANS 60644-1. Note that the final CT design must however be presented to the Engineer, as field equipment and loading could potentially change during final equipment offering stage.

CTs must be of the air-cooled type, with suited mounting facilities. Split-core units will not be accepted.

4.2.10.5 *Starter Equipment*

Each outgoing starter must be provided with a door-mounted run-hour meter, analogue ammeter with linear scale for specific motor loading characteristic, start and stop pushbuttons and reset pushbutton (where required and no manual equipment reset is available).

Should the pump/motor protection equipment offered, for warranty or other purposes, require additional protections than specified, protections such as overheat, seal fail or over-torque, amongst others, then this protection, along with indication lights, control cables and control functionality updates must be provided complete as part of the tender offer and no additional claims in this regard will be entertained.

4.2.10.6 *Lamp test*

A lamp test functionality must be provided by means of a pushbutton where when it is pressed, all the indication lights on the MCC come on.

In the case of an MCC having more than three tiers (wireways not included), then each panel equipped with an indication light must be provided with a dedicated lamp test pushbutton.

4.2.10.7 *Indication Lights*

They must be of the LED type, with dedicated colours as follows:

- GREEN: General run, start demand and enable levels
- YELLOW: Suction low level, process signals not being faults
- RED: General trip, alarm and emergency levels
- BLUE: Special status such as SCADA CONTROL

4.2.11 ***Metering and Indication Equipment***

All meters must be able to measure, display and record the following parameters as instantaneous and monthly averages:

- Line and phase voltages
- Line currents
- kW per phase
- kVA per phase
- kVar per phase
- Power factor
- Total energy demand (kWh)
- Voltage and current harmonics

The main incoming meter, where specified, must be provided with CTs and display module included as part of the final offer. The display must be flush mounted with the MCC front-plate, but care must be taken to remove this unit during transport and installation.

The meter must be equipped with storage capacity, either on-board or expandable, so as to log the usage of the site over a daily, weekly and monthly cycle.

The unit must further be fitted with a communication port for network communications with a central control station via the telemetry, preferably of the Ethernet/IP or Modbus type.

The meter must be of the Landis & Gyr, Lovato, ABB or similar and equal type, with Class 1 accuracy.

4.2.12 ***Ancillary Items***

4.2.12.1 Drawings

All drawings must be submitted to the Engineer in electronic format. All drawings must contain gridlines, or referencing grid-blocks, so as to be able to comment on specific sections.

Construction may not commence until drawings have been commented on by the Engineer. Any modifications as a result of failing to comply with this requirement will be for the account of the Contractor.

Note that all revision must be listed on the drawings as the revision process carries out. Note that not additional payment will be made for revising drawings.

4.2.12.2 Civil Requirements

As part of the drawings stage in the project, detailed civil requirements as a result of the equipment must be provided as soon as possible. This relates to items such as cable trench depths, width and location, sleeves and other entry/exit points from the MCC room (size, amount and location, where applicable), applicable MCC dimensions, ventilation and heat exchange, cable racking routes and any other electrical requirements that could have an impact on the civil design and construction.

Note that the room is existing and provision has been made under the civil contract to expand it for this phase, as well as the future intended upgrades. Provision must be made for inputs into MCC layouts, trench and sleeve sizing, existing cable relocation as well integration with existing structure. All related civil and coordination costs must be included as part of the tender offer and qualified accordingly.

4.2.12.3 Payment

As a MCC is considered a complete and functional unit, interim payments will not be made. Only after a factory inspection and test has been carried out on a unit, and it has been found satisfactorily in line with the specification, will payment be certified for the unit in line with the contractual arrangements (MOS, guarantee, etc.).

4.3 MCC CONSTRUCTION

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

4.3.13 **Inlet Works MCC**

A new outdoor MCC of the front and back-access type must supplied and installed on the plinth provided. Note the civil design requirements as per section 4.2.12.2 above.

The MCC design, steelwork and all required switchgear fault rating must be 10kA minimum, to be confirmed by the Engineer before construction.

The MCC must consist of the following:

4.3.13.1 **Incoming Section**

a) Main incoming CB size for full MCC load

b) Surge arrestors

c) Phase failure protection

d) Power meter of the Lovato, ABB and/or similar type

e) E-Stop with indication light

4.3.13.2 **Outgoing Section for New Mechanical Screen (1 Off), Equipped With:**

a) Power and control equipment for motor and pump protection as well as control philosophy both internal and door-mounted

b) 0.75kW Direct On Line (DOL) FWD/REV Starter with specified protections

4.3.13.3 **Outgoing Section for New Screenings Washer/Compactor (1 Off), Equipped With:**

a) Power and control equipment for motor and pump protection as well as control philosophy both internal and door-mounted

b) 2.2kW Direct On Line (DOL) FWD/REV Starter with specified protections

4.3.13.4 **Outgoing Section for New Paddle Drive (1 Off), Equipped With:**

a) Power and control equipment for motor and pump protection as well as control philosophy both internal and door-mounted

b) 0.75kW Direct On Line (DOL) Starter with specified protections

4.3.13.5 **Outgoing Section for New Grit Pump (1 Off), Equipped With:**

a) Power and control equipment for motor and pump protection as well as control philosophy both internal and door-mounted

b) 2.2kW Direct On Line (DOL) Starter with specified protections

4.3.13.6 **Outgoing Section for New Grit Classifier (1 Off), Equipped With:**

a) Power and control equipment for motor and pump protection as well as control philosophy both internal and door-mounted

b) 1.1kW Direct On Line (DOL) Starter with specified protections

4.3.13.7 **Outgoing Section for Local Lighting and Power**

a) 15A SP CB, with 30mA Earth Leakage Unit, as well as 15A door-mounted socket outlet

b) 10A SP CB for local lighting

c) 10A SP CB for site lighting

d) 20A SP CB for electric fencing kiosk

e) 15A SP CB, with 30mA Earth Leakage Unit, for outdoor outlet circuit

f) 10A SP CB for future telemetry

g) 5 x 10SP CB spare positions and 2 x 20A TP CB spare positions

5. SYSTEM CONTROL

5.1 Inlet Mechanical Front Rake Screen

5.1.14 Control modes

The screen can either be run in manual or automatic mode, with the screen timer controlled in auto mode.

The rake panel must be equipped with a three-position selector switch labelled Manual/Off/Auto, with the control as set-out below. A running rake must stop when switched to off and cannot be initiated to run with the selector switch in the off position.

5.1.14.1 Manual Mode

The rake must be controlled via a forward, reverse and stop pushbutton on the MCC, as well as from the field via a local control station near the rake (forward/reverse/E-Stop).

5.1.14.2 Automatic Mode

Primary Timer Control

The front rake screen must be timer controlled by means of a dual-type interval timer (adjustable), allowing the rake to run for a certain amount of time, at a certain interval period. The timer values for both interval initiation and run duration must easily be adjustable by an operator, depending on the inflow quality. Two separate timers can also be used for this purpose.

The rake screen must start when the timer enters its timing cycle (initiated through the interval timer function) and stop when the timing duration cycle is finished. At the start of the timing cycle a TIMING CYCLE START DEMAND indication light must come on and switch off once the timing duration cycle has stopped.

Secondary Level Control

In the instance where the level differential before and after the rake increases above a certain setpoint, then the rake must start, regardless of the rake's timer values.

The levels will be provided by means of a new differential ultrasonic level sensor, connected to two sensors. The controller must be programmed for a rake run initiation, where after the duration timer must run for its set period. At the start of the level-initiated timing cycle a LEVEL START DEMAND indication light must come on and switch off once the timing duration cycle has stopped.

The rake run (duration) timer is therefore applicable to both timer (primary) and level (secondary) initiation.

Wash Water Control

Provision must be made for the control of a solenoid for the period when the rake is running, regardless of primary, secondary or emergency control. The solenoid must be energised to open, with voltage to suit the specific equipment supplier's recommendation (24VDC or AC).

5.1.14.3 **Emergency Control**

The rake screen must be equipped with a torque switch detecting when the rake has become blocked.

In this instance the screen must run in the reverse direction (for an adjustable period), stop and run forward again (for an adjustable period) to try and dislodge the blockage. If after the third attempt of the front and back sequence did not clear the blockage, then the rake screen must stop and a SCREEN BLOCKED indication light must come on.

5.1.15 **Protections**

The rake must be protected, in all control modes, by means of the protective devices described below. At the occurrence of a fault, the motor must STOP and a FAULT indication light must energize.

Each protective device must be accompanied with a manual reset capability, either inherently built-in, or via a separate reset door-mounted push-button. No tripped equipment may start running until a manual reset has been initiated.

Motor/Pump Protection

- Overload protection
- Torque trip for blockage

5.1.16 **Alarm and Status Indication**

Each item monitored must be provided with the relevant indication as detailed below:

a) Rake Screen Panel

- RUN FORWARD
- RUN REVERSE
- OVERLOAD TRIP
- TIMING CYCLE START DEMAND
- LEVEL START DEMAND
- SCREEN BLOCKED
- E-STOP

5.2 **Screenings Washer/Compactor**

Depending upon the final equipment offering by the mechanical contractor, the control must be suited for the specific application, including timers and associated control.

5.2.17 **Control modes**

The washer can either be run in manual or automatic mode, with the washer controlled in auto mode by means of the run signal from the conveyor.

The washer must be equipped with a three-position selector switch labelled Manual/Off/Auto, with the control as set-out below. A running washer must stop when switched to off and cannot be initiated to run with the selector switch in the off position.

5.2.17.1 **Manual Mode**

The washer must be controlled via a forward, reverse and stop pushbutton on the MCC, as well as from the field via a local control station near the washer (forward/reverse/E-Stop).

5.2.17.2 **Automatic Mode**

The washer must run when the conveyor is running.

The RUN signal from the conveyor must initiate the WASHER START DEMAND indication light and the light must switch off and the washer must stop once the conveyor has stopped, but only after a delay-stop timer (adjustable) has timed out.

Wash Water Control

Provision must be made for the control of a solenoid for the period when the washer is running, regardless of primary, secondary or emergency control. The solenoid must be energised to open, with voltage to suit the specific equipment supplier's recommendation (24VDC or AC).

5.2.18 **Emergency Control**

It is not impossible that stones, pieces of metal and hard wood end up in the press, and objects that are large enough to cause a jam up situation or cause damage to the press and cause overload should be sensed by a rise in the amps from the drive motor.

This in turn should send a signal to reverse the drive for a few seconds and then re-start in the forward direction to try and clear up the blockage. After three reversal and start attempts where the blockage has not been cleared, the motor should cut out and an alarm initiated so that the operator can come and rectify the problem.

5.2.19 **Protections**

The washer mixer must be protected, in all control modes, by means of the protective devices described below. At the occurrence of a fault, the motor must STOP and a FAULT indication light must energize.

Each protective device must be accompanied with a manual reset capability, either inherently built-in, or via a separate reset door-mounted push-button. No tripped equipment may start running until a manual reset has been initiated.

Motor/Pump Protection

- Overload protection

5.2.20 **Alarm and Status Indication**

Each item monitored must be provided with the relevant indication as detailed below:

a) Washer Mixer Panel

- RUN FORWARD
- RUN REVERSE
- OVERLOAD TRIP
- WASHER START DEMAND
- E-STOP

5.3 **Grit Paddle Drive**

5.3.21 **Control modes**

The paddle can either be run in manual or automatic mode.

The paddle panel must be equipped with a three-position selector switch labelled Manual/Off/Auto, with the control as set-out below. A running paddle must stop when switched to off and cannot be initiated to run with the selector switch in the off position.

5.3.21.1 **Manual Mode**

The paddle must be controlled via a start and stop pushbutton on the MCC, as well as start and E-stop pushbuttons on the local control station mounted next to each piece of equipment.

5.3.21.2 **Automatic Mode**

The paddle must run by means of a 24/7 adjustable timer, with minimum 15min dip intervals. The timer must be provided with an override facility.

5.3.22 **Protections**

The paddle must be protected, in all control modes, by means of the protective devices described below. At the occurrence of a fault, the motor must STOP and a FAULT indication light must energize.

Each protective device must be accompanied with a manual reset capability, either inherently built-in, or via a separate reset door-mounted push-button. No tripped equipment may start running until a manual reset has been initiated.

Motor Protection

- Overload protection

5.3.23 **Alarm and Status Indication**

Each item monitored must be provided with the relevant indication as detailed below:

a) Paddle Panel

- RUN
- OVERLOAD TRIP
- E-STOP

5.4 **Grit Pump**

5.4.24 **Control modes**

The pump can either be run in manual or automatic mode, with the pump timer controlled in auto mode.

The pump panel must be equipped with a three-position selector switch labelled Manual/Off/Auto, with the control as set-out below. A running pump must stop when switched to off and cannot be initiated to run with the selector switch in the off position.

5.4.24.1 **Manual Mode**

The pump must be controlled via a start and stop pushbuttons on the MCC, as well as from the field via a local control station near the pump (start/E-Stop).

5.4.24.2 **Automatic Mode**

Primary Timer Control

The pump must be timer controlled by means of a dual-type interval timer (adjustable), allowing the pump to run for a certain amount of time, at a certain interval period. The timer values for both interval initiation and run duration must easily be adjustable by an operator, depending on the inflow quality. Two separate timers can also be used for this purpose.

The pump must start when the timer enters its timing cycle (initiated through the interval timer function) and stop when the timing duration cycle is finished. At the start of the timing cycle a TIMING CYCLE START DEMAND indication light must come on and switch off once the timing duration cycle has stopped.

5.4.25 **Protections**

The pump must be protected, in all control modes, by means of the protective devices described below. At the occurrence of a fault, the motor must STOP and a FAULT indication light must energize.

Each protective device must be accompanied with a manual reset capability, either inherently built-in, or via a separate reset door-mounted push-button. No tripped equipment may start running until a manual reset has been initiated.

Motor/Pump Protection

- Overload protection

5.4.26 **Alarm and Status Indication**

Each item monitored must be provided with the relevant indication as detailed below:

a) Pump Panel

- RUN
- OVERLOAD TRIP
- TIMING CYCLE START DEMAND
- E-STOP

5.5 **Grit Classifier**

5.5.27 **Control modes**

The grit classifier can either be run in manual or automatic mode, with the screw conveyor controlled in auto mode linked to the operation of the submersible grit pump.

The grit classifier must be equipped with a three-position selector switch labelled Manual/Off/Auto, with the control as set-out below. A running grit classifier must stop when switched to off and cannot be initiated to run with the selector switch in the off position.

5.5.27.1 **Manual Mode**

The grit classifier must be controlled via a forward, reverse and stop pushbutton on the MCC, as well as from the field via a local control station near the grit classifier (forward/reverse/E-Stop).

5.5.27.2 **Automatic Mode**

The grit classifier shall be able to operate automatically, linked to the operation of the submersible grit pump. There shall be a facility to allow the classifier to run for a variable set time after the submersible grit pump has stopped operating.

5.5.28 **Emergency Control**

The grit classifier shall be protected from damage caused by jamming, which is actuated by a mechanical torque sensing device, and which shall be capable of switching off the drive and transmitting an alarm.

When the motor stops because of this, the OVER TORQUE indication light must energize.

5.5.29 **Protections**

The grit classifier must be protected, in all control modes, by means of the protective devices described below. At the occurrence of a fault, the motor must STOP and a FAULT indication light must energize.

Each protective device must be accompanied with a manual reset capability, either inherently built-in, or via a separate reset door-mounted push-button. No tripped equipment may start running until a manual reset has been initiated.

Motor/Pump Protection

- Overload protection
- Inherent over-torque protection

5.5.30 **Alarm and Status Indication**

Each item monitored must be provided with the relevant indication as detailed below:

a) Grit Classifier Panel

- RUN

- OVERLOAD TRIP
- OVER-TORQUE TRIP
- E-STOP

6. INSTRUMENTATION

Refer standard specification for detailed instrumentation requirements.

6.1 Level

Ultrasonic level sensor

One pair of ultrasonic level sensor must be provided:

- One for differential levels around the mechanical screen (two sensors per controller)

The differential level controller must be field-mounted, with two sensors per controller. Each sensor must be installed by means of a stainless support bracket mounted on either side of the structure. The controller must be of the IP68 type and installed outdoors next to each mechanical screen.

Note that outdoor boxes must be provided with hinged-doors, with sun protective display covers, to prevent windows from becoming opaque.

6.2 Torque Limit Switches

The following limit switches (24VDC) must be provided for the following equipment:

- Rake screen for jam protection on the screen
- Screening wash press for jam protection on screening wash press
- Classifier for jam protection on grit classifier

The limit switches must be minimum IP67 and suited for the specific industrial application, complete with NO/NC contacts and Zinc Alloy Lever mechanism.

6.3 Solenoid Valve

A solenoid valve must be provided for the following equipment, with voltage suited for specific equipment application:

- Wash water for screen wired into the control circuit.
- Wash water for compactor

7. GENERAL ELECTRICAL WORK

The general electrical installation covers the supply, installation and connection of equipment provided under this contract, as well as the connection of other MCCs and control panels provided by others.

7.1 CABLES AND SUNDRIES

The Contractor must allow for the supply and installation of all required electrical, control and instrumentation cables outside and within the plant as per the schedule in the Bill Of Quantities (BOQ).

7.1.31 Technical Requirements

General LV cables must be of the 600 / 1000V Cu PVC insulated, steel wire armoured, overall PVC contained type, in compliance and accordance with SANS 1574. Instrumentation cables must be of the multi-cored twisted pair, individually and overall screened, armoured type.

All unarmoured cable being installed in trenches must be provided with protective concrete slab, or similar and equal type, covers. The slabs must completely cover the length of the cable, installed a minimum of 300mm above the cable. The slabs must also extend a minimum of 100mm on either side of the final cable width.

7.1.32 Pricing

Note that the cable sizes and distances are provisional for pricing only. All final cable distances must be measured on-site by the Contractor, in line with the final agreed-upon cable route. Only after the final cable route distances have been provided to the Engineer, can the final cable sizes for ordering and installation be determined. All cable distances are therefore re-measurable and payment will only be made for final installed distances. Note that 1m cable slack must be provided for in the final rates at each cable end and that the rates must include provision for any further wastage at these cable ends.

7.1.33 Installation Schedule

A detailed cable, wiring and tray schedule must be compiled and maintained by the Contractor. The purpose of the schedule it to log and monitor all re-measurable items. The schedule must be complete with sections stating to and from feeds and broken down into the specific components, so as to be able to trace and audit all re-measurable components installed. The schedule must remain live and up to date throughout the installation procedure. No payment will be made without evidence of an up to date schedule.

7.1.34 Terminations

All cable terminations must be properly planned in terms of spacing on the respective gland plates. All cable ends must be properly made-off with cable glands to suit the cable type and size, with one gland per cable only. Note the bonding requirements of the armouring, that all cable ends must be sealed with colour-coded heat-shrink and the lugs must be properly rated for the final cable size. In the instances where CB stubs are too close together, or where the bending radius of the cable is exceeded due to space limitations, then flared busbar ‘stubs’ must be provided to suit the application requirements.

All gland openings not used must be properly closed-off.

All external glands must be of the Pratley Enviro (double seal) type and motor terminal boxes must be designed and cater accordingly.

7.1.35 Routes and Existing Cables

As the plant is existing and remain in operation throughout the project, it is imperative that the location of the existing cables be determined before any work is done. Allowance must be made for location and hand excavation around these existing cables, especially the entire area around the back and side of the existing MCC building.

Allowance must further be made for identification of each of the cables in terms of purpose and end-destination (ie site lighting circuits, DB feeds, equipment supply, etc.). This must be cross-checked with the existing and new distribution section and confirm that all required distribution CBs, both is amounts and sizes, are catered for. No claims will be entertained at a later stage for a lack of coordination.

Some of the plant cables will be re-used, while in other instances new power and control cables will have to be provided. Where possible existing cables routes must be re-used to new and old structures.

7.1.36 Labelling

Each cable on the plant must be provided with a permanent cable label indicating what the cable is supplying and from where, on both ends.

7.2 EXCAVATIONS

The cables must be installed at a depth of 750mm and the trench must be made wide enough that it does not fall in on itself while introducing the bedding, cable and backfilling and compaction.

No bedding may be provided until the trench has been approved by the either the Engineer or Municipality.

Note that all OHS Act requirements must be met, specifically relating to an open trench and barricading and signage for the public and other workers' protection and safety.

7.2.37 Cable Installation

A minimum of 150mm bedding must be provided for the cable, with the material having a low clay content and a maximum resistivity of 1.2Km/W. After the cable is installed, in as straight a line as possible, an additional 150mm cover must be provided.

Thereafter a 400mm backfilling section is to be provided, properly compacted.

Two runs of danger tape must be installed on top of this layer, ensuring that the tape is installed directly above the cable. The tape must be polyethylene, nominally 230mm wide and imprinted

with a triangle and electrical flash symbol, as well as the words "DANGER, GEVAAR, INGOZI", at no more than 1m intervals.

The final round of backfilling must be provided and the entire trench properly compacted as per 6.2.3 below.

Cable route markers must be provided at every cable turn and every 50m along a straight run.

7.2.38 Bedding, Grading and Backfilling

Both the bedding and backfilling material must be free of all plant materials, stones and clots larger than 15mm and any other foreign objects that could potentially damage the cable. Sea and/or river side is not acceptable due to their high thermal resistivity values.

In light of the material requirements above, as much as possible of the excavated material must however still be used. The excavated material must be sifted to ensure compliance. Only in the instance where there is not enough suitably graded backfilling material on-site, can suitable imported material be sourced. Payment for bedding and backfill material will only be done for sourced material, with the excavated material paid as part of the cable excavation's labour component.

7.2.39 Compaction

Note that backfilling must be done in sections of no more than 150mm at a time (after compaction). Compaction must be done to an AASHTO-density percentage of 98% and record must be kept and supplied to the Engineer for each layer of compaction done.

7.3 PLANT CHANGEOVER

The changeover of plant equipment, cables as well as MCCs must be very carefully planned in consultation with all team members, as well as the mechanical and civil portions of the plant upgrade.

Before any work is done, a detailed method statement must be compiled and approved by the Client and Consultant Team. It must focus on items such as allowable down-time, times of operation, critical plant areas, risk mitigation and contingency planning.

7.4 CABLE TRAY

7.4.1 Tray

Cables must be installed on heavy duty hot dipped galvanized/stainless steel cable tray (as per BOQ), with a minimum of 76mm depth. The tray widths will be dependent upon the final routes and positions, as well as the amount of cables running along a certain section. The provisional sizes as per the BOQ must be used for the purpose of pricing, with all final sizes and routes to be confirmed with the Engineer before ordering of equipment. Any modifications during construction stage due to a lack of coordination upfront will be for the Contractor's account.

Regardless of the route and installation type mentioned below, all cable tray will be measured and paid for final installed distance. The rate must include for all radius bends and changing in

the Y- or X-axis. All directional changes must be of the pre-fabricated type and no bending or cutting of the tray will be accepted on-site.

The metre rate must further include all required ancillary, securing and fastening as well as spacer material, equipment and labour components for a fully compliant installation. Note at certain sections where the cable tray must connect to the control panels from the centre column, additional floor supports will have to be provided and this must be included as part of the tender price.

Note that all tray must be securely bonded and tied-into the plant's earthing system. These resistance measurements must be done and included with the final COC documentation.

The final size of the tray must take into account that the trays must leave 30% spare position on them. If needs be, vertically stacked trays must be installed, to prevent the width of the trays becoming too much.

7.5 LOCAL CONTROL STATIONS

Local control stations must be equipped with a Start push-button and a Red mushroom-head push lock, pull unlock pushbutton, or additional forward/reverse pushbuttons where specified. The control station must be installed within arms-reach of the motor and the emergency stop must be wired fail safe.

The control station stand must be manufactured from HDG channel, with the pushbuttons mounted flush onto a stainless steel 316, IP65 hinged housing cover, with min. 50mm roof overhang. The channel stand must be provided with slots so as to fasten the cables and be no less than 550mm high.

In the instance where an outdoor cable termination/connection box is required, it must be of the IP67 stainless steel type and can be combined with a local control station to form a functional unit for the power and control cables.

All ancillary equipment such as nuts, bolts, hinges, etc. must be manufactured from stainless steel.

Note that all wires and terminals within control stations and terminal boxes must be numbered, so as to be able to trace all cables from the source to main point of supply.

All existing equipment must also be supplied with new control stations and associated cabling and control.

7.6 REDUNDANT EQUIPMENT

All redundant equipment, in line with the installation program, must carefully be removed and taken to the Municipal stores for safe-keeping. A signed delivery receipt must be obtained for the equipment dropped-off and forwarded to the Engineer for record-keeping purposes.

7.7 SYSTEM EARTHING

Where specified and indicated on the drawings and in the BOQ, dedicated Bare Copper Earth Conductors (BCEC) must be installed alongside and strapped to its associated electrical supply cable. The size of the BCEC is provisional along with the supply cable size. BCEC must be fitted crimped lugs and must be solidly bolted at both ends.

Wire armouring may not be used as a dedicated earth, BUT must be earthed none the less.

All required electrical points and paths along the installation must be solidly bonded, with the return path solidly connected to the MCC's main earth.

In addition, a dedicated earth mat must also be supplied and connected to the main MCC's earth bar. The mat must be a minimum 1m x 1m with 70mm^2 BCEC Cadwelded together, with internal grids of no more than 200mm x 200mm. The earth mat must be installed adjacent to the MCC and connected by means of a 70mm^2 BCEC to ensure an earth resistance of one ohm or less. All required excavations, connections and coordination must be included as part of the earth mat price.

Note that should the mat be installed without the initial supply cable earth wire readings provided to Engineer, then no compensation will be provided to the Contractor for the earth mat nor ancillaries, as the existing earth could potentially be acceptable as is.

Note that for mechanical strength reasons no BCEC may be smaller than 4mm^2.

All ancillary equipment such as nuts, bolts, hinges, etc. must be manufactured from stainless steel.

8. ELECTRIC FENCING KIOSK

8.1 General

An electric fence shall be installed on the inside and along the entire length of the existing brick wall. The fence shall be a free standing electric fence with 7 electrified strands.

The new stand-alone electric fence shall be 2.1m high from the finished ground level and all strands shall be spaced 200mm apart. Support posts / poles for the stand alone electric fence shall be of the heavy-duty thick wall type. All poles shall be hot dipped galvanized prior to installation on site. All drilling required shall be done prior to the hot dipped galvanizing process. Any additional holes required when on site shall be cold galvanized. All fasteners, bolts, and other fastening equipment required for the fence supports shall be galvanized.

The electric fence and its associated equipment shall comply with the following additional standard specifications:

- SANS 10222-3: 2006 : Electric security fences (non-lethal)
- SANS60335-2-76: 2006 : Particular requirements for electric fence energizers
- F200 : SSI General Specifications for electronic installations

The contractor shall ensure that the electric fence is sufficiently marked with DANGER/WARNING signage as per the SANS 10222-3 Section 4.2.

8.2 Electric Fence Kiosk

The electric fence kiosk shall be of the weatherproof type manufactured from 3CR-12 and have an inspection window. The electric fence kiosk shall be mounted on a suitable concrete plinth/ The contractor shall ensure that the kiosk is appropriately sized to house the energizer and the GSM telemetry transmitter. A detail workshop drawing of the kiosk shall be submitted to the engineer for approval before manufacturing.

The electric fence kiosk shall house the following equipment associated with the electric fence:

- Energizer units as described in Section 8.3.
- GSM Telemetry transmitter.

The kiosk shall have hinged lockable doors and shall be equipped with anti-tamper indication contacts. When the door of the security kiosk is opened an alarm SMS shall be sent to the responsible individual via the GSM telemetry transmitter.

8.3 Energizer Units

A single energizer shall be installed in the electric fence kiosk.

- The energizer shall be a single zone energizer with a LCD display to display the conditions of the electric fence and energizer. The energizer shall have suitable contacts to connect to the GSM telemetry transmitter to communicate the required alarm signals.
- Fence conductors shall be energized either as alternatively polarized (4.5kV between conductor and earth and 9kV between any adjacent conductors) or the conventional live-earth-live arrangement.
- The energizers shall be a type A energizer as defined in SANS 60335-2-76:2006, i.e. a battery-operated energizer suitable for connection to the mains, consisting of an impulse generating circuit, a battery charging circuit and a battery; the impulse generating circuit being connected to the mains or the battery when the energizer is in operation.
- The energizer shall have an internal back-up battery capable of operating the energizer at full output voltage for at least eight hours.
- The energizer output characteristics shall be in accordance with SANS 60335-2-76: 2006 to ensure compliance with the Electrical Machinery Regulations of the Occupational Health and Safety Act.

8.4 Electric Fence

The electric fence shall comprise of:

- An eleven (11) strand stand-alone system throughout and the strands shall be installed 200mm with the first strand installed 100mm from the finished ground level;

- Long life, UV stabilised electric fence support insulator strainers and tensioners; The heavy duty UV stabilized nylon type is preferred to eliminate any chance of galvanic reactions between the stainless steel wire and the galvanized materials;

- Reinforced, heavy duty, highly rigid support poles. The support poles shall be provided as an integral component of the electric fence support system.

- Galvanized fencing support poles (minimum 96mm dia x 2mm thickness), galvanized stays, galvanized intermediate electric fence poles, galvanized brackets etc for the entire perimeter fence to complete the electric fence installation. Please note that the rate shall include for all casting in concrete (minimum 15 MPa/19 mm) of support posts, stays, and intermediate electric fence poles.

Holes shall be drilled prior to hot dip galvanizing. Where additional holes are required on site they shall be cold galvanized. The use of silver paint is prohibited.

The fence conductors shall be a minimum of 1.6mm diameter 316 grade stainless steel wire, strained between corners and/or straining posts. Both ends of the conductors shall be insulated from the straining posts by means of suitably rated insulators (designed to prevent pollution build-up) with Nylon strainers and tensioners installed in series with the fence conductors.

The tensioners and strainers will be heavy-duty Nulon. All other hardware and fixings associated with the electric fence shall be stainless steel or heavy-duty UV stabilized Nylon.

8.5 GSM Telemetry Transmitter

The GSM telemetry transmitter shall be installed in the electric fence kiosk. The telemetry transmitter shall receive alarm conditions from the electric fence energizer when the following conditions occur:

- The energizer loses power;

- The Zone is in alarm;

- The kiosk door is opened.

The transmitter shall send out the alarm conditions to the responsible party. The Alarm condition shall be sent via SMS to the programmed cell phone number. The SMS shall contain the following information:

- The time of the alarm occurrence;

- The type of alarm condition;

The GSM telemetry transmitter shall be programmed with the above mentioned functionality and an off site test shall be arranged with the engineer for approval before the installation on the site commences.

8.6 Connectivity and Control Philosophy

The energizer and the telemetry transmitter shall be powered from an new electrical distribution board located in the MCC. Final power supply point to be determined on site and to be approved by the engineer before installation commences.

The Energizer shall have internal backup batteries and no additional external battery backup is required, provided that 8 hours of backup is achieved.

The following indications shall be provided on the energizer:

- Fence condition;
- Energizer condition;
- Fence mode;
- Fence voltage;
- Power indication of the energizer;
- Fence alarm.

An alarm condition shall be visible through the inspection window.

When one of the following conditions occurs a SMS shall be sent to the responsible party via the GSM telemetry transmitter:

- The energizer loses power;
- The Zone is in alarm;
- The kiosk door is opened.

Kiosks shall be equipped with anti-tamper indication, such that entry to the kiosks for any reason shall trigger an alarm and a SMS shall be sent to the responsible individual.

8.7 Earthing

All accessible metal parts of the electric fence which are not normally live, but which may become live accidentally shall be earthed.

The earthing of the electric fence shall be provided to suit the actual arrangement of the energizing conductors. The energizer shall be connected to a dedicated earth electrode which shall be provided as part of the electric fence system.

Contractor	Witness 1	Witness 2	Employer	Witness 1	Witness 2

Section 4: Telemetry / scada

NOT APPLICABLE

Section 5: Drawing List

The following drawings are provided for tendering purposes:

Drawing Number	Drawing description
P1174/M01	Nduli Screening Facility: Mechanical & Electrical Equipment Layout
P1174/M02	Nduli Screening Facility: General Civil Layout
P1174/M03	Nduli Screening Facility: Process Flow Diagram

Section 6: Standard Specifications

The following Standard Specifications shall be applicable to the project, and shall be read in conjunction with the scope of Works in Sections 1 to 6:

1. MECHANICAL STANDARD SPECIFICATIONS
    a. Pumping Equipment
    b. Pipework and Valves
    c. Materials and Coatings
    d. Ancillary Equipment
2. ELECTRICAL STANDARD SPECIFICATIONS
    a. Medium Voltage
    b. LV and Control
    c. Instrumentation and Control Devices
    d. Telemetry and SCADA

    The standard specifications are attached to Addendum No 1.

Appendix A – Health and Safety Specification GUIDELINES

Refer Civil Contractor for requirements and specifications.

Section 6: Standard Specifications

The following Standard Specifications shall be applicable to the project, and shall be read in conjunction with the scope of Works in Sections 1 to 6:

1. MECHANICAL STANDARD SPECIFICATIONS
    a. Pumping Equipment
    b. Pipework and Valves
    c. Materials and Coatings
    d. Ancillary Equipment
2. ELECTRICAL STANDARD SPECIFICATIONS
    a. Medium Voltage
    b. LV and Control
    c. Instrumentation and Control Devices
    d. Telemetry and SCADA

    The standard specifications are attached to Addendum No 1.

MECHANICAL STANDARD SPECIFICATION 01 – PUMPING EQUIPMENT:

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1. PUMP CHARACTERISTICS GUARANTEE AND TESTING OF PUMP SETS:

The performance of the pump set(s) offered shall be guaranteed to comply within the tolerances as described in ISO 9906:2012 Grade 2B. The following characteristics shall be guaranteed as a minimum:

- Pump rate
- Total dynamic pumping head
- Pump efficiency
- Shaft Power

Where specified in the Project Specification, the Contractor shall include for costs to factory bench test as follows:

a) The contractor shall make provision to test each pump set at the manufacturer's premises according to ISO 9906:2012 Grade 2B, including pump efficiency, (unless otherwise indicated in the Project Specification) and send the test reports to the Engineer for approval. The test reports must be approved in full before the pump sets may be shipped to site.
   Should one or more of the pump sets fail to comply with any of the guaranteed parameters the contractor shall be liable for all cost involved to rectify the issue or to replace the pump set, as well as the cost to retest the pump set(s).
   The Contractor must allow for all costs involved with the testing of the pump sets and supplying Test Certificates as well as provided sufficient time in the programme for this.

b) The contractor shall make provision to witness test each pump set at the manufacturer's premises according to ISO 9906:2012 Grade 2B, including pump efficiency, (unless otherwise indicated in the Project Specification).
   The Contractor shall allow for all costs involved to send three persons (1x Employer representative, 1x Engineer representative and 1x Contractor representative) to witness the factory bench testing of all the pump sets. Theses cost shall include for all costs incurred by the representative to attend the testing, including but not limited to the transport, airfares, visas, accommodation, incidentals, subsistence etc, shall be provided for in the pricing.
   Should one or more of the pump sets failed fail to comply with any of the guaranteed parameters the contractor shall be liable for all cost involved to rectify the problem or to replace the pump set, as well as the cost to retest the pump set(s) including the cost involved for all parties required to be at the witness testing.
   The Contractor must allow for all costs involved with the testing of the pump sets and supplying Test Certificates as well as provided sufficient time in the programme for this.

2. RAW SEWAGE PUMP SETS:

2.1. Submersible type sewage pump set:

Submersible sewage pump sets shall be designed for handling raw, unscreened sewage and be suitable for a complete submerged installation. The pump sets shall be close-coupled centrifugal type of pump sets.

The pump volute, motor housing and seal housing shall be constructed out of grey cast iron, EN-GJL-250 or similar approved. The impeller shall be constructed out of the following materials: Grey Cast Iron (EN-GJL-250); Duplex Stainless Steel (EN 1.4593 or higher); Nickle-Aluminium Bronze (BS EN 12163); or Tin Bronze (C90300 / SAE620). The preferred material shall be Grey Cast Iron unless otherwise indicated in the Project Specification. The pump - and motor shafts shall be constructed out of 316 grade Stainless Steel (EN 1.4401 or higher).

The preferred impeller type shall be the Vortex type with a minimum solids handling of 80mm, unless otherwise indicated in the Project Specification. For higher flow applications, single or two (s) channel non-clog impeller with a minimum solids handling of 100mm may be considered. The complete rotating assembly shall be dynamically balanced to ensure optimum operation.

Shaft seals shall be double mechanical type seals and oil lubricated. All bolts sets shall be of grade 316 Stainless Steel or higher. Bearings shall be of the permanently lubricated, ball - and angular roller type bearings. All motors larger than 22kW shall be equipped with insulated bearings on both the drive end and non-drive end of the motor.

The electrical motors shall be suitable for underwater operation and shall have a IP 68 rating and class F insulation. Electrical motors shall preferably have a rated speed lower than 1500 rpm. Higher rated speed shall be considered in special conditions. The motor sizing shall be selected at least 15% larger than the shaft power required with the impeller / pump combination at the design duty point. It shall also allow for at least 20% higher flow than the design point without overloading the motor. For a non-overloading power curve characteristic, the motor shall be sized at 10% above the maximum power required impeller / pump combination.

Motor cables shall be suitably sized for the motor rating and the length of cable shall such to reach the Motor Control Centre (MCC) or a cable connection box as discussed in the Electrical Specification but shall not be shorter than 10m. Cable extension shall not be accepted. All cables shall be installed and sealed in the factory.

The motor shall be equipped with moisture-ingress – and seal-failure sensors. It shall also be equipped with three thermal switches (Klixon), one on each phase.

All Submersible pump sets shall be installed on an auto coupling and shall be supplied complete with a duckfoot-bend, grade 316L guide rails and cast iron top bracket. For pump sets with a weight more than 100kg or in the case where the sump is deeper than 4m, a twin guide rail arrangement shall be supplied and installed. The pump sets shall be equipped with a 10mm long, grade 316L Stainless Steel lifting chain, including rated shackle to connect to the pump set and a hook installed in the manhole opening to hang the chain from. The duckfoot-bend shall be installed with Stainless Steel chemical anchor bolts with a minimum length of 150mm.

Pump sets installed on a pedestal and equipped with a flexible hose shall not be accepted.

The pump shall be equipped with a name plate with the following information as a minimum:

a) Pump Manufacturer
b) Pump range and model number

c) Impeller size
d) Operational speed
e) Design duty point (pump rate and pressure head)
f) Electrical motor sizing

2.2. Immersible / dry well type sewage pump set:

Immersible sewage pump sets shall be designed for handling raw, unscreened sewage and be suitable for a complete submerged or dry-well (complete or partial) installation. The pump sets shall be close-coupled centrifugal type of pump sets.

The pump volute, motor housing, cooling jacket and seal housing shall be constructed out of grey cast iron, EN-GJL-250 or similar approved. The impeller shall be constructed out of the following materials: Grey Cast Iron (EN-GJL-250); Duplex Stainless Steel (EN 1.4593 or higher); Nickle-Aluminium Bronze (BS EN 12163); or Tin Bronze (C90300 / SAE620). The preferred material shall be Grey Cast Iron unless otherwise indicated in the Project Specification. The pump - and motor shafts shall be constructed out of 316 grade Stainless Steel (EN 1.4401 or higher).

The preferred impeller type shall be the Vortex type with a minimum solids handling of 80mm, unless otherwise indicated in the Project Specification. For higher flow applications, single or two (2) channel non-clog impeller with a minimum solids handling of 100mm may be considered. The complete rotating assembly shall be dynamically balanced to ensure optimum operation.

Shaft seals shall be oil lubricated, mechanical type seals. All bolts sets shall be of grade 316 Stainless Steel or higher. Bearings shall be of the permanently lubricated, ball - and angular roller type bearings. All motors larger than 22kW shall be equipped with insulated bearings on both the drive end and non-drive end of the motor.

The electrical motors shall be suitable for underwater operation and shall have a IP 68 rating and class F insulation. Electrical motors shall preferably have a rated speed lower than 1500 rpm. Higher rated speed shall be considered in special conditions. The motor sizing shall be selected at least 15% larger than the shaft power required with the impeller / pump combination at the design duty point. It shall also allow for at least 20% higher flow than the design point without overloading the motor. For a non-overloading power curve characteristic, the motor shall be sized at 10% above the maximum power required impeller / pump combination.

The motor shall be equipped with cooling jacket with a closed internal cooling circuit for effective cooling of the motor under any situations. Making use of the pumped medium for cooling purposes shall not be accepted.

Motor cables shall be suitably sized for the motor rating and the length of cable shall such to reach the Motor Control Centre (MCC) or a cable connection box as discussed in the Electrical Specification but shall not be shorter than 10m. Cable extension shall not be accepted. All cables shall be installed and sealed in the factory.

The motor shall be equipped with moisture-ingress – and seal-failure sensors. It shall also be equipped with three thermal switches (Klixon), one on each phase.

In a submerged application, the pump sets shall be installed on an auto coupling and shall be supplied complete with a duckfoot-bend, grade 316L guide rails and cast iron top

bracket. For pump sets with a weight more than 100kg or in the case where the sump is deeper than 4m, a twin guide rail arrangement shall be supplied and installed. The pump sets shall be equipped with a 10mm long, grade 316L Stainless Steel lifting chain, including rated shackle to connect to the pump set and a hook installed in the manhole opening to hang the chain from. The duckfoot-bend shall be installed with Stainless Steel chemical anchor bolts with a minimum length of 150mm.

In a drywell application, the pump sets shall be installed either in a vertical or horizontal orientation, as indicated int eh project specification and drawings. The pump set shall be properly supported on a purpose made base plate, providing support to both the pump and motor. The base plate shall be constructed out of heavy duty hot dipped galvanised mild steel. The base plate shall be fixed to the concrete plinth by means of chemical anchor bolts.

The pump shall be equipped with a name plate with the following information as a minimum:

a) Pump Manufacturer
b) Pump range and model number
c) Impeller size
d) Operational speed
e) Design duty point (pump rate and pressure head)
f) Electrical motor sizing

2.3. Self-priming type sewage pump set:

The pump shall be of the centrifugal, self-priming type designed to handle raw, unscreened sewage or slurries up to 5% consistency. The pump volute shall be designed in such a way to allow for automatic re-priming of the pump in a totally open system without the use of external non-return valves on the suction and discharge. The impeller shall be of the two-vane, semi-open, non-clog type impeller and shall be designed to allow a solid spherical object up to 75mm in diameter to pass through the pump without causing blockages. The impeller shall be equipped with integral pump-out vanes on the back of the impeller. The wear plate / impeller alignment shall be adjustable for outside of the pump set. The complete rotating assembly shall be dynamically balanced to ensure optimum operation.

The volute shall be equipped with suitably pressure rated flange connections for both suction and discharge pipe connections, with threaded both holes to suit.

The pump shall be equipped with an inspection hatch, providing access to the pump internals without dismantling any pipework to gain access. The hatch may not weigh more than 30kg and shall be adequately sized to allow for servicing of the pump set. It must be possible to replace the complete rotating assembly, impeller, shaft, bearings and seal, through the access hatch without disturbing the pipework.

The pump shall be equipped with a self-cleaning, replaceable wear plate, which shall have notches, grooves and a lacerating tooth to break up stringy material. Wear plates making use of sharp chopper blades shall not be accepted. The pump will be equipped with a moulded, one-piece, suction check valve which must be replaceable through the hatch.

The pump volute and seal housing shall be constructed out of grey cast iron, EN-GJL-250 or similar approved. The impeller shall be constructed out of the following materials: Grey Cast Iron (EN-GJL-250).

The shaft and bearings shall be installed in a suitably sized bearing pedestal that can handle all forces exerted on the pump / rotating assembly. Suitable ball type thrust and - radial bearings shall be used.

The pump shall be driven by an TEFC type electrical motor, rated for 400 V, 50 Hz, and shall be mounted on a common base plate. The electrical motor shall have a rated speed lower than 1500 rpm.

Preferably, the motor shall be coupled to the pump by means of a direct type coupling. The motor coupling shall be either a flexible pin and bush type coupling or a flexible grid coupling, both of which must be suitable for operating with a VSD. The assembly shall be laser aligned to ensure optimal operation. Alternatively, should motor / pump duty / impeller combination not allow for this, the pump shall be belt driven and shall be supplied with suitable pulleys, v-belts and coupling guard that cover all moveable parts.

The pump set shall be installed on a purpose built base plate, housing both the pump, electrical motor and belt drive. The base plate shall be constructed out of heavy duty hot-dipped galvanised mild steel and shall be designed to handle all static and dynamic forces. The base plate shall provide for a pedestal onto which the electrical motor shall be installed, and it shall be equipped with four jacking bolts to align the motor. Provision shall be made in the baseplate to tension the belt drive to the correct tension required for the installation. The base plate shall be bolted to the concrete plinth by a minimum of 3 bolts on each length side, or as recommended by the manufacturer.

The pump and motor shall be properly aligned by means of laser alignment by an approved third party to the specification and requirements of the manufacturer prior to commissioning or start-up to ensure no damage to the equipment.

The pump shall be equipped with a name plate with the following information as a minimum:

a) Pump Manufacturer
b) Pump range and model number
c) Impeller size
d) Operational speed
e) Design duty point (pump rate and pressure head)

2.4. End-suction type centrifugal pump set:

The pumps shall be horizontally installed, single-stage, volute casing type, end-suction centrifugal pump, and shall be driven by an electric motor. The pump shall be designed to handle raw, unscreened sewage or slurries up to 5% consistency and shall have an axial inlet port, a radial outlet port and a horizontal shaft.

The impeller shall be of the semi-open, non-clog type impeller and shall be designed to allow a solid spherical object up to 75mm in diameter to pass through the pump without causing blockages. The complete rotating assembly shall be dynamically balanced to ensure optimum operation.

All pumps shall be equipped with a single / double mechanical seal according to EN 12756. Oil-lubricated, deep-groove ball bearings shall be used.

The volute shall be equipped with suitably sized pressure-rated flange connections for both suction and discharge pipe connections, with threaded bolt holes to suit.

The pump shall be equipped with an inspection hatch, providing access to the pump internals without dismantling any pipework to gain access. The hatch may not weigh more than 30kg and shall be adequately sized to allow for servicing of the pump set.

The pump volute and seal housing shall be constructed out of grey cast iron, EN-GJL-250 or similar approved. The impeller shall be constructed out of the following materials: Grey Cast Iron (EN-GJL-250).

Where a priming system is called for, a dry/vacuum priming system shall be provided. Priming of the pump shall be achieved by means of a vacuum pumping system integrated with the installed pump, as specified and supplied by the manufacturer. The priming system shall be suitable for pumping raw, unscreened, sewage with the required pumped media to air / vacuum isolating membranes or float in the air box. The priming system shall consist of, but not limited to, a vacuum pump, positive sealing float box, piping and float assembly. The system shall be driven by the pump shaft by means of a drive belt. The pump shall be equipped with a system to protect the shaft seal from dry running operation as experienced during the priming process. A check valve shall be supplied on, or near, the pump delivery port, or as specified by the manufacturer.

The pump casing shall provide for a back-pull-out design to remove the complete rotating assembly without disturbing the suction - and discharge pipework. The shaft and bearings shall be installed in a suitably sized bearing pedestal that can handle all forces exerted on the pump / rotating assembly. Suitable ball-type thrust and - radial bearings shall be used.

The pump shall be driven by a TEFC type electrical motor, rated for 400 V, 50 Hz, and shall be mounted on a common base plate. The electrical motor shall have a rated speed lower than 1500 rpm. All rotating assemblies must be completely covered by guards.

Preferably, the motor shall be coupled to the pump by means of a direct-type coupling. The motor coupling shall be either a flexible pin and bush type coupling or a flexible grid coupling, both of which must be suitable for operating with a VSD. The assembly shall be laser-aligned to ensure optimal operation. Alternatively, should the motor / pump duty / impeller combination not allow for this, the pump shall be belt driven and shall be supplied with suitable pulleys, v-belts and coupling guards that cover all moveable parts.

The pump set shall be installed on a purpose-built base plate, in accordance with ISO 3661, housing both the pump, electrical motor and coupling. The base plate shall be constructed out of heavy-duty, hot-dipped galvanised mild steel and shall be designed to handle all static and dynamic forces. The base plate shall provide for a pedestal onto which the electrical motor shall be installed, and it shall be equipped with four jacking bolts to align the motor. The base plate shall be bolted to the concrete plinth by a minimum of 3 bolts on each length side, or as recommended by the manufacturer.

The pump and motor shall be properly aligned by means of laser alignment by an approved third party to the specification and requirements of the manufacturer prior to commissioning or start-up to ensure no damage to the equipment.

The pump shall be equipped with a nameplate with the following information as a minimum:

a) Pump Manufacturer
b) Pump range and model number
c) Impeller size
d) Operational speed
e) Design duty point (pump rate and pressure head)

3. RAW – AND POTABLE WATER DRYWELL PUMPS

3.1. End-suction type centrifugal pump sets

The pumps shall be horizontally installed, single-stage, volute casing type, end-suction centrifugal pump, suitable for pumping potable and screened raw water and shall be driven by an electrical motor. The pump shall have an axial inlet port, a radial outlet port and a horizontal shaft.

The pump shall comply with ISO 5199:2002, ISO 9905: 1994 and ISO 9908: 1993 as well as ISO 2858: 1975. All flanges dimensions and drillings shall be according to EN 1092-2.

The pump casing, bearing housing and seal housing shall be constructed out of grey cast iron (EN-GJL-250) or similar approved. The impeller shall be constructed out of the following materials: Grey Cast Iron (EN-GJL-250); Duplex Stainless Steel (EN 1.4593 or higher); Nickle-Aluminium Bronze (BS EN 12163); or Tin Bronze (C90300 / SAE620). The preferred material shall be Tin Bronze unless otherwise indicated in the Project Specification. The pump - and motor shafts shall be constructed out of 316 grade Stainless Steel (EN 1.4401 or higher).

The impeller shall be of the closed, radial type impeller with multiple curved vanes. The impeller shall be trimmed to suit the design duty point, unless otherwise indicated in the Project Specification, and the electrical motor shall be sized accordingly. The complete rotating assembly shall be dynamically balanced to ensure optimum operation.

All pumps shall be equipped with a single / double mechanical seal according to EN 12756. Oil lubricated, deep-groove ball bearings shall be used.

The pump casing shall provide for a back-pull-out design to remove the complete rotating assembly without disturbing the suction - and discharge pipework. The pump shall be equipped with suitably designed bearing housing and - pedestal to handle all static and dynamic forces. Bearing brackets shall be considered for smaller pump application by the Engineer.

The pump shall be driven by an electrical motor mounted on a common baseplate. The pump and motor shall be coupled by means of a flexible rubber coupling, suitable for use with a VSD. All rotating assemblies must be completely covered by guards. Close coupled pump and motor sets shall only be considered where the motors are smaller than 9 kW.

The pump set shall be installed on a purpose built base plate, in accordance with ISO 3661, housing both the pump, electrical motor and coupling. The base plate shall be constructed out of heavy duty, hot-dipped galvanised mild steel and shall be designed to handle all static and dynamic forces. The base plate shall provide for a pedestal onto which the electrical motor shall be installed, and it shall be equipped with four jacking

bolts to align the motor. The base plate shall be bolted to the concrete plinth by a minimum of 3 bolts on each length side, or as recommended by the manufacturer.

The pump and motor shall be properly aligned by means of laser alignment by an approved third party to the specification and requirements of the manufacturer prior to commissioning or start-up to ensure no damage to the equipment.

The pump shall be equipped with a name plate with the following information as a minimum:

f) Pump Manufacturer
g) Pump range and model number
h) Impeller size
i) Operational speed
j) Design duty point (pump rate and pressure head)

3.2. Horizontal, multistage type centrifugal pump sets

The pumps shall be horizontal, high-pressure, multi-stage, ring sectional design, radial-suction and -discharge type centrifugal pump, suitable for pumping potable and screened raw water and shall be driven by an TEFC type electrical motor, rated for 400 V 50 Hz.

All flanges dimensions and drillings shall be according to EN 1092-2.

The pump casing, bearing housing and seal housing shall be constructed out of grey cast iron (EN-GJL-250) or similar approved. The impeller shall be constructed out of the following materials: Grey Cast Iron (EN-GJL-250); Duplex Stainless Steel (EN 1.4593 or higher); Nickle-Aluminium Bronze (BS EN 12163); or Tin Bronze (C90300 / SAE620). The preferred material shall be Tin Bronze unless otherwise indicated in the Project Specification. The pump - and motor shafts shall be constructed out of 316 grade Stainless Steel (EN 1.4401 or higher).

The pump shall have a radial inlet port (at the drive end of the pump), a radial outlet port (at the non-drive end of the pump) and a horizontal shaft. The individual casing parts and volute rings shall be sealed by O-rings clamped together by means of external tie bolts / rods. The pump feet shall form part of the suction and discharge casings and arranged to be beneath the pump. The orientation of the suction and discharge ports shall be indicated on the drawing(s).

The impeller shall be of the closed, radial type impeller with multiple curved vanes. The impeller shall be trimmed to suit the design duty point, unless otherwise indicated in the Project Specification, and the electrical motor shall be sized accordingly. The complete rotating assembly shall be dynamically balanced to ensure optimum operation.

All pumps shall be equipped with a single / double mechanical seal according to EN 12756. Oil lubricated bearings shall be used in bearing housings flanged onto each end of the pump. Cylindrical roller bearings shall be used on the suction side of the pump and deep groove / angular bearing for the discharge side. The rotating assembly shall be hydraulically balanced by means of back vanes at the rear of the impeller to minimise the axial thrust created. All residual thrust shall be handled by the bearing on the discharge side.

The pump shall be driven by an electrical motor mounted on a common baseplate. The pump and motor shall be coupled by means of a flexible rubber coupling, suitable for use with a VSD. All rotating assemblies must be completely covered by guards. Close coupled pump and motor sets shall only be considered where the motors are smaller than 9 kW.

The pump set shall be installed on a purpose built base plate, in accordance with ISO 3661, housing both the pump, electrical motor and coupling. The base plate shall be constructed out of heavy duty, hot-dipped galvanised mild steel and shall be designed to handle all static and dynamic forces. The base plate shall provide for a pedestal onto which the electrical motor shall be installed, and it shall be equipped with four jacking bolts to align the motor. The base plate shall be bolted to the concrete plinth by a minimum of 3 bolts on each length side, or as recommended by the manufacturer.

The pump and motor shall be properly aligned by means of laser alignment by an approved third party to the specification and requirements of the manufacturer prior to commissioning or start-up to ensure no damage to the equipment.

The pump shall be equipped with a name plate with the following information as a minimum:

a) Pump Manufacturer
b) Pump range and model number
c) Impeller size
d) Operational speed
e) Design duty point (pump rate and pressure head)

3.3. Horizontal split-case type centrifugal pump sets

The pumps shall be horizontally installed, single-stage, volute casing type, horizontal split-case centrifugal pump, suitable for pumping potable and screened raw water and shall be driven by an electrical motor. The pump shall have flanged radial inlet- and outlet ports with an inline design, and a horizontal shaft and make use of a double-suction design to reduce axial forces. The operational speed of the pump shall not exceed 1500rpm.

Pump shall comply with. All flanges dimensions and drillings shall be according to EN 1092-2.

The pump casing, bearing housing and seal housing shall be constructed out of grey cast iron (EN-GJL-250) or similar approved. The impeller shall be constructed out of the following materials: Grey Cast Iron (EN-GJL-250); Duplex Stainless Steel (EN 1.4593 or higher); Nickle-Aluminium Bronze (BS EN 12163); or Tin Bronze (C90300 / SAE620). The preferred material shall be Duplex Stainless Steel unless otherwise indicated in the Project Specification. The pump - and motor shafts shall be constructed out of 316 grade Stainless Steel (EN 1.4401 or higher).

The impeller shall be of the closed, double-suction type impeller. The impeller shall be trimmed to suit the design duty point, unless otherwise indicated in the Project Specification, and the electrical motor shall be sized accordingly. The complete rotating assembly shall be dynamically balanced to ensure optimum operation.

The shaft shall be supported by both drive-end – and non-drive-end bearings. All pumps shall be equipped with a single / double mechanical seal according to EN 12756. Oil lubricated, deep-groove ball bearings shall be used.

The pump casing shall provide for a horizontal split casing design to remove the complete rotating assembly without disturbing the suction - and discharge pipework. The pump shall be equipped with suitably designed bearing housing and - pedestal to handle all static and dynamic forces.

The pump shall be driven by an electrical motor mounted on a common base plate. The motor coupling shall be either a flexible pin and bush type coupling or a flexible grid coupling, both of which must be suitable for operating with a VSD.

The pump set shall be installed on a purpose built base plate, housing both the pump, electrical motor and coupling. The base plate shall be constructed out of heavy duty, hot-dipped galvanised mild steel and shall be designed to handle all static and dynamic forces. The base plate shall provide for a pedestal onto which the electrical motor shall be installed, and it shall be equipped with four jacking bolts to align the motor. The base plate shall be bolted to the concrete plinth by a minimum of 4 bolts on each length side, or as recommended by the manufacturer.

The pump and motor shall be properly aligned by means of laser alignment by an approved third party to the specification and requirements of the manufacturer prior to commissioning or start-up to ensure no damage to the equipment.

The pump shall be equipped with a name plate with the following information as a minimum:

a) Pump Manufacturer
b) Pump range and model number
c) Impeller size
d) Operational speed (pulley sizes if applicable)
e) Design duty point (pump rate and pressure head)

3.4. Vertical Multi-stage type centrifugal pump sets

The pumps shall be vertical, high-pressure, multi-stage, inline radial-suction and - discharge type centrifugal pump, suitable for pumping potable water and shall be driven by a flanged TEFC type electrical motor, rated for 400 V 50 Hz.

All flange dimensions and drillings shall be according to EN 1092-2.

The follow materials of construction shall be met or surpassed:

- Pump head : Ductile cast iron (EN-GJS-500-7)
- Base : Ductile cast iron (EN-GJS-500-7)
- Base plate : Ductile cast iron (EN-GJS-500-7)
- Motor stool : Grey cast iron (EN-GJL-200)
- Shaft : Stainless Steel 431 (EN 1.4057)
- Impeller : Stainless Steel 304 (EN 1.4301)
- Chamber : Stainless Steel 304 (EN 1.4301)
- Sleeve : Stainless Steel 304 (EN 1.4301)
- O-ring for sleeve : EPDM

- Neck ring : Carbon-graphite-filled PTFE
- Shaft seal (seal faces) : Silicon carbide / silicon carbide
- Bearing ring : Silicon carbide / silicon carbide
- Support bearing : Carbon-graphite-filled PTFE
- Staybolts : Bright Steel (EN 1.0533)

The pump shall have a radial inlet - and outlet ports, inline at the base of the pump set and a vertical shaft. The sleeve shall be sealed between the pump head and base by O-rings clamped together by means of external tie bolts / rods. The suction and discharge ports shall for part of the pump base. The pump head shall have a plugged vent hole for use when priming the pump.

The impeller shall be of the closed, radial type impeller with multiple curved vanes. Reduced-diameter impellers shall be selected (where necessary) to suit the specified duty point and the electrical motor shall be sized accordingly. The complete rotating assembly shall be dynamically balanced to ensure optimum operation.

All pumps shall be equipped with a cartridge type double mechanical seal according to EN 12756. Lubricated bearings shall be used in bearing housings flanged onto the pump head and base. Foer smaller pump sets, the motor bearings shall be designed to handle the axial thrust generated by the impellers. Pumps equipped with 75 kW rated motors and larger shall be equipped with a thrust handling devise in the base of the pump to absorb the thrust force generated by the impellers and therefore reduces the resulting axial force the motor bearings must absorb. It shall consist out of a rotary part mounted on the shaft below the impellers and a stationary part mounted to the base of the pump.

The pump shall be driven by a flanged, TEFC type electrical motor mounted on the motor stool. The pump and motor shall be coupled by means of a fixed coupling, suitable for use with a VSD. All rotating assemblies must be completely covered by guards.

The pump set shall be installed on a purpose-built base plate, in accordance with ISO 3661, housing the pump set. The base plate shall be constructed out of heavy duty, hot-dipped galvanised mild steel and shall be designed to handle all static and dynamic forces. The base plate shall be bolted to the concrete plinth by a minimum of 2 bolts on each length side, or as recommended by the manufacturer.

The pump and motor shall be properly aligned by means of laser alignment by an approved third party to the specification and requirements of the manufacturer prior to commissioning or start-up to ensure no damage to the equipment.

The pump shall be equipped with a name plate with the following information as a minimum:

a) Pump Manufacturer
b) Pump range and model number
c) Impeller size
d) Operational speed
e) Design duty point (pump rate and pressure head)

4. SLUDGE AND OTHER APPLICATIONS DRYWELL PUMPS

4.1. Positive displacement – progressive cavity pump sets

The pumps shall be horizontally installed, single rotor type progressive cavity type pump, suitable for pumping raw – or potable water as well as slurries and sludge with a solids content of at least 4 % (40 000mg/l). The pump shall have an axial inlet port, a radial outlet port and a horizontal shaft.

The flanged ports, pump casing, bearing housing and seal housing shall be constructed out of grey cast iron (EN-GJL-250) or similar approved. The stator housing shall be constructed from thick-wall mild-steel tubing. The rotor shall be constructed out of the following materials: EN8 carbon steel; heat-treated tool steel or 316 Stainless Steel. The Stator shall be manufactured from nitrile, natural, Hypalon or viton rubber. The Supplier shall confirm the suitable material that suits the pump medium. The pump shaft shall be constructed out of 316 grade Stainless Steel (EN 1.4401 or higher).

The rotor shall be of the helical type, suitable for reversible and self-priming action with a high suction capability. The motor shall be size to handle at least 15% motor the maximum shaft power. The complete rotating assembly shall be dynamically balanced to ensure optimum operation.

All pumps shall be equipped with a double mechanical seal according to EN 12756. Oil lubricated, taper-roller bearings shall be used.

The pump casing shall provide for a front-pull-out design to remove the complete rotating assembly without disturbing the discharge pipework. The suction pipework shall be designed in suction a way that a short spool piece is provided that can easily be removed should the rotor be required to be removed. The pump shall be equipped with suitably designed bearing housing and - pedestal to handle all static and dynamic forces. The pedestal shall provide suitable fixing points for the reduction gear box and motor.

The pump shall be driven by an electrical motor mounted on a reduction gearbox. The pump and motor shall be coupled by means of a fixed coupling in the gearbox, and shall be suitable for use with a VSD.

The pump set shall be installed on a purpose built base plate, in accordance with ISO 3661, housing both the pump, electrical motor and gearbox. The base plate shall be constructed out of heavy duty, hot-dipped galvanised mild steel and shall be designed to handle all static and dynamic forces. The base plate shall provide for a pedestal onto which the electrical motor shall be installed, and it shall be equipped with four jacking bolts to align the motor. The base plate shall be bolted to the concrete plinth by a minimum of 3 bolts on each length side, or as recommended by the manufacturer.

The pump shall be equipped with a name plate with the following information as a minimum:

a) Pump Manufacturer
b) Pump range and model number
c) Impeller size
d) Operational speed
e) Design duty point (pump rate and pressure head)

5. ELECTRICAL MOTORS FOR DRYWELL PUMPS

Electrical motors utilised to drive drywell pumps shall comply with the following requirements.

The electrical motor shall be a TEFC type motor, rated for 400 V, 50 Hz. The motor casing, dimensions and ratings shall comply with the SANS 1804. Testing of the motors shall be according to IEEE Standard 112-2004.

The motor casing shall be constructed from cast iron. It shall be equipped with cooling fins that is positioned in such a way that will not accumulate liquids and dust over the motor. The motor casing shall be equipped with a minimum of 2 eyebolts for lifting purposes. The motor shall be equipped with a directly coupled fan, with a fan cover, for cooling of the motor.

The motor terminal box shall preferably be placed on the side of the motor, with the electrical wiring entering from the bottom.

The motor shall be equipped with deep groove, ball bearings. Both drive-end - and non-drive-end bearings shall be insulated to ensure the motor is rated for use with Variable Frequency Drive (VFDs). Where applicable, motors must be adapted and rated to work with a VFD to be able to handle the voltage spikes, additional stresses, etc.

The motor shall have a IE3 level of efficiency (Premium Efficiency). The enclosure shall be IP55 rated according to IC411-TEFC and shall be foot-mounted. Where the installation or environment require a higher IP rating, the motor supplied shall comply with such requirements. Electrical motors installed at the ocean or close to the ocean, the motor shall be rated for marine applications.

The electrical motor shall be equipped, assessed based upon the respective motor sizing, with the following protection proposed:

a) Rating of 2.2kW to 22kW – Starter protection only
b) Rating of 22kW to 110kW – Motor overheat protection by means of thermistor protection in the motor winding (two per winding)
c) Rating of 132kW and greater – Motor protection by means of PT100's installed in the motor windings (two per winding) and at the motor bearings (drive and non-drive ends), as well as general vibration protection of the pump and motor respectively (drive and non-dive ends of both).

In situations where the motor operates at low speeds, forced cooling shall be provided by means of external forced ventilation kit. In such case the supplied base plate must have adequate space to place the kit.

Higher rated speed shall be considered in special conditions. The motor sizing shall be selected at least 15% larger than the shaft power required with the pump / speed combination at the design duty point. It shall also allow for at least 20% higher flow than the design point without overloading the motor. For a non-overloading power curve characteristic, the motor shall be sized at 10% above the maximum power required impeller / pump combination.

Operational speeds higher than 1450 rpm shall not be allowed in motor sizing larger than 90 kW.

6. REDUCTION GEARBOX FOR MOTORS FOR DRYWELL PUMPS

The gearbox / speed reducer shall be designed for continues operation over 24h per day. The mechanical power ratings (according to AGMA rating) shall be greater than 2.25 times the installed power and shall account for D.O.L. starting of the unit at full load conditions (maximum immersion). Thermal power ratings shall be based on an ambient temperature of 40°C.

Speed reducers units shall be specifically designed and selected for horizontally mounted surface aerator duties and shall use standardised components. Only units specifically designed and certified by the manufacturer to be used for aerators duties shall be considered (supporting documentation must be submitted at tender stage), non-compliance may lead to rejection of the tender. Tenderers will be required to provide a catalogue of the make of speed reducer offered and to indicate how the selection was done.

The helical and spur gears shall be manufactured from alloy steel and shall be thoroughly hardened and ground after machining. The gears shall have a high durability factor, maximum strength and low noise level. Worm gears shall not be considered.

All bearings shall be designed for a life of at least 100 000h at a L10 rating. In addition, the bearings on the output shaft shall be capable of withstanding the resultant forces caused by the combination of radial and axial loads, imposed by the aerator, acting simultaneously, and shall be selected such that the following condition is complied with:

$$\left(\frac{Actual\ Radial\ Load}{Permissible\ Radial\ Load}\right) + \left(\frac{Actual\ Axial\ Load}{Permissible\ Axial\ Load}\right) \leq 1$$

The Permissible loads are the manufacturer's figure for 5 000h at a L10 rating. Tenderers shall indicate what these forces are and how they are accommodated.

The casings shall be manufactured out of close grain cast iron and shall be designed such as to prevent moisture from entering the unit. A standard dry well for the vertical down shaft, low speed shaft bearing is required to avoid complete drainage of oil in the event of an oil seal failure. The housing shall be equipped with a breather, drain and oil level plugs which shall be accessible from above the mounting frame.

All speed reducers must be provided with jacking bolts of Stainless Steel, allowing at least 100mm adjustment up and down.

The motor shall be vertically mounted to the speed reducer via an accurately located lantern housing. A precision high speed flexible coupling, incorporating rubber buffers shall transmit power from the motor to the speed reducer.

Inspection of the speed reducer and gears shall be possible without dismantling the speed reducer. It shall have lifting lugs for lifting purposes. The coupling between the aerator and the speed reducer shall be such that the aerator can be easily removed without shifting the speed reducer.

The speed reducer shall be fitted with an effective and accessible oil filling plug, oil level indication mechanisms and drain plug. Speed reducers rated at more than 75kW shall have oil pressure indicators and oil pressure limit switches fitted for protection purposes.

Forces cooling and cooling fans shall not be permitted, and the thermal power rating of the speed reducer shall exceed the motor power after derating for 40°C ambient temperature.

All bearings shall be located within the speed reducer and shall be lubricated by means of a positive splash-action system. Where immersion or splash lubrication is not deemed adequate by the manufacturer, lubrication shall be achieved by a forced lubrication system directly driven by a reducer shaft. Oil levels shall be easily controlled. Should greasing of certain bearings be required, the grease pump shall be driven by the movement of the speed reducer.

The speed reducer shall be mounted on a suitable base plate. Each unit shall be fitted with a nameplate showing at least the following information:

- Speed reducer Manufacturer, type and model number
- Serial number
- AGMA rating
- Nominal ratio
- Approximate oil quantity required

MECHANICAL STANDARD SPECIFICATION 02 – PIPEWORK AND VALVES:

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1. PIPEWORK:

The specification covers the design, manufacture and supply of electric welded, low carbon steel pipes, specials and other fittings for the conveyance for water for duties up to 4.6MPa.

The Contractor shall be responsible for the detail design and compilation of workshop drawings for the pipework to be approved by the Engineer. The pipework shall be designed in such a manner that allows dismantling of the pipework for inspections and maintenance. All pipework shall be properly supported and anchored by means of suitably designed pipe-supports to handle stresses caused by static and dynamic forces, including shocks caused by water hammer, in the pipework. The weight if the pipework may not be supported by the pump, and suitable supports shall be provided.

Unless indicated in the Project Specification, Steel pipes and specials up to and including DN150 shall be in accordance with SANS 62 with a Heavy Wall specification and API 5L with a steel grade up to X52, and pipes of DN200 and larger, shall be in accordance with SANS 719 with steel grades of A, B and C as well as API 5L steel grades X46, X52, X56 and X60. The minimum wall thickness shall be as follows:

Nominal Pipe Sizing:	Minimum wall thickness (mm):
DN200 to DN500	6
DN600 to DN800	8
DN900 to DN1200	10
DN1300 to DN1600	12
DN1700 to DN1800	14
DN1900 to DN2200	16
>DN2200	TBC

In the case where there is additional specification provided for pipe sizes larger than DN2200, the specification used for pipes of DN2200 shall apply. Tolerance on all pipe diameters shall be in accordance with SANS 719, except for pipes larger than DN1200, tolerances shall be +6mm and -6mm.

Pipe flanges shall be manufactured from steel plates in accordance with SANS 50025 300W. Flange dimensions and drillings shall be accordance with SANS 1123 table 3. The minimum rated nominal pressure shall be 1000kPa.

All welds shall be in accordance with SANS 719 and SANS 10044.

All pipe specials and fittings shall be manufactured in accordance with SANS 1476 from materials that correlate with the applicable pipe sizing as above and according to SANS 62 and SANS 79 as applicable. All manual or semi-automatic welds and repairs may only be done by qualified welders, as per the tests laid down in the Code of Practice for Welding SANS 10044.

Pipe flanges shall be in accordance with SANS 1123 table 3 and shall have a minimum rating of 10bar. Unless the flange rating and drilling schedule is indicated in the Project Specification, it shall be selected higher than the applicable pump's shut-off pressure head.

All pipe bends shall be long radius, smooth formed. With pipework larger than ND700, segmented bend may be considered and must be approved by the Engineer. The

maximum angle between oblique butt-ends of segments for gusseted bends shall not exceed 22.5°. Segmented bends shall be long radius type with the radius are equal to three times the diameter. Cut-and-shut bends shall not be accepted.

All tee-offs or tee-connections shall be long radius, smooth formed, swept tees. The thickness of the barrel and branch plates shall be sufficient so that the maximum stress shall not be greater than that for an uncut piece of pipe of the theoretically required thickness. In cases where it is more economical to make use of saddle-type rings or triform shoes as external reinforcements, it may be considered and shall be approved by the Engineer. Full penetration welding shall be used for the attachment of reinforcements.

All reducers shall not have an angle larger than 8°. Reducers on the suction side of pump sets shall always be eccentric reducers, and reducers on the delivery of the pump may be concentric reducers.

Couplings shall be of the flange adapter, self-anchoring type and shall be able to handle deflection of ±3°. The pipework shall incorporate a restraining flange to anchor the flange adapter when it is utilised on the delivery pipework and the pipework is not anchored within a wall. Flanges adapters shall be supplied with all required accessories and fasteners.

Ø32mm sockets shall be provided on all pump suction and delivery pipework for ancillary mechanical and electrical gauges and instrumentation. The sockets shall be positioned on the suction and delivery pipe reducers. It shall be positioned in such a way that the turbulence caused by the pump suction and delivery flows or created by valves have as little as possible influence on readings taken at the points.

All pipes and specials shall be clearly hard stamped alongside a longitudinal or spiral weld on one end of the pipe section with the following information provided:

a) The grade and thickness of Steel used;
b) The serial number of the pipe or pipe-special;
c) The nominal diameter;
d) The hydraulic test pressures.

The applicable flange drilling table shall be clearly hard stamped on the periphery of all flanges.

All underground pipework shall be wrapped in a petrolatum paste / wrap to prevent corrosion.

Underground pipework shall be installed on sand bedding and - blanket, as described in SANS 1200, to provide sufficient support to pipework and prevent damage to the coating.

<u>Manufacturing Quality Control:</u>

The Contractor (or his Manufacturer) shall compile a data booklet as part of their inhouse quality control procedures. The data book shall include, but not limited to, all workshop drawings, material certificate, standard operating procedures, inspection lists, non-destructive testing results, etc. and shall be present to the Engineer at the inspection of the equipment.

The Contractor shall allow for the following non-destructive tests to be done on all welds of the pipework, and shall be deemed to be included in the cost of the pipework:

- Magnetic particle inspection or Dye penetrant test NDT
- Radiography NDT

The test results shall be made available to the Engineer at the equipment inspection.

Should the Project Specification call for an external certified inspector to do additional inspections and tests on welds, the Contractor shall provide access for such an inspector for non-destructive testing at the premises of the Manufacturer. The cost of such inspections (inspector and all associated costs for material, plant and labour) shall be for the Contractor's account and allowed for in the Bill of Quantities.

2. VALVES:

2.1. Shut-off valves:

2.1.1. Gate valves - General:

All gate valves shall be double flanged and shall be either of the resilient seated – or wedge-gate type valves. The gate shall lift completely clear of the stream in the open position. The valve shall make use of a non-rising spindle. It shall be capable of withstanding both specified test pressures and nominal pressures (PN) from both sides of the valve and the gate shall be fully operational in both conditions. All valves shall be right-hand closing, unless otherwise indicated in the Project Specification.

The minimum pressure rating for the supplied valves shall be 10bar (PN10) but shall be indicated in the Project Specification and drawings. The pressure rating of the valve shall not be less than the pressure rating of the connecting pipework. Valve bodies shall be test to 1.5x PN rating (in bar) and the seal to 1.1x PN rating (in bar). Flange drillings shall be in accordance with SANS 1123 with the applicable pressure rating.

The valves shall be designed and constructed in accordance with SANS 664. The body of the valve shall be designed and constructed to withstand all forces and not to distort under high pressure conditions. The valve body shall make provision for connecting flanges to install an external gearbox or actuator, and it shall not be directly on the stuffing box.

All valves shall be fitted with a back seal to permit replacement of the stem seal under pressure without disturbing the pipework.

All valves larger than DN400 shall be equipped with a bypass and valve. Resilient Seated valves may be considered for sizing up to DN300 mm and approval must be obtained from the Engineer. Wedge-gate valves shall have preference for sizes DN50 to DN700.

The Manufacturer shall have an ISO 9000 certified quality system which is audited by an independent third party. Each finished item shall be tested for compliance with the product standards and local market specification.

2.1.2. Gate valves – Flanged Resilient Seated Gate Valves:

The valve body shall provide a straight, unobstructed body passage free of pockets or crevice's that might catch debris or cause stagnant water. Prominent gate guides shall be incorporated in the body of the valve. It shall be designed in such a way to provide

support to the gate for in all positions, yet is shall not interfere with the flow path of the water.

The wedge of the valve shall be fully vulcanized with a drinking water approved EPDM type rubber compound and it shall be drop tight over the pressure range of the valve. It shall be designed to ensure even distribution of sealing pressure and it shall be capable of handling foreign matter up to a particle size of 1mm. The wedge shall be equipped with an integral wedge shoe and it shall accurately fit the body guide profile to allow smooth operation of the wedge and not cause shudder.

The stem shall be manufactured out of 316 grade Stainless Steel and shall have wedge stops and rolled threads for high strength. The valve shall have a wiper / scraper to ensure the shaft is clean and prevent foreign matter ingress. Low friction materials suitable for drinking water application shall be used with O-rings to seal the valve body. The valves shall have a non-rising stem unless otherwise indicated in the Project Specification.

The bonnet gasket shall be encircled the bonnet bolts which must be countersunk and sealed.

The valve body, bonnet and wedge shall be constructed out of Ductile Iron (EN-GJS-500), the stem shall be 316 grade Stainless Steel, the stem nut shall be Bronze, and all the fasteners shall be Stainless Steel. The valve body shall internally and externally be coated with a drinking water approved epoxy coating to a DFT of 300microns.

2.1.3. Gate valves – Flanged Wedge-Gate Valves:

The valve body shall provide a straight, unobstructed body passage. Prominent gate guides shall be incorporated in the body of the valve. It shall be designed in such a way to provide support to the gate for in all positions, yet is shall not interfere with the flow path of the water.

The wedge shall be manufactured out of Ductile Iron (EN-GJS-500) with firmly secured Copper Alloy or Aluminium Bronze face rings which shall be machined to a fine surface finish to ensure optimum contact seal with the body seat rings. The guides shall ensure uniform closure irrespective of the pressure and shall be capable of handling foreign matter up to a particle size of 1mm. The housing shall be designed in such a way that prevent water from accumulating in a pocket or become stagnant.

The stem shall be manufactured out of 316 grade Stainless Steel and shall have wedge stops and rolled threads for high strength. The valve shall have a wiper / scraper to ensure the shaft is clean and prevent foreign matter ingress. Low friction materials suitable for drinking water application shall be used with O-rings to seal the valve body.

The bonnet gasket shall be encircled the bonnet bolts which must be countersunk and sealed.

The valve body, bonnet and wedge shall be constructed out of Ductile Iron (EN-GJS-500), the seats and faces shall be Copper Alloy or Aluminium Bronze, the stem shall be 316 grade Stainless Steel, the stem nut shall be Bronze, and all the fasteners shall be Stainless Steel. The valve body as well as the wedge shall internally and externally be coated with a drinking water approved epoxy coating to a DFT of 300microns.

2.1.4. Gate valves – Knife-Gate Valves:

The valve body shall provide a straight, unobstructed body passage. Prominent gate guides shall be incorporated in the body of the valve. It shall be designed in such a way to provide support to the gate for in all positions, yet is shall not interfere with the flow path of the water.

The wedge shall be manufactured out of Stainless Steel (AISI 304 for raw and potable water applications and AISI 316 for sewage and sludge application). The seat shall be metal / metal or EPDM rubber. The guides shall ensure uniform closure irrespective of the pressure and shall be capable of handling foreign matter and the body and seat shall assure non-clogging shut-off on suspended solids. The housing shall be designed in such a way that prevent water from accumulating in a pocket or become stagnant.

The stem shall be manufactured out of 316 grade Stainless Steel and shall have wedge stops and rolled threads for high strength. The packing shall be OTFE impregnated synthetic fibre and will have an EPDM o-ring.

The valve body, bonnet and wedge shall be constructed out of Cast Iron (EN-GJS-400), the seats and faces shall be Copper Alloy or Aluminium Bronze, the stem shall be 316 grade Stainless Steel, the stem nut shall be Bronze, and all the fasteners shall be Stainless Steel. The valve body shall have lugs for locating purposes with the flange bolts. The valve body shall internally and externally be coated with a drinking water approved epoxy coating to a DFT of 300microns.

2.1.5. Butterfly Valves - General:

Butterfly valves shall be of the double flanged, long body, double-offset, full-bore type butterfly valves unless otherwise indicated in the Project Specification. Wafer – and lug type valves may be considered for low cost or temporary applications and shall not exceed ND150. All valves shall be designed, manufactured and tested in accordance with BS EN 593.

The maximum flow rate in a valve shall not exceed 5m/s and the blade in the fully open position shall not cause any cavitation. The valves shall be capable of opening and closing under the maximum specified head and flow rate. The disk shall be designed to eliminate any flutter under open conditions.

The valves shall be installed in an orientation that the valve will operate along the horizontal axis, with the lower part of the disk opens towards the downstream side of the valve. Direction of closing shall be right-hand. The valve shall be water tight in both flow directions and shall be of the resilient seal type.

The hubs for the shaft bearings housing shall be incorporated in the valve body. The valve body shall be equipped with adjustable mechanical stops to prevent the disk from over travel in the open and closed positions.

The valve body shall allow for a connecting flange to install a gearbox or actuator. All valves shall be equipped with a gearbox and hand wheel, unless the Project Specification states otherwise.

The disk shall be manufactured from a single casting of approved hydrofoil section. The combined stresses in the disk in situations where an unbalanced force is applied to the valve may not exceed 20% of the minimum yield strength of the material used.

The retaining rings shall be coated Stainless Steel to prevent galvanic corrosion. All recesses for the retaining ring, both in the body and on the disk, shall be coated and the retaining ring inserted while the coating is still wet.

Valve shall make use of resilient seal type arrangement. The seal shall be adjustable, removable and replaceable from the down stream side of the valve without removal of the valve body from the pipework. The seals shall be suitable for potable water, non-weathering, non-sticking and long-life properties.

The valve body shall have a smooth and continuous seat profile and the design shall allow the seal to open and close on the Stainless Steel seat only. Seats and seals installation shall prevent water ingress under the seat or seal in any of the operating positions and it shall be designed and manufacture in such a water to prevent the seal or seat to come loose.

The shafts shall be of the stub-shaft design configuration and shall extend at least 1.5 times the shaft diameter into the disk hub. The shaft shall not protrude from the hubs. It shall be connected to the disk by means of keys, dowel pins or taper pins and shall be designed to transmit shaft torque equivalent to at least 75% of the torsional strength of the shaft. Dowel – and taper pins shall be mechanically secured in place.

The bearings shall be fitted to the hubs in the valve body and shall be of the self-lubricating sleeve type bearing. The valve shall be equipped with at least one adjustable thrust bearing in order to adjust and hold the disc securely concentric with the seat.

The valve body and disk shall be constructed out of Ductile Iron (EN-GJS-500), the seal retaining ring shall be grade 304 Stainless Steel, the shaft shall be grade 304 Stainless Steel, the disc or body seal shall be EPDM type rubber, and all the fasteners shall be Stainless Steel. The valve body and disk shall internally and externally be coated with a drinking water approved epoxy coating to a DFT of 300microns.

The Manufacturer shall have an ISO 9000 certified quality system which is audited by an independent third party. Each finished item shall be tested for compliance with the product standards and local market specification.

2.2. Non-return valves:

2.2.1. Non-return / check valve – General:

The body shall be designed in accordance with SANS 1551 or BS EN 1074. Both the housing and the disk shall be free off flow obstructions or pockets.

The minimum pressure rating for the supplied valves shall be 10bar (PN10) but shall be indicated in the Project Specification and drawings. The pressure rating of the valve shall not be less than the pressure rating of the connecting pipework. Valve bodies shall be test to 1.5x PN rating (in bar) and the seal to 1.1x PN rating (in bar). Flange drillings shall be in accordance with SANS 1123 with the applicable pressure rating.

The body of the valve shall be designed and constructed to withstand all forces and not to distort under high pressure conditions.

The valve body, bonnet and disk shall be constructed out of Ductile Iron (EN-GJS-400 or higher), the seal inlay shall be Bronze, the shaft shall be grade 304 Stainless Steel, and all the fasteners shall be Stainless Steel. The valve body and disk shall internally and externally be coated with a drinking water approved epoxy coating to a DFT of 300microns.

The Manufacturer shall have an ISO 9000 certified quality system which is audited by an independent third party. Each finished item shall be tested for compliance with the product standards and local market specification.

2.2.2. Single disk, swing type non-return valve:

Single disk, swing type non-return valves shall be of the double flanged, long-body, type check valve suitable for potable and raw water, or raw unscreened sewage.

The main seal shall be a bronze ring inlaid along the circumference of the disk and shall be closing along another bronze ring inlaid into the housing seat. The disk shall be completely enclosed (except for the seal ring) in potable water approved EPDM. The valve body shall be equipped with a bonnet that allow full access to the internals of the valve for maintenance and repairs without disturbing the pipework connections. It must be able to remove the disk through the opening.

The disk shall be mounted on a hinge made of epoxy coated ductile iron for sizes larger than DN250 and Stainless Steel for sizes up to and including DN200. The connection shall be a loose-fitting polyamide bushing that enables the disk to tilt slightly in all directions to adjust exactly to the valve seat. The shaft shall extend from the valve body to fit a counter weight and lever. All valves shall be equipped with a counter weight and lever and the valve shall be capable of either horizontal or vertical installation and operation.

2.2.3. Tilting disk non-return valve:

Tilting disk type non-return valves shall be of the double flanged, long-body, type check valve suitable for potable and raw water, or raw unscreened sewage. The valve shall be of the eccentric butterfly valve design and the seat shall be angled at ±20° to provide a shorter stroke for opening and closing of the valves. It shall be equipped with a metal seat.

The valves shall be equipped with an external hydraulic damper, unless otherwise stated in the project specification, to control the opening and closing of the valve. The damper shall be adjustable to control the rate of closing.

2.2.4. Ball type non-return valve:

Ball type non-return valves shall be of the double flanged, long-body, type check valve suitable for raw unscreened sewage. The valve shall be designed to ensure a self-cleaning construction, where the ball rotates during operation to eliminate the chance of impurities getting stuck on the ball. The flow passage shall be full bore to ensure minimum pressure drop over the valve.

The ball shall be manufactured from aluminium for sizes up to and including DN100 and cast iron for sizing larger than DN100. The ball shall be rubber coated. The rubber coating shall be of such hardness to prevent the ball from getting stuck in the seat, not will the seat create indents on the rubber.

The body shall be equipped with a removable bonnet to inspect the internals and replace the ball without disturbing the pipework.

2.2.5. Axial sprung, silent closing type non-return valve:

The valve shall be of the long body, axial sprung, silent closing type valve suitable for potable and raw water. The valve design shall prevent shock closing the valve body shall designed to have a hydrodynamically efficient flow path to minimise head loss through the valve. The spring shall be Stainless Steel and the guide rod shall be supported within a non-corroding, non-galling bearing material.

2.2.6. Double door wafer type non-return valve:

Double door, wafer type non-return valves shall be suitable for potable and raw water. These valves shall may be used for sized up to and including DN80.

The body shall be constructed from cast iron, the flaps / doors shall be constructed from stainless steel with machined sealing faces. The flaps shall be light, butterfly type and it shall be specifically designed to be non-sticking and be equipped Teflon bearings washers. The axles and springs shall be stainless steel. The springs shall be designed to initiate closing before reverse flow are experienced.

2.3. Air Release valves:

2.3.1. For liquids carrying solid particles

Provision shall be made for the supply and installation of a flanged, double action / combination type, air-release valve specifically designed for liquids carrying solid particles such as raw water / - sewage installation. Valves shall be rated at the same pressure rating than that of the pipework it is installed on, with flange drilling to suit the pipework (minimum PN10). Each air-release valve shall be equipped with a suitably sized flanged, cast iron, resilient seated gate valve, suitable for raw water / - sewage. The valve shall have an operating range from 0.5 bar to the valve PN rating.

A drainage pipe running continuously to the sump from the air-release valve shall be supplied and installed, to direct any liquid released by the valve back to the sump / drainage channel. The air-release valve body shall be designed to have a screw connection onto which the drainpipe will connect.

The minimum grade for material and coatings shall be as follows:

- Body : Epoxy coated steel
- Cover : Reinforced nylon
- Discharge outlet : HDPE
- Inner metal parts : Stainless Steel 316
- Floats : Polypropylene / Polycarbonate
- Fasteners : Stainless Steel 316

The position and sizing of the valves shall be in accordance with the Mechanical drawings and Bill of Quantities.

2.3.2. For liquids not carrying solid particles:

Provision shall be made for the supply and installation of a flanged, double action / combination type, air-release valve specifically designed for liquids not carrying solid

particles such as screened / filtered water or effluent installation. Valves shall be rated at the same pressure rating than that of the pipework it is installed on, with flange drilling to suit the pipework (minimum PN10). Each air-release valve shall be equipped with a suitably sized flanged, cast iron, resilient seated gate valve, suitable for raw water / - sewage. The valve shall have an operating range from 0.1 bar to the valve PN rating.

A drainage pipe running continuously to the sump from the air-release valve shall be supplied and installed, to direct any liquid released by the valve outside of the building / to a drainage channel. The air-release valve body shall be designed to have a screw connection onto which the drainpipe will connect.

The minimum grade for material and coatings shall be as follows:

- Body : Epoxy coated ductile iron
- Cover : Epoxy coated ductile iron
- Discharge outlet : Epoxy coated ductile iron
- Inner metal parts : Stainless Steel 316
- Floats : Polypropylene, glass reinforced Nylon
- Fasteners : Stainless Steel 316

The position and sizing of the valves shall be in accordance with the Mechanical drawings and Bill of Quantities.

3. ELECTRIC ACTUATORS

Electric Actuators shall be provided in either partial-turn or multi-turn models and it shall be specifically matched to the valve design as described in the Project Specification, applicable drawings and Bill of Quantities. Actuators shall either have open/close or modulating function, and units with modulating function shall be designed for continues modulation operation.

The actuator motor shall be rated for 400 V, 50 Hz supply, shall have a class F (or better) insulation. It shall be equipped with thermostats for overload protection. The motor and gearbox shall form one integrated unit and the complete unit, including all glands and controls, installation work shall have an ingress protection rating of IP67 or higher (unless otherwise indicated in the Project Specification). Each unit shall be equipped for manual override operation by means of a level operated clutch and handwheel (hand operated gearwheel) and the unit shall have indication of open and close directions. The output drive shall be hollow to accept rising valve stems. All components of the drive shall be designed to prevent backlash. The unit shall be equipped with oil bath lubrication that will enable the unit to be installed in any orientation.

The continuous actuator torque rating shall be at least 200 % and 400 % of the start- or stop torque, to open/close and modulating units respectively, which ever is higher as specified by the manufacturer for the application (taking the mechanical advantage into account provided by the gearbox).

The gear ratio of the gearbox shall be such to provide a continuous operation between opening and closing, without any pulsing during the operation, to conform to the opening / closing time as specified in the Project Specification, without the motor having to stop or start during the closing / opening operation.

Each unit shall have local controls to operate the actuator. It shall be equipped with a Local / Off / Remote switch, to change between Local and Remote control of the actuator, and an Open / Close push button switches for local control (opening and closing) of the actuator.

Each unit shall be equipped with continues mechanical valve position indication, even without power. The terminal compartment shall be separately sealed from the mechanisms and internal control electronics. The actuator unit shall be equipped with independent torque and position sensor for protection.

It shall initiate a trip condition if:

a) It fails to move the valve within a suitable period,
b) Failure to open or close,
c) The motor windings overheat,
d) High torque situation,
e) Phase imbalance / phase rotation.

Each actuator shall have discreet control inputs and outputs for control, as follows:

a) Valve position,
b) Valve action (opening or closing),
c) Valve control,
d) Trip condition.

The actuator shall be equipped with the following functions should the Project Specification call for it:

a) The actuator shall provide an impact effect to overcome a tightly sealed valve or unintended loss of movement.
b) The actuator shall be network compatible to feed the following information to the control panel or, if applicable, to the SCADA system:
    - Torque on output shaft,
    - Valve position,
    - Valve action (opening or closing),
    - Valve control,
    - Trip conditions,
c) It shall be possible to configure the control instructions and interrogate the actuator status without removing the covers.

MECHANICAL STANDARD SPECIFICATION 03 – MATERIAL AND COATINGS:

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1. MATERIAL SELECTION

Any references made to the South African National Standards (SANS) or the British Standards Institution (BS) shall be deemed to refer to the latest revision of the applicable specification, or in cases where a standard was replaced with a new one, the new standard shall apply.

In general, all materials offered, shall be the best grade of material in its specific class and shall be suitable for the working conditions (including working pressures, temperatures, environment, etc.) without distorting or deteriorating or creating stresses in the material.

The Contractor shall supply corrosion resistant materials in cases where high corrosive environments are expected, for instance where the material will be in contact with water or sewage. Should any material show signs of corrosion, pitting or tuberculation, during the defects liability period, it shall be replaced by the Contractor at his own account with materials as approved by the Engineer.

All joints, channels, angles, plates and structural steel shall conform to SANS 2001.

2. PAINTING, COATINGS AND FINISHES

In general, the following shall apply for all items to be painted or coated under this specification:

a) The surface of the item to be painted shall be thoroughly cleaned in accordance with ISO 12944-4 (Part 6.1.4 Alkaline Cleaning) to remove all traces of oil, grease, dust, mill-scale, rust or corrosion, or any residue of any nature before paint or coating may be applied.
b) Metal surfaces shall be moisture dry before paint is applied, and paint surfaces shall be “hard” dry before further coats may be applied, unless otherwise specified.
c) In situations where the shop coat was left for several months, the surface shall be cleaned with emery paper or steel wool prior to applying the final coating.
d) The final coating must be applied to the equipment prior to final installation in situations where surfaces are inaccessible after installations.
e) The painter shall ensure that the final coat covers all prior coatings.
f) A non-destructive thickness gauge shall be used to measure the final dry film thickness (DFT).
g) The coating manufacturer’s instructions and requirements must be strictly adhered to.

Preparation of Metal surfaces shall be as follows:

a) All metal surfaces shall be sandblasted to a minimum of Sa2½ finish, according to ISO 8501-1 to the roughness as specified by the coating manufacturer.
b) The abrasive material shall fully comply with SANS 064 and shall be free of any traces of grease, oil, foreign objects or corrosive contaminants.
c) The abrasive and blast cleaning process shall be adjusted to ensure that the minimum amount of abrasive material remains embedded in the steel.
d) The blast cleaning shall only be conducted in the correct environment and atmospheric conditions. No cleaning shall be done if there is dew on the metal

surface or when the humidity is such that moisture condenses at the nozzle during work in the case of nozzle blasting.

e) The blasted surface shall be cleaned of all abrasive material prior to being painted by brushing or vacuuming. The primary coat shall be applied as soon as possible, but not later than 4 hours after blasting.

The preparation of the paint, the environment and application of the coatings shall be strictly in accordance with the manufacturer's requirements and specifications. Method statements for these processes shall be submitted to the Engineer and approved prior to commencement of the painting process.

2.1. Specification for structural steel:

The following specifications shall be used, unless otherwise specified in the Project Specification. Preparation and application shall strictly comply with the manufacturer's requirements and specifications and it must be adhered to at all time.

2.1.1. General Steelwork (Dry conditions – low to medium corrosive environment)

Primer : One coat of a two-component amine cured epoxy coating, suitable for use in highly corrosive environments, similar or equally approved to Jotun Penguard Express. Minimum DFT of 150 microns. The product shall at least a 74% solids of volume content according to ISO 3233.

Finishing coat : One coat, two components chemically curing aliphatic acrylic polyurethane coating, suitable for use in highly corrosive environments, similar or equally approved to Jotun Hardtop XP. Minimum DFT of 60 microns. The product shall at least a 63% solids of volume content according to ISO 3233.

Minimum total dry film thickness: 210 microns

2.1.2. General Steelwork (Dry conditions – high corrosive environment)

Primer : Two coats of a two-component amine cured epoxy coating, suitable for use in highly corrosive environments, similar or equally approved to Jotun Penguard Express. Minimum DFT of 125 microns. The product shall at least a 74% solids of volume content according to ISO 3233.

Finishing coat : One coat, two components chemically curing aliphatic acrylic polyurethane coating, suitable for use in highly corrosive environments, similar or equally approved to Jotun Hardtop XP. Minimum DFT of 60 microns. The product shall at least a 63% solids of volume content according to ISO 3233.

Minimum total dry film thickness: 310microns

2.1.3. General Steelwork (Wet conditions – fresh – and sea water)

Primer : One coat of a two-component polyamine cured epoxy coating, suitable for use in highly corrosive environments, similar or equally approved to Jotun Marathon in 038 grey colour. Minimum DFT of

300 microns. The product shall at least an 80% solids of volume content according to ISO 3233.

Finishing coat : One coat of a two-component polyamine cured epoxy coating, suitable for use in highly corrosive environments, similar or equally approved to Jotun Marathon in 038 grey colour. Minimum DFT of 300 microns. The product shall at least an 80% solids of volume content according to ISO 3233.

Both epoxy coatings shall be high scratch resistant and suitable for use in marine applications. Minimum total dry film thickness: 310microns

2.1.4. Hot-dipped Galvanised Steel

All traces of protective coatings must be removed prior to painting using the approved cleaning agent(s)

Primer(s) : One coat approved galvanising etching agent
Undercoat : One coat universal undercoat
Finishing coat(s) : Two coats approved gloss enamel

2.2. Specification for pipes (Epoxy Coating):

The following specification shall be used, unless otherwise specified in the Project Specification:

- Internal Lining:
  - Surface preparation: Perform an abrasive blast to Sa2½ as per ISO 8501-1, blasting profile 40-70microns;
  - Coating 1: Apply two coats of reinforced high solids type coating (similar to Sigmaguard 720 or another approved epoxy coating) to a minimum DFT of 125-150microns;
  - Coating 2: Apply reinforced high solids type coating in pipe blue (similar to Sigmaguard 720 pipe blue or another approved epoxy coating) to a minimum DFT of 125-150microns;
  - The total coating minimum DFT should be 375microns
- External Coating:
  - Surface preparation: Perform an abrasive blast to Sa2½ as per ISO 8501-1, blasting profile 40-70 microns;
  - Coating 1: Apply a two-component, high solids, polyamide cured, zinc rich epoxy primer (similar to SigmaZinc 109 HS7200 or another approved epoxy primer) to a minimum DFT of 75-100microns;
  - Coating 2: Apply two coats of a Two-component, high-build, micaceous iron oxide-pigmented, polyamide-cured recoatable epoxy coating (similar to SigmaCover 435 or another approved epoxy coating) to a minimum DFT of 100-125microns for each coat;
  - Coating 3: Apply a two-component, aliphatic acrylic polyurethane finish coat (similar to Sigmadur 550 or another approved coating) to a minimum DFT of 50-60;
  - The total coating minimum DFT should be 325microns

The colour of the external top coat (Coating 3) shall be in accordance with SANS 10140 to indicate the specific medium flowing through or in contact with the pipe surface.

2.3. Specification for pipes (Hot-dipped Galvanising):

The following specification shall be used, unless otherwise specified in the Project Specification:

Where the specification refers to Galvanising, it shall always be heavy-duty, hot-dipped galvanising and shall be done in accordance with and comply with SANS 121 (ISO 1461) for fabricated iron and steel articles and SANS 32 (BS EN 10240) for tubes or pipes including all preparation work required. In addition to the National and International Standards, it shall comply with the requirements set out by the Hot Dip Galvanizers Association of Southern Africa (HDGASA).

The surface of the item to be galvanised shall be thoroughly cleaned to remove all traces of oil, grease, or any residue of any nature before the coating may be applied. Further cleaning must be done by means of acid pickling, and a coating of flux must be applied once the object is sufficiently cleaned and rinsed. All items shall be shot blasted to sa2 according to ISO 8501-1 sa2 to remove all dust, mill-scale, rust or corrosion and to achieve a thicker galvanising coating.

The applicable standards shall apply for the specific composition of material, the zinc temperature, the immersion items, etc. A coating of at least 765g/m² must be achieved.

Sweep blast cleaning shall be performed on all freshly galvanised items as the surface preparation for painting of duplex coating of items. This shall be done in accordance with the Code of Practice as described by HDGASA.

When repairs to the galvanising surfaces may be required due to onsite modification, zinc rich epoxy (Galvpatch or similar approve) may be used, provided that the repaired surface achieves a coating thickness of at least 100microns. Repairs may only be considered if the repaired area does not exceed 0.5% of the total surface area of the component, nor shall an individual repair exceed 10cm². Should the repair area be larger, the entire component must be re-galvanised.

2.4. Specification for pipes (Duplex Coating):

Where the Project Specification calls for a Duplex Coating, all items shall first be Hot-dipped Galvanised, and then an epoxy coating shall be applied. Both coatings shall be according to the specific specifications as discussed in the Standard Specification, including the final film thickness as stated in the respective sections / standards.

2.5. Final Paint Coating:

After installation, all galvanised and epoxy coated pipework shall be painted with an approved enamel paint and shall be colour coded and marked according to SANS 10140 for the respective mediums. Where SANS 10140 does not specify requirements for a type of medium, the following shall apply:

Type of medium	Basic colour	Colour code indicator (single band)
Raw & industrial water	Brilliant Green (H10)	Golden Yellow (B49)
Cold drinkable (potable) water	Brilliant Green (H10)	Cornflower (F29)
Firefighting water	Signal Red (A11)	
Backwash water	Brilliant Green (H10)	Light Stone (C37)
De-sludge water	Brilliant Green (H10)	Canary Yellow (C61)

Final treated effluent	Aquamarine (E67)	
Raw sewage	Olive Green (H05)	
Sea water	Light Brunswick Green (H07)	
Primary sludge	Dark Brown (B03)	
Waste activated sludge	Light Brown (B15)	
Digested Sludge	Light Brown (B15)	Light Olive Green (H21)

The basic colour shall be applied to the entire length of pipe, including all flanges and all valves. The indicate band shall be 250mm wide and not further than 4 000mm apart.

2.6. Coating of underground Pipework:

All underground pipework, flange connections and valves shall be coated with a thick polymer bitumen adhesive tape with a tough plasticised PVC backing. An overwrap shall be applied to act as mechanical protection to the coating.

MECHANICAL STANDARD SPECIFICATION 04 – ANCILLARY EQUIPMENT:

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1. FASTENERS:

1.1. Nuts, Bolts and Ready-bar

Unless otherwise indicated in the Project Specification, all nuts, bolts, washers (2 per bolt set) and ready-bar used for galvanised or epoxy coated mild steel pipework shall be hot-dipped galvanised. When ready-bars and bolts are cut, the ends must be treated with a corrosion protective coating. All nuts, bolts, washers (2 per bolt set) and ready-bar used for Stainless Steel pipework shall be grade 316 Stainless Steel. All bolts shall be high tensile bolts (grade 8.8).

All nuts, bolts, washers and ready-bar shall be in accordance with SANS 1700 and shall be sized according to the flange requirements as described in SANS 1123 table 3. Bolts and ready-bar shall be sized to allow for at least two screw threads to be visible above the nut when tightened.

1.2. Packings and Gaskets

Packings or Gaskets shall be of the full-face type, with pre-punched holes for the bolts to suite the applicable flange and drilling table. Material of manufacture shall be high quality, Non-Asbestos grade based on aramid fibre with a nitrile rubber binder. The gaskets/packings shall not be less than 3mm thick (uncompressed) and suitably rated for the “Shut Off/Maximum” pressures where used.

2. PRESSURE GAUGES:

Pressure gauges shall be installed on each pump set’s dedicated suction (where applicable) and delivery pipework. Pressure take-off points shall be allowed for on the pipework and the pressure gauges shall not be mounted directly on the pipework. Pressure take-off points on pumps shall not be accepted. It shall be installed on Hot dipped galvanised gauges stands, positioned in such a way to allow for the operator to read the gauges while standing in front of the MCC. High pressure nylon pressure hose shall be used to connect the gauges to the pressure take-off points. The pipes shall be of adequate length to be neatly routed from the pipework to the gauges. Bosal piping shall be used to protect the nylon hoses.

The pressure gauges shall be of the bourdon tube type and shall be no less than 100mm in diameter. It shall be glycerine filled with Stainless Steel bodies with a pressure range suited to the pump’s delivery, unless otherwise indicated in the Project Specification. All gauges shall comply with a class 1.0 accuracy class and shall be IP65 rated. Each gauge shall be equipped with a Stainless Steel surface mounting flange and a brass, three-way isolating cock. All fittings and accessories required for a fully operational installation must be allowed for.

Suction and delivery gauges shall be labelled as such. After commissioning, the operating pressure (or range if applicable) shall be neatly labelled on the gauge.

Pressure gauges in sewage pump stations shall be suitable for handling raw sewage, including the connecting hose / and fittings.

The gauge stand shall be suitably sized to house two gauges, and the height of the stand shall be such that the pressure gauges shall be on the same height as the pump inlet /

centre line. The gauge stand shall be hot-dipped galvanised, mild steel and shall be bolted to the floor by a minimum of four hold down bolts.

3. LIFTING EQUIPMENT – CHAIN BLOCK:

Lifting equipment shall be of the manual, hand chain blocks type be with a minimum Safe Working Load (SWL) of 500kg or as otherwise indicated in the project specification. Manual chain blocks shall be applicable up to a SWL of 2000kg. All chain blocks shall comply with SANS 1594. The chain block covers shall be manufactured from thick, pressed steel and shall be of a rugged design to be operational in extreme conditions. Both the gear and wheel shall be fully enclosed. The hoist shall be equipped with a self-activating, double pawn mechanism, load brake with asbestos-free friction discs.

The hoist shall be provided with a load rated, top hook that is able to swivel through a complete 360°. Both top and bottom hook shall be drop-forged and fracture-resistant. The hooks shall gradually deform as a safety indicator when being overloaded and not reaching the breaking point and fail. It shall be equipped with a stopping mechanism to prevent damage to the unit due to excessive lowering. Both hooks shall be ISO 7597 compliant and it shall be equipped with latches.

The hand chain shall be hot dipped galvanised, and the load chain shall be high strength, grade 80, galvanised alloy steel.

In applications at sewage pump stations, both the hand chain and the load chain shall be Stainless Steel to handle the corrosive environment. The length of chain shall be determined on site and shall be long enough to lift items from ground level or bottom of a sump, which ever may be applicable.

All chain hoists shall be supplied with geared trolley / crawl that had the same SWL rating as the hoist. Push type trolley shall not be accepted. The trolleys shall be adjustable to accept a wide range of beams. It shall be equipped with steel wheels and self-lubricated ball bearings. Anti-tilt and anti-drop devices shall be incorporated in the body. The material for the hand chain shall be similar to the hand chain of the chain block.

All lifting equipment shall be supplied with a load testing certificate from the manufacturer, which must be included in the applicable section of the operation and maintenance manual as specified.

4. LIFTING EQUIPMENT – OVERHEAD TRAVELLING CRANE

4.1. General

All Overhead Travelling Cranes shall comply with specification and applicable International and Industry Standards. A complete and fully functional, electrical driven Overhead Travelling Crane (including, but not limited to: the rails, trollies, section – and main girders, electrically driven trolley, electrical hoist, all control and electrical connections and accessories, etc.) shall be provided for, including all installation costs.

The design, manufacture, installation working of the Overhead Travelling Crane shall comply with the following codes and standards (latest available revision or replacement standard where applicable), including all reference documents:

- BS EN 15011: Cranes – Bridges and gantry cranes
- BS EN 1991: Actions on Structures
- BS EN 14492: Power driven hoists

- BS EN 13001: Crane – General design
- BS EN 1993: Design of steel structures
- BS EN 12385: Steel wire ropes
- ISO 16625: Cranes and hoists – Selection of wire ropes, drums and sheaves
- ISO 4301: Cranes – Classifications
- SANS 10375: The inspection, testing and examination of overhead cranes
- Occupational Health and Safety Act (Act 85 of 1993)

In the absence of an alternative proposal, it shall be understood that all requirements in the specification and related standards are met without any exception.

All cranes shall be load tested and certified in accordance with the applicable standard by a certified third party. All cost shall be allowed for.

4.2. Scope of Supply

The Contractor shall inform the Engineer about elements in the scope of supply that might be inadequately defined or missing. The Contractor shall allow for the supply and installation of a complete, fully functional travelling crane, including all accessories and ancillary equipment required. This shall include, but not limited to, the following:

- A set of runway beams and - rails, to suit the building / structure, including all clamps and bolt sets required,
- A single / double overhead girder, including all accessories required,
- Motorized End-trucks to suit the girder,
- Motorized trolley for hoist to suit girder,
- Electrical hoist, including all accessories,
- Resilient bumpers and rubber buffer or hydraulic pumpers where necessary,
- End stops at crane rail ends and / or at hoist beam ends
- Anti-derailing devices
- Lubricators on all moving parts
- Chain and cable guides
- Swivel type hook with safety latch
- Rail sweepers
- Oil and grease for the first filling
- Maintenance platform, if required
- Access ladders and walkways
- All fittings, bolt sets, etc
- Special tools required for maintenance
- Surface finishing and painting
- Chain basket for chain hoists
- Electrical control unit
- Electrical supply cable, isolator etc.

4.3. Design Requirements

4.3.1. General Design Requirements:

The equipment and installation shall be designed with a service life of 25 years. The maximum Safe Working Load (SWL) of the crane shall be clearly and visibly marked in

English on the equipment. It shall be neatly painted directly on the equipment and shall be done on two opposing visible sides of the crane. Hand operated cranes shall be limited SWL less than 3 tonnes, when frequent or fast cranes are not required.

The hoist brake system shall automatically prevent the load from falling in the event of loss of electrical power and the brake shall not overrun or creep. The supplier shall propose a system to lower the load under the before mentioned. The brake system shall be of the enclosed, disc type. No external brakes shall be allowed.

Unless otherwise indicated in the Mechanical Project Specification, the operating speeds of the equipment shall be as follows:

- Electrical hoist : slow speed : 0.3 – 0.4 m/min with jog or inching facility
- Electrical hoist : high speed : 4.5 – 5.5 m/min with jog or inching facility
- Cross Travel speed : 5 – 7 m/min with jog or inching facility
- Long Travel speed : 8 – 10 m/min with jog or inching facility

4.3.2. Mechanical Design Requirements:

The following mechanical design requirements shall be allowed for:

a) Energy absorbing end stop brackets and buffers shall be supplied and installed at the limits of the long – and cross travel motions. These stop brackets and buffers shall be designed in such a way to ensure that a the fully loaded crane travelling at the maximum speed into the stop will not cause any damage to the supporting structure or create a hazardous situation.

b) The supplier shall specify the maximum resulting horizontal dynamic forces of the trolley with maximum vertical load hitting the bumpers. As this has an impact on the supporting structure design or building, this value shall be agreed upon between the Supplier and the Contractor prior to the purchase order.

c) All wheels shall be manufactured from non-sparking material, such as bronze alloy, brass, cast iron, etc.

d) The crab of the crane shall be equipped with tamper proof, overload protection device. It shall be set at a maximum of 10% above the crane's SWL.

e) All rotating parts such as wheels, motors, etc., shall be equipped with sealed bearings (dust and sand proof) and shall be in accordance with ISO standards with a minimum bearing service life (L 10H) of 20 000 hours.

f) All mechanical moving parts of the crane, such as travel wheels, reeving, gears etc., shall be guarded. For hazardous areas, these guards shall be manufactured from non-sparking material. Plastic guards shall not be allowed.

g) Steel wire rope shall be preferred to chains. Chains are not allowed above 7 tonnes capacity or 30 m length. The hoist rope or chain shall be designed to have a minimum safety factor of 5 times that of the SWL of the crane. The length of rope or chain shall be such that there are no less than 5 full wraps on the winding drum when the hook is at the lowest position, as given in the Project Specification. Unless otherwise indicated, this shall be the lowest floor level of which the crane is servicing.

h) The capacity of the winding drum shall be sized in accordance with the required length and size of rope or chain required. Winding on drums shall be restricted to a single layer.

i) Sheaves shall be designed to prevent the wire rope from slipping off and to facilitate reeving. The sheaves shall have a machined rope surface and shall be equipped with sealed bearings. The surfaces shall have hardness qualities compatible with the rope, as recommended by the rope manufacturer.

j) The load hook shall incorporate a safety latch and shall be of the swivel type.

4.3.3. Structural Design Requirements:

The following structural design requirements shall be allowed for:

a) Single girder cranes shall not be used in applications where the span is more than 15 m and or a lifting height more than 10 m.
b) The crane girders shall be designed for a maximum vertical deflection (under test load conditions) to be less than L/750 of the span between the two rails.
c) The fabrication of the crane structure or girders shall be such that no welding shall be required on site.
d) Bolts used for the bridge-to-end-carriage connections should be of a minimum grade 8.8 and shall be in accordance with the applicable Standard Specification.

4.3.4. Maintenance and access Design Requirements:

The crane design shall facilitate safe access to all areas for inspections and maintenance. All walkways, ladders, platforms, lighting, etc required for access shall be provided for. Walkways and platforms shall not be narrower than 750 mm and shall be equipped with hand railings.

4.3.5. Electrical Design Requirements:

The following electrical design requirements (where applicable) shall be allowed for:

a) Cranes shall have electric drives for hoisting, long and cross travel (unless otherwise indicated in the Project Specification). The control unit and the associated switch gear shall be capable of performing any two of the three crane motions operations simultaneously.
b) The electrical installation and components, including but not limited to the electrical motors, control circuit, cabling, connection, junction boxes, etc., shall be designed as per the applicable standards and regulations, including the IEC standards, and shall be rated for temperatures of up to 50°C.
c) All electrical motors shall be rated for 3 phase, 50 Hz (400 V) supply and the control circuit and equipment shall be rated for single phase, 50 Hz (230V).
d) All motors shall be controlled, protected and isolated within the package.
e) All electrical equipment shall be designed for an intermittent duty of up to 150 operations per hour.
f) The contractor shall allow for all cables required, and the supply point shall be situated in the MCC as described under the Electrical Specification.

4.3.6. Control Design Requirements:

The following electrical design requirements (where applicable) shall be allowed for:

a) A pendant type control unit / box suspended from the crane shall be provided.

b) The control box shall allow for low - and high-speed selection of the motors (hoist) and shall make use of push button. These shall be designed so that the machinery motion will stop when pressure is released from the button.

c) The pendant / control box shall be made from high impact (non-breakable), antistatic plastic. The weight of the pendant shall be supported by a galvanised wire, suspended from the crane. Making use of the electrical control cable to support the weight of the unit is not allowed.

d) An emergency stop push button shall be provided for on the pendant. It shall cut control supply to all motions.

e) The pendant shall be IP56 rated and the control signals shall be 24V DC.

f) Two sets of limited switches shall be supplied for each range of motion (bridge travelling / long travel, trolley traverse / cross travel and hook lifting / lowering). The first set will reduce the operating speed (lower to slow speed) and the second set shall stop the motion.

5. LIFTING EQUIPMENT – MANUAL OPERATED OVERHEAD TRAVELLING CRANE

5.1. General

All Overhead Travelling Cranes shall comply with specification and applicable International and Industry Standards. A complete and fully functional, electrical driven Overhead Travelling Crane (including, but not limited to: the rails, trollies, section – and main girders, gear driven trolley, manual chain block and accessories, etc.) shall be provided for, including all installation costs.

The design, manufacture, installation working of the Overhead Travelling Crane shall comply with the following codes and standards (latest available revision or replacement standard where applicable), including all reference documents:

- BS EN 15011: Cranes – Bridges and gantry cranes
- BS EN 1991: Actions on Structures
- BS EN 13001: Crane – General design
- BS EN 1993: Design of steel structures
- ISO 16625: Cranes and hoists – Selection of wire ropes, drums and sheaves
- ISO 4301: Cranes – Classifications
- SANS 10375: The inspection, testing and examination of overhead cranes
- Occupational Health and Safety Act (Act 85 of 1993)

In the absence of an alternative proposal, it shall be understood that all requirements in the specification and related standards are met without any exception.

All cranes shall be load tested and certified in accordance with the applicable standard by a certified third party. All cost shall be allowed for.

5.2. Scope of Supply

The Contractor shall inform the Engineer about elements in the scope of supply that might be inadequately defined or missing. The Contractor shall allow for the supply and installation of a complete, fully functional travelling crane, including all accessories and ancillary equipment required. This shall include, but not limited to, the following:

- A set of runway beams and - rails, to suit the building / structure, including all clamps and bolt sets required,

- A single / double overhead girder, including all accessories required,
- Gear operated end-trucks to suit the girder, including chain loop for operator use,
- Gear operated trolley for hoist to suit girder,
- Manual chain block,
- Electrical hoist, including all accessories, including chain loop for operator use,
- Resilient bumpers and rubber buffer or hydraulic pumpers where necessary,
- End stops at crane rail ends and / or at hoist beam ends
- Anti-derailing devices
- Lubricators on all moving parts
- Chain guides
- Swivel type hook with safety latch
- Rail sweepers
- Oil and grease for the first filling
- Maintenance platform, if required
- Access ladders and walkways
- All fittings, bolt sets, etc
- Special tools required for maintenance
- Surface finishing and painting

5.3. Design Requirements

5.3.1. General Design Requirements:

The equipment and installation shall be designed with a service life of 25 years. The maximum Safe Working Load (SWL) of the crane shall be clearly and visibly marked in English on the equipment. It shall be neatly painted directly on the equipment and shall be done on two opposing visible sides of the crane. Hand operated cranes shall be limited SWL less than 3 tonnes, when frequent or fast cranes are not required.

5.3.2. Mechanical Design Requirements:

The following mechanical design requirements shall be allowed for:

a) Energy absorbing end stop brackets and buffers shall be supplied and installed at the limits of the long – and cross travel motions. These stop brackets and buffers shall be designed in such a way to ensure that a the fully loaded crane travelling at speed into the stop will not cause any damage to the supporting structure or create a hazardous situation.

b) The supplier shall specify the maximum resulting horizontal dynamic forces of the trolley with maximum vertical load hitting the bumpers. As this has an impact on the supporting structure design or building, this value shall be agreed upon between the Supplier and the Contractor prior to the purchase order.

c) All wheels shall be manufactured from non-sparking material, such as bronze alloy, brass, cast iron, etc.

d) The crab of the crane shall be equipped with tamper proof, overload protection device. It shall be set at a maximum of 10% above the crane's SWL.

e) All rotating parts such as wheels, motors, etc., shall be equipped with sealed bearings (dust and sand proof) and shall be in accordance with ISO standards with a minimum bearing service life (L 10H) of 20 000 hours.

f) All mechanical moving parts of the crane, such as travel wheels, reeving, gears etc., shall be guarded. For hazardous areas, these guards shall be manufactured from non-sparking material. Plastic guards shall not be allowed.
g) Chain blocks will be as per Standard Specification
h) Gear operated end trucks and – trolley shall be equipped with a suitable reduction gearing suited to the SWL of the equipment. The gearing shall be actuated by means of a chain loop of suitable length to the height of the crane for the operator to use.

5.3.3. Structural Design Requirements:

The following structural design requirements shall be allowed for:

a) Single girder cranes shall not be used in applications where the span is more than 15 m and or a lifting height more than 10 m.
b) The crane girders shall be designed for a maximum vertical deflection (under test load conditions) to be less than L/750 of the span between the two rails.
c) The fabrication of the crane structure or girders shall be such that no welding shall be required on site.
d) Bolts used for the bridge-to-end-carriage connections should be of a minimum grade 8.8 and shall be in accordance with the applicable Standard Specification.

5.3.4. Maintenance and access Design Requirements:

The crane design shall facilitate safe access to all areas for inspections and maintenance. All walkways, ladders, platforms, lighting, etc required for access shall be provided for. Walkways and platforms shall not be narrower than 750 mm and shall be equipped with hand railings.

6. VENTILATION FAN:

Where forced ventilation fans (extractor fans) are indicated on the plans and in the project specifications, plate mounted, axial aerofoil type fans shall be supplied and installed.

The fan shall be mounted in a fibreglass / GRP mounting plate suitably sized for opening as indicated on the drawing(s). An alternative mounting plate manufactured from galvanised mild steel shall only be accepted in low humidity / dry climate / low corrosive environment applications. It will have an aerodynamic inlet bell to optimise fan efficiency. The air inlet side / motor side of the fan shall be equipped with a spiral wound, epoxy coated, wire guard with integrated motor supports. For fans sizes larger than Ø700 mm, separate motor support arms shall be provided. The fan discharge side of the fans shall also be equipped with a wire guard, as well as a wall cowl, all suitably sized as per the manufacturer's recommendations.

The fan shall make use of aerofoil shaped aluminium impellers in a pressed steel hub suitable for developing medium pressures at large flow rates. The impeller assembly shall be balanced in accordance with ISO 1940 to grade G6.3. The flow rate and static fan pressure required shall be described in the Mechanical Project Specification.

The fan shall be driven by a 3 phase, 400 V, class F, IP55 electrical motor with a minimum IE2 efficiency class rating. Where applicable, explosion proof motors shall be supplied. The fan shall be supplied with, but not limited to, all starters, controllers and cables /

wiring and other equipment required for a complete automatic operation. The fan shall be controlled by means of an external temperature controller which shall start and stop the fan on a set temperature (adjustable on site). The fan shall be operational between - 10 °C and + 40 °C. All wiring and cable work shall be done in accordance with the applicable SANS standards and in manner as described in the Electrical Project and Standard Specifications. Further electrical requirements shall be as per the applicable Electrical Specifications.

Each fan shall be supplied with a suitably sized wall cowl mounted on the outside of the building and comply with the fan manufacturer's requirements. The cowl shall be manufactured from electroplated or hot dipped galvanised sheet metal and epoxy coated. It shall be designed to prevent (rain) water from entering the through the wall opening the air intake shall be close to horizontal (perpendicular to the wall). The cowl shall be a continues short radius bend and segmented cowls shall not be accepted. The wire mesh shall be installed at the opening to prevent medium to large objects from entering the cowl. It shall be fastened to the wall by means of Stainless Steel fasteners.

7. ELEVATED WALKWAYS AND PLATFORMS, HAND RAILINGS, STAIRCASES AND LADDERS:

7.1. Elevated Walkways and platforms

Open grid steel covers and floor panels shall be manufactured by an approved firm specialising in such work. All walkway shall have a minimum of 900 mm internal clearance (between hand railings). They shall be pressure locked or welded (or both). All platforms, walkways, staircases -structures and floors shall be designed to handle the dead weight load of the structure plus a dynamic load of 250 kg/m² or a point load of 100 kg which ever may produce the worst deflection. All span-bars shall have a thickness, depth and spacing such that the deflection of any bar under design load conditions does not exceed 1/200th of the clear span, or 10 mm, whichever is lesser.

Flooring shall be of the open grid type floor made up in panels of sizes that conform to the overall dimensions given on the drawings. The panels shall be supplied prefabricated with cut-outs that conform to the details given. All floors shall be hot dipped galvanised after manufacturing. Unless authorised to do so, the Contractor shall not cut or weld open grid floor panels on Site. All floor sections shall be supplied with a toe-board / kick plate at the edges with a minimum height of 100 mm and 6mm thick flat bar.

The frames and structures shall be constructed out of mild steel sections and hot-dipped galvanised after manufacturing. All walkways and platforms shall be supplied complete with all the necessary fixing bolts, nuts, etc.

7.2. Hand railings

Handrails shall be of the tube and sphere type similar to Monoweld and shall be manufactured by an approved firm specialising in such works.

Handrails shall be 1 000 mm high and shall consist of a handrail and a knee-rail, both manufactured of steel tubing of nominal thickness 2,6 mm and of nominal outside diameter of at least 34 mm. The guard rails around walkways and platforms, as well as staircases, shall be able to handle a point load of 55 kg or a 33 kg/m load, whichever produces the worst deflection applied at any point or direction on the top rail.

Stanchions shall be manufactured pre-formed in one piece and shall be of steel tubing of nominal thickness of 2,6 mm and of nominal outside diameter of at least 42 mm. The

bases of the stanchions shall be manufactured of 150 mm x 75 mm x 12,5 mm flat bars and shall be pre-formed to suit the situation in which they are to be installed (i.e. for platform- or side-mounting, and for horizontal- or sloped-mounting on concrete or steel), and the stanchion spheres shall be pre-formed to suit right angled or other angled intersections), all as shown on the drawings.

Stanchions shall be spaced at intervals not exceeding 1,5 m and shall be fixed with two M16 galvanised bolts, washers and nuts each. All joints shall be welded.

Handrails shall be hot-dip galvanised after manufacture.

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 be supplied complete with all the necessary fixing bolts, nuts, etc.

7.3. Staircases and ladders

Staircases shall be used to provide quick and safe access to areas. Ladders shall only be used where insufficient space is available for a staircase. The material and equipment used for walkways shall be used for the staircases. All staircases shall have a minimum of 900 mm internal clearance (between hand railings). All steps shall have a going of 250 mm long and a rise of 200 mm. All staircases shall be equipped with hand railings on both sides of the staircase.

The length of a staircase section shall not be more than 18 rises after which a landing is required. A change in direction shall be provided after every 36 rises, unless the landing is more than 2 m long. Provision shall be made for all necessary fixing bolts, nuts, etc.

Ladders may be used where there is an occasional requirement for access. It shall be positioned in such a way to ensure no objects blocks the path of the user and will provide comfortable clearance to all body parts.

Ladders shall be at least 600mm wide to allow for step through actions. All ladders shall terminate with hand rails to the at least 1 000 mm higher than the platform to ensure ample support for the user to enter or exit the ladder at the top. The styles shall be flat bar with a minimum width of 80 mm by 10 mm thick, but the ladder shall be designed to be stable and deflect under load. The rungs shall be at least Ø20 mm and be able to match the load carrying capacity of a 20 mm mild steel solid bar. The rungs shall be spaced at 250 mm and it shall be fully sealed to the styles. All ladders shall be manufactured out of hot-dipped galvanised mild steel, unless otherwise indicated in the Project Specification. All ladders that is partially of completely submerged in water or sewage shall be manufactured out of Stainless Steel 316L or higher.

A ladder cage shall be supplied to all ladders where a person may fall more than 4 m, unless it is superseded by a local legislation that is stricter. The cage shall be manufactured out of flat-bar, with an internal dimension of 1 000 mm. The cage shall be welded to the ladder and the material of the cage shall be equal to that of the ladder. All ladders shall be bolted to concrete or steel structures with spacings no more than 1.5 m apart.

8. ELECTRICALLY DRIVEN MACERATOR

8.1. General

The Contractor shall make allowance for the supply and installation of the complete macerating mechanical and electrical equipment. This shall include the mechanical machinery including driver, electrical and control equipment and all cabling required for a complete and working operation.

All equipment or components shall be provided by the same manufacturer.

All National - and International Standards listed in the Project Specification shall adhere to, as well as the following:

- American Society for Testing and Materials (ASTM) A36 Carbon Steel Plate
- American Society for Testing and Materials (ASTM) A536-84 Ductile Iron Castings
- American Iron and Steel Institute (AISI) 4130 Heat Treated Alloy Steel
- American Iron and Steel Institute (AISI) 4140 Heat Treated Alloy Steel
- American Iron and Steel Institute (AISI) 8620 Heat Treated Alloy Steel
- American Iron and Steel Institute (AISI) 303 Stainless Steel
- American Iron and Steel Institute (AISI) 304 Stainless Steel
- American Iron and Steel Institute (AISI) 316 Stainless Steel
- American Society for Testing and Materials (ASTM) Grade 630 (UNS S17400) Stainless Steel
- Society of Automotive Engineers (SAE) 660 Bearing Bronze
- National Electrical Manufacturer's Association (NEMA) Standards
- National Electrical Code (NEC)
- Underwriters Laboratory (UL and cUL)
- International Electrotechnical Commission (IEC)

All equipment must be equipped with a corrosion-resistant nameplate, indicating Manufacturer's name and address, equipment model name, serial number, etc.

The Manufacturer shall be ISO9001 certified. All equipment shall be factory tested and verified prior to shipment.

Prior to ordering of equipment, the contractor shall submit documentation for final approval. This shall include equipment description and sizing, functional descriptions, operating instructions, dimensional drawings, catalog data, installation (job specific) drawings, manufacturer's instructions and recommended spares.

The supplier shall submit two (2) copies of the complete operation & maintenance manuals. An electronic version of the complete manuals shall also be provided. The manuals shall include equipment descriptions, operating instructions, drawings, troubleshooting techniques, a recommended maintenance schedule, recommended lubricants, and recommended spares.

The Manufacturer shall provide a minimum 12 months warranty on the equipment supplied and installed, or in accordance with the liability period as disrobed in the Contract Conditions, which ever may be longer.

All equipment shall be packaged, handled, shipped, stored etc strictly in accordance with the manufacturer's requirements and procedures.

8.2. Mechanical Equipment

Performance requirements:

The Grinder / Macerator shall reduce or shred suspended solids to acceptable sizes (in accordance with the down stream equipment) to protect downstream equipment from blockages and damage.

The following design summary is applicable:

- Number of Grinders : Refer Project Specification
- Grinder installation configuration : Refer Project Specification
- Number of motor Controllers : Refer Project Specification
- Environmental rating for grinders : Non-hazardous
- Environmental rating for motor controllers : Non-hazardous
- Power supply : 3 phase / 400 V / 50 hz
- Nominal Stack Height : Refer Project Specification
- Minimum liquid handling capacity per grinder : Refer Project Specification
- Maximum head drop across cutter stack : Refer Project Specification
- Cutter type : Serrated 17-tooth
- Spacer type : Knurled
- Shaft seal type : Mechanical, Tungsten Carbide
- Seal maximum pressure : 90 psi (620 kPa)
- Speed reducer type and ration : Cycloidal, 29:1
- Installed power : 2.2 kW
- Motor type : TEFC, rated for high humidity environments
- Motor service factor : 1.15
- Minimum motor efficiency rating : IE3
- Minimum peak shaft torque : 720 Nm/kW
- Minimum peak force at cutter tip : 12 kN/kW

Frame and Support:

The frame and / or support shall provide a method for securely positioning the grinder / macerator in a channel or wet well. Should a flanged unit be required, the frame shall incorporate suitable flange connections on both sides of the frame in accordance with the connecting pipework as described in the Project Specifications and Drawings. The frame of channel mounted grinders shall allow installation and removal without any disassembly of the frame of grinder.

The frame shall be fabricated of 304 Stainless Steel and epoxy coated as a minimum. The frame shall be designed to prevent unwanted bypassing of the unit. A baffle plate shall be provided and installed to suit the chamber / sump / channel and shall be fabricated of 304 Stainless Steel.

Grinder:

The grinder shall be of the two-shafted design consisting of individual cutters and spacers driven by hexagonal shafts. The cutters shall actively grab and pull material into the stack for shredding. It shall have upper and lower housings to retain the shafts support bearings

and seals. Each shaft shall be supported both on the drive-end and non-drive-end. An electrical motor, including speed reducer, shall be used to drive the shafts. The maximum shaft speed shall not exceed 60 rpm. The cutters be serrated and shall be specifically designed to operate in Municipal sewage, such as rags, wipes, bottles, etc.

Grinder Components:

- Cutters and Spacers:
  - The cutting stacks shall be of nominal height listed in the Project Specification
  - The cutting stacks shall consist out of interleaved cutters and spacers
  - The cutters and spacers shall be individual disks constructed of heat treated allow steel with a hardness of 45-53 HRc and 34-53 HRc respectively.
  - Cutters shall have at least 17 teeth.
  - The cutter shall have radial serrations on the leading edges.
  - The cutter tooth height shall not be greater than 13mm above the base diameter of the cutter
  - The cutter and spacer tolerances shall be +0.000/-0.025mm and +0.025/-0.000mm respectively.
  - The spacers design shall aid in tearing of material by having a knurled outside diameter.
  - The cutter to cutter clearance shall not be greater than 0.25mm
  - The cutters and spacers shall be at least 10mm thick.

- Shafts:
  - The shafts shall be hexagonal, with a minimum of 50mm across flats
  - The shafts shall be of heat treated 4140 alloy steel with a minimum tensile strength of 1000 kPa and a hardness of 38-42 HRc.

- Intermediate Shaft Yoke:
  - The intermediate shaft yokes shall be provided where applicable and shall provide radial support to the shafts during severe grinding demands.
  - It shall be constructed from 304 Stainless Steel and shall be lubricated by means of high temperature marine grade grease
  - Grease nipples / fittings shall be provided for periodic maintenance.
  - Intermediate shaft yokes shall by supplied on cutter stacks of 810mm and taller.

- Side Rails:
  - Side rails shall be constructed from ASTM A536 ductile iron
  - Cutter side rails shall have evenly spaced horizontal fingers. It shall be designed to create a pressure differential towards the centre of the grinder, directing solids into the cutter stack, while minimizing the pressure drop through the grinder.
  - Clearance between cutter side rails and adjacent cutters shall not exceed 2.6mm

- Shaft Bearings and Seals:

- Sealed, oversized, deep-groove ball bearings shall be used to bear all radial and axial loads.
- Shaft seals shall be of the mechanical type.
- Each bearing and seal arrangement shall be incorporated into a cartridge-style housing.
- Cutter shafts shall be supported on both drive-end and non-drive-ends. Single supports shall not be permitted.
- Dynamic and rotating seal faces shall be Tungsten Carbide with 6% Nickel binder
- Seal cartridges shall be rated to a maximum of 620 kPa
- All O-rings shall be of BUNA-N.
- Seal cartridges shall not require flushing and seals shall be rated to operate both wet or dry.

- Housing and Covers:
  - Housings and top covers shall be of ASTM A536 ductile iron and the bottom cover shall be of A36 carbon steel.
  - The end housings shall have integrated busing deflectors to guide solids away from the seal cartridges.

- Transfer Gears:
  - Transfer gears shall be of the involute profile and fabricated from heat treated alloy steel.
  - The design, thickness and hardness of the transfer gears shall be suited to the transfer torque between the shafts up to the rated breakdown torque of the motor.
  - The interface between gears shall be lubricated by means of grease.
  - The transfer gear ratio shall be such that the ratio of the cutter tip speed on the low speed shaft and high speed shaft shall be between greater than 0.9 and less than 1.0. This shall be to promote tearing of material pass through the grinder.

- Low Speed Coupling:
  - It shall be of the 3-jaw type and shall be manufactured out of 4140 alloy steel.
  - Each low speed coupling half shall be encapsulated on its mating shaft to facilitate proper engagement of coupling lobes (1.5 – 3.0 mm)
  - The interface between lobes shall be lubricated by means of grease.

- Speed reducer:
  - Speed reducers shall be of the cycloidal type and have a speed reduction of 29:1
  - It shall be grease lubricated

- High Speed coupling:
  - It shall be of the 3-jaw type with elastomer spider and the halves shall be of sintered iron
  - The spider shall be of BUNA-N

- Motor:
  - The motor shall be of the TEFC, rated for high moisture environments
  - The motor housing shall allow for flanged mounting.

- Lifting Brackets:
  - The grinder shall be fitted with two (2) lifting rings / brackets rated for the weight of the unit.

Finishes / Coatings:

Paint Coatings (Ferrous Materials)

- Ferrous metal surfaces shall be prepared to SSPC-SP6 (Commercial Blast Cleaning) and shall be coated in accordance with the applicable Standard Specification with a minimum 150-200 microns TDFT thickness.
- All mechanical frames, motors, etc shall be coated.

Paint Coatings (Previously Coated Materials)

- All previously coated components (motors, speed reducers, etc.) shall be prepared to SSPC-SP1 (Solvent Cleaning) and SSPC-SP2 (Hand Tool Cleaning) and shall be coated in accordance with the applicable Standard Specification with a minimum 150-200 microns TDFT thickness.

8.3. Electrical Equipment and Control

A complete and functional electrical control panel shall be supplied and installed to provide programmable operation of the grinder system. The controller shall have all required switches, indicator lights and other control devices required. It shall be designed and rated for the performance requirements indicated in the specification. The Contractor will allow for all cables, connections, trunking, etc. for the complete electrical installation to the Standard as described in the Electrical Project - and Standard Specifications.

All motor control panels shall adhere to the applicable National and International Standards and regulations.

Components:

- Enclosure:
  - The enclosure shall be powder coated mild steel, rated at IP66
  - It shall house all components, including the motor starter, PLC and other control devices
- Selector Switches:
  - All selector switches shall be 22mm or larger in size, and shall be rated equal or higher than the enclosure
  - The Grinder selector switch shall be three-position and indicate On, Off / Reset, Remote.
- Pilot Lights:
  - Lights will be 22mm in size, LED (pilot lamp), and shall be rated equal or higher than the enclosure

    - Indication / pilot lights shall be provided as a minimum for POWER ON, GRINDER RUN, GRINDER JAMMED, and MOTOR FAULT
- Motor Starter:
    - The Starter shall be IEC compliant, full voltage, and reversing
    - Contactor shall have 110V / 230V operating coils
    - Overload relays shall be adjustable and sized to full load amperes (FLA) of the motor
- Control Power Transformer:
    - The transformer shall produce 110V / 230V AC power from the power supply to provide power to the control circuit. It shall be correctly sized in accordance with the applicable codes and regulations to accommodate the control power requirements.
- Controller:
    - A Programmable Logic Controller (PLC) shall be used for the control of all equipment.
- Current Transducer:
    - The current Transducer shall be of the discrete output type
    - It shall have an adjustable set point range of 1A - 135A, with a 200ms or faster response time.
- Cabling:
    - All motor - and signal cables, including terminations, required for the full operation shall be supplied and installed as part of the cost.
    - Cable sizing shall be in accordance with the Electrical Project – and Standard Specifications.
- Emergency stop:
    - An Emergency Stop shall be provided within arm's length from the grinder equipment, and shall include all required cabling.
    - The activation of the Emergency Stop will immediately stop the grinder and de-energize the motor.

8.4. Operation:

The system shall have the following operational functionality:

- Selector switch functionality:
    - OFF / RESET – the grinder shall not run, and the motor controller faults shall be cleared
    - ON – the grinder shall start and run in the forward direction
    - REMOTE – the grinder shall operate as controlled by a remote start / stop dry contact
- When an obstruction jams the grinder, the controller shall stop the grinder and reverse the rotation to clear the obstruction. If the obstruction is cleared the controller shall return the grinder to normal operation. If three (3) reverse cycles occur within a 30 second period, the controller shall stop the motor and activate the GRINDER JAMMED indicator and relay
- In a motor overload or motor over-temperature condition, the motor shall be de-energized, the MOTOR FAULT indicator lamp shall be illuminated, and the MOTOR FAIL contact shall be closed

- When a power failure occurs while the system is operating, the system shall return to normal operation when power is restored. Should a power failure occur while the grinder is in a fail condition, the system shall return to a fail state / condition when the power is restored, the fail state / condition shall not be cleared until it is reset
- Rest of the grinder shall only be accomplished from the controller selector switch

8.5. Execution:

Installation:

The Contractor shall coordinate and execute the installation of the equipment strictly in accordance with the manufacturer's instructions, drawings and related specification sections. The installation and equipment shall be in accordance with all Occupational Health and Safety Act requirements and Mechanical and Electrical National – and International Standards and Regulations.

Commissioning / Start-up:

The Contractor shall allow for all cost involved for a representative of the equipment supplier / manufacturer for a minimum of one (1) day to inspect the equipment for proper installation, apply power for the first time and check proper motor rotation, oversee the initial introduction of material into the system and confirm the equipment operates as intended. The representative will also provide services as detailed in the Training Requirements below.

Training:

Training by a representative of the equipment supplier / manufacturer shall be provided to all operating, maintenance and supervisory staff and shall form part of the formal training described elsewhere in the documentation. The training shall cover the key components of the equipment, the operating procedures and requirements, maintenance procedures and requirements and troubleshooting techniques.

MECHANICAL STANDARD SPECIFICATION 05 – MECHANICAL EQUIPMENT FOR WASTEWATER TREAMENT WORKS:

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1. GENERAL

The Mechanical Project Specification shall take preference over the Mechanical Standard Specifications should there be contradictions. The Mechanical Specifications shall also be read in conjunction with the Electrical Project Specification and Electrical Standard Specification(s) to ensure integration and allowance made for interfaces that may be required for instrumentation and other electrical equipment.

2. FRONT RAKE FINE MECHANICAL MULTIPLE BAR SCREEN:

2.1. Specific requirements for Front Rake Fine Mechanical Multiple Bar Screens

The specific requirements for the equipment shall be in accordance with the applicable Project Specification.

2.2. General requirements for Front Rake Fine Mechanical Multiple Bar Screens

2.2.1. Scope of Works

This part of the specifications covers the design, supply, delivery to site, installation and commissioning of the main and ancillary equipment required for the automated, channel fitted, multiple bar, front rake, fine mechanical screens designed to remove floating or suspended debris from the raw incoming sewage. The screenings would generally consist out of rags, paper, plastics, organic matter, large solids, etc.

Each screen shall comprise of (but not limited to) the following basic components:

a) A framework to which all components are attached.
b) A sole plate at the base of the framework.
c) A flat bar rack that will accumulate the screenings.
d) A flat bar dead plate which extends above the bar rack to the discharge chute.
e) An endless chain conveyer system, comprising of two chains and sprocket assemblies, one at each side of the frame.
f) Multiple rakes, attached to the chain conveyer system, to clean the bar rack of accumulated screenings.
g) A pivoting scraper for discharging the screenings from the raking tines.
h) A chute for discharging screenings from the assembly.
i) A drive assembly, which will provide motive power to the chain assemblies for screen operation.
j) The control and instrumentation required for automated operation (as described in the Electrical Specification).

A screen system that requires periodic manual cleaning of the bar rack shall not be accepted. The screen construction shall be robust and simple. The design shall be such that it does not require regular maintenance and only screen of proven ability shall be provided.

The Contractor shall ensure that the equipment offered comply or exceed the requirements set out in the specification and that it is suitable for the application. The Contractor shall make allowance for a fully functional and integrated system, including all interconnecting systems that may be required. This specification shall be read in conjunction with the other Mechanical Standard Specifications whether there are specific references or not.

2.2.2. General Design Criteria

The equipment shall meet the following requirements:

a) It shall be designed to facilitate the efficient manufacture, inspection, transportation, installation, maintenance, cleaning and repairs.
b) It shall be designed with a minimum expected life of 20 years of safe and satisfactory operation under the conditions prevailing at the site
c) The design shall prevent undue stresses caused the expansion and contractions due to temperature changes and other local natural manmade conditions.
d) The design shall keep maintenance costs to a minimum
e) It shall be designed to comply completely with the legal requirements in respect of safety and the prevention of environmental pollution.
f) It shall satisfy any specific requirements contained in the relevant statutory codes and legislation.
g) The design shall allow for 24-hour operation, 365 days a year under the specific design conditions.
h) The equipment installed shall be complete and fully operational as per the requirements set out in the Scope of Works.
i) All material used for the equipment shall be suitable for the operation and environment and compatible with the intended use.
j) The design shall allow for suitable treatment to prevent corrosion and erosion of the materials and equipment.
k) After approval by the Engineer, at the time of award of the Contract, the information stated in the Data Sheets shall be fully complied with, notwithstanding the specified scope of the Contract.
l) All electrical equipment, forming part of the specified equipment, as described in the Electrical Specification, shall be sealed against penetration by hose cleaning operations as well as being accessible for repairs and maintenance.

2.2.3. Materials

All the mechanical components of the screen shall be manufactured from at least 316L Stainless Steel (or higher grades) shapes (rods, angles, and channels), pipes, and sheets. All side frames and guides, bar rack, rake assembly, scraper assembly, shafting, chains and sprockets, discharge chute, fasteners and anchor bolts shall be made of this material. 304 Stainless Steel and lower grade Stainless Steel or steel shall not be accepted. Screen shall be manufactured in a Stainless Steel only factory to prevent contamination of the Stainless Steel with rusty dust.

All Stainless Steel components and structures shall be submersed in a chemical bath of nitric acid and hydrofluoric acid (pickling bath) to remove any residues that may be present on the material as a result of forming, manufacture, or handling. After removal from the pickling bath, the equipment must be washed with a high-pressure wash of cold water to remove any remaining surface debris and promote the formation of an oxidized passive layer which is critical to the long life of the Stainless Steel.

Chains and sprockets shall be made from at least 316L Stainless Steel (or higher grades). Chain rollers shall be made of polyamide RCH1000.

Lower sprocket bearings shall have a Stainless Steel casing. The design shall be as such to prevent grit from entering the bushing system. Proof of such a design shall be furnished on request of the Engineers. Grease lubricated bushes or bearings will not be accepted. Screens utilizing bottom guides or tracks to guide the chain shall not be accepted.

Upper sprocket bearings shall have a paint coated cast iron casing and include ball bearings that are greased for life and shall be double-sealed.

2.2.4. Construction

Mechanical Components

The bar screen shall remove debris (screenings) from the incoming wastewater by means of a positively cleaned bar rack that is installed in a concrete channel. The screen shall retain debris at the bar rack. A multitude (a minimum of 6 bladed unless otherwise indicated in the project specification) of rake blades shall remove and lift the debris to a discharge mechanism. The bar rack shall be cleaned by a series of rakes engaging the bar rack from the upstream side (front) at the bottom of the channel and then moving up along the bar rack. The debris shall be lifted above the channel and dropped on a discharge chute at the downstream side (back) of the screen. Screens with single rakes engaging in the screenings field at any time shall not be approved. Screens employing brushes and spray water for screenings removal shall not be approved.

The bar rack shall consist of equally spaced (bar spacing or opening shall be indicated in the Project Specification), straight tear drop design bars that are inclined from the horizontal with the inclination angle specified above. The bar thickness shall be designed such to prevent deflection in the lateral direction, therefore it shall be dependent on the bar length (screen area depth). It shall be provided with a curved base plate such that the rakes positively remove all screenings from the bottom of the bar rack. The depth of the bars shall be a minimum of 60 mm. The bar rack shall be securely fastened to the frame of the screen and be readily removable. Trapezoidal or tapered bars shall not be accepted.

The bar screen shall be provided with a dead plate extending from the bar rack to the discharge chute. The dead plate shall be stiffened by structural members so that it is flat without undulation so that the tips of the rake's teeth ride evenly past it. The dead plate shall be securely fastened to the side frames.

A discharge chute shall be provided that fully encloses the discharge section of the screen. An access hatch with hinges and a handle shall be provided in the chute permitting easy access. The discharge chute shall be mounted to direct screenings into the appropriate receiving container or conveyor. The chute shall have a slope of minimum 60 degrees. The discharge chute shall be made of a minimum 4 mm thick Stainless Steel plate.

A frame shall be designed to handle all static and dynamic loads without distorting. It shall be designed to handle the maximum load caused by the upstream liquid at the maximum level (overflow or channel depth, which ever is higher) when the screen field is completely blocked, without distorting or twisting. It shall also be capable of handling the maximum torque of the geared motor at lock rotor condition without distorting or twisting. The maximum allowable deflection of the frame at 50 kN at 3000 mm length

shall be no more than 1.0 mm. Additional supports to handle forces may be required based on the manufacturer's design.

The screen shall be provided with easily removable, sufficiently stiffened covers made of 1.5 mm thick Stainless Steel plates with edges on all sided. The covers shall be provided with turn locks and handles. All covers shall be designed so that a single person is able to handle or remove a panel, therefore the size and weight must be taken into account.

Neoprene strips shall be fastened to the side frames to seal the lateral gaps between the side frames and the channel walls.

Drive chains for the rakes shall be roller type chains and shall have links made from Stainless Steel. The chain bushes and pins shall be made from Duplex Stainless Steel. Drive chains, chain guides, sprockets and their bearings shall be replaceable without the need for removing the screen from the channel. Chain pitch shall be no less than 160mm. Screens utilizing drive chains constructed from lower grade materials (than indicated in Materials paragraph or project specification) will not be acceptable for this project due to the corrosive nature of wastewater.

The sprocket drive shaft(s) shall be designed to handle the maximum torque in the system (the maximum start-up torque under 100% clogging or higher) and shall have a minimum safety factor of 3:1.

Each screen shall be provided with four identical sprockets with a reference diameter larger than 300 mm. Each sprocket shall be made of two pieces that are flanged to the shaft or bearing. Screens utilizing different materials for the sprocket assemblies will not be acceptable.

Stainless Steel guards shall be provided to partially cover the lower sprockets to provide protection from debris. These guards shall be bolted to the frame and shall cover reach above the maximum liquid level.

Upper bearings shall be of the ball bearing type, it shall be greased for life or shall be equipped with grease nipples for lubrication and shall be double-sealed with Nilos rings.

Lower bearings shall be of the slide bearing type in a Stainless Steel casing. Bearings employing slide bushings made of plastic or metal material and requires greasing shall not be accepted.

Rakes shall include rake bars utilising a channel profile sized to handle the expected forces based on the width of the screen. Rake blades shall be bolted on the rake bars. The rake blades shall have teeth matching and engaging the bars of the bar rack. The rake blades shall each consist of several pieces with teeth such that only one of the pieces needs to be replaced in case that a tooth should be damaged. To lower the forces exerted on a rake assembly, the number of teeth on the rake may be designed to fit every other bar opening, with successive rakes cleaning alternative bar openings.

A pivoting scraper mechanism shall be positioned at the point of discharge and shall be attached to the side frames. The scraper shall clean the rake on each pass and return to its rest position with minimal shock. The scraper shall be designed such that screenings do not wrap around the rake or scraper. The scraper shall be provided with an adjustable 10 mm thick wiper made of Polyethylene. The scraper shall be connected to the frame

through a pair scraper arms and a pair of shock absorber elements made of neoprene shall be provided to dampen the cleaning action.

The drive shaft shall have a diameter of minimum 80mm and a wall thickness of minimum 5 mm. It shall include an integral rocker arm assembly on the drive end that flexes if the screen rakes get jammed.

The rocker arm assembly shall consist of a drive unit mounted to a Stainless Steel arm. The Stainless Steel arm will be held in place by a flanged roller bearing connected to the drive shaft and two heavy duty tension springs. The rocker arm shall be maintained in the standard operating position by the two tension springs. If the screen rakes experience a jam, the force will cause the rocker arm to rotate around the drive shaft, compressing one of the tension springs. This motion shall be limited by a rocker guide. When the rocker arm rotates out of the normal operating position a proximity sensor will send a signal to the PLC causing the motor to enter a self-clearing mode. If the self-clearing mode should prove unsuccessful then the system shall initiate an alarm signal.

Screens depending only on electronic overload protection devices to safeguard the screen will not be accepted.

Drive Unit

The drive unit shall be designed for continuous service uncovered and in the corrosive environment and intermittent spray water or rain contact.

The bevel gear reducer shall be a totally enclosed unit. Gear reducer shall have ball or roller bearings throughout with all moving parts immersed in oil. Gear reducers which require periodic disassembly of the unit and manual re-greasing of bearings are not acceptable. The nominal input power rating of the gear reducer shall be at least equal to the nominal horsepower of the drive motor. Gear reducer shall be designed and manufactured in compliance with applicable AGMA or equivalent standards. During continuous operation the oil temperature shall not exceed 95 degrees C.

The rake assembly shall be driven by an electric motor. The motor shall be UL rated for operation in Class 1, Div 2 environment. The motor shall be rated at a minimum of 0.75 kW, 400 Volts, 50 Hz, 3-phase, with a service factor of at least 1.5 over the maximum power and torque requirements (whichever is higher under start-up with a 100% clogged screen field). The motor shall be rated for operation in a 40 °C environment. The Contractor shall ensure the orientation of the drive units so that it does not interfere with other screens or equipment, it may be require to have the drive unit on sperate sides of the screens installed under the same contract.

Instrumentation

The equipment shall include all limit / torque switches and protection instrumentation, seen necessary by the Manufacturer to ensure the validity of the warrantee, to prevent damage to the equipment in overloading, etc conditions. The equipment shall have the functionality to operate in forward / reverse to try and dislodge blockages.

2.2.5. Walkways, Platforms and Staircases

Walkways, platforms and staircases shall be provided for all equipment that require operators to work (for operating or maintenance purposes) at heights higher than 1.2 m

above the NGL. These platforms, walkways, staircases and their respective support structures shall be constructed from GRP or epoxy coated hot dipped galvanised.

All walkways, platforms and staircases shall be equipped with suitable hand railings and all equipment and structures shall be in accordance with the applicable Standards and the Health and Safety Act.

2.2.6. Spare Parts

The following Spare Parts shall be included and supplied together with the equipment:

- 2 set of rake plates
- 4 upper bearings assemblies
- 4 lower bearings assemblies
- 2 wipers for scraper
- 4 shock absorbers for scraper
- 2 proximity switches

Spare parts shall be packaged with labels indicating the contents of each package and shall be delivered to Owner as directed.

2.2.7. Installation and Testing

The Contractor shall verify all dimensions in the field to ensure compliance of equipment dimensions with the drawings. Contractor shall notify the Engineer of significant deviations.

Installation of the equipment shall be in strict accordance with the contract documents and the manufacturer's instructions and shop drawings. Manufacturer shall supply equipment, including anchor bolts for the equipment. Contractors shall install the equipment in accordance with the manufacturer's recommendations.

Supplier shall use the services of a factory-trained Service Engineer to inspect the installation, observe start up, and provide operator training. The duration and frequency shall be such to confirm to the requirements set out in the Project General Specification with regards to the commissioning, optimisation and training of operators.

Equipment shall not be energized, or "bumped" to check the electrical connection for motor rotation without the Service Engineer present.

The Service Engineer shall make all necessary adjustments and settings to the controls.

The Service Engineer shall demonstrate proper and sequential operation of the screen and demonstrate that the equipment achieved the requirements set out in the Specifications. The screen shall operate automatically based on the differential water levels and on a timer basis.

3. MANUAL RAKE BAR SCREEN:

3.1. Specific requirements for Manual Rake Bar Screen

The specific requirements for the equipment shall be in accordance with the applicable Project Specification.

3.2. General requirements for Manual Rake Bar Screen

3.2.1. Scope of Works

This part of the specifications covers the design, supply, delivery to site, installation and commissioning of the main and ancillary equipment required for the automated, channel fitted, multiple bar, front rake, fine mechanical screens designed to remove floating or suspended debris from the raw incoming sewage. The screenings would generally consist out of rags, paper, plastics, organic matter, large solids, etc.

Each screen shall comprise of (but not limited to) the following basic components:

a) A framework to which all components are attached.
b) A flat bar rack that will accumulate the screenings.
c) A drainage platform onto which screenings will be scraped to be dewatered.

The design shall be such that it does not require regular maintenance and only screen of proven ability shall be provided.

The Contractor shall ensure that the equipment offered comply or exceed the requirements set out in the specification and that it is suitable for the application. The Contractor shall make allowance for a fully functional and integrated system, including all interconnecting systems that may be required. This specification shall be read in conjunction with the other Mechanical Standard Specifications whether there are specific references or not.

3.2.2. General Design Criteria

The equipment shall meet the following requirements:

a) It shall be designed to facilitate the efficient manufacture, inspection, transportation, installation, maintenance, cleaning and repairs.
b) It shall be designed with a minimum expected life of 20 years of safe and satisfactory operation under the conditions prevailing at the site
c) The design shall prevent undue stresses caused the expansion and contractions due to temperature changes and other local natural manmade conditions.
d) The design shall keep maintenance costs to a minimum
e) It shall be designed to comply completely with the legal requirements in respect of safety and the prevention of environmental pollution.
f) It shall satisfy any specific requirements contained in the relevant statutory codes and legislation.
g) The design shall allow for 24-hour operation, 365 days a year under the specific design conditions.
h) The equipment installed shall be complete and fully operational as per the requirements set out in the Scope of Works.
i) All material used for the equipment shall be suitable for the operation and environment and compatible with the intended use.
j) The design shall allow for suitable treatment to prevent corrosion and erosion of the materials and equipment.
k) After approval by the Engineer, at the time of award of the Contract, the information stated in the Data Sheets shall be fully complied with, notwithstanding the specified scope of the Contract.

l) All electrical equipment, forming part of the specified equipment, as described in the Electrical Specification, shall be sealed against penetration by hose cleaning operations as well as being accessible for repairs and maintenance.

3.2.3. Materials

The screen shall be manufactured from at least 316 Stainless Steel (or higher grades) shapes (rods, angles, and channels), pipes, and sheets. All side frames and guides, bar rack, drainage platform, fasteners and anchor bolts shall be made of this material. 304 Stainless Steel and lower grade Stainless Steel shall not be accepted. Screen shall be manufactured in a Stainless Steel only factory to prevent contamination of the Stainless Steel with rusty dust.

All Stainless Steel components and structures shall be submersed in a chemical bath of nitric acid and hydrofluoric acid (pickling bath) to remove any residues that may be present on the material as a result of forming, manufacture, or handling. After removal from the pickling bath, the equipment must be washed with a high-pressure wash of cold water to remove any remaining surface debris and promote the formation of an oxidized passive layer which is critical to the long life of the Stainless Steel.

3.2.4. Construction

The bar screen shall remove debris (screenings) from the incoming wastewater by means of a positively cleaned bar rack that is installed in a concrete channel. The screen shall retain debris at the bar rack. The screenings shall be manually removed by the operator by means of a hand rake. The debris shall be lifted above the channel and dropped on a drainage platform at the downstream side (back) of the screen.

The bar rack shall consist of equally spaced, straight flat bars. The bar spacing shall be indicated in the Project Specification. The top end of the bar rack shall protrude above the channel wall, and end with a downward curve onto a drainage platform to enable debris being raked onto the platform. It shall be provided with a base plate such that the rakes remove all screenings from the bottom of the bar rack. The depth of the bars shall be designed such that rags does not tangle around the bar. The bar rack shall be securely fastened to the frame of the screen and shall be removable. The screen design shall allow for stiffener(s) for the bar rack to prevent bars from bending in the lateral direction. These stiffeners shall not impede the rake operation and therefore may not protrude past the bars.

The drainage platform shall be constructed from perforated Stainless Steel plate with a minimum of 8 mm thick. It shall be profiled to allow for water to drain towards the centre of the channel, and not allow water to run towards the channel walls. The surface of the platform shall be such that the operator can scoop up the drained debris by means of a shovel. The platform shall be supported by means of cross members and shall be suitable design to carry the weight of an operator as well as wet screenings. The minimum loading shall be 200 kg. The platform support structure shall be manufactured from Stainless Steel profiles and suitable fastened to the channel walls by means of Stainless Steel anchor bolts. The perforated plate shall be secured to the support structure.

A suitable rake shall be supplied that suits the rack spacing to allow for easy cleaning and operation.

3.2.5. Spare Parts

The following Spare Parts shall be included and supplied together with the equipment:

- None

Spare parts shall be packaged with labels indicating the contents of each package, and shall be delivered to Owner as directed.

3.2.6. Installation and Testing

The Contractor shall verify all dimensions in the field to ensure compliance of equipment dimensions with the drawings. Contractor shall notify the Engineer of significant deviations.

Installation of the equipment shall be in strict accordance with the contract documents and the manufacturer's instructions and shop drawings. Manufacturer shall supply equipment, including anchor bolts for the equipment. Contractors shall install the equipment in accordance with the manufacturer's recommendations.

The Service Engineer shall demonstrate proper and sequential operation of the screen and demonstrate that the equipment achieved the requirements set out in the Specifications. The screen shall operate automatically based on the differential water levels and on a timer basis.

4. CONVEYORS:

4.1. Specific requirements for the Conveyor

The specific requirements for the equipment shall be in accordance with the applicable Project Specification. Conveyors shall be suitable for transporting screenings, sludge, dewatered sludge cake, etc. as indicated in the project specification.

4.2. General requirements for the Conveyor

4.2.1. Scope of Works

This part of the specifications covers the design, supply, delivery to site, installation and commissioning of the main and ancillary equipment required for the automated, horizontal, shaftless screw designed to transport screenings from the mechanical, front rake screen(s) to the washer / compactor. The screenings would generally consist out of rags, paper, plastics, organic matter, large solids, etc.

Each conveyer shall comprise of (but not limited to) the following basic components:

a) A framework to which all components are attached.
b) U-shape transport trough, including cover
c) Shaftless screw to drive screenings
d) Chutes, suitable for washer / compactor unit(s).
e) Drive motor, including gearbox
f) Support structure
g) All ancillary equipment and controls for a complete and operational unit.
h) The control and instrumentation required for automated operation (as described in the Electrical Specification).

A conveyer system that requires periodic manual cleaning of the screw shall not be accepted. The construction shall be robust and simple and the design shall be such that

it does not require regular maintenance and only screen of proven ability shall be provided.

The Contractor shall ensure that the equipment offered comply or exceed the requirements set out in the specification and that it is suitable for the application. The Contractor shall make allowance for a fully functional and integrated system, including all interconnecting systems that may be required. This specification shall be read in conjunction with the other Mechanical Standard Specifications whether there are specific references or not.

4.2.2. General Design Criteria

The equipment shall meet the following requirements:

a) It shall be designed to facilitate the efficient manufacture, inspection, transportation, installation, maintenance, cleaning and repairs.
b) It shall be designed with a minimum expected life of 20 years of safe and satisfactory operation under the conditions prevailing at the site
c) The design shall prevent undue stresses caused the expansion and contractions due to temperature changes and other local natural manmade conditions.
d) The design shall keep maintenance costs to a minimum
e) It shall be designed to comply completely with the legal requirements in respect of safety and the prevention of environmental pollution.
f) It shall satisfy any specific requirements contained in the relevant statutory codes and legislation.
g) The design shall allow for 24-hour operation, 365 days a year under the specific design conditions.
h) The equipment installed shall be complete and fully operational as per the requirements set out in the Scope of Works.
i) All material used for the equipment shall be suitable for the operation and environment and compatible with the intended use.
j) The design shall allow for suitable treatment to prevent corrosion and erosion of the materials and equipment.
k) After approval by the Engineer, at the time of award of the Contract, the information stated in the Data Sheets shall be fully complied with, notwithstanding the specified scope of the Contract.
l) All electrical equipment, forming part of the specified equipment, as described in the Electrical Specification, shall be sealed against penetration by hose cleaning operations as well as being accessible for repairs and maintenance.

4.2.3. Materials

The conveyer trough, end plates, covers, chutes, slide gates, support structure and fasteners shall be manufactured from at least 316 Stainless Steel (or higher grades) shapes (rods, angles, and channels), pipes, and sheets. The spiral flights and inserts shall be manufactured from epoxy coated 300WA steel (unless otherwise indicated in the Project Specification). 304 Stainless Steel and lower grade Stainless Steel shall not be accepted. Conveyers shall be manufactured in a Stainless Steel only factory to prevent contamination of the Stainless Steel with rusty dust. The wear liner shall be of ultra-high-molecular-weight polyethylene.

All Stainless Steel components and structures shall be submersed in a chemical bath of nitric acid and hydrofluoric acid (pickling bath) to remove any residues that may be present on the material as a result of forming, manufacture, or handling. After removal from the pickling bath, the equipment must be washed with a high-pressure wash of cold water to remove any remaining surface debris and promote the formation of an oxidized passive layer which is critical to the long life of the Stainless Steel.

4.2.4. Construction

Spiral / screw:

The spiral shall be centreless, and the minimum flight thickness shall be 20 mm. It shall have sufficient stability to prevent distortion and jumping in the trough. The spiral size (outer diameter and pitch) shall be designed to suit the required transfer rate and media that is transferred (i.e. inorganic materials (screenings), sludge, etc) as indicated in the Project Specification.

Trough:

Each conveyer trough shall be U-shaped, fabricated form a minimum 3 mm Stainless Steel plate. It shall be equipped with inlet and discharge connections or ports, as indicated on the drawings to suit the mechanical screen(s) and washer / compactor. The outlet opening(s) shall be in the bottom of the trough and shall be sized to prevent screw conveyer plugging.

The entire length of the trough / screw conveyer, expect the filling chute, shall be covered by a bolted cover. The cover shall be manufactured Stainless Steel in sections with a maximum of 1.5 m lengths to allow for easy access and handling.

Wear Liner:

A wear liner shall be provided for the trough and cover. It shall be made of a minimum 10 mm thick ultra-high-molecular-weight polyethylene and shall be manufacture in section with a maximum of 2 m lengths to allow for easy handling and replacement. The liner shall be 2 colour to indicate wear.

Conveyor Support:

All conveyers shall be complete with a support structure mounted to the operation floor, designed to handle all static and dynamic forces and prevent vibrations of the conveyer. It shall be manufactured from structural Stainless Steel shapes and plates. Supports shall be provided at both the drive-end and non-drive-end of the conveyer. Intermediate supports shall also be provided in order to have unsupported spans of more than 4.5 m. All supports shall be designed and installed in such a way not to interfere with other equipment and supports.

Over-torque protection:

The rocker arm assembly shall consist of a drive unit mounted to a Stainless Steel arm. The Stainless Steel arm will be held in place by a flanged roller bearing connected to the drive shaft and two heavy duty tension springs. The rocker arm shall be maintained in the standard operating position by the two tension springs. If the spiral jam, the force will cause the rocker arm to rotate around the drive shaft, compressing one of the tension

springs. This motion shall be limited by a rocker guide. When the rocker arm rotates out of the normal operating position a proximity sensor will send a signal to the PLC causing the motor to stop, with the associated alarm triggered.

Coveyors depending only on electronic overload protection devices to safeguard the screen will not be accepted.

Conveyor Drive System:

The conveyer shall be driven by an electrical motor, equipped with a reduction gearbox and it shall be rated for continues operation. The drive motor shall be having a minimum rating of 1.1 kW, rated for 400V, 50 hz with a service factor of at least 1.5 over the maximum power and torque requirements (whichever is higher). It shall be rated for Class 1, division 2 areas. The motor speed shall not exceed 1500 rpm. It shall be coupled directly to the screw drive through the gearbox. The motor and gearbox shall be properly supported to handle all static and dynamic forces.

Instrumentation:

The equipment shall include all limit switches and protection instrumentation, seen necessary by the Manufacturer to ensure the validity of the warrantee, to prevent damage to the equipment in overloading, etc conditions. The equipment shall have the functionality to operate in forward / reverse to try and dislodge blockages.

4.2.5. Walkways, Platforms and Staircases

Walkways, platforms and staircases shall be provided for all equipment that require operators to work (for operating or maintenance purposes) at heights higher than 1.2 m above the NGL. These platforms, walkways, staircases and their respective support structures shall be constructed from GRP or epoxy coated hot dipped galvanised.

All walkways, platforms and staircases shall be equipped with suitable hand railings and all equipment and structures shall be in accordance with the applicable Standards and the Health and Safety Act.

4.2.6. Spare Parts

The following Spare Parts shall be included and supplied together with the equipment:

- 2 sets of drive-end and non-drive-end bearings.

Spare parts shall be packaged with labels indicating the contents of each package, and shall be delivered to Owner as directed.

4.2.7. Installation and Testing

The Contractor shall verify all dimensions in the field to ensure compliance of equipment dimensions with the drawings. Contractor shall notify the Engineer of significant deviations.

Installation of the equipment shall be in strict accordance with the contract documents and the manufacturer's instructions and shop drawings. Manufacturer shall supply equipment, including anchor bolts for the equipment. Contractors shall install the equipment in accordance with the manufacturer's recommendations.

Supplier shall use the services of a factory-trained Service Engineer to inspect the installation, observe start up, and provide operator training. The duration and frequency shall be such to confirm to the requirements set out in the Project General Specification with regards to the commissioning, optimisation and training of operators.

Equipment shall not be energized, or "bumped" to check the electrical connection for motor rotation without the Service Engineer present.

The Service Engineer shall make all necessary adjustments and settings to the controls.

The Service Engineer shall demonstrate proper and sequential operation of the equipment and demonstrate that the equipment achieved the requirements set out in the Specifications. The conveyer shall operate automatically based on the mechanical bar screen operation.

5. SCREENIGNS WASHER / COMPACTOR:

5.1. Specific requirements for the Washer / Compactor of the screenings

The specific requirements for the equipment shall be in accordance with the applicable Project Specification.

5.2. General requirements for the Washer / Compactor of the screenings

5.2.1. Scope of works

This part of the specifications covers the design, supply, delivery to site, installation and commissioning of the main and ancillary equipment required for the mechanical washer and screw type screening press for the washing, compaction and removal of moisture from the wet screenings received from the mechanical screens. The press equipment shall be designed to remove organic matter, by means of a mechanical washing action, and removing moisture from the screenings to produce a relatively clean product, which is suitable for disposal at a Municipal landfill.

The Contractor shall ensure that the equipment offered comply or exceed the requirements set out in the specification and that it is suitable for the application. The Contractor shall make allowance for a fully functional and integrated system, including all interconnecting systems that may be required. This specification shall be read in conjunction with the other Mechanical Standard Specifications whether there are specific references or not.

The press shall be of the progressive screw type, incorporating a gravity inlet hopper and a positive method of forcing all accumulating screening solids into a compression chamber for dewatering and compaction of wet screenings by the back pressure created by a venturi or propelling the product up a discharge chute.

Screenings shall derive mainly from domestic sewerage incorporating some industrial effluent shall contain items like paper, rages, plastic, faecal and other organic matter, etc. Other items may also include pieces of wood, metal cans, bottles etc.

The press shall be sized for the duties as specified in the specific requirements.

The wet screenings shall have an anticipated moisture content of between 90% and 95% and after dewatering and compacting, the discharge product shall have a moisture content of not more than 50% by weight.

Each Washer Compactor shall comprise of the following basic components:

a) A screw chamber and inlet hopper.
b) A wash chamber with mechanical agitators.
c) A compression chamber.
d) A conveying and compressing screw.
e) A discharge chute.
f) A venturi tube (If required).
g) A drainage trough.
h) A support frame.
i) A drive assembly, which will provide motive power to the screw
j) A set of wheels or a pivoting retraction device

Presses that requires manual cleaning will not be acceptable. The press construction shall be robust and simple. The design shall be such that it does not require regular maintenance and only press of proven ability shall be provided.

The press assembly shall be able to pivot away or be rolled out of position for easy accessibility during maintenance and repairs without the need to be disconnected from the electrical power supply. In the latter position it shall be possible to position a 6m³ skip under the conveyer discharge.

The Contractor shall ensure that the equipment offered comply or exceed the requirements set out in the specification and that it is suitable for the application. This specification shall be read in conjunction with the other Mechanical Standard Specifications whether there are specific references or not.

5.2.2. General Design Criteria

The screenings shall be deposited cleanly into a receiving hopper of the press from the feeding conveyer or directly form the applicable screen.

From the hopper the screenings shall gravitate into the wash chamber where screenings shall be agitated, and batch washed in a water bath. At the completion of the mechanical wash cycle, the water shall be drained from the chamber through discharge pipe and lead back to the main screen channel. Moisture and organic matter shall be flushed to one side of the through by the action of spray nozzles. The discharge shall be regulated by a motorized ball valve. The screening shall pass to the screw chamber of the press where initial dewatering shall take place as the horizontal screw slowly rotates within the chamber.

Narrow slots or small holes in the lower portion of the chamber shall allow the liquid to drain into the collection trough below, where it is then flushed by sprays and routed back to the main screen channel for disposal.

From the open screw chamber, the screenings shall be propelled by the horizontal screw into the compression chamber where the final dewatering takes place. Compression shall be achieved by forcing the screenings through a venturi or a pipe placed at the end of the compression chamber, pressure being built up by the venturi or by friction in the discharge pipe and chute. The displaced liquid and soft organic matter shall be forced through the small slots or holes in the compression chamber and collected in the trough.

From the compression chamber the dewatered screenings shall be forced into the discharge tube and chute where they are slowly conveyed to the discharge point. The chute shall be inclined to the required discharge height as required by the skip system.

The operation of the press shall be activated for a pre-set time to coincide with the operation of the screens and the feed conveyer. The timer for the press shall run for a longer duration (adjustable on site) than that of the screens and conveyer.

The equipment shall meet the following requirements:

a) It shall be designed to facilitate the efficient manufacture, inspection, transportation, installation, maintenance, cleaning and repairs.
b) It shall be designed with a minimum expected life of 20 years of safe and satisfactory operation under the conditions prevailing at the site
c) The design shall prevent undue stresses caused the expansion and contractions due to temperature changes and other local natural manmade conditions.
d) The design shall keep maintenance costs to a minimum
e) It shall be designed to comply completely with the legal requirements in respect of safety and the prevention of environmental pollution.
f) It shall satisfy any specific requirements contained in the relevant statutory codes and legislation.
g) The design shall allow for 24-hour operation, 365 days a year under the specific design conditions.
h) The equipment installed shall be complete and fully operational as per the requirements set out in the Scope of Works.
i) All material used for the equipment shall be suitable for the operation and environment and compatible with the intended use.
j) The design shall allow for suitable treatment to prevent corrosion and erosion of the materials and equipment.
k) After approval by the Engineer, at the time of award of the Contract, the information stated in the Data Sheets shall be fully complied with, notwithstanding the specified scope of the Contract.
l) All electrical equipment, forming part of the specified equipment, as described in the Electrical Specification, shall be sealed against penetration by hose cleaning operations as well as being accessible for repairs and maintenance.

5.2.3. Materials

The complete washer / compactor shall be manufactured from at least 316 Stainless Steel (or higher grades) shapes (rods, angles, and channels), pipes, and sheets. It shall be manufactured in a Stainless Steel only factory to prevent contamination of the Stainless Steel with rusty dust. 304 Stainless Steel and lower grade steels shall not be accepted.

All Stainless Steel components and structures shall be submersed in a chemical bath of nitric acid and hydrofluoric acid (pickling bath) to remove any residues that may be present on the material as a result of forming, manufacture, or handling. After removal from the pickling bath, the equipment must be washed with a high-pressure wash of cold water to remove any remaining surface debris and promote the formation of an oxidized passive layer which is critical to the long life of the Stainless Steel.

5.2.4. Construction

Screenings Washer Body:

The screenings washer body shall be fabricated from minimum 3 mm thick Stainless Steel plate. The opening or hatch through which the screen material is deposited shall be size to suit the processing requirments. A level mounting-flange shall be provided around the trough for the transitional hopper that directs the screenings into the trough of the screening's washer. The hopper shall be fabricated from minimum 3.0 mm thick Stainless Steel plate.

The screenings washer launder shall house the propeller type mixer, driven by an dedicated electrical motor, a water level pressure probe, one wash water connection and one overflow pipe connection. The connections shall be sized to suit the requirements of the specific model. The launder shall include an inspection hatch that enters from one side. The mixer unit shall have an intermediate flanged connection of net less than 20 mm thick Stainless Steel welded to the trough. The sealing arrangement shall ensure no water leaks through the shaft seal. The mixer shaft shall be oil lubricated and the oil filling shall be done from the outside of the launder and fitted with a level sight glass for inspections.

The screenings washer body shall house the shafted screw and shall include two flanged wash water drain connections on both sides of the drain pan, two flanged wash water connections on the drain pan, and shall include connections for the drain pan to collect the spent wash water.

The screenings washer body shall include 5mm diameter perforations spaced in a vertical alignment in the washing and compaction zones to drain the excess wash water and filtrate the water pressed from the screenings to the drain pan.

Shafted Screw:

The shafted screw shall convey the screenings from the trough area into the main washing zone and shall force the compacted screenings out of the discharge pipe. It shall be fabricated from Stainless Steel.

The screw flights in the compression area shall be at least 50% thicker than in the wash area.

A Stainless Steel brush with nylon bristles shall be attached to the shafted screw with Stainless Steel holder clips and fasteners for the full length of the perforated washing zone.

Plant Water Manifold:

The screenings washer shall be equipped with a manifold to provide plant water to the different washing inlet locations. It shall be provided with not less than three separate connections for injecting wash water into the screenings. The unit shall be designed to accept either potable water or non-potable water from a plant's final effluent.

Wash water consumption shall not be more than 40 m^3/h. Water pressure required at the connection to the unit shall not be less than 300 kPa for proper operation.

The main wash water supply line to the wash and press unit shall be provide with at least three 1" diameter normally closed solenoid valves with a maximum operating pressure of 8 bar. These solenoid valves shall be independently controlled by the PLC in the control panel. One solenoid valve shall supply wash water entering the launder; the second and the third solenoid valve shall supply wash water to the drain pan beneath the screenings washer body.

Drain Pan:

The drain pan shall collect the spent wash water and filtrate water squeezed from the screenings. It shall be fabricated from Stainless Steel plate and it shall be completely welded to the screenings washer body with inspections hatches / covers with clasps for easy removal.

It shall include two 1" threaded inlet connections for wash water from the manifold to flush the trough for cleaning purposes. A flanged drain connection on each side of the drain pan shall be provided to discharge the drained water into the channel on the drown stream side of the screen. An electrically actuated flanged ball / butterfly valve shall be fitted on the one side of the pan drain flanges and it shall be controlled by the PLC.

Discharge Pipe:

The discharge pipe shall be made of stainless steel and shall be connected to the screenings washer body by a flanged connection. The diameter of the straight section of the discharge pipe shall increase in size to ease the transport of the screenings. The diameter of the discharge pipe straight section shall over the length of the chute. The discharge bend fittings on the unit's discharge pipe shall have a radius that is three times larger than the pipe diameter.

The length of pipe shall be sufficient to discharge drained screenings into the skip system adjacent to the screenings washer.

Gear Motor Drive Mechanism:

The drive units shall be an electrical gear motor rated for continuous duty. The drive motors for the screw and mixing impellor shall be sized with a service factor of at least 1.5 over the maximum power and torque requirements (whichever is higher). It shall be totally enclosed fan cooled (TEFC) units designed for application in a Class 1, Division 2 areas. The motor shall be a constant speed unit rotating at a maximum of 1500 rpm for the screw and 1000 rpm for the mixing impellor, and shall be powered by 380/400 VAC, 50 Hz, and 3-phase power.

The drive unit shall be direct coupled to the screw and impellor drive shafts through the gearbox. The gearbox housing shall be constructed from ASTM A-48, Class 30 cast iron. The shaft mounted geared motor shall have a torque support bolted to the body of the screenings washer for the screw drive. Units without a torque support shall not be allowed

Nominal and minimum motor efficiencies shall comply with NEMA MG 1. The gearbox shall be designed for AGMA Class II, 24-hour duty.

Over-torque protection:

The rocker arm assembly shall consist of a drive unit mounted to a Stainless Steel arm. The Stainless Steel arm will be held in place by a flanged roller bearing connected to the drive shaft and two heavy duty tension springs. The rocker arm shall be maintained in the standard operating position by the two tension springs. If the spiral / screw jam, the force will cause the rocker arm to rotate around the drive shaft, compressing one of the tension springs. This motion shall be limited by a rocker guide. When the rocker arm rotates out of the normal operating position a proximity sensor will send a signal to the PLC causing the motor to stop, with the associated alarm triggered.

Controls and instrumentation:

The equipment shall include all limit switches and protection instrumentation, seen necessary by the Manufacturer to ensure the validity of the warrantee, to prevent damage to the equipment in overloading, etc conditions. The equipment shall have the functionality to operate in forward / reverse to try and dislodge blockages.

5.2.5. Walkways, Platforms and Staircases

Walkways, platforms and staircases shall be provided for all equipment that require operators to work (for operating or maintenance purposes) at heights higher than 1.2 m above the NGL. These platforms, walkways, staircases and their respective support structures shall be constructed from GRP or epoxy coated hot dipped galvanised.

All walkways, platforms and staircases shall be equipped with suitable hand railings and all equipment and structures shall be in accordance with the applicable Standards and the Health and Safety Act.

5.2.6. Spare Parts

The following Spare Parts shall be included and supplied together with the equipment:

- One set of brushes
- One set of wear bars
- Any other parts deemed critical by the manufacturer.
- Two sets of drive-end and non-drive end bearings

Spare parts shall be packaged with labels indicating the contents of each package, and shall be delivered to Owner as directed.

5.2.7. Installation and Testing

The Contractor shall verify all dimensions in the field to ensure compliance of equipment dimensions with the drawings. Contractor shall notify the Engineer of significant deviations.

Installation of the equipment shall be in strict accordance with the contract documents and the manufacturer's instructions and shop drawings. Manufacturer shall supply equipment, including anchor bolts for the equipment. Contractors shall install the equipment in accordance with the manufacturer's recommendations.

Supplier shall use the services of a factory-trained Service Engineer to inspect the installation, observe start up, and provide operator training. The duration and frequency

shall be such to confirm to the requirements set out in the Project General Specification with regards to the commissioning, optimisation and training of operators.

Equipment shall not be energized, or “bumped” to check the electrical connection for motor rotation without the Service Engineer present.

The Service Engineer shall make all necessary adjustments and settings to the controls.

The Service Engineer shall demonstrate proper and sequential operation of the equipment and demonstrate that the equipment achieved the requirements set out in the Specifications. The washer / compactor shall operate automatically based on the mechanical bar screen(s) and conveyer operation.

6. VORTEX GRIT REMOVER:

6.1. Specific requirements for the Vortex Grit Remover

The specific requirements for the equipment shall be in accordance with the applicable Project Specification.

6.2. General requirements for the Vortex Grit Remover

6.2.1. Scope of works

This part of the specifications covers the design, supply, delivery to site, installation and commissioning of the main and ancillary equipment required for the rotating paddle system the promotes the settling of grit from the screened sewage stream and removal pumping equipment for extraction of the settled grid from the cylindrical chambers / hoppers.

The primary means of grit removal shall comprise of a circular tank with a sloping floor towards the centre and a grit collecting hopper. The contents of the tanks shall be kept in motion by means of a tangential inlet to the tank and by means of a rotating paddle system when the minimum inlet flow is inadequate to maintain the optimum velocity to keep the organic matter present in suspension. The construction of the concrete tank and hopper falls outside the scope of the mechanical and electrical project.

The Contractor shall supply and install a complete, functional paddle system, designed to operate in raw, screened sewage, in the constructed concrete tank / hopper. This will include a grit extraction pumping system.

Water pipes shall be routed to the bottom of the grit sump for purposes of fluidising and washing the accumulated grit. The water supply for this process shall either be provided from jockey pumps or Municipal supply. Refer the project Specific Requirements for the project specific fluidisation requirements.

The settled grit shall be removed as a slurry from the chamber by means of a pumping system. The grit slurry shall be pumped to the grit washer / classifier.

The discharged product from the grit chambers shall have a dry organic content of not more than 10% by weight.

The Contractor shall ensure that the equipment offered comply or exceed the requirements set out in the specification and that it is suitable for the application. The Contractor shall make allowance for a fully functional and integrated system, including all interconnecting systems that may be required. This specification shall be read in

conjunction with the other Mechanical Standard Specifications whether there are specific references or not.

Grit shall derive mainly from domestic sewerage incorporating some industrial effluent, with some wash off from roads and blown sand.

The paddle system and extraction pumps shall be sized for the duties as specified in the specific requirements. All dimensions must be confirmed on site prior to procurement of equipment.

Each Grit removal system shall comprise of the following basic components:

a) Electrically driven paddle system, including mechanical drives, gearbox, supporting structure, etc.
b) A pumping system, including pipework and valves.
c) A complete installation of all necessary piping and valves for the agitation / fluidising water.
d) Transfer pipework to the grit washer / clarifier.

Equipment requiring manual clearing of grit from the tank hopper will not be acceptable. The screen construction shall be robust and simple. The design shall be such that it does not require regular maintenance and only screen of proven ability shall be provided.

6.2.2. General Design Criteria

The vortex degritters shall operate continuously, and will be designed such that the tangential inlet creates a rotary motion to the tank contents of such a velocity that will keep the organic particles in suspension while settling of the grit particles are achieved. When the difference between the PWWF and the ADWF is generally more than 2 : 1, the ideal tank velocity range shall be maintained by a series of rotating paddles.

The settled grit particles shall be washed into the central collection hopper where it shall be temporarily stored prior to washing and removal by means of pumps.

The equipment shall meet the following requirements:

a) It shall be designed to facilitate the efficient manufacture, inspection, transportation, installation, maintenance, cleaning and repairs.
b) It shall be designed with a minimum expected life of 20 years of safe and satisfactory operation under the conditions prevailing at the site
c) The design shall prevent undue stresses caused the expansion and contractions due to temperature changes and other local natural manmade conditions.
d) The design shall keep maintenance costs to a minimum
e) It shall be designed to comply completely with the legal requirements in respect of safety and the prevention of environmental pollution.
f) It shall satisfy any specific requirements contained in the relevant statutory codes and legislation.
g) The design shall allow for 24-hour operation, 365 days a year under the specific design conditions.
h) The equipment installed shall be complete and fully operational as per the requirements set out in the Scope of Works.
i) All material used for the equipment shall be suitable for the operation and environment and compatible with the intended use.

j) The design shall allow for suitable treatment to prevent corrosion and erosion of the materials and equipment.
k) After approval by the Engineer, at the time of award of the Contract, the information stated in the Data Sheets shall be fully complied with, notwithstanding the specified scope of the Contract.
l) All electrical equipment, forming part of the specified equipment, as described in the Electrical Specification, shall be sealed against penetration by hose cleaning operations as well as being accessible for repairs and maintenance.

6.2.3. Materials

The complete paddle and drive system (paddle drive tube, paddle arms and paddles, pipework, submerged steelwork and brackets, pipework, fasteners etc) shall be manufactured from at least 316 Stainless Steel shapes (rods, angles, and channels), pipes, and sheets. It shall be manufactured in a Stainless Steel only factory to prevent contamination of the Stainless Steel with rusty dust. The paddle drive housing may be manufactured from hot dipped galvanised mild steel. All pipework, including the extraction from the hopper and delivery pipework to the grit washer / clarifier shall be manufactured from 316 Stainless Steel.

The material for the pump sets shall be suited for highly abrasive environments and the materials (unless otherwise indicated in the Project Specification) shall be hardened iron used for the impeller, wear plate, seal plate and volute. The material hardness shall be a minimum of 400 Bhn.

The bridge / platform shall be constructed from standard mild steel profiles, and shall be heavy duty hot-dipped galvanised and epoxy coated with a minimum coating thickness of 400 µm. The grid flooring shall be Glass Reinforced Polymer, and the hand railings shall be hot-dipped galvanised mild steel. All fasteners shall be Stainless Steel (galvanically isolated from the components to prevent galvanic corrosion).

All Stainless Steel components and structures shall be submersed in a chemical bath of nitric acid and hydrofluoric acid (pickling bath) to remove any residues that may be present on the material as a result of forming, manufacture, or handling. After removal from the pickling bath, the equipment must be washed with a high-pressure wash of cold water to remove any remaining surface debris and promote the formation of an oxidized passive layer which is critical to the long life of the Stainless Steel.

6.2.4. Construction

<u>Design and operation:</u>

The optimum velocity within the body of the tank shall be between 0.3 to 0.4 m/s, equating to a tangential inlet velocity upwards of 0.6 m/s, to remove grit particles with sizes larger than 0.2 mm.

Certain organic matter of similar size the grit and may be settled together to the bottom of the hopper. Prior to extracting the settled grit from the bottom of the hopper, it shall be fluidised by a counter flow of water under pressure. The fluidisation and wash water shall be controlled on a timer basis in conjunction with the washing and extraction operation.

Where available, the wash – and fluidisation water shall be supplied by means of self-priming pumps pumping final effluent or extracting sewage down-stream from the degritters from the common channel, or use of municipal water if none of the above is available or viable.

The source of the wash – and fluidisation water shall be indicated in the Project Specification. A diaphragm valve shall automatically open to supply fluidising and wash water to the selected vortex degritters tank, prior to one of the extraction pumps starting. The washing action shall be timer based controlled in conjunction with the degritting system.

The hydraulic flow and the expected variation in flow, the volume of grit, including the nature of the raw sewage to be degritted are described in the Project Specification.

Paddle Mechanism:

Where required as indicated in the Project Specification, a constant velocity condition shall be achieved by means of slow rotating paddle system, operating in the same direction of the sewage flow.

The drive tube shall allow for sufficient internal diameter to allow for the grit extraction suction pipework, or delivery pipework depending on the type of pump used, to be route through the centre of the drive tube. The drive tube shall be directly connected to the reduction gearbox.

Four paddles shall be installed, fixed onto the drive tube. The paddles shall be adjustable in all directions and locked into place by means of counter bolts. The complete unit shall be manufactured from Stainless Steel and designed to operate in raw screened sewage.

Over-torque protection:

The rocker arm assembly shall consist of a drive unit mounted to a Stainless Steel arm. The Stainless Steel arm will be held in place by a flanged roller bearing connected to the drive shaft and two heavy duty tension springs. The rocker arm shall be maintained in the standard operating position by the two tension springs. If the spiral / screw jam, the force will cause the rocker arm to rotate around the drive shaft, compressing one of the tension springs. This motion shall be limited by a rocker guide. When the rocker arm rotates out of the normal operating position a proximity sensor will send a signal to the PLC causing the motor to stop, with the associated alarm triggered.

Paddle Drive Unit:

The paddle drive unit shall be driven by an electrical motor connected to reduction gearbox. A suitable slew ring gear arrangement shall be provided to drive the centre tube. No water submerged gears, bearings, drive wheels or guides will be accepted. A method of easily varying the output speed shall be provided.

The geared slewing ring bearings shall have a safety factor of at least 5 : 1 based on the permissible axial loading and safety factor of at least 5 : 1 based on the permissible gear loading at the driving spur - or slew gear interface. The geared slewing ring shall be oil bath lubricated, with facilities to check, maintain and drain the oil, on tanks in excess of 5.0 m in diameter. The oil bath shall be contained in a sealed and weatherproof enclosure.

Grease lubricated slewing rings will only be accepted on tanks up to and including 5.0m in diameter.

The drive motor, gearbox and bearings shall be of the totally enclosed type suitable for regular hosing down operations.

Speed reducers shall be of the helical of bevel gear type geared motor, suitable for continuous operation in outdoor conditions and subject to torrential downpours and direct sunlight with temperature ranging between -5°C and 40°C. It must be able to operate in both directions of rotation.

The gearbox shall be rated with a service factor of at least 3 : 1 based on the maximum absorbed power and in accordance with the method laid down by the I.S.O. Gearbox casings shall be constructed of high-grade grey cast iron.

All gearbox bearings shall be rated with an L20 life of at least 100 000 hours. Bearings shall be of the heavy-duty deep groove ball, cylindrical or spherical roller type, and oil bath splash lubricated.

All gearbox shafts shall be manufactured from high carbon steel suitably precision machined and heat-treated. Gears shall be of the helical or bevel type manufactured from the highest quality alloy steel, gas carburized and accurately ground.

The gearbox shaft seals shall be of the lip type. Lubrication shall be by oil bath and splash to all bearings and gears. An easily accessible oil level plug shall be incorporated to measure the oil level in the gearbox. An oil drain plug shall be fitted in an easily accessible attitude for draining of the oil.

The drive to the gearbox may be by a direct coupled motor as in the 'geared motor' type. The gearbox shall incorporate a moisture proof breather plug.

Drive Motor:

The motor shall be selected for continuous operation in outdoor conditions and subject to torrential downpours and direct sunlight with temperatures ranging from -5°C to 40°C and humidity up to 95%. It shall be rated for 400V, 50hz electrical supply. It shall be able to operate in both directions of rotation and shall conform to the relevant Standard Specification.

The motor shall be rated with at least a 2 : 1 service factor on the absorbed power at the maximum speed.

Floor plate:

Floor plates shall be supplied and installed to cover the opening(s) to the grit chamber. The plates shall be suited to the specific paddle and pumping system, and it shall be constructed in two sections with lifting lugs to easy handling. The plate thickness shall not be thinner than 10mm and shall be from similar material than that of the paddle drive.

Bridge or Platform:

Where the Project Specification indicates, specifically designed bridge / platform shall be designed to span over the sump to house the paddle drive unit and possibly the extraction pump.

The platform shall be constructed using standard steel profiles, sized to allow operators to walk past equipment with a minimum of 800mm wide free space. Open grid flooring shall be fastened to the bridge structure and hand-railings shall be installed on both sides of the bridge / platform.

The bridge shall be designed to handle the static and dynamic forces caused by the equipment installed on it.

Provision shall be made for cable ducts to route power and control cables to the respective equipment.

Grit Extraction Pump:

Extraction pump sets shall be supplied and installed for the extraction of the settled grit from the hoppers. Each hopper will have a dedicated extraction pump. The extraction pumps shall pump via a dedicated delivery pipe to the grit washer / clarifier.

The type of pump set shall be described in the Project Specification.

Pipework, Valves and ancillaries:

The Contractor shall allow for all pipework required for the extraction of grit from the hoppers and delivering it to the grit washer / clarifier as indicated on the drawings. All pipework shall be flanged, and it shall be manufactured from at least 316 grade Stainless Steel. Pipework shall be in accordance with the applicable Standard Specification and shall have a minimum diameter of DN100. It shall be sized so that the flow velocity does not exceed 1.8 m/s.

Each pump shall be equipped with a suitably sized and pressure rated flanged gate valve and flanged, single door swing type non-return valve on the delivery. The non-return valves shall have a lever and counterweight and shall be suitable to have a limit switch installed. The gate valves shall be of the rising spindle type, equipped with a hand wheel. All valves shall be in accordance with the applicable Standard Specifications and suitable for abrasive slurries.

All pipework and valves shall be properly supported and anchored by means of suitable supports / anchors designed to handle both static and dynamic forces. All supports and anchors shall be constructed from hot dipped galvanised mild steel. Steps shall be taken to prevent galvanic corrosion between the pipework and supports.

All fasteners shall be Stainless Steel.

Wash / Fluidising Water Piping and Valves:

The wash water piping shall be of HDPE PE100 PN10 type where it is installed underground and flanged, medium wall Stainless Steel type within the sump, utilising flanged connections and valves etc.

The piping shall be at least DN80 and DN100 for degritting tanks up to 5.0 m and 8.0 m in diameter respectively. The piping shall be sized with a pipe friction of less than 2,0 m per 100 m at the design duty.

An automatically operated diaphragm isolating valve and a manually operated flanged gate type isolating valve shall be provided at each grit chamber / hopper. The automatically operated valve shall be actuated by high pressure compressed air, when available. Otherwise, the valve shall be electrically actuated / electrical solenoid, depending on the size.

All piping shall be provided between the wash water supply / equipment and the grit camber / hopper tank equipment.

General:

When a paddle drive system is to be employed, the stationary suction pipe shall pass vertically through the rotating paddle drive tube. The wash water pipe shall run down the side of the outer grit chamber / hopper tank profile, running in a channel type rebate cast into the tank wall in the circulation area where exposed pipes would hinder the necessary rotational velocity in the tank.

When a paddle drive system is not to be employed, the required pipes shall run vertically down from the support bridge in a cluster. The cluster shall be possible to remove as one unit and shall be positioned at the center of each vortex chamber / hopper. This shall be achieved by disconnecting the relevant flanges and unions at bridge level and by disconnecting the cluster from the bridge.

The design of the brackets for fixing the cluster to the bridge shall be such that removal is easy by removing accessible bolts and that later relocation in the exact same position is ensured.

All valves shall be positioned for safe and easy access for both operation and maintenance purposes and close to walkways and bridges etc. Valves shall be easily removable from pipelines by unbolting flanged pipe sections or unscrewing unions on small bore pipes.

Pipes conveying grit or sewage shall incorporate nozzles with blank flanges to allow easy cleaning. Walkways and bridges shall not be obstructed with pipelines or cables.

Controls and instrumentation:

The equipment shall include all limit switches and protection instrumentation, seen necessary by the Manufacturer to ensure the validity of the warrantee, to prevent damage to the equipment in overloading, etc conditions. The equipment shall have the functionality to operate in forward / reverse to try and dislodge blockages.

6.2.5. Walkways, Platforms and Staircases

Walkways, platforms and staircases shall be provided for all equipment that require operators to work (for operating or maintenance purposes) at heights higher than 1.2 m above the NGL. These platforms, walkways, staircases and their respective support structures shall be constructed from GRP or epoxy coated hot dipped galvanised.

All walkways, platforms and staircases shall be equipped with suitable hand railings and all equipment and structures shall be in accordance with the applicable Standards and the Health and Safety Act.

6.2.6. Spare Parts

The following Spare Parts shall be included and supplied together with the equipment:

- A set of special tools (if required)
- Any other parts deemed critical by the manufacturer.

Spare parts shall be packaged with labels indicating the contents of each package, and shall be delivered to Owner as directed.

6.2.7. Installation and Testing

The Contractor shall verify all dimensions in the field to ensure compliance of equipment dimensions with the drawings. Contractor shall notify the Engineer of significant deviations.

Installation of the equipment shall be in strict accordance with the contract documents and the manufacturer's instructions and shop drawings. Manufacturer shall supply equipment, including anchor bolts for the equipment. Contractors shall install the equipment in accordance with the manufacturer's recommendations.

Supplier shall use the services of a factory-trained Service Engineer to inspect the installation, observe start up, and provide operator training. The duration and frequency shall be such to confirm to the requirements set out in the Project General Specification with regards to the commissioning, optimisation and training of operators.

Equipment shall not be energized, or "bumped" to check the electrical connection for motor rotation without the Service Engineer present.

The Service Engineer shall make all necessary adjustments and settings to the controls.

The Service Engineer shall demonstrate proper and sequential operation of the equipment and demonstrate that the equipment achieved the requirements set out in the Specifications. The paddle system and grit removal pumps shall operate automatically based on a timer basis.

7. GRIT CLASSIFIER:

7.1. Specific requirements for the Grit Classifier

The specific requirements for the equipment shall be in accordance with the applicable Project Specification.

7.2. General requirements for the Grit Classifier

7.2.1. Scope of works

This part of the specifications covers the design, supply, delivery to site, installation and commissioning of the main and ancillary equipment required for the vortex type grit washer / classifier with auger for the dewatering and removal of organic matter from the grit extracted from sewage.

The equipment shall be designed to remove organic matter and moisture from the grit to produce a relatively clean product, which is easy to handle and dispose of by burial.

It shall be a complete, free standing unit. It shall comprise of an Archimedean screw contained inside a include trough and a lower hopper section. The machine shall be contained in a robust steel fabricated enclosure suitably for mounting on a flat concrete slab.

Each Grit removal system shall comprise of the following basic components:

a) A grit washer tank / hopper and screw trough
b) An inlet pipe nozzle
c) A stilling baffle
d) An overflow weir
e) An outlet pipe connection
f) A discharge chute, including inclined elevating screw
g) A cover with air-vents
h) A drive assembly, which will drive the screw
i) A stirring device with gear motor (if required)
j) Electrical control and instrumentation

Grit containing water from the grit chamber shall be introduced through the vortex chamber, creating a rotating flow pattern, and through the inlet flow director into the grit washer tank. The water flow is directed by the inlet flow director from an axial flow to a radial flow towards the overflow weir that is provided at the circumference of the grit washer tank. This change of the flow direction leads to effective settling of the grit towards the bottom of the grit washer tank.

A fluidised grit bed shall be maintained in the bottom portion of the grit washer tank, where the grit is intensively washed, and organic material is effectively removed from the mineral particles. Wash water shall be introduced into the bottom of the grit washer and dispersed through a perforated diaphragm to generate the fluidised bed in the bottom portion of the grit washer. This wash water shall also effectively flush the organic components out of the fluidized bed towards the overflow weir.

Effective stratification of particles, depending on their specific density, but not depending on their particle size and weight, shall be achieved within the conical portion of the grit washer tank. A connection with an automatically operated ball valve shall be provided for removal organic material out of the conical section of the tank. The stirrer shall move organic matter toward this connection.

Washed grit shall be removed through a central tube at the bottom of the grit washer. The stirrer shall move washed grit to this tube. The grit to be removed shall drop into an inclined auger. This screw shall dewater and convey the grit above the level of the overflow weir. The washed and dewatered grit is discharged at the upper end of the screw.

It shall be possible to position a standard 6 m^3 waste skip on a trolley system under the classifier discharge, and there shall be a clearance of at least 2 m under the bottom of the chute.

Equipment requiring manual clearing of grit from the tank hopper will not be acceptable. The screen construction shall be robust and simple and the design shall be such that it

does not require regular maintenance and only equipment of proven ability shall be provided.

The Contractor shall ensure that the equipment offered comply or exceed the requirements set out in the specification and that it is suitable for the application. The Contractor shall make allowance for a fully functional and integrated system, including all interconnecting systems that may be required. This specification shall be read in conjunction with the other Mechanical Standard Specifications whether there are specific references or not.

7.2.2. General Design Criteria

The equipment shall meet the following requirements:

a) It shall be designed to facilitate the efficient manufacture, inspection, transportation, installation, maintenance, cleaning and repairs.
b) It shall be designed with a minimum expected life of 20 years of safe and satisfactory operation under the conditions prevailing at the site
c) The design shall prevent undue stresses caused the expansion and contractions due to temperature changes and other local natural manmade conditions.
d) The design shall keep maintenance costs to a minimum
e) It shall be designed to comply completely with the legal requirements in respect of safety and the prevention of environmental pollution.
f) It shall satisfy any specific requirements contained in the relevant statutory codes and legislation.
g) The design shall allow for 24-hour operation, 365 days a year under the specific design conditions.
h) The equipment installed shall be complete and fully operational as per the requirements set out in the Scope of Works.
i) All material used for the equipment shall be suitable for the operation and environment and compatible with the intended use.
j) The design shall allow for suitable treatment to prevent corrosion and erosion of the materials and equipment.
k) After approval by the Engineer, at the time of award of the Contract, the information stated in the Data Sheets shall be fully complied with, notwithstanding the specified scope of the Contract.
l) All electrical equipment, forming part of the specified equipment, as described in the Electrical Specification, shall be sealed against penetration by hose cleaning operations as well as being accessible for repairs and maintenance.

The pumped entry into the inlet chamber of the hopper shall wash the grit, causing the organic matter to separate from the grit particles, prior to settling. The large grits shall settle into the intermediate portion of the screw length just prior to elevating above the water surface. After washing, the flow shall enter the quiescent zone, where smaller grits shall settle, and the organic fraction shall be discharged over the weir. The heavier organic fraction, which has settled initially with the grit, shall be slowly released by the rotating action of the screw.

7.2.3. Materials

The complete grit classifier system (washer tank including internal, stirrer, screw, conveyer chute, fasteners, etc) shall be manufactured from at least 316 Stainless Steel

shapes (rods, angles, and channels), pipes, and sheets. It shall be manufactured in a Stainless Steel only factory to prevent contamination of the Stainless Steel with rusty dust. The paddle drive housing may be manufactured from hot dipped galvanised mild steel.

The material for the pump sets shall be according to the applicable Standard Specification.

All Stainless Steel components and structures shall be submersed in a chemical bath of nitric acid and hydrofluoric acid (pickling bath) to remove any residues that may be present on the material as a result of forming, manufacture, or handling. After removal from the pickling bath, the equipment must be washed with a high-pressure wash of cold water to remove any remaining surface debris and promote the formation of an oxidized passive layer which is critical to the long life of the Stainless Steel.

7.2.4. Construction

Trough and Washer Hopper:

The inclined trough and hopper shall be a specially shaped fabricated container, which shall house the screw, the outlet weir and baffle, which separates the turbulent zone from the quiescent zone. The hopper shall have side inclined at more than 60° to the horizontal and it shall be complete with feet, legs and pipe connections for mounting onto a level concrete floor or plinth. A cover shall be incorporated over the wet area to contain any splashing and odours.

Screw and Shaft:

A centreless screw and shaft assembly shall mount within the length of the inclined trough and hopper. It shall be inclined at ±30° and mounted at each end between special bearings which take all axial and radial static and dynamic forces.

The screw flights shall be welded to a central tubular, heavy wall shaft to which shall be fixed the upper and lower ends. It shall be welded securely to the central tube to form a continuous helix. No intermediate bearings shall be employed.

A specially selected clearance by the manufacturer shall be allowed between the screw flights and the inner wall of the trough to ensure adequate grit movement and still allow drainage as the grit is elevated up the trough.

The single start screw pitch shall be approximately 50% of the screw outside diameter, and the blade thickness not less than 2% of the screw outside diameter. The hollow centre shaft shall be not less than 35% of the screw outside diameter, with a wall thickness of not less than 5mm.

The top - and bottom shafts ends shall be machined truly concentric with the screw assembly.

A centreless screw, without a centre tube and bottom bearing, and running on liners within the trough, will not be permitted.

The drive shaft shall pass through the drive end plate, to which is bolted a self-aligning ball bearing in a flanged housing with grease seals.

Shaft Bearings:

The bottom bearing shall comprise of a solid Stainless Steel stub shaft fixed to the inside of the trough at the lower end. A Vesconite bush (or similar and equally approved) fitted within the end of the tubular screw shaft shall rotate on the stub shaft. All surfaces shall be accurately machined to be truly concentric and give the correct running clearance. In this manner no leaks shall occur to the outside of the trough and hopper.

The bottom bearing assembly shall be subject to radial loads only. The bush which may eventually be subject to some wear shall rotate on the shaft and therefore any such wear will be equal around the inside surface of the bush and not in one place as with a stationary bush.

The bottom bearing assembly shall be grease lubricated from the outside of the housing by a continuous grease supply from an automatic motorised lubricator.

It shall be possible to remove the bottom bearing assembly from the trough end for repair or replacement without removing the screw from the classifier.

The top bearing shall be of the self-aligning ball bearing type in a flanged cast iron housing. This bearing shall be well above water level and situated on the top end plate outside the trough. Grease seals shall be fitted to the bearing, and the bearing shall incorporate a grease nipple for periodic manual lubrication.

The top bearing shall be subject to both axial and radial loading. It shall be designed for an L10 life of at least 100 000 hours.

Outlet Weir:

An adjustable outlet weir plate shall be incorporated within the hopper. Water containing the organic matter will pass over this weir prior to leaving the classifier and returning to the main sewage flow.

The weir shall be sized for a maximum flow of not more than 20 l/s per m width.

Over-torque protection:

The rocker arm assembly shall consist of a drive unit mounted to a Stainless Steel arm. The Stainless Steel arm will be held in place by a flanged roller bearing connected to the drive shaft and two heavy duty tension springs. The rocker arm shall be maintained in the standard operating position by the two tension springs. If the spiral / screw jam, the force will cause the rocker arm to rotate around the drive shaft, compressing one of the tension springs. This motion shall be limited by a rocker guide. When the rocker arm rotates out of the normal operating position a proximity sensor will send a signal to the PLC causing the motor to stop, with the associated alarm triggered.

Screw Drive Unit:

The screw shaft drive unit shall comprise of a hollow shaft geared motor which mounts directly on the screw top shaft. It shall be mounted outside of the trough and shall be prevented from rotating by a torque arm and bracket fixed to the trough end.

The drive motor, gearbox and bearings shall be of the totally enclosed type suitable for regular hosing down operations.

Speed reducers shall be of the helical of bevel gear type geared motor, suitable for continuous operation in outdoor conditions and subject to torrential downpours and direct sunlight with temperature ranging between -5°C and 40°C. It must be able to operate in both directions of rotation.

The gearbox shall be rated with a service factor of at least 3 : 1 based on the maximum absorbed power and in accordance with the method laid down by the I.S.O. Gearbox casings shall be constructed of high-grade grey cast iron.

All gearbox bearings shall be rated with an L10 life of at least 100 000 hours. Bearings shall be of the heavy-duty deep groove ball, cylindrical or spherical roller type, and oil bath splash lubricated.

All gearbox shafts shall be manufactured from high carbon steel suitably precision machined and heat-treated. Gears shall be of the helical or bevel type manufactured from the highest quality alloy steel, gas carburized and accurately ground.

The gearbox shaft seals shall be of the lip type. Lubrication shall be by oil bath and splash to all bearings and gears. An easily accessible oil level plug shall be incorporated to measure the oil level in the gearbox. An oil drain plug shall be fitted in an easily accessible attitude for draining of the oil.

The drive to the gearbox may be by a direct coupled motor as in the 'geared motor' type. The gearbox shall incorporate a moisture proof breather plug.

Drive Motor:

The motor shall be selected for continuous operation in outdoor conditions and subject to torrential downpours and direct sunlight with temperatures ranging from -5°C to 40°C and humidity up to 95%. It shall be rated for 400V, 50hz electrical supply. It shall be able to operate in both directions of rotation and shall conform to the relevant Standard Specification.

The motor shall be rated with at least a 2 : 1 service factor on the absorbed power at the maximum speed.

Piping and Valves:

All piping shall be of flanged, Stainless Steel pipework in accordance with the specific Standard Specification, utilising flanged connections and valves etc.

All pipework and isolating valves required to transfer the wastewater containing organic matter back to the main screened sewage channel shall be allowed for. The configuration of the pipework will be such to ensure all water are able to feed back into the channel under gravity alone, and it shall not be pumped.

Each pump shall be equipped with a suitably sized and pressure rated flanged gate valve and flanged single door swing type non-return valve on the delivery. All valves shall be in accordance with the applicable Standard Specifications.

All pipework and valves shall be properly supported and anchored by means of suitable supports / anchors designed to handle both static and dynamic forces. All supports and anchors shall be constructed from hot dipped galvanised mild steel. Steps shall be taken to prevent galvanic corrosion between the pipework and supports.

All fasteners shall be Stainless Steel.

Controls and instrumentation:

The equipment shall include all limit switches and protection instrumentation, seen necessary by the Manufacturer to ensure the validity of the warrantee, to prevent damage to the equipment in overloading, etc conditions. The equipment shall have the functionality to operate in forward / reverse to try and dislodge blockages.

7.2.5. Walkways, Platforms and Staircases

Walkways, platforms and staircases shall be provided for all equipment that require operators to work (for operating or maintenance purposes) at heights higher than 1.2 m above the NGL. These platforms, walkways, staircases and their respective support structures shall be constructed from GRP or epoxy coated hot dipped galvanised.

All walkways, platforms and staircases shall be equipped with suitable hand railings and all equipment and structures shall be in accordance with the applicable Standards and the Health and Safety Act.

7.2.6. Spare Parts

The following Spare Parts shall be included and supplied together with the equipment:

- A set of special tools (if required)
- Any other parts deemed critical by the manufacturer.

Spare parts shall be packaged with labels indicating the contents of each package, and shall be delivered to Owner as directed.

7.2.7. Installation and Testing

The Contractor shall verify all dimensions in the field to ensure compliance of equipment dimensions with the drawings. Contractor shall notify the Engineer of significant deviations.

Installation of the equipment shall be in strict accordance with the contract documents and the manufacturer's instructions and shop drawings. Manufacturer shall supply equipment, including anchor bolts for the equipment. Contractors shall install the equipment in accordance with the manufacturer's recommendations.

Supplier shall use the services of a factory-trained Service Engineer to inspect the installation, observe start up, and provide operator training. The duration and frequency shall be such to confirm to the requirements set out in the Project General Specification with regards to the commissioning, optimisation and training of operators.

Equipment shall not be energized, or "bumped" to check the electrical connection for motor rotation without the Service Engineer present.

The Service Engineer shall make all necessary adjustments and settings to the controls.

The Service Engineer shall demonstrate proper and sequential operation of the grit classifier and demonstrate that the equipment achieved the requirements set out in the Specifications. It shall operate automatically based on a batch system.

8. SKIP DOLLY SYSTEM

8.1. Specific requirements for the Skip Dolly System

The specific requirements for the equipment shall be in accordance with the applicable Project Specification.

8.2. General requirements for the Skip Dolly System

8.2.1. Scope of works

The specification covers the design, supply, delivery to site, installation and commissioning of dolly system to house and move waste skips.

It shall be possible to position either one (1) or two (2) standard waste skips (the size and number of skips shall be as per the Project Specification) on the trolley system and the rail system design shall enable the skips to be moved from the location where screenings are discharged into the skip, to a location where a truck can remove the skip(s) from the trolley for transport.

The construction shall be robust and simple and the design shall be such that it does not require regular maintenance and only equipment of proven ability shall be provided.

Each skip dolly system shall comprise of the following basic components:

a) A pair of rails, to suit the dolly
b) Electrically driven Skip dolly(s)
c) Electrical lead to dolly(s)
d) Electrical control and instrumentation

The Contractor shall ensure that the equipment offered comply or exceed the requirements set out in the specification and that it is suitable for the application. The Contractor shall make allowance for a fully functional and integrated system, including all interconnecting systems that may be required. This specification shall be read in conjunction with the other Mechanical Standard Specifications whether there are specific references or not.

8.2.2. General Design Criteria

The equipment shall meet the following requirements:

a) It shall be designed to facilitate the efficient manufacture, inspection, transportation, installation, maintenance, cleaning and repairs.
b) It shall be designed with a minimum expected life of 20 years of safe and satisfactory operation under the conditions prevailing at the site
c) The design shall prevent undue stresses caused the expansion and contractions due to temperature changes and other local natural manmade conditions.
d) The design shall keep maintenance costs to a minimum
e) It shall be designed to comply completely with the legal requirements in respect of safety and the prevention of environmental pollution.
f) It shall satisfy any specific requirements contained in the relevant statutory codes and legislation.
g) The design shall allow for 24-hour operation, 365 days a year under the specific design conditions.

h) The equipment installed shall be complete and fully operational as per the requirements set out in the Scope of Works.
i) All material used for the equipment shall be suitable for the operation and environment and compatible with the intended use.
j) The design shall allow for suitable treatment to prevent corrosion and erosion of the materials and equipment.
k) After approval by the Engineer, at the time of award of the Contract, the information stated in the Data Sheets shall be fully complied with, notwithstanding the specified scope of the Contract.
l) All electrical equipment, forming part of the specified equipment, as described in the Electrical Specification, shall be sealed against penetration by hose cleaning operations as well as being accessible for repairs and maintenance.

8.2.3. Materials

The complete rail and trolley system shall be manufactured from at least epoxy coated and hot dipped galvanised mild steel shapes (rods, angles, and channels), and sheets. The epoxy coating shall have a minimum dry film thickness of 350 microns.

The rail / tracks shall be enamel painted according to the Standard Specification.

8.2.4. Construction

A complete dolly system, including a rail system, and motorised trolley, suitable to hold standard waste skip(s) is required at the inlet works. The Contractor shall design, manufacture, supply to site, install and commission such a dolly system which runs rails that will be fixed to and grouted into a new concrete slab that shall be situated alongside the inlet works.

Rail tracks:

The rail tracks shall be constructed from standard "I" rail profiles. Other profiles must be submitted for approval by the Engineer. It shall be designed to handle at least 3x the total weight of the dolly system (trolley + weight of X m^3 skip(s) + total allowable skip payload(s); where X is the required skip size).

The tracks shall be installed on cross bars to ensure that it runs parallel to one another. The rails shall extend to at least twice the length of the dolly and shall ensure that empty skips can be loaded onto the dolly and full skips can be removed from the dolly without any double handling of skips. The tracks shall be firmly anchored to the concrete slab by means of chemical anchors and suitable standard cleats.

After it was aligned and levelled over the entire length of the rail, it shall be grouted in so that only the minimum surface area is exposed to the environment.

End stops shall be provided at each end of the rail tracks (on both rials), designed to withstand the forces of the loaded trolley (weight calculated as 3x the trolley + weight of X m^3 skip(s) + total allowable skip payload(s); where X is the required skip size) moving at full speed.

Trolley:

Each dolly / trolley shall be designed to hold standard waste skip(s). The number – size of skips that it shall hold shall be as per the Project Specification. The dolly / trolley shall be designed to handle the weight of the skip(s), as well as a minimum of 3x the maximum permissible payload without distorting or bending. It shall have locating lugs that keep the skip in position but do not prevent the skip from being easily loaded onto the dolly. The dolly / trolley shall be able to move along the rail tracks by means a geared motor installed on the dolly / trolley.

The wheels shall be of the heavy-duty resilient type wheels and suitably spaced to ensure stability of the dolly / trolley. The wheels shall consist out of cast iron wheel hub with a polyurethane type tyre securely bonded to the hub. The tyre shall be rated for high wear resistance and resistant to oil and water. The wheels shall be equipped with a flange to prevent the dolly / trolley from derailing.

The dolly / trolley shall be able to move without losing tractions when no skips, one or two skips are positioned on the dolly and the skips can be empty, partially empty or full.

Drive unit:

The geared motor shall be suitably sized and design to suit the maximum allowed total weight of the trolley system and drive two of the wheels on the same axle. The motor and gearbox shall incorporate a service factor in excess of 3 : 1 of the design maximum absorbed torque.

The dolly system shall be equipped with an automatically retractable reel, externally reinforced flexible cable of sufficient length to suit the trolley movement. The length of cable shall be at least 3 m longer than the required travel distance of the trolley. The size of cable shall be suitable for the power requirements of the geared motor(s). The reel shall keep tension on the cable, preventing it from laying on the ground / rails and shall be positioned such that the cable does not cross the rails. The reel shall be enclosed to that the cable that is rolled up is protected from the sun and possible damage.

Enclosure:

Should the Project Specification call for an enclosure over the skip(s), the Contractor shall design a portal frame type structure, cladded with coated IBR to partially enclose the skip. It shall be suitably sized to allow operators to walk around the skips while being inside the enclosure.

The enclosure shall prevent rain from collecting in the skips.

The Contractor shall design the frame and roof structure to withstand all static and dynamic loads caused by environmental and other factors. The wind load for the area shall be considered when designing the structure. The beams and structure shall be heavy duty, hot-dipped galvanised. The columns shall be installed and fixed onto dedicated plinths designed to handle the loads.

Operation:

The dolly / trolley shall be set into motion by Operator intervention by means of the start / stop control station at the dolly system. The Operator shall start the dolly to move the dolly by selecting either forward / reverse to move the dolly back and forth, stopping it by means of the stop button.

The rail system shall have limit switches at both ends of the rail system as emergency stops. These switches shall be such to stop the dolly immediately before the trolley hits the track end stops.

Controls and instrumentation:

The equipment shall include all limit switches and protection instrumentation, seen necessary by the Manufacturer to ensure the validity of the warrantee, to prevent damage to the equipment in overloading, etc conditions. The equipment shall have the functionality to operate in forward / reverse to try and dislodge blockages.

8.2.5. Spare Parts

The following Spare Parts shall be included and supplied together with the equipment:

- A set of special tools (if required)
- Any other parts deemed critical by the manufacturer.

Spare parts shall be packaged with labels indicating the contents of each package, and shall be delivered to Owner as directed.

8.2.6. Installation and Testing

The Contractor shall verify all dimensions in the field to ensure compliance of equipment dimensions with the drawings. Contractor shall notify the Engineer of significant deviations.

Installation of the equipment shall be in strict accordance with the contract documents and the manufacturer's instructions and shop drawings. Manufacturer shall supply equipment, including anchor bolts for the equipment. Contractors shall install the equipment in accordance with the manufacturer's recommendations.

Supplier shall furnish the services of a factory-trained Service Engineer for one (1) trip including a total of two (2) days to inspect the installation, observe start up, and provide operator training.

Equipment shall not be energized, or "bumped" to check the electrical connection for motor rotation without the Service Engineer present.

The Service Engineer shall make all necessary adjustments and settings to the controls.

The Service Engineer shall demonstrate proper and sequential operation of the equipment and demonstrate that the equipment achieved the requirements set out in the Specifications.

9. PERIPHERAL DRIVE ROTATING BRIDGE CLARIFIER AND THICKENER MECHANISMS

9.1. Specific requirements for the Rotating Bridge Clarifier and Thickener Mechanisms

The specific requirements for the equipment shall be in accordance with the applicable Project Specification.

9.2. General requirements for the Rotating Bridge Clarifier and Thickener Mechanisms

9.2.1. Scope of works

The specification covers the design, supply, delivery to site, installation and commissioning of peripheral drive rotating bridge type clarifiers and thickener

mechanisms installed in circular concrete tanks and with a concrete centre inlet and support.

The scope of work for all the concrete structures to accommodate the equipment shall fall under other Contractor(s). The Contractor shall liaise closely with the (Civil / Structural) Contractor responsible for the construction of the structures to ensure all structural requirements / provisions required by the equipment are met during the construction of the tanks.

The design shall be such that it does not require regular maintenance and only equipment of proven ability shall be provided.

The Contractor shall ensure that the equipment offered comply or exceed the requirements set out in the specification and that it is suitable for the application. The Contractor shall make allowance for a fully functional and integrated system, including all interconnecting systems that may be required. This specification shall be read in conjunction with the other Mechanical Standard Specifications whether there are specific references or not.

9.2.2. General description of the Clarifier / Thickener

The clarifier inlet pipework (supplied and installed by others) passes under the tank floor turning upwards at the centre to discharge and disperse the influent through a diffuser assembly evenly into the deflector drum, inducing an even radial flow into the body of the tank.

Sludge is deposited onto the floor of the tank and is scraped to the sludge collecting hopper at the centre of the tank, from where it is withdrawn under hydrostatic head through an underground pipe to the discharge point outside the clarifier. On a Suction Lift type Clarifier, the sludge is lifted through a pipework system into a sight box from where it is transferred through a siphon pipe into a central collection drum an then withdrawn under hydrostatic head through an under floor pipe to the discharge point outside the clarifier.

The design of the scraper mechanism must be based upon proven features of equipment installed in Southern Africa and emphasis must be placed on good mechanical and electrical engineering practices and high factors of safety shall be employed in all features of the design.

Unless otherwise specified, the mechanical / electrical equipment shall comprise of the following:

a) An inlet diffuser mounted on the concrete centre column (activated sludge clarifiers only)
b) A centre bearing assembly
c) A rotating half bridge spanning the tank radius or a double bridge spanning the tank diameter and comprising of two half bridges
d) A bridge end carriage for each half bridge
e) Two, shaft mounted, wheels with support bearings for each half bridge
f) A geared motor drive mounted to the leading wheel. Normally on one half bridge only
g) A bridge walkway leading to the tank centre, including handrails

h) A set of scraper blades spanning the tank radius, including the supports, suspended from each bridge
i) An inlet stilling chamber
j) A set of "V" notch weir plates around the edges of the outlet launder
k) A set of scum baffle plates set away from the outlet launder
l) A scum skimmer blade attached to the bridge
m) An automatic scum removal device situated at the tank periphery
n) An electrical slip ring assembly at the tank centre.

On Suction Lift type clarifiers, the following additional equipment will be required:

a) Sludge uptake pipes and flow control valves from each "V" scraper assembly
b) Sludge horizontal pipes from each uptake pipe to a sight box
c) A sight box to view the discharge from each horizontal pipe
d) A siphon pipe to transfer the sludge from the sight box to the centre drum
e) A stationary centre drum to collect the sludge and transfer it to the outlet pipe
f) A vertical outlet pipe to connect to the under-floor sludge pipe
g) A priming pump, valve and piping to keep the siphon primed.

9.2.3. Design Criteria

General Design:

The equipment shall meet the following requirements:

a) It shall be designed to facilitate the efficient manufacture, inspection, transportation, installation, maintenance, cleaning and repairs.
b) It shall be designed with a minimum expected life of 20 years of safe and satisfactory operation under the conditions prevailing at the site
c) The design shall prevent undue stresses caused the expansion and contractions due to temperature changes and other local natural manmade conditions.
d) The design shall keep maintenance costs to a minimum
e) It shall be designed to comply completely with the legal requirements in respect of safety and the prevention of environmental pollution.
f) It shall satisfy any specific requirements contained in the relevant statutory codes and legislation.
g) The design shall allow for 24-hour operation, 365 days a year under the specific design conditions.
h) The equipment installed shall be complete and fully operational as per the requirements set out in the Scope of Works.
i) All material used for the equipment shall be suitable for the operation and environment and compatible with the intended use.
j) The design shall allow for suitable treatment to prevent corrosion and erosion of the materials and equipment.
k) After approval by the Engineer, at the time of award of the Contract, the information stated in the Data Sheets shall be fully complied with, notwithstanding the specified scope of the Contract.
l) All electrical equipment, forming part of the specified equipment, as described in the Electrical Specification, shall be sealed against penetration by hose cleaning operations as well as being accessible for repairs and maintenance.

Hydraulic Design:

The following criteria shall be taken into consideration in the overall design of the equipment:

- The Surface Loading rate at Peak Wet Weather Flow (PWWF) in m/h (excluding the sludge return rate). This shall be based on 3 x the Average Dry Weather Flow (ADWF) unless otherwise specified. Unless otherwise specified the maximum surface loading rates shall apply:
    - 1,0 m/h for Final Activated Sludge Clarifiers
    - 1,5 m/h for Humus Sludge Clarifiers
    - 2,4 m/h for Primary Clarifiers and Sludge Thickeners.

- The Stilling Chamber Loading rate at PWWF in m/h (including the sludge return rate). Unless otherwise specified the maximum Stilling Chamber loading rates shall be as follows:
    - 25 m/h for Final Activated Sludge Clarifiers
    - 50 m/h for Humus and Primary Clarifiers
    - 100 m/h for Sludge Thickeners.

- The 'V' Notch Weir Plate Loading rate in m^3/m.h (excluding the sludge return rate). Unless otherwise specified the maximum Weir Plate Loading rates shall be as follows :
    - 10 m^3/ m.h for Final Activated Sludge Clarifiers
    - 15 m^3/ m.h for Humus Sludge Clarifiers
    - 20 m^3/ m.h for Primary Clarifiers and Sludge Thickeners.

- The Sludge Return rate in m^3/h. This shall be equal to 1 x the Average Dry Weather Flow (ADWF) unless otherwise specified.

Mechanical Design:

The following criteria shall be taken into consideration in the overall design of the equipment:

a) The inside tank diameter – refer available drawings
b) The type of sludge and the resistance it will impose upon the scrapers in N/m of the tank radius
   For sludges derived from mainly domestic sewage with 300mm deep scraper blades, the following minimum resistance shall be applied:

   - For Activated Sludge up to 1,5% dry solids concentration 75 N/m
   - For Humus Sludge up to 2,5% dry solids concentration 120 N/m
   - For Primary Sludge up to 5,0% dry solids concentration 270 N/m
   - For Thickened Sludge up to 8,5% dry solids concentration 480 N/m

   The tank radius or - diameter shall be multiplied by the relevant abovementioned figure(s) to obtain the total sludge loading for single – or double bridges respectively.

c) The mean depth from the bridge to the tank floor in metres [m]. (For design purposes to be taken as the water depth at half the tank radius plus 1.0 m)

d) The sludge load, as applicable for the number of half bridges
e) The twisting moment on each half bridge at the mid span of the bridge
f) The drive torque required to drive the leading wheel at the tank periphery. For double bridges, this drive torque shall be multiplied by 2. The gearbox torque rating shall be 3 x greater than the calculated drive torque.
g) The load on any one of the wheels. Each wheel shall be sized as follows:
To calculate the permissible load on the wheel (PWhL)
PWhL = 1,9 x 10^6 x [WhWi – 0,33 TyTh] x TyTh x $MWhD^{0,15}$ in Newtons [N].

Where:
- **WhWi** is width of the wheel in metres [m]
- **TyTh** is the thickness of the polyurethane tyre in metre [m]
- **MWhD** is the mean wheel diameter in metre [m] = 0,5 x [Hub Casting Dia. + Tyre Outside Dia.]
(The hub casting diameter shall not be less than 65% of the tyre outside diameter).

h) The load on any one of the wheel bearings.
i) The wheel shaft stress. The wheel shaft stress shall not exceed 75 MPa.
j) The axial Load on the centre pivot bearing.
k) The centre tilting moment on the centre pivot bearing.
l) The centre pivot bearing shall be selected with at least a 3 : 1 service factor on the permissible axial load when the calculated centre tilting moment is taken into consideration. When the bearing is not subject to any tilting moment the bearing shall be selected with at least a 6 : 1 service factor on the permissible radial load for a deep groove ball bearing, and 15 : 1 service factor on the permissible radial load for a double spherical roller bearing.
m) The load on the bridge shall be assumed for calculation purposes that it is equal to the rotating mass plus a live load of 800 N/m over the length of the bridge. The rotating mass shall include the weight of the bridge, scrapers, supports, walkway, hand railings, end carriage, drive, scum skimmer and stilling chamber, if supported from the bridge.
n) The maximum allowable bending stress in the bridge under this loading shall be 75 Mpa.
o) The maximum allowable bending deflection in the bridge under this loading shall be 1/500 of the span or 25 mm whichever is the lower figure.
p) The maximum allowable shear stress in the bridge shall be 40 Mpa.
q) The maximum allowable twist in the bridge under maximum loading shall be 8,7 x 10^{-3} Radians or 0.5°.
r) The minimum distance from the leading drive wheel to the bridge centre line shall be sufficient to prevent the trailing wheel lifting off the track under maximum sludge loading.
s) The available traction of the wheel on the concrete track in both wet and dry conditions.
t) The scraper support framework the framework shall not deflect more than 0.05 m when subject to the maximum sludge loading. This deflection shall not take into consideration any movement due to twisting of the bridge.

The above criteria are specified as the minimum requirements and not withstanding the above, the Contractor shall be responsible for ensuring adequate and satisfactory design and operation of the equipment.

The Contractor shall ensure that the equipment offered comply or exceed the requirements set out in the specification and that it is suitable for the application. Notwithstanding the above, the Contractor shall be responsible for ensuring adequate and satisfactory design and operation of the equipment. The Contractor shall make allowance for a fully functional and integrated system, including all interconnecting systems that may be required. This specification shall be read in conjunction with the other Mechanical Standard Specifications whether there are specific references or not.

9.2.4. *Construction:*

Inlet Arrangements:

The inlet pipe passes underneath the tank and rises vertically at the centre encased in a concrete column with a cap on the top. The cap extends above the T.W.L. at a suitable height for fixing on the centre pivot bearing assembly. Vertical slots are positioned in the sides of the concrete column to direct the incoming flow into the stilling chamber.

On activated sludge clarifiers, the vertical concrete column is open ended and terminates at approximately 30% of the tank water depth below the T.W.L. (to be confirmed on site) On top of this column an inlet diffuser is to be provided and bolted in position by the Mechanical Contractor. The details of this steel double shrouded, and veined diffuser are shown generally on the attached drawing. The purpose of the diffuser, which bears a resemblance to a double shrouded pump impeller, is to diffuse the incoming flow evenly into the stilling chamber. The inlet area of the diffuser shall be approximately 50% greater than the cross-sectional area of the inlet pipe and the outside diameter of the diffuser approximately 3.5 x the inlet pipe diameter. The depth of the diffuser shall be approximately one third of the pipe diameter but not less than 100 mm. Tubes of at least 89 mm diameter shall be positioned in front of each diffuser vane to prevent the snagging of rags. A steel column shall extend from the top of the diffuser to a suitable height for fixing on the centre pivot bearing assembly.

A cylindrical stilling chamber to prevent short circuiting of the flow into the body of the tank shall be positioned concentrically around the centre column. The diameter of the stilling chamber shall be as indicated in the Hydraulic Design criteria above. The depth of the stilling chamber shall be between 55% and 60% of the water depth at the stilling chamber periphery. The top of the chamber shall be 50 mm below the T.W.L. in the tank to allow scum to escape over the top. The construction of the chamber shall preferably be of glass reinforced polymer (GRP) sheeting, supported at the top and bottom with steel angle rings. On small tanks, stilling chambers constructed completely from steel may be more economic.

The stilling chamber shall ideally be supported from the centre column by a steel structure or if not feasible from the bridge. The supports shall maintain the chamber truly circular and level on the top. Each support point shall be capable of supporting an additional weight of 80 Kg without deforming.

Rotating Bridge:

The main purpose of the rotating bridge, which spans from the peripheral wall to the tank centre is to rigidly support the sludge scraping assembly. If a scum skimmer is to be supplied this shall also be suspended from the bridge. The support of a walkway to access the centre bearing and electrical slip ring is a secondary requirement.

Taking the abovementioned requirements into account, the bridge shall be designed as such to prevent bending or twisting due to static and dynamic forces created by the weight of the bridge, scraper, scum skimmer, etc as well as the sludge load on the scrapers.

The bridge design must be done with weight and therefore cost saving in mind while still conforming to the requirements. Easy access to all exposed surfaces is important to enable corrosion protection maintenance. The ability to Hot Dip Galvanise the bridge without the risk of distortion is also considered an important factor. Differing designs will be considered generally of the following type.

a) A single tubular construction. This should be economic on small to medium sized tanks and will be highly resistant to twisting. It should be easily galvanised without distortion and can be hermetically sealed to prevent the accumulation of rainwater and corrosion from the inside. Its torsional rigidity may allow the use of a simple self-aligning centre pivot bearing without the need to resist bridge twisting at this point. Calculation for sizing is simple and straightforward.
b) A rectangular hollow construction. This should also be economic on small to medium sized tanks with a good resistance to twisting. It should be easily galvanised without distortion and can also be hermetically sealed to prevent the accumulation of rain water and corrosion from the inside.
c) Traditional parallel channel construction with top and bottom cross bracing. These may be economical on medium to large tanks but do not have a good resistance to twisting. Sectional cross braces at intervals will be necessary to help control twisting. They are also not suitable for Hot dip Galvanising and pose difficulties maintaining the corrosion protection. Calculation to verify resistance against both bending and twisting is complex.
d) Lattice structure construction is economical on very large tanks. They may also be suitable for Hot Dip Galvanising, but angle iron structures pose severe difficulties to maintain the corrosion protection. A tubular lattice structure with a triangular cross section employing three longitudinal tubes is preferred due to its torsional rigidity provided that all the tubes can be hermetically sealed after galvanizing.

The bridge shall not twist by more than 0,5° at any point along its length when the scrapers are subject to the maximum sludge design loading.

Double bridges comprising of two half bridges shall be driven from one end unless otherwise specified. The required torque shall be adequately transmitted through the bridges across the tank centre over the centre pivot whilst allowing provision for any required up and down movement as the end carriages travel along the concrete track. In this case the end carriage at one side will have a leading drive wheel and a trailing idler wheel. The end carriage at the opposite side will have two idler wheels. The bridge connection at the tank centre shall ensure smooth travelling of the end carriages.

An open type grating walkway shall be incorporated along the upper side of the bridge, flanked on both sides by double row tubular type hand railing and stanchions to provide

access to the centre pivot bearing and electrical slip rings. A 150 mm high kick board shall be provided as part of the walkway gratings along each side and at the walkway end.

With double bridges such a walkway is only required on one half bridge unless it is of the suction lift type.

The bridge shall be designed to carry a superimposed live load over the walkway area and to cater for a deflection no greater than specified. It shall also be able to resist the twisting due to the scraper sludge load (all as indicated in the Mechanical Design section above).

A ladder shall be incorporated at the end of each walkway for easy access from ground level. The hand railing shall be easily reached for safe climbing of the ladder when standing on the ground.

Centre Pivot:

A pivot bearing assembly shall be used to mount the bridge on the centre column. The centre pivot shall incorporate a properly sealed ball bearing unit/s or slewing ring designed to carry the bridge with superimposed loading plus any twisting loads imposed by the scrapers if the bridge and end carriage are unable to resist this twisting moment.

Should a bridge twisting resistance be required at the tank centre an arrangement shall be incorporated to allow small vertical movement of each bridge at the tank centre without imposing any twisting in the cross plane to the bearing assembly. Grease nipples shall be installed on the assembly, at bridge level, to allow easy lubrication. The bearing arrangement shall be such that rain is deflected away and cannot collect in any pockets.

A totally enclosed weatherproof electrical slip ring assembly, suitably rated for the installed power of the drive unit shall be installed on the centre pivot assembly. The assembly shall be rated for IP55 protection with 7 pickup rings rated at 25 Amps and incorporate a removable cover for inspection of the rings and sliders. All parts shall be resistant to prolonged UV radiation.

End Carriage and Drive Unit:

At the drive end, the bridge shall rigidly connect to an end carriage with two heavy duty resilient wheels suitably spaced to resist any twisting imposed by the scrapers. The wheels shall consist out of cast iron wheel hub with a polyurethane type tyre securely bonded to the hub. The tyre shall be rated for high wear resistance and resistant to oil and water.

The leading wheel shall be driven by a TEFC weatherproof, hollow shaft helical geared, motor unit mounted on to the wheel shaft. The motor shall have Class ‘F’ insulation with IP55 protection. The wheel shaft shall be supported in two sealed pillow or plummer block bearing units rigidly fixed to the end carriage. The wheel bearings shall be fitted with grease nipples.

The tolerances of the wheel shaft to the hollow shaft shall be f7/H8 to ensure easy removal for maintenance purposes. Adjustment shall be available to ensure that the wheel shafts can be truly aligned with the centre of the tank.

The gearbox shall incorporate a service factor in excess of 3 : 1 of the design absorbed torque and be torque arm mounted to the bridge.

Each wheel shall be surrounded by a 10 mm thick neoprene skirt extending from the underside of the end carriage down to the track level to prevent accidents.

A deflector shall be incorporated in front of the leading wheel to deflect any foreign objects to the outside of the tank and prevent accidents. Covers shall be suppled to prevent operators from reacting pinch-points accidentally.

Scrapers:

The type of scraper arrangement and sludge removal system to be employed will depend upon the tank diameter and upon the maximum sludge retention time allowable in the sedimentation tank. Unless otherwise specified the following procedure shall be employed in selecting the system to be used:

- With stable activated sludges it is recommended that the sludge retention time should not exceed 60 minutes.
- With activated sludges derived from plants where de-nitrification is not always guaranteed it is recommended that the sludge retention time should not exceed 30 minutes.

With a sludge retention time not exceeding 60 minutes it is estimated that the most economical mechanisms will be of the following type:

- Up to 9,0 m tank Dia. - Half Bridge Echelon Blade
- Up to 21,0 m tank Dia. - Half Bridge Spiral Blade
- Up to 38,0 m tank Dia. - Half Bridge Suction Lift

With a sludge retention time not exceeding 30 minutes it is estimated that the most economical mechanisms will be of the following type:

- Up to 5,0 m tank Dia. - Half Bridge Echelon Blade
- Up to 12,0 m tank Dia. - Half Bridge Spiral Blade
- Up to 23,0 m tank Dia. - Half Bridge Suction Lift
- Up to 38,0 m tank Dia. - Double Bridge Suction Lift

The scraper mechanism shall scrape the entire floor area and shall be of the spiral type with a constant “angle of attack” of 30°.

Scraper blades shall be at least 300 mm overall depth and shall incorporate a synthetic rubber wearing edge sandwiched with a retainer to the metal blade. The wearing edge shall extend at least 50 mm below the metal blade. The sandwich assembly shall be fixed with Stainless Steel M10 bolts, nuts and washers at not less than 150 mm centre spacing. The metal blade shall be of a press braked angle cross section to maintain adequate rigidity and shall be at least 6,0 mm thick in mild steel or 4,5 mm thick in stainless steel. Retainers shall be of a similar thickness. The wearing edge shall be at least 10 mm thick and shall be adjusted or trimmed to the contour of the tank floor.

Wearing edges may alternatively be manufactured from High Density Polyethylene. In this case they shall be fixed to the blades with Stainless Steel M10 bolts, nuts and large diameter washers at not less than 100 mm centre spacing and the retainer strips will not be required. The wearing edge shall be at least 12 mm thick and shall be adjusted and trimmed to the contour of the tank floor.

The scraper assembly shall be fixed to the bridge by a rigid framework assembly suitable for resisting the maximum sludge load with a factor of safety of at least 3 : 1 on the yield stress of the framework material. The deflection of the framework under the maximum sludge loading shall not exceed 50mm at the scrapers. The framework shall be of a bolted construction comprising of angle, channel or tube members. Members shall be such that they collect as little as possible settled sludge and promote easy maintenance of the corrosion protection. Tubular members shall be hermetically sealed to prevent any corrosion on the inside.

The scraper assembly shall incorporate a vertical adjustment of at least 50 mm, 25 mm up and down from the mean position.

Sludge Thickener Mechanism – Picket Fence:

When specified, a sludge thickener mechanism shall incorporate a picket fence to prevent stratification and enhance flocculation of the sludge particles. The picket fence shall comprise of vertical bars extending up from the scraper blades to 100 mm above the top water level in the tank. These bars shall be manufactured from at least 50 x 50 x 5 mm thick rolled steel angles and shall be spaced at not less than 300 mm centre spacing, extending from the outer wall of the tank to the stilling chamber. They shall be adequately supported from the scraper frame assembly.

Suction Lift Mechanisms (if required):

- Sludge Uptake Pipes:
  The sludge uptake pipes shall be vertically positioned at the apex of each "V" scraper assembly. Each scraper assembly shall be rigidly fixed to the bottom of each uptake pipe and shall incorporate a vertical scraper assembly adjustment of at least 50 mm, 25 mm up and down from the mean position. Each "V" scraper shall be fixed to its adjacent scraper with a bolted cleat. The bottom of each pipe shall have 45° chamfer to allow easy entry of the sludge and the top of the pipe shall be securely bracketed and bolted to the bridge.

  A tee-piece approximately 325 mm below top water level shall be incorporated on each uptake pipe to transfer the sludge to the relevant horizontal pipe. A flow control valve shall be incorporated at this point and operated from the bridge above. This valve shall be of the rotating or lifting type to control the flow from maximum to approximately 10% of maximum.

  The uptake pipes shall not be spaced at more than 1.8 m on tank diameters up to 25 m and not more than 2.5 m on tank diameters up to 38 m. A minimum of two uptake pipes shall be used. The uptake pipe diameters shall not be less than DN100 on tank diameters up to 25 m and not less than DN150 on tank diameters up to 38 m. The friction loss in each uptake pipe shall not exceed 0.75 m / 100 m.

- Sludge Horizontal Pipes:
  Each uptake pipe shall discharge into a horizontal pipe at the abovementioned tee piece, which shall then lead to the common sight box. These pipes shall be connected at each end with a flexible type of pipe coupling and shall be supported adequately from the bridge to handle all static and dynamic forces.

- Sight Box:

The sight box, which collects the sludge from the horizontal pipes, shall have an open top at least 80 mm above TWL and shall be rigidly suspended from the bridge. It shall be possible to easily view the amount of sludge discharged from each horizontal pipe into the sight box.

- Siphon pipe:
  A siphon pipe shall transfer the sludge from the sight box to the centre drum. This pipe shall be immersed by approximately 1.1 m into the sight box and drum at each end with a clearance of at least 0.5 x the siphon pipe diameter under the open pipe ends. The amount of pipe length above tank W.L. shall be kept to a minimum to allow easy priming. The siphon pipe shall be securely supported from the bridge to handle all static and dynamic forces and the friction loss in the siphon pipe shall not exceed 0.25m / 100m.

  The upper most point of the siphon shall incorporate a threaded nozzle to which a priming pipe shall be fitted. This pipe shall lead to a hand operated lever type priming pump mounted at an easily operable level on the bridge's hand railings. A drip tight, manually operated, isolating valve shall be incorporated in a rigid part of the pipe leading to the pump. The pump shall be of the durable type and resistant to prolonged UV radiation.

- Centre Sludge Drum:
  The centre sludge drum shall be fixed to the top of the inlet diffuser which in turn is fixed to the top of the concrete centre column. The concrete centre column is open ended and terminates at approximately 1.6 m below the tank top water level (to be confirmed on site). The inlet arrangement is as described above for activated sludge clarifiers. A steel column shall extend from the base of the drum to a suitable height for mounting the centre pivot bearing assembly.

  A ND50 flanged gate valve shall be attached to the steel centre column and arranged in such a way that the drum can be primed as the tank is filled with liquid. This valve shall be easily accessible for closing when the tank is in normal operation.

- Sludge Outlet Pipe:
  A sludge outlet pipe shall be installed between the underside of the sludge drum and the floor of the tank. This pipe shall be connected to a nozzle on the underside of the drum using a flexible pipe coupling and connected to the underfloor sludge pipe which will terminate in a vertical position at a pre-determined distance above the floor, also using a flexible pipe coupling. The underfloor pipe will form part of the civil / structural contract. The vertical outlet pipe shall be positioned parallel to the centre inlet column and within the concrete benching around the centre column so that it does not impede the rotating scrapers.

  The friction loss in the pipe shall not exceed 1.0 m / 100 m.

<u>Stamford Baffle (if required):</u>

A Stamford baffle will be supplied and installed should the Specific Requirements calls for one. The Stamford baffle shall be designed to suit the size of the tank and shall be installed at the bottom edge of the launder inner wall.

The Stamford baffle shall be designed, unless otherwise indicated in the specific requirements, to be angled at 45 ° and the diagonal length will be 600 mm. It shall be designed to be robust and shall not deflect more than 5 mm on the inner edge when static and dynamic forces are applied to the baffle.

The baffle shall be manufactured in sections with each section may not exceeding 1.2 m or 10 ° as measured on the outside edge (whichever is smallest). The outer and inner diameter baffle shall be rolled to conform to the radius of the tank. A rubber seal shall be installed on the outer edge of the baffle to act as a seal between the concrete wall and the baffle.

The sheet metal shall have lips on the outer – and inner edges for stiffness – and mounting purposes. These lips shall at a minimum be 50 mm, however the designer shall confirm the requirements to ensure the required stiffness in the baffle. The sections shall be designed to interlink with one another to help with overall strength and the sections shall be bolted together with a minimum of 3 bolts on each side. Each section shall be bolted to the will with bolt spacings not larger than 300 mm.

Additional support brackets shall be installed at each of the section joints. These brackets shall be constructed from sheet metal with lips on all edges for stiffness – and mounting purposes. These lips shall at a minimum be 50 mm, however the designer shall confirm the requirements to ensure the required stiffness in the baffle. The baffles shall be bolted to these brackets.

Specials shall be made up for the sections around the scum box / scum outlet pipe. The baffles shall allow for an elliptical opening for the pipe to pass through.

The brackets and baffles shall be bolted to the wall and together. Chemical anchors may be used to bolt the equipment to the concrete structure. All sheet material shall be manufactured from sheet metal with a minimum thickness of 4.5 mm.

<u>Peripheral Weirs:</u>

Peripheral "V" notch weir plates shall be designed for mounting around the outside of the launder walls of the tank. The weir plates shall have vertical slots to enable vertical adjustments by means of set screw and fixed to the wall by use of anchor inserts. Alternatively, the weir plates may be clamped to the walls utilizing clamp plates fixed with anchor inserts and set screws. The amount of vertical adjustment shall be 30 mm on tank diameters up to 25 m and 50 mm on tank diameters up to 38 m.

The “V” notches shall be 90° x 50 mm deep at no more than 300 mm centre-to-centre spacing on tanks up to 25 m diameter and 90° x 70 mm deep at no more than 150 mm centre-to-centre spacing on tanks up to 38 m diameter.

The weir plates shall be at least 200 mm deep on tanks up to 25 m diameter and at least 250 mm deep on tanks up to 38 m diameter. The plate shall have a minimum thickness of 4.5 mm.

Fixing anchors shall be spaced at not more than 500 mm centre spacing.

A sponge type flexible jointing material such as Sondorband Jointex PLN, or similar and equally approved, shall be used to seal the space between the weir plate and the wall. This material shall be durable but soft enough to prevent any kinking of the weir plates at the fixing points. Leaking of effluent between the weir plates and the wall will not be permitted.

Scum Baffles:

Peripheral scum baffles which extend below and above T.W.L. shall be fitted between the inner portion of the tank and the launder wall in front of the "V" notch weir plates. They shall be fitted to the wall by adjustable brackets at appropriate centres not exceeding 750 mm. The brackets shall be fixed to the wall using anchor inserts and M12 set screws. Each bracket shall have three separate adjustments, a vertical adjustment of 20 mm, a radial adjustment of 60 mm and a tangential adjustment of 30 mm. These adjustments shall ensure that the scum baffle is maintained truly concentric to the centre of the tank and that the scum skimmer end rubber always maintains contact with the baffle. Each bracket shall be able to support an additional weight of 80 Kg at the baffle without deforming.

The baffle shall be at least 300 mm deep and positioned 250 mm away from the weir plates on tanks of up to 25 m in diameter and 400 mm deep and 300 mm away from the weir plates on tanks of up to 38 m in diameter. The plates shall extend 75 mm above the top water level. The plate shall have a minimum thickness of 4.5 mm.

Bolted joint plates shall be used to connect the baffle segments such that a smooth surface with no steps or kinks is presented to the skimmer end rubber and no bolt heads or nuts shall protrude up to 200 mm from the top edge of the baffle on the inside.

Scum Skimmer:

An angled scum skimmer blade set at 15° to the tank radius shall extend from within the tank to the scum baffle. The total skimmer blade length from the scum baffle shall be equal to at least 0.20 x tank diameter but not less than 2.0 m long and shall be fixed rigidly to the bridge. The skimmer shall extend 75 mm above the top water level and where it is not passing over the scum box it shall extend at least 150 mm below the water level.

The outer portion of the skimmer blade shall be set back below the bridge by approximately 1200 mm to form a scum collecting pocket in conjunction with the stationary scum baffle. The outer skimmer shall incorporate a rubber loop which shall form a seal against the scum baffle and prevent the escape of scum as it passes over the scum hopper. Scum which has been collected in the moving pocket shall be automatically discharged through the scum pipe as the bridge passes over the scum hopper and valve assembly.

Scum Discharge Hopper:

The scum hopper shall be mounted against the scum baffle, adjacent to the effluent launder and shall be flooded on three sides. A pipe shall transfer the scum to a chamber situated outside the tank. The scum discharge shall be initiated by a lifting plug valve situated within the scum hopper and over the discharge pipe. A rubber seal shall operate when the valve is in the closed position. The valve shall be operated from a rocker arm and wheel which engages with an adjustable cam track attached to the underside of the

bridge. The valve shall be designed such that it opens wide enough to discharge all accumulated scum and not snag any scum solids. When closed it shall not leak and shall be drip tight.

The cam track shall open the valve when the skimmer blade is within approximately 1.8 m of the valve and shall close the valve when the skimmer has just passed over the valve. The cam track shall also be adjustable so that the degree of opening diameter of the plug valve can be varied.

The scum hopper shall be at least 450 mm wide and the radial length shall be equal to 0,05 x tank diameter but not less than 450 mm. The valve opening and the discharge pipe shall be at least DN150.

It shall be possible to adjust the scum hopper level and vertically by 50 mm with the invert of the hopper 20 mm below the maximum possible water level in the highest position. This adjustment shall be possible through easily accessible adjusting screws without draining down the water level. A flexible type of pipe coupling shall be incorporated in the vertical scum pipe leg to facilitate this adjustment.

The scum removal system shall employ a minimum of moving parts subject to wear and shall be generally maintenance free apart from periodic cleaning with a hose pipe.

Protection Instrumentation:

Provision must be made for over-torque limit switch(es) for the protection of the operator and drive unit. This switch shall stop the rotation of the bridge.

The equipment shall include all limit switches and protection instrumentation, seen necessary by the Manufacturer to ensure the validity of the warrantee, to prevent damage to the equipment in overloading, etc conditions. The equipment shall have the functionality to operate in forward / reverse to try and dislodge blockages.

Materials and Surface Finishes:

The minimum material thickness (unless otherwise stated) shall be:

- Mild steel fabrications - 5.0 mm
- 3CR12 or Stainless-Steel fabrications - 4.5 mm

All Stainless Steel (all grades, including 3CR12, 304(L), 316(L) or above) components and structures shall be submersed in a chemical bath of nitric acid and hydrofluoric acid (pickling bath) to remove any residues that may be present on the material as a result of forming, manufacture, or handling. After removal from the pickling bath, the equipment must be washed with a high-pressure wash of cold water to remove any remaining surface debris and promote the formation of an oxidized passive layer which is critical to the long life of the Stainless Steel. It shall be manufactured in a Stainless-Steel only factory to prevent contamination of the Stainless Steel with rusty dust.

All fabricated mild steel components shall be shot blasted and hot-dipped galvanised or coated in accordance with the specified requirements and relevant Standard Specification.

The Contractor shall ensure that the material offered comply or exceed the requirements set out below, unless indicated otherwise in the Project Specification, and that it is suitable for the application:

Bridge and End Carriage	:	Epoxy Coated and Hot dipped galvanised mild steel
Centre Pivot Assembly	:	316L Stainless Steel
Drive assembly	:	Painted mild steel
Wheel hubs and tyres	:	Cast iron and Polyurethane
Hand railings	:	GRP
Walkway gratings	:	GRP
Inlet diffuser	:	316L Stainless Steel
Upper Centre Column	:	316L Stainless Steel
Stilling Chamber	:	316L Stainless Steel & GRP
Scrapers and Frames	:	316L Stainless Steel
Scraper wearing edges	:	Neoprene or HDPE
Sludge Thickeners – Picket Fence	:	316L Stainless Steel
Suction Lift type – Uptake pipes	:	316L Stainless Steel
Suction Lift type – Horizontal pipes	:	316L Stainless Steel
Suction Lift type – Sight box	:	316L Stainless Steel
Suction Lift type – Siphon pipe	:	316L Stainless Steel
Suction Lift type – Sludge drum	:	316L Stainless Steel
"V" notch weir plates	:	316L Stainless Steel
Scum baffle	:	316L Stainless Steel
Scum removal equipment in contact with water	:	316L Stainless Steel
Scum puddle pipe	:	316L Stainless Steel
Stamford baffle and brackets	:	316L Stainless Steel
Fasteners below TWL	:	316 Stainless Steel
Fasteners above TWL	:	316 Stainless Steel
Anchor bolts for concrete	:	316 Stainless Steel

<u>Civil Requirements:</u>

The general arrangement drawing for the concrete tanks shows the basic plan and section through the tank for tender purposes. All dimensions must be confirmed on site prior to manufacturing.

The civil contractor shall be required to ensure that the finish of the concrete work is good and that all reasonable tolerances are adhered to. The successful tenderer will be required to indicate all his requirements in relation to finishes and tolerances which could affect the satisfactory installation and operation of his equipment.

A 75 mm O.D. continuous H.D.P.E. conduit pipe, with no sharp bends, (complete with a cable draw wire, protruding and fixed at each end of the conduit) will be installed by the civil contractor to convey the incoming electrical cable underneath the tank. The ends will be blocked off to prevent the entry of any foreign material during the construction period. The mechanical contractor will be expected to maintain the integrity of this pipe during the installation period.

The tank floor shall be screeded after the installation of the mechanical equipment but before the fixing of the scraper wearing edges. This shall be undertaken by the Civil Contractor but shall only take place under the supervision and in the presence of the Mechanical Contractor. The geared motor shall be disconnected from the drive wheel and wooden screeding boards shall be fixed to the scraper blades by the Civil contractor for this purpose. The screeding shall be carried out progressively by gently pushing the mechanism around by hand.

Controls and instrumentation:

The equipment shall include all limit switches and protection instrumentation, seen necessary by the Manufacturer to ensure the validity of the warrantee, to prevent damage to the equipment in overloading, etc conditions. The equipment shall have the functionality to operate in forward / reverse to try and dislodge blockages.

9.2.5. Spare Parts

The following Spare Parts shall be included and supplied together with the equipment:

- A set of special tools (if required)
- Any other parts deemed critical by the manufacturer.

Spare parts shall be packaged with labels indicating the contents of each package and shall be delivered to Owner as directed.

9.2.6. Installation and Testing

General:

The Contractor shall verify all dimensions in the field to ensure compliance of equipment dimensions with the drawings. Contractor shall notify the Engineer of significant deviations.

Installation of the equipment shall be in strict accordance with the contract documents and the manufacturer's instructions and shop drawings. Manufacturer shall supply equipment, including anchor bolts for the equipment. Contractors shall install the equipment in accordance with the manufacturer's recommendations.

Supplier shall furnish the services of a factory-trained Service Engineer for one (1) trip including a total of twenty-eight (28) days to inspect the installation, observe start up, and provide operator training.

Equipment shall not be energized, or "bumped" to check the electrical connection for motor rotation without the Service Engineer present. The Service Engineer shall make all necessary adjustments and settings to the controls and shall demonstrate proper and sequential operation.

Performance Checking and Testing:

- Works Testing:
  When there are more than two mechanisms of the same size to be supplied and installed, one unit shall be fully assembled in the workshop and the finished assembly witness and approved by the Engineer.
- Testing Prior to Start Up:
  The following tasks / checks shall be done by the Service Engineer prior to starting-up:
    - Check for correct oil in gearbox filled to the correct level
    - Charge all bearings with grease
    - Check for all bolts to the correct torque
    - Check for alignment and levelling of the whole assembly
    - Check for satisfactory rotating of the mechanism for at least one revolution by hand with the drive disconnected
    - Check for correct wheel alignment with the tank centre
    - Check for deflection of the scraper assembly by imposing a load equivalent to the design scraper loading. The scrapers must not deflect more than 50 mm
    - Check for member and joint strength of the scraper assembly by imposing a load equivalent to twice the design scraper loading. There shall be no perceptible deformation from its original state once the load has been removed
    - Check for twisting of the bridge by imposing a load equivalent to the design scraper loading. The bridge must not twist by more than 0.5° at any point along its length
    - On installations with double bridges, check for the strength of the centre pivot fixing and the torque transmission end connection by restraining the idler end carriage from movement, and starting the drive motor and gearbox. The wheel should either spin on the concrete, or the drive should trip out on overload (if an overload device is fitted). There shall be no perceptible deformation from its original state once the motor has been switched off and the load has been removed.
- Testing after Start-up:
  The following tasks / checks shall be done by the Service Engineer after the start-up:
    - Check for correct direction of rotation of motors and gearboxes
    - Check for correct Amps drawn during operation
    - Check for smooth rotational operation
    - Check for unusual noises on both gearbox and motor of all other equipment. The Engineer shall determine the acceptable noise level
    - Check for adjustment of the scraper wearing edges to the tank floor.

- Checking During Defects Liability Period:
  The following tasks / checks shall be done by the Service Engineer during the liability period:
  - Check all equipment for correct operation and functioning at 1 month, 5 month and 11 months after plant takeover.
  - Check that no scuffing is taking place on the polyurethane wheel treads.
  - Check oil levels and greasing points.

10. TELESCOPIC VALVE

The contractor shall allow for the supply and installation of a suitably size telescopic valve at the sludge outlet of the new Secondary Settling Tank. The valves shall be sized to suit the sludge outlet pipework and manufactured from 316 Stainless Steel.

It shall be flanged and drilled to suit the pipework supplied and installed under the civil contract.

The valve shall have an adjustable range of 800 mm and shall make use of a flanged joint between the adjustment - and standpipe to house the replaceable EPDM type seals.

The adjustment of the valve shall be done by means of a spindle and handwheel. The spindle and handwheel shall be properly supported by a projecting bracket headstock installed on the wall of the chamber to ensure the required alignment.

11. WASHWATER / SPARGE WATER CONNECTION

The contractor shall allow for all costs involved for the required underground pipework to route water from the connection point to the applicable equipment for washing and sparge purposes.

A water point shall be provided under the civil contract (preliminary identified on the drawings, this shall be confirmed on site) from where the Mechanical Contractor shall route suitably rated and sized HDPE PE100 pipelines to the required locations as per their layout and design. The pipeline shall be sized as to not allow frictional losses higher than 1 m / 100 m pipe.

All lines shall be equipped with shut-off valves at the connection point to the equipment.

Allowance shall be made for all fitting required including trenching and backfill, including bedding / blankets in accordance with SANS 1200.

12. MECHANICAL SLUICE GATES / ADJUSTABLE WEIRS

12.1. Specific requirements for Mechanical Sluice Gates / Adjustable Weirs

The specific requirements for the equipment shall be in accordance with the applicable Project Specification.

12.2. General requirements for Mechanical Sluice Gates / Adjustable Weirs

12.2.1. Scope of works

This specification covers the design, manufacture, testing and supply of sluice / channel gates and adjustable weirs for the use in wastewater - and potable water treatment plants.

The construction shall be robust and simple and the design shall be such that it does not require regular maintenance and only equipment of proven ability shall be provided.

The Contractor shall ensure that the equipment offered comply or exceed the requirements set out in the specification and that it is suitable for the application. The Contractor shall make allowance for a fully functional and integrated system, including all interconnecting systems that may be required. This specification shall be read in conjunction with the other Mechanical Standard Specifications whether there are specific references or not.

A copy of the signed factory test certificate shall be bound in the in with the manual, while the original shall be handed to the Engineer. This shall include:

- Operating instructions
- Maintenance instructions
- Lubrication instructions
- Spare parts list
- Drawings
- Brochures.

12.2.2. General Design Criteria

The equipment shall meet the following requirements:

a) It shall be designed to facilitate the efficient manufacture, inspection, transportation, installation, maintenance, cleaning and repairs.
b) It shall be designed with a minimum expected life of 20 years of safe and satisfactory operation under the conditions prevailing at the site
c) The design shall prevent undue stresses caused the expansion and contractions due to temperature changes and other local natural manmade conditions.
d) The design shall keep maintenance costs to a minimum
e) It shall be designed to comply completely with the legal requirements in respect of safety and the prevention of environmental pollution.
f) It shall satisfy any specific requirements contained in the relevant statutory codes and legislation.
g) The design shall allow for 24-hour operation, 365 days a year under the specific design conditions.
h) The equipment installed shall be complete and fully operational as per the requirements set out in the Scope of Works.
i) All material used for the equipment shall be suitable for the operation and environment and compatible with the intended use.
j) The design shall allow for suitable treatment to prevent corrosion and erosion of the materials and equipment.
k) After approval by the Engineer, at the time of award of the Contract, the information stated in the Data Sheets shall be fully complied with, notwithstanding the specified scope of the Contract.
l) All electrical equipment, forming part of the specified equipment, as described in the Electrical Specification, shall be sealed against penetration by hose cleaning operations as well as being accessible for repairs and maintenance.

The design shall be done in accordance with DIN 19569.

All parts shall be designed for the duty required, but the minimum factor of safety against structural failure shall not be less than 3, based on the working stress of the material. In the design, due consideration shall be given to the thickness of materials with regard to corrosion and operating conditions. The force required at the handwheel or crank to raise the gate or open the weir shall be in the order of 100 N, and the design parameters must be submitted in the Technical Schedule.

12.2.3. Materials

The Contractor shall ensure that the material offered comply or exceed the requirements set out below, unless indicated otherwise in the Project Specification, and that it is suitable for the application:

Frame	:	316L Stainless Steel
Slide	:	316L Stainless Steel
Guides	:	Polyethylene
Seal	:	EPDM
Seal Retainer	:	316L Stainless Steel
Frame guide	:	316L Stainless Steel
Stem	:	316L Stainless Steel
Stem nut	:	Bronze
Yoke	:	316L Stainless Steel
Handwheel	:	Epoxy Coated Cast Iron
Stem Protector	:	Methacrylate

12.2.4. Construction

Sluice and Channel Gates:

The sliding frames, floor seats and gates of wall mounted as well as channel type gates with head frame shall be made of material grade as specified above. All gates shall be well guided with no possibility of jamming. The gates shall be held uniformly against the side facings of the frames by the action of adjustable wedges and shall provide drop-tight closure under the operating conditions. Sluice gates shall be of the standard or flush invert type fitted with renewable seals of a non-biodegradable material on the invert.

Channel gates shall be dimensioned such that their installation in the channels and openings shown on the drawings is facilitated. The channel gates shall be standard items and shall be installed so that head frames shall be flush with vertical channel walls and do not project horizontally into the channel. Vertical sliding frames and floor seat to be cast into concrete so as to leave an unobstructed waterway to dimensions indicated on the drawing. Pre-formed recess details for casting in of frames to be submitted by the supplier. Head frame bridge for a channel gate to allow indicated water level to pass under the gate when in UP-position.

All nuts, bolts, washers and other components shall be manufactured from same grade stainless steel specified for gate.

Gates shall be robustly designed and constructed, having vertical and horizontal ribs to withstand pressures from both directions. The matching head frame for channel gates shall be adequately designed to resist distortion, and both the gate and the frame shall have machined seating faces to ensure perfect sealing. The head frame shall extend above the concrete channel, to support the gate in the fully open position.

Seating pressure as well as unseating pressure may act on any channel or circular sluice gate and the sluice gate shall be able to resist these pressures.

Holding down bolts of penstocks fixed against concrete walls shall be made of Grade 304 Stainless Steel.

Gates shall be fitted with position indicators. Fully closed, fully open and intermediate positions shall be indicated in corrosive proof and robust design indicators

All gates shall be equipped with suitable spindles and handwheels to open / close the valves. The direction of opening and closing must be indicated on the hand wheel.

Adjustable Weirs:

The sliding frames, floor seats and gates of wall mounted as well as channel type gates with head frame shall be made of material grade as specified above. All gates shall be well guided with no possibility of jamming. The gates shall be held uniformly against the side facings of the frames by the action of adjustable wedges and shall provide drop-tight closure under the operating conditions. Weirs shall be of the standard or flush invert type fitted with renewable seals of a non-biodegradable material on the invert.

Adjustable weirs shall be of the downward opening type, with suitable guides of sufficient lengths to allow the weir to open completely underneath the wall opening. Head frame bridge for a wall mounted weir to allow indicated water level to pass over the gate when in down-position.

All nuts, bolts, washers and other components shall be manufactured from same grade stainless steel specified for gate.

Gates shall be robustly designed and constructed, having vertical and horizontal ribs to withstand pressures from both directions. The matching head frame for channel gates shall be adequately designed to resist distortion, and both the gate and the frame shall have machined seating faces to ensure perfect sealing. The head frame shall extend above the concrete channel, to support the spindle and handwheel assembly.

Seating pressure as well as unseating pressure may act on any channel or circular sluice gate and the sluice gate shall be able to resist these pressures.

Holding down bolts of penstocks fixed against concrete walls shall be made of Grade 304 Stainless Steel.

Gates shall be fitted with position indicators. Fully closed, fully open and intermediate positions shall be indicated in corrosive proof and robust design indicators

All gates shall be equipped with suitable spindles and handwheels to open / close the valves. The direction of opening and closing must be indicated on the hand wheel.

12.2.5. Spare Parts

The following Spare Parts shall be included and supplied together with the equipment:

- A set of special tools (if required)
- Any other parts deemed critical by the manufacturer.

Spare parts shall be packaged with labels indicating the contents of each package, and shall be delivered to Owner as directed.

12.2.6. Installation and Testing

The Contractor shall verify all dimensions in the field to ensure compliance of equipment dimensions with the drawings. Contractor shall notify the Engineer of significant deviations.

Installation of the equipment shall be in strict accordance with the contract documents and the manufacturer's instructions and shop drawings. Manufacturer shall supply equipment, including anchor bolts for the equipment. Contractors shall install the equipment in accordance with the manufacturer's recommendations.

The installation of sluice / channel gates and overflow weirs shall include all jointing materials and labour required for the proper installation and sealing of the frames to the channel or walls, including but not limited to grouting, gaskets, etc.

Supplier shall furnish the services of a factory-trained Service Engineer for one (1) trip including a total of one (1) day to inspect the installation, observe start up, and provide operator training.

The Service Engineer shall make all necessary adjustments.

The Service Engineer shall demonstrate proper and sequential operation of the equipment and demonstrate that the equipment achieved the requirements set out in the Specifications.

13. LOW SPEED AERATORS

13.1. Specific requirements for Low Speed Aerators

The specific requirements for the equipment and type of aerator shall be in accordance with the applicable Project Specification.

13.2. General requirements for Low Speed Aerators

13.2.1. Scope of works

This specification covers the design, manufacture, testing and supply of electrically driven, horizontally mounted, brush type aerators.

The construction shall be robust and simple and the design shall be such that it does not require regular maintenance and only equipment of proven ability shall be provided.

The Contractor shall ensure that the equipment offered comply or exceed the requirements set out in the specification and that it is suitable for the application. The Contractor shall make allowance for a fully functional and integrated system, including all interconnecting systems that may be required. This specification shall be read in

conjunction with the other Mechanical Standard Specifications whether there are specific references or not.

A copy of the signed test certificate shall be bound in the in with the manual, while the original shall be handed to the Engineer. This shall include:

- Operating instructions
- Maintenance instructions
- Lubrication instructions
- Spare parts list
- Drawings
- Brochures.

13.2.2. General Design Criteria

The equipment shall meet the following requirements:

a) It shall be designed to facilitate the efficient manufacture, inspection, transportation, installation, maintenance, cleaning and repairs via a stable walkway.
b) It shall be designed with a minimum expected life of 20 years of safe and satisfactory operation under the conditions prevailing at the site
c) The design shall prevent undue stresses caused the expansion and contractions due to temperature changes and other local natural manmade conditions.
d) The design shall keep maintenance costs to a minimum
e) It shall be designed to comply completely with the legal requirements in respect of safety and the prevention of environmental pollution.
f) It shall satisfy any specific requirements contained in the relevant statutory codes and legislation as well as prevention of water and air pollution.
g) The design shall allow for 24-hour operation, 365 days a year under the specific design conditions.
h) The equipment installed shall be complete and fully operational as per the requirements set out in the Scope of Works.
i) All material used for the equipment shall be suitable for the operation and environment and compatible with the intended use.
j) The design shall allow for suitable treatment to prevent corrosion and erosion of the materials and equipment.
k) After approval by the Engineer, at the time of award of the Contract, the information stated in the Data Sheets shall be fully complied with, notwithstanding the specified scope of the Contract.
l) All electrical equipment, forming part of the specified equipment, as described in the Electrical Specification, shall be sealed against penetration by hose cleaning operations as well as being accessible for repairs and maintenance.

The design shall be done in accordance with DIN 19569.

All parts shall be designed for the duty required, but the minimum factor of safety against structural failure shall not be less than 3, based on the working stress of the material. In the design, due consideration shall be given to the thickness of materials with regard to corrosion and operating conditions. The force required at the handwheel or crank to raise

the gate or open the weir shall be in the order of 100 N, and the design parameters must be submitted in the Technical Schedule.

Certification:

Tenderers shall provide proof or sufficient evidence of oxygenation capacities and oxygenation efficiencies (for instance by submitting a report by a recognised testing organisation on the performance) and must state clearly how aerator performance was assessed. Failure to submit this information shall lead to the rejection of the tender on the grounds of being incomplete.

Before final adjudication of the tender, the Engineer may call upon a Tenderer to verify his claims for oxygenation capacities and efficiencies by conducting a complete set of performance tests on the actual type and size of aerator offered in the presence of the Engineer (i.e. complete aerator, gearbox and electric motor) in a test tank of the same size and proportion as a pocket in the aeration basin, according to the procedure as described below under the conditions specified by the Tenderer (depth of immersion, speed of rotation) for optimum performance. The tests are to be carried out during normal working hours in a test facility provided by the Tenderer at his facilities.

Tenderers shall make separate provision at the end of the priced schedule of prices for conducting these tests. This item shall not form part of the contract and shall be paid to those tenderers who are called upon to conduct these tests, as reimbursement for costs involved (excluding subsistence and travelling allowances for the Engineer to witness the tests) in conducting the demonstration tests.

Oxygenation Capacity Determination:

The oxygenation capacity of an aerator is defined for the contract as the mass of oxygen (in kilograms) that the aerator can introduce per hour at 20°C and 760 mm pressure into tap water containing no surface active agents, zero dissolved oxygen and not more than 1 000 mg/l of dissolved solids in a test unit which resembles a single aeration pocket of the proposed aeration basin in its basic geometrical dimensions and energy level.

The unsteady state test method using sodium sulphite to deoxygenate the water in the test vessel shall be employed. In this set-up the following relationship holds:

$$\frac{dC}{dt} = K_L a(T).[C_S(T)-C] \qquad (1)$$

where:

$\frac{dC}{dt}$ is the rate of change of oxygen concentration [mg/l/hr]

$K_L a(T)$ is the oxygen coefficient in tap water at T°C [hr^{-1}]

$C_s(T)$ is the rate of change of oxygen concentration per unit driving force (mg/l/hr per mg/l oxygen deficiency) saturation concentration of oxygen in tap water at T°C and ambient barometric pressure [mg/l]

C is the actual concentration of oxygen in tap water in aeration basin [mg/l]

The value of $C_s(T)$ to be used in equation (1) is calculated from the following relationship:

$$Cs(T) = \frac{468-2.65S}{31.6+T}\ x\ \left(\frac{P-pw}{760-pw}\right) \quad (2)$$

where:

$C_s(T)$ saturation concentration of oxygen in tap water at T°C and ambient barometric pressure [mg/l]

S is the dissolved solids in tap water in aeration basin [parts per 1000]

T is the temperature in the tap water in the aeration basin [°C]

P is the barometric pressure [mm Hg]

pw is the saturation vapour pressure of water at T°C [mm Hg]

In equation (1) $\frac{dC}{dt}$ and C can be determined, and $C_S(T)$ can be obtained from equation (2) above, so that the value of $K_La(T)$ can be calculated.

Its value at 20°C can then be obtained using the follow relationship:

$K_La(T) = K_La(20) \times 1.02^{(T-20)}$

$K_La(20) = K_La(T) \times 1.02^{(20-T)}$

From the value of $K_La(20)$ the oxygenation capacity of the aerator in tap water in the test unit is calculated as follows:

$O.C = K_La(20).C_S(20).V \times 10^{-3}$

where:

O.C is the oxygen transfer capacity under Standard Conditions [kg.O_2/hr]

$C_S(20)$ is the saturation concentration of oxygen in tap water containing 1000 mg/l dissolved solids at 20 °C and 760 mm barometric pressure [mg/l]

Is taken as 9.02 mg/l

V is the volume of test unit under consideration [m^3]

13.2.3. Materials

The Contractor shall ensure that the material offered comply or exceed the requirements set out below, unless indicated otherwise in the Project Specification, and that it is suitable for the application:

Brush type Aerator:

Baseplate and splash guard	:	316 Stainless Steel
Rotor / drum	:	Epoxy coated and Hot-dipped galvanised mild steel
Stub shafts	:	316 Stainless Steel
Brushes	:	LDX Stainless Steel
Bolt-in shafts	:	316 Stainless Steel
Walkway, removable covers	:	Epoxy Coated HDG Mild Steel
Handrailings	:	Epoxy Coated HDG Mild Steel
Guides	:	Polyethylene
Seal	:	EPDM

Vertical shaft type Aerator:

Baseplate and splash guard	:	316 Stainless Steel
Rotor	:	Fibreglass with mild steel reinforcement
Shaft	:	316 Stainless Steel
Bolt-in shafts	:	316 Stainless Steel
Aerator platform, brackets, Pontoon, fasteners, etc.	:	316 Stainless

13.2.4. Construction – Brush Type Aerator

Rotor:

Stainless Steel brushes shall be welded to a suitably sized rotor or flanged pipe. The brushes shall be orientated in a spiral configuration to achieve balance and rotation. The brush width and length shall be designed to meet the requirements of the design parameters as indicated in the Project Specification. The rotor and shaft assembly shall be designed to handle all static and dynamic forces exerted on it by the water.

The rotor assembly shall have welded-in, machined inner plates that allow both the drive- and non-drive end shafts the ability to be bolted into the rotor. It shall be a piloted type bolt-in shaft assembly, where the bolt-in shaft fits into the machined inner plate. A wedge-flange on the outer diameter of the rotor with a bolt-on shaft is not acceptable.

The rotor shall have a flange or disc installed on the drive-end to prevent excessive water to be splashed on the drive unit.

Gearbox Assembly:

Each aerator shall be directly coupled to a suitably designed gearbox and directly driven by an electrical motor via a flexible coupling.

The gearbox / speed reducer shall be designed for continues operation over 24h per day. The mechanical power ratings (according to AGMA rating) shall be greater than 2.25 times the installed power and shall account for D.O.L. starting of the unit at full load conditions (maximum immersion).

Motor:

The electric motors shall be coupled to the gearboxes by means of a pin type flexible coupling.

The size of the aerators and aerator gearboxes shall be based on standard electric motor sizes and shall be rated to absorb the total mechanical power delivered by the standard electric motor. The power available for aeration at the motor shaft shall be de-rated to 90% of motor rated power, namely an allowance of 10% shall be made for additional losses in the electrical motor at full load.

A heater shall be provided for each motor and shall be rated for the corrosive environment of the site. Motors shall be fitted with weather hoods to prevent ingress of rain into the motor.

Electrical motors shall be orientated to ensure the shortest possible length of cable to the motors. All unused holes for lifting lugs and other appurtenances in the motor housing shall be plugged.

For a detailed specification for the electrical motors required refer to applicable Mechanical Standard Specification

Non-drive End Rotor Bearing / Pillar Block:

The non-drive end bearing shall be grease lubricated, Stainless Steel, eccentric collar, ball bearing assembly. The bearing shall have a 304L Stainless Steel inspection cover and an auxiliary, non-corrosive seal mounted in a 304L Stainless Steel seal plate on the rotor assembly side of the bearing bracket.

The eccentric collar shall have a Stainless Steel rear cover mounted above and around the bearing bracket sides.

All bearings shall be designed for a life of at least 100 000h at a L10 rating.

A spring-loaded grease feeder shall be provided with each aerator to lubricate the non-drive end bearing. The feeder shall provide grease to the bearing as needed. Manual greasing of the bearing shall not be allowed. The feeder shall be manually refilled, and the frequency of the refill shall be indicated in the Operating and Maintenance Manual.

Neither plastic bearings that may or may not use wear sleeves or bushings nor water lubricated bearings shall not be acceptable.

Alternative lubrication methods of the bearings may be submitted as alternative to the main offer for approval by the Engineer.

Aerator Mixing:

It is essential that the aerators can mix the content of the aeration basin all the time, especially when the oxygen demand is low. Since the pumping capacity of an aerator

varies inversely with the tip speed of the aerator, preference will be given to aerators have a good pumping action when operating at low rotational velocity at high speed. The aerator tip speed and rotational velocity shall not exceed the following limits:

Aerators ≥ 45kW: 5.0 m/s tip speed with a maximum acceptable rotational speed of 80 rpm

Aerator Support Structure:

Each aerator rotating assembly shall be mounted in a purpose designed and suited Stainless Steel frame or baseplate, ensuring the required tolerances for operation are met and all equipment is supported and anchored to handle all static and dynamic forces, including deflection by the rotor. The frame shall be constructed out of standard Stainless Steel profiles and designed to fit the concrete structure. The frame shall be designed such that no sagging is experience over the width of the channel.

The structure will also include a splash guard on both the drive- and non-drive end of the rotor to prevent water from reaching the drive- and non-drive bearing units.

The frame shall incorporate a walkway, including removable inspection panels and hand railings.

13.2.5. Construction – Vertical shaft Aerator

Rotor:

The rotor shall be one-piece moulded fibreglass of monolithic construction and internally reinforced with a steel structure to maximise strength and performance. The entire assembly shall be filled with closed cell polyurethane foam for additional structural support and to assume the rotor floats in the water for ease of assembly and reducing downward load on the gear drive. Each blade shall be smooth-edged to prevent ragging and specifically designed to maximise oxygen transfer.

Shaft:

The aerator shaft shall be Stainless Steel of adequate size to transfer the applied torque and to resist bending. A precision machined Stainless Steel flange type coupling shall be welded to the upper end of the shaft to connection with the output shaft of the geared motor.

Gearbox Assembly:

Each aerator shall be directly coupled to a suitably designed gearbox and directly driven by an electrical motor via a flexible coupling.

The gearbox / speed reducer shall be designed for continues operation over 24h per day. The mechanical power ratings (according to AGMA rating) shall be greater than 2.25 times the installed power and shall account for D.O.L. starting of the unit at full load conditions (maximum immersion).

Motor:

The electric motors shall be coupled to the gearboxes by means of a pin type flexible coupling.

The size of the aerators and aerator gearboxes shall be based on standard electric motor sizes and shall be rated to absorb the total mechanical power delivered by the standard electric motor. The power available for aeration at the motor shaft shall be de-rated to 90% of motor rated power, namely an allowance of 10% shall be made for additional losses in the electrical motor at full load.

A heater shall be provided for each motor and shall be rated for the corrosive environment of the site. Motors shall be fitted with weather hoods to prevent ingress of rain into the motor.

Electrical motors shall be orientated to ensure the shortest possible length of cable to the motors. All unused holes for lifting lugs and other appurtenances in the motor housing shall be plugged.

For a detailed specification for the electrical motors required refer to applicable Mechanical Standard Specification

Non-drive End Rotor Bearing / Pillar Block:

The non-drive end bearing shall be grease lubricated, Stainless Steel, eccentric collar, ball bearing assembly. The bearing shall have a 304L Stainless Steel inspection cover and an auxiliary, non-corrosive seal mounted in a 304L Stainless Steel seal plate on the rotor assembly side of the bearing bracket.

The eccentric collar shall have a Stainless Steel rear cover mounted above and around the bearing bracket sides.

All bearings shall be designed for a life of at least 100 000h at a L10 rating.

A spring-loaded grease feeder shall be provided with each aerator to lubricate the non-drive end bearing. The feeder shall provide grease to the bearing as needed. Manual greasing of the bearing shall not be allowed. The feeder shall be manually refilled, and the frequency of the refill shall be indicated in the Operating and Maintenance Manual.

Neither plastic bearings that may or may not use wear sleeves or bushings nor water lubricated bearings shall not be acceptable.

Alternative lubrication methods of the bearings may be submitted as alternative to the main offer for approval by the Engineer.

Aerator Mixing:

It is essential that the aerators can mix the content of the aeration basin all the time, especially when the oxygen demand is low. Since the pumping capacity of an aerator varies inversely with the tip speed of the aerator, preference will be given to aerators have a good pumping action when operating at low rotational velocity at high speed. The aerator tip speed and rotational velocity shall not exceed the following limits:

Aerators ≥ 45kW: 5.0 m/s tip speed with a maximum acceptable rotational speed of 50 rpm

Aerator floats:

A three-pontoon system with supporting brackets and mounting platform shall be provided for each aerator (if required). This float assembly shall be manufactured by a reputable manufacturer approved by the Engineer.

Each pontoon shall have all seams and ends fully closed. Marine grade polymer foam shall be injected into each pontoon to totally fill the interior. All foam fill ports shall be plugged and sealed. Each pontoon shall be provided with Stainless Steel supports on which brackets can be bolted.

Structural members shall be provided to span between the pontoons and provide a support for the aerator mounting platform and accessories. The mounting platform shall be 20 mm minimum thick plate and incorporate four threaded rods and nuts for adjusting the aerator rotor depth of submergence over a range of 300 mm.

Each float system shall provide a floatation safety factor of at least twice the total assembly weight, including the aerator, geared motor and accessories, while still providing a stable platform. The flotation system shall withstand normal wave action, wind velocities and aerator torque without capsizing. The complete floatation system (pontoon) shall not be more than 75% submerged when a 120kg person is standing on it.

Floats shall be designed in such a way that ballast can be added for stability and to achieve the optimum level of aerator efficiency by varying the immersion.

Each floatation system shall be capable of being moored in position as shown on the layout drawing(s). Special Stainless Steel eye attachments shall be provided on at least three points on the concrete wall for anchoring the aerator in place. The unit shall be supplied with all Stainless Steel cables and joints to moor the aerator.

13.2.6. Spare Parts

The following Spare Parts shall be included and supplied together with the equipment:

- A set of special tools (if required)
- Any other parts deemed critical by the manufacturer.

Spare parts shall be packaged with labels indicating the contents of each package and shall be delivered to Owner as directed.

13.2.7. Installation and Testing

The Contractor shall verify all dimensions in the field to ensure compliance of equipment dimensions with the drawings. Contractor shall notify the Engineer of significant deviations.

Installation of the equipment shall be in strict accordance with the contract documents and the manufacturer's instructions and shop drawings. Manufacturer shall supply equipment, including anchor bolts for the equipment. Contractors shall install the equipment in accordance with the manufacturer's recommendations.

Supplier shall furnish the services of a factory-trained Service Engineer for one (2) trip including a total of three (3) days to inspect the installation, observe start up, and provide operator training.

The Service Engineer shall make all necessary adjustments.

The Service Engineer shall demonstrate proper and sequential operation of the equipment and demonstrate that the equipment achieved the requirements set out in the Specifications.

Performance Testing Procedure:

The tests for oxygenation capacity and oxygenation efficiency shall consist of the measurement of the rate of increase of dissolved oxygen in the water and the measurement of the gross power consumption of the aerator under test. The points at which the dissolved oxygen concentration in the test tank are to be measured, shall be to the satisfaction of the Engineer and shall be selected to provide a reading that best represents the average dissolved oxygen concentration in the whole tank. There shall be at least three such points. Dissolved oxygen measurement shall be made with direct reading probes, standardised in accordance with the instructions supplied with the instrument. The instrumentation shall be supplied by the Contractor.

At the time of the test, the temperature of the water shall be taken immediately before and immediately after the test run at each probe. The average of all these readings shall be taken as the average temperature of the water in the tank. A sample of the water shall be taken immediately after the test run for determination of the total dissolved solids concentration.

The barometric pressure at or near the water level in the tank shall be read once during the test period.

From the results of the test conducted as described above, the oxygenation capacity of the aerator under test shall be calculated as set out in 12.2.2.

The power consumption during a test of the aeration equipment in the test basin shall be registered on a calibrated and certified kW/h meter that is specifically connected to register only the power supply to the aerator under the test.

The oxygenation efficiency of the aeration equipment (aerator, gearbox and electric motor) shall be calculated from the oxygenation capacity and power consumption as the mass of oxygen measured in kilograms which the aerator can introduce over a period into a body of completely deoxygenated water, divided by the power input to the motor over the same period, measured in kilowatt-hours.

The test shall be repeated if inconclusive or if required by the Engineer.

14. GRAVITY THICKENER AND BELT PRESS:

14.1. Specific requirements for Gravity Thickener and Belt Press

The specific requirements for the equipment shall be in accordance with the applicable Project Specification.

14.2. General requirements for Gravity Thickener and Belt Press

14.2.1. Scope of Works

This part of the specifications covers the design, supply, delivery to site, installation and commissioning of the main and ancillary equipment required for the automated, gravity thickener and belt press designed to lower the water content in waste activated sludge.

The dewatering plant shall consist out of a Gravity Belt Thickener (GBT) as a linear screen and a Dewatering Press as a belt-filter press.

Each linear screen shall comprise of (but not limited to) the following basic components:

k) An inline flocculation mixer
l) A thickener framework supporting all equipment
m) A feed and maturing unit
n) A set of rollers
o) A filter belt
p) Belt supporting members
q) Sludge ploughs or chicanes
r) A sludge retention ramp
s) A belt discharge craper
t) A drive unit
u) A belt tensioning system
v) A belt tracking system
w) A belt washing system
x) A wash water collection and drainage system
y) A filtrate collection and drainage system
z) All necessary enclosures and guards

Each belt filter press shall comprise of (but not limited to) the following basic components:

a) A rigid framework
b) A feed chute
c) A set of dewatering rollers / drums
d) Filter belts
e) Belt support member
f) Sludge ploughs / chicanes
g) Belt discharge scrapers
h) A drive unit
i) A belt tensioning system
j) A belt tracking system
k) A belt washing system
l) A wash water collection and drainage system
m) A filtrate collection and drainage system
n) All necessary enclosures and guards

A dewatering system that requires periodic manual cleaning of the belts and rollers shall not be accepted. The construction shall be robust and simple. The design shall be such that it does not require regular maintenance and only linear screens and belt filter presses of proven ability shall be provided.

The Contractor shall ensure that the equipment offered comply or exceed the requirements set out in the specification and that it is suitable for the application. The Contractor shall make allowance for a fully functional and integrated system, including all interconnecting systems that may be required. This specification shall be read in

conjunction with the other Mechanical Standard Specifications whether there are specific references or not.

14.2.2. Design Criteria

The equipment shall meet the following general requirements:

a) It shall be designed to facilitate the efficient manufacture, inspection, transportation, installation, maintenance, cleaning and repairs.
b) It shall be designed with a minimum expected life of 20 years of safe and satisfactory operation under the conditions prevailing at the site
c) The design shall prevent undue stresses caused the expansion and contractions due to temperature changes and other local natural manmade conditions.
d) The design shall keep maintenance costs to a minimum
e) It shall be designed to comply completely with the legal requirements in respect of safety and the prevention of environmental pollution.
f) It shall satisfy any specific requirements contained in the relevant statutory codes and legislation.
g) The design shall allow for 24-hour operation, 365 days a year under the specific design conditions.
h) The equipment installed shall be complete and fully operational as per the requirements set out in the Scope of Works.
i) All material used for the equipment shall be suitable for the operation and environment and compatible with the intended use.
j) The design shall allow for suitable treatment to prevent corrosion and erosion of the materials and equipment.
k) After approval by the Engineer, at the time of award of the Contract, the information stated in the Data Sheets shall be fully complied with, notwithstanding the specified scope of the Contract.
l) All electrical equipment, forming part of the specified equipment, as described in the Electrical Specification, shall be sealed against penetration by hose cleaning operations as well as being accessible for repairs and maintenance.

<u>Linear Screen:</u>

The linear screen shall be of the multi-stage continuous type, designed to achieve the performance requirements as mentioned in the Project Specification. It shall consist out of the following process stages:

a) A flocculation unit,
b) A flocculation head box
c) A horizontal gravity drainage zone
d) An extended thickening zone

The linear screen shall comprise three (3) separate thickening zones, as described as follows:

a) A flocculation head box – Sludge is fed to the linear screen feed, consisting of a head for for extensive flocculation reaction time
b) A horizontal gravity drain zone – sludge is thickened on the belt by means of gravity and free filter surface is generated by a plough system

c) An extended thickening zone – the sludge thickening process is extended by means of an adjustable ramp device

Each zone shall be designed in such a way that water is progressively removed from the sludge without floc break up and loss of sludge solids through the belt and into the filtrate. The design layout of the linear screen should be compact, with minimum filter-belt area wastage. Separate collection compartments shall be provided to collect the clear filtrate and the wastewater of the belt wash system.

Belt filter press:

The linear screen shall be of the multi-stage continuous type, designed to achieve the performance requirements as mentioned in the Project Specification. It shall consist out of the following process stages:

a) A gravity dewatering section
b) A wedge dewatering section
c) A section where pressure is applied to dewater the sludge

The belt filter press shall comprise five (5) separate dewatering zones, as described as follows:

a) A horizontal dewatering zone – sludge is thickened on a single belt by means of gravity and free filter surface is created by a plough system
b) A wedge dewatering zone – sludge is subjected to a gradual increase in pressure as the two belts converge and all free water is removed from the conditioned sludge before it passes between the belts
c) A low pressure dewatering zone – slowly increasing pressure on the sludge as the two belts pass around a large perforated drum with shovels inside
d) A pressure dewatering zone – decreasing roller diameters to increase the pressure upon the sludge
e) A high pressure (shear) dewatering zone – additional small rollers for increased pressure and shear on the sludge

The design of the dewatering zone shall permit a gradual increase in dewatering pressure after exiting the horizontal dewatering zone. Each zone shall be designed so that water is progressively removed from the sludge without floc break up and loss of sludge through the belt and into the filtrate. Emphasis shall also be placed upon the design relating to the transfer of sludge from zone to zone to ensure minimum shock and subsequent loss of sludge solids to the filtrate.

The design layout of the pressure zones shall be compact, with minimum filter-belt area wasted in tangents between press rollers. Separate collection pans / shall be provided to collect the filtrate from the gravity dewatering zone, from the wedge- and low-pressure dewatering zones, and from the belt wash system.

14.2.3. Materials

The materials for the linear screen shall meet or exceed the following material requirements:

Framework:	316 Stainless Steel
Access Panels and Guards:	316 Stainless Steel
Collection pans:	316 Stainless Steel
Inline-mixer:	Aluminum cast
Feed chute:	316 Stainless Steel
Drive roller:	Carbon steel, rubber coated
Tensioning roller:	Carbon steel, coated
Belt Supports:	316 Stainless Steel
Sludge ploughs/chicanes:	Gray cast iron hot galvanized, plastic PE 1000
Spray wash system:	316 Stainless Steel
Belt discharge scraper:	Steel hot galvanized, plastic PE 1000

Corrosion Protection for the linear screen:

The tensioning roller shall be coated with 'Vestosint' or equal thermo plastic polymer material layer thicker than 1mm. The drive roller shall be coated with reinforced neoprene rubber layer thicker than 5mm. The geared motor shall be epoxy coated. All Stainless Steel shall be correctly pickled and passivated and all surfaces shall be clear of ferrous stain at commissioning.

The materials for the belt filter press shall meet or exceed the following material requirements:

Framework:	Mild Steel, hot dipped galvanized
Feed chute:	316 Stainless Steel
Rollers:	Carbon steel, coated
Perforated rollers:	Hot galvanized steel
Belt Supports:	316 Stainless Steel
Sludge ploughs/ chicanes:	Gray cast iron hot dipped galvanized, plastic PE 1000
Spray wash system:	316 Stainless Steel
Belt discharge scraper:	Steel hot galvanized, plastic PE 1000
Collection pans:	316 Stainless Steel
Internal piping:	316 Stainless Steel / plastic PP

Corrosion Protection belt filter press:

The roller shall be coated with 'Vestosint' or equal thermo plastic polymer material layer thicker than 1mm. The drive roller shall be coated with reinforced neoprene rubber layer thicker than 5mm. The geared motor shall be epoxy coated. All Stainless Steel shall be

correctly pickled and passivated and all surfaces shall be clear of ferrous stain at commissioning.

14.2.4. Construction – Linear Screen

Framework:

The framework shall be a robust, heavy-duty assembly to suit the highly corrosive and particular operating environment. It must consist of a tight full penetration weld Stainless Steel sheet trough design. The framework shall incorporate the following compartments:

- A feed and maturing compartment for optimized sludge flow and maximised floc build-up
- A big filtrate compartment with suitably sized discharge and wash water pump connections
- A separate wastewater compartment for separate capture and discharge of contaminated wash water

The structural frame shall be designed to provide maximum rigidity and be such that rollers can be removed from the side, top or end of the frame with minimum disturbance to the other roller assemblies. Complete protection shall be provided against egress of spray or spillage and against accidental contact with the rolling assemblies during operation.

Tight and large access hatches shall be provided at all points where access would be required during normal operation to observe the machine operation, or for wash down and maintenance purposes. The structural frame shall be designed to take all horizontal loads imposed by the components without external support (e.g. from the building or floor).

Flocculation Unit:

A flocculation unit shall be supplied and installed upstream of the sludge feed flange of the linear screen. This unit shall consist of an inline mixing unit with at least four points of injection for polymer as well as mixing device that would allow adjustment.

The unit shall be positioned to allow the required contact time of the polymer with the product prior to reaching the linear screen.

Sludge Feed Head Box:

The feed box shall be designed for a continues sludge flow from the bottom feed flange / flanges to the top overflow edge to feed the revolving belt of the linear screen. The volume of the feed box shall be designed to provide a long flocculation reaction time. The design should avoid sedimentation of sludge under all operation conditions. The sludge flocculation shall be enhanced by moderate turbulence without floc break up, therefore mechanical or electrical agitators are not acceptable.

The feed of sludge to the revolving belt shall be evenly distributed over the full effective belt width in such a manner as to avoid excessive turbulence and consequent floc break up.

The overflow edge shall of an abrasion resistant plastic ridge must be replaceable. The design shall be such that the sludge cake will freely discharge off the belt without manual assistance.

Plough System (Chicanes):

Ploughs, either hinged or vertically sliding in individual guides, shall be incorporated to rest on and be in light contact with the top belt to gently move the sludge in such a way that the belt does not blind / clog with solids, and provide efficient drainage. It shall 'plough' the sludge blanket so that the maximum degree of free drainage is achieved in the gravity section.

The sludge ploughs shall be designed to facilitate safe adjust by the operator. It shall be possible to remove the ploughs from the sludge blanket if considered necessary during operation. A minimum of three rows of ploughs shall be provide and the life of a plough shall be guaranteed for at least 30 000 hours of continuous running.

Belt Support Members:

The top side of the belt shall be kept truly flat to ensure that the ploughs are always in sufficient contact with the sludge on the belt. This is achieved by easily replaceable engineered plastic slider bars, in conjunction with keeping the belt tension. Slider members shall be guaranteed for at least 5 000 hours of continuous running. A set of filtrate pans shall be provided to drain the filtrate to the filtrate compartment, to avoid rewetting the cleaned belt.

Filtrate Compartment:

The design of the filtrate compartment shall include a minimum of one discharge pipe connection as well as one wash water pump pipe connection at the bottom of the compartment. Buffering of clear filtrate for belt washing purposes shall be possible in the compartment.

Extended Thickening Zone:

For further sludge thickening, the sludge blanket shall be retained by an increasing ramp formed device, which shall be situated between the horizontal gravity thickening zone and the sludge discharge. The ramp angle shall be adjustable, and the ramp shall be liftable. The ramp scraper shall not damage the belt or cause excessive wear or damage to the filter cloth. The blade shall be adjustable to allow for wear and shall be exchangeable. The blade material shall be an abrasion resistant plastic. The blade support shall be sufficiently stiff to prevent deflection in operation which would permit thickened cake to pass by.

Roller Construction:

Roller bearing shafts and end flanges shall be so designed to transmit bearing loads to the outer periphery of the end flange without significant diaphragm mode deflection of the end flange.

Roller shafts shall be stressed on the assumption that the end flange is rigid. Sufficient information shall be provided by the suppliers to demonstrate the integrity of the end flange design.

Where through-shafts are proposed, the supplier shall demonstrate that the design provides adequate support to the through-shaft to prevent bending, excessive stress ro fretting in service.

Roller shafts shall be an adequate interference fit in the end flanges. Stub-welding shall be permitted only on the inner or hidden side of the flange and must be used for location purposed on and not to carry load. Welding shall be full-penetration and shall not take place a high stress points. Metallurgical notches shall be avoided, and the welded roller assembly shall be fully stress relieved prior to machining. The heat shrinking of sub shaft assemblies to the tube may be employed to eliminate metallurgical notches caused by welding.

All rollers shall be designed to withstand the stress reversals inherent in rotating elements with a minimum safety factor of 4.0 over the yield stress of the material for shafts, connections between shafts, end plates, drums and roller bodies, etc.

The basic design criteria for rollers shall be a maximum center span deflection of 0.5 mm/m width at maximum belt tension. The design tension shall be stated. Roller dimensions and stress calculations shall be provided at tender stage. The cylindrical bodies of all rollers and drums shall be manufactured from steel tube with dimensions to ANSI B 36.10 and have a wall thickness of at least Schedule 40, or similar DIN2448.

Stub shafts shall be manufactured from low carbon steel bar and not less than 55mm in diameter. Mechanical notches shall be avoided by using smooth and large radii at the knuckle. Flanges shall be manufactured from carbon steel plate. All rollers shall be machined on the cylindrical outer surface to be truly concentric with the stub shafts.

Bearings and Bearing Housings:

All bearings shall be of the adjustable roller or ball self-aligning type and suitable for the environment in which they will operate including high pressure washing. Housings shall have one or two locating rings. The locating ring/s shall only be installed in one of the rollers bearings so that thermal expansion of the relevant roller can be taken up in the housing at the opposite end. Seals shall be suitable for the environment in which they will operate and be resistant to high pressure washing. A triple fold labyrinth-contact-type seal, preferably spring-loaded, shall be provided to give further protection on the inner side.

Bearings or other tracking and tensioning mechanical or electrical equipment, shall only be located inside the enclosure in the wetted area of the linear screen if designed for such purposes. Bearings shall accommodate a misalignment of up to 3 ° included angle without reduction in capacity.

Bearing inserts shall be stock sizes readily available from local distributors and suppliers.

In addition, the bearings on the output shaft shall be capable of withstanding the resultant forces caused by a combination of radial and axial loads, for example roller self-weight and drive torque.

Bearing selection data shall be submitted at tender stage showing the method of calculating L10 bearing life and detailing methods of calculating bearing loads. Bearings

shall be selected for a L10 life of 200 000 hours minimum, using maximum operating conditions. Calculations shall also allow for roller self-weight and drive torque.

Bearing housings shall be provide with multiple lip seals to prevent ingress of moisture and other contaminants. Shafts shall pass through a solid bulk head separating the wetted area of the linear screen from the bearing location area and shall include a separate shaft seal through the bulkhead as additional protection.

A full list of bearings with identification type numbers shall form part of the technical submittals.

Lubrication nipples shall be reachable from the outside of the linear screen for lubrication during machine operation.

Belts:

The linear screen belt shall be manufactured from high permeability durable woven monofilament polyester fiber selected to meet the duty requirements with a minimum operational life before replacement of approx. 3000 – 4000 hours before refurbishment. The belt and belt cloth shall be selected for high tension operation.

The belt shall be able to operate at a speed of between 7 m/mine and 40 m/min. The speed of the belt shall be variable during the operation of the unit.

The tensile strength of the belt shall be selected by the Contractor to meet the operational requirements of the equipment, including belt tension and roller diameter. The belt shall be joined by an approved clipper seam using high tensile steel cable bonded with resin and incorporating a chevron or similar stabilizing seam. Belt edges shall be heat sealed and bonded for stability. All metallic parts of the belt joint seam shall be stainless steel.

Belt tensioning:

The belt tensioning system shall ensure appropriate operation without formation of belt wrinkles. Elongation of belts shall be compensated for automatically. Each tensioning unit shall be of robust design incorporating double spring-loaded rods to avoid tilting, therefore single spring-loading is not acceptable. The design of each tensioning unit shall be configured for installation inside the linear screen.

Belt tracking:

For proper belt alignment, the linear screen shall include a mechanical belt tracking system which shall not use any items which lead to any belt edge deformation or wear. The belt tracking system shall comprise of at least 2 guiding plates with ceramic faces on each belt edge side. In addition, one sensor at each side of the belt shall be provided to sense a shut-down misalignment condition. The sensors shall be used to initiate and alarm in the control panel.

Dished rollers for belt tracking are not acceptable, nor shall hydraulic or pneumatic tracking systems be used.

Belt Wash System:

A belt washing system shall be provided to ensure adequate cleaning of the belt and to prevent blinding. Spray nozzles shall be specifically designed for cleaning purpose and shall have an overlapping pattern. The nozzle header shall be easily removable for cleaning and inspection, if required. The spray bar shall be provided by the Contractor with a built-in cleaning brush of STAMM or equivalent type. This shall be capable of being used while the linear screen is in operation.

The spray system to wash the belt, nozzles and pipework shall be manufactured of Grade 316 Stainless Steel.

The contaminated wash water shall be captured in the wastewater compartment forming an integral part of the linear screen construction. The wastewater shall be discharged by pipe connections in the required dimensions.

Sludge Cake Removal Blades:

A scraper mechanism shall be provided for removing the sludge cake from the belt. The scraper shall not damage the belts or causing excessive wear or damage to the filter cloth.

The blade shall be adjustable to allow for wear. Blade material shall be an abrasion resistant plastic. The design shall be such that the sludge cake will freely discharge off the belt without manual assistance. The blade support shall be sufficiently stiff to prevent deflection in service which would permit dewatered cake to pass by.

Transfer Chute:

The discharge sludge shall be transferred to the dewatering press in a transfer chute system and shall be manufactured from grade 316 Stainless Steel. The design of the chute system shall be focused on a gentle sludge transfer without breaking up floc.

Drive Unit:

The belt shall be driven through a geared motor-speed-reducer drive, incorporating helical gears. Worm gears will not be considered. Gears shall be manufactured from the highest quality alloy steel, gas-carburized and accurately ground. All gears and pinions shall be manufactured by an approved process to AGMA 390.02 Class 12 or ISO. 1328 Class 6.

The belt drive arrangement shall provide positive drive of the filter belt and shall be operated via variable frequency supply. The gear box shall be totally enclosed, oil tight and grease lubricated. It shall be possible to inspect all transmission components by removing the cover plate. It shall be possible to inspect or replace transmission components without disturbing rollers, and to simply drain and re-fill oil.

DC motors or AC variable frequency systems shall be acceptable for the variable speed drive. The effective speed range of the configuration offered shall be clearly stated, together with overall transmission efficiencies over the speed range. Particular attention shall be paid to the cooling of the motors at low speeds. Geared motors shall be selected from a standard range, ideally from one of the following manufacturers who are well represented in South Africa: Flender, SEW or Bauer or equally and similar approved.

The variable frequency inverter will be located in the Thickening Unit's control panel of the Motor Control Centre and is discussed in the applicable Electrical Project and Standard Specification.

Inspection Panels and Guards:

The linear screen shall be designed and constructed in accordance with the requirements of the Occupational Health and Safety Act, in such a way as to provide maximum protection for operational staff against injury from moving machinery and any harm to health from the bio-hazards present in air borne particles from sprays containing sewage sludge.

The linear screen shall be enclosed at the sides, ends and bottom to prevent splashing, aerosol and spray discharge from the units. Protection shall be provided against accidental contact with rolling assemblies, drives and pinch zones between roller and belt and other moving parts during operation, by the provision of hinged guard panels in the framework enclosure.

Tight lockable access hatches and panels shall be provided at all points on the linear screen where access would be required for inspection, maintenance and cleaning purposes.

For health and safety reasons and for convenient access to the sludge discharge side the linear screen shall be equipped with gas spring-loaded Stainless Steel covers.

Instrumentation:

The equipment shall include all limit switches and protection / operational / monitoring instrumentation, seen necessary by the Manufacturer to ensure the validity of the warrantee, to prevent damage to the equipment in overloading, etc conditions and to ensure automated operation.

14.2.5. Construction Belt Press

Framework:

The framework shall be a robust, heavy-duty assembly to suit the highly corrosive and particular operating environment. The structure of the enclosed framework shall be steel plates on the outside, designed in such a way to provide maximum strength and rigidity. The design shall be such that the framework could be hot-dipped-galvanized without distortion (if so required).

The structural frame of the belt press shall be designed to provide maximum rigidity and shall be designed that rollers can be removed from the side, top or end of the frame with minimum disturbance to other roller assemblies. Full and complete protection shall be provided against egress of spray or spillage and against accidental contact with rolling assemblies during operation. Guard panels as specified elsewhere and cable grommets in the framing shall be of tight execution to avoid leakage of liquids from the inside of the belt press.

The structural frame shall be designed to take all the horizontal loads imposed by the press components without external support, e.g. from the press building.

Sludge Feed:

The sludge feed shall be designed to receive the thickened sludge transferred from the linear screen. The feed shall distribute sludge evenly over the full effective belt width in such a manner as to avoid excessive turbulence and consequent floc break up.

The chute shall incorporate a retention plate underneath the belt and an adjustable flap to ensure that distribution onto the belt is uniform.

Plough System (Chicanes):

Ploughs, either hinged or vertically sliding in individual guides, shall be incorporated to rest on and be in light contact with the top belt to gently move the sludge in such a way that the belt does not blind / clog with solids, and provide efficient drainage. It shall 'plough' the sludge blanket so that the maximum degree of free drainage is achieved in the gravity section.

The sludge ploughs shall be designed to facilitate safe adjust by the operator. It shall be possible to remove the ploughs from the sludge blanket if considered necessary during operation. A minimum of six rows of ploughs shall be provide and the life of a plough shall be guaranteed for at least 30 000 hours of continuous running.

Belt Support Members:

The top side of the belt shall be kept truly flat to ensure that the ploughs are always in sufficient contact with the sludge on the belt. This may be achieved with either rollers or by easily replaceable engineered plastic slider bars, in conjunction with keeping the belt tension. Slider members shall be guaranteed for at least 5 000 hours of continuous running.

Drainage and Wedge Zones:

Sludge shall be contained in the gravity dewatering zone by suitable and adjustable side seals. The side seals shall be designed to minimize wear on the belt fabric. The gravity dewatering zone shall have a minimum length of 3.7 m for optimum drainage. The wedge zone shall have a minimum length 0.9 m and designed to allow dewatering to both sides of the wedge area by vertical arrangement. A limit switch shall be installed on the gravity dewatering zone for detecting sludge cake or no sludge cake.

The equipment arrangement shall be such as to guarantee that any spillages, however caused, and whether by process upset or operator action, shall be contained within the belt press structure and conveyed to a common outlet sump.

Pressure Dewatering Zone:

To avoid pressure shock to the sludge, the low pressure zone should have at least three perforated rollers. The first perforated roller must have a minimum diameter of 900 mm with shovels inside for optimized filtrate drainage without rewetting the sludge cake. The second roller must have a minimum diameter of 450 mm. The third roller should be perforated with a minimum diameter of 340 mm to prevent a harsh reduction of the roller diameter.

To avoid pressure shock on the sludge, similarly the first roller diameter in the high pressure dewatering zone shall be appropriately sized based on the preceding roller in

the low pressure dewatering zone. The pressure dewatering zone shall incorporate at least eight press rollers.

Depending on the sludge characteristics the high pressure dewatering zone shall be capable to be configured with additional 2, 4 or 6 press rollers. The press design should accommodate the installation of the additional press rollers in this zone should it be required.

The Contractor shall select the roller arrangement in the high pressure shear-press zone. The area of the pressure zone shall be calculated as the belt contact area with the press rollers and shall not include any allowance for tangents between rollers. The roller diameters shall be selected to provide the correct combination of dewatering area, applied pressure profile and time.

Roller Construction

Roller bearing shafts and end flanges shall be so designed to transmit bearing loads to the outer periphery of the end flange without significant diaphragm mode deflection of the end flange.

Roller shafts shall be stressed on the assumption that the end flange is rigid. Sufficient information shall be provided by the suppliers to demonstrate the integrity of the end flange design.

Where through-shafts are proposed, the supplier shall demonstrate that the design provides adequate support to the through-shaft to prevent bending, excessive stress ro fretting in service.

Roller shafts shall be an adequate interference fit in the end flanges. Stub-welding shall be permitted only on the inner or hidden side of the flange and must be used for location purposed on and not to carry load. Welding shall be full-penetration and shall not take place a high stress points. Metallurgical notches shall be avoided, and the welded roller assembly shall be fully stress relieved prior to machining. The heat shrinking of sub shaft assemblies to the tube may be employed to eliminate metallurgical notches caused by welding.

All rollers shall be designed to withstand the stress reversals inherent in rotating elements with a minimum safety factor of 4.0 over the yield stress of the material for shafts, connections between shafts, end plates, drums and roller bodies, etc.

The basic design criteria for rollers shall be a maximum center span deflection of 0.5 mm/m width at maximum belt tension. The design tension shall be stated. Roller dimensions and stress calculations shall be provided at tender stage. The cylindrical bodies of all rollers and drums shall be manufactured from steel tube with dimensions to ANSI B 36.10 and have a wall thickness of at least Schedule 40, or similar DIN2448.

Stub shafts shall be manufactured from low carbon steel bar and not less than 55mm in diameter. Mechanical notches shall be avoided by using smooth and large radii at the knuckle. Flanges shall be manufactured from carbon steel plate. All rollers shall be machined on the cylindrical outer surface to be truly concentric with the stub shafts.

Bearings and Bearing Housings

All bearings shall be of the adjustable roller or ball self-aligning type and suitable for the environment in which they will operate including high pressure washing. Housings shall have one or two locating rings. The locating ring/s shall only be installed in one of the rollers bearings so that thermal expansion of the relevant roller can be taken up in the housing at the opposite end. Seals shall be suitable for the environment in which they will operate and be resistant to high pressure washing. A triple fold labyrinth-contact-type seal, preferably spring-loaded, shall be provided to give further protection on the inner side.

Bearings or other tracking and tensioning mechanical or electrical equipment, shall only be located inside the enclosure in the wetted area of the linear screen if designed for such purposes. Bearings shall accommodate a misalignment of up to 3 ° included angle without reduction in capacity.

Bearing inserts shall be stock sizes readily available from local distributors and suppliers.

In addition, the bearings on the output shaft shall be capable of withstanding the resultant forces caused by a combination of radial and axial loads, for example roller self-weight and drive torque.

Bearing selection data shall be submitted at tender stage showing the method of calculating L10 bearing life and detailing methods of calculating bearing loads. Bearings shall be selected for a L10 life of 200 000 hours minimum, using maximum operating conditions. Calculations shall also allow for roller self-weight and drive torque.

Bearing housings shall be provide with multiple lip seals to prevent ingress of moisture and other contaminants. Shafts shall pass through a solid bulk head separating the wetted area of the linear screen from the bearing location area and shall include a separate shaft seal through the bulkhead as additional protection.

A full list of bearings with identification type numbers shall form part of the technical submittals.

Lubrication nipples shall be reachable from the outside of the linear screen for lubrication during machine operation.

Belts

The linear screen belt shall be manufactured from high permeability durable woven monofilament polyester fiber selected to meet the duty requirements with a minimum operational life before replacement of approx. 3000 – 4000 hours before refurbishment. The belt and belt cloth shall be selected for high tension operation.

The belt shall be able to operate at a speed of between 4.8 m/mine and 10 m/min. The speed of the belt shall be variable during the operation of the unit.

The tensile strength of the belt shall be selected by the Contractor to meet the operational requirements of the equipment, including belt tension and roller diameter. The belt shall be joined by an approved clipper seam using high tensile steel cable bonded with resin and incorporating a chevron or similar stabilizing seam. Belt edges shall be heat sealed and bonded for stability. All metallic parts of the belt joint seam shall be stainless steel.

Belt tensioning

A hydraulic belt tensioning system shall be provided to tension the upper and the lower belt separately under all operational conditions. Mechanical tensioning methods using springs will not be acceptable. Belt tension shall be adjustable from the minimum to the maximum design value, required for correct belt tracking. The range of adjustment shall be from approximately 2 to 10 kg/cm and shall be compatible with the values used in the bearing selection and roller stressing calculations. The system shall accommodate the increase in belt path length which occurs under sludge andwater loading.

The tensioning mechanism shall be designed to prevent loss of tension due to component failure, on one side of the belt only. The system shall also provide positive protection against over-tensioning. It shall be possible to adjust tension manually during operation, or when the press is stopped. A tension indicator shall be provided at each adjustment point. The belt tensioning system shall be completely maintenance-free and require no adjustment in service.

Two proximity switches shall be installed at the max position of the tensioning rollers for belt break detection and two proximity switches shall be installed at the min position of the tensioning rollers for overload detection.

The hydraulic power pack for belt tensioning, including high pressure hoses, shall be part of the scope of supply. Mechanical belt tensioning methods will not be acceptable.

Belt tracking

A hydraulic belt tracking system shall be provided to control alignment of the belt on the rollers under all operational conditions. The tracking device shall not use any components which would lead to any belt edge deformation or wear. The belt tracking system shall be able to react to belt movement and take corrective action proportional to belt ‘drift’. Systems which do not provide a proportional control of belt position shall not be acceptable.

The belt tracking system shall comprise a slewing guide roller on each belt. The control mechanism shall not have excessive belt wrap angles around the guide roller, nor excessive slew travel, which would lead to belt deformation and wear.

The slewing mechanism shall include a hydraulic linear actuator coupled directly to the bearing housing on the slewing roller. The slewing bearing housing shall be provided with low-friction tracks.

One sensor at each side of both belts, shall be provided to sense a misalignment condition. The sensors shall be used to initiate an alarm in the control panel and shut down the plant if necessary

The hydraulic power pack for belt tracking, including high pressure hoses, shall be part of the scope of supply. Mechanical belt tracking methods will not be acceptable.

Belt Wash System

A belt washing system shall be provided to ensure adequate cleaning of the belt and to prevent blinding. Spray nozzles shall be specifically designed for cleaning purpose and

shall have an overlapping pattern. The nozzle header shall be easily removable for cleaning and inspection, if required. The spray bar shall be provided by the Contractor with a built-in cleaning brush of STAMM or equivalent type. This shall be capable of being used while the linear screen is in operation.

The spray system to wash the belt, nozzles and pipework shall be manufactured of Grade 316 Stainless Steel.

Sludge Cake Removal Blades

A scraper mechanism shall be provided for removing the sludge cake from the filter belt. Scrapers shall not damage the belts or cause excessive wear or damage to the filter cloth.

The blade shall be fitted with a means of adjustment to allow for wear. Blade material shall be an abrasion resistant plastic. The design shall be such that the sludge cake will freely discharge off the belt without manual assistance. The blade support shall be sufficiently rigid to prevent deflection in service therefore preventing cake to slip through. For health and safety purposes each blade shall be exchangeable from the sides of the press.

Sludge chutes to guide the sludge cake onto the dry-cake conveyors shall be provided.

Drive Unit

The belts shall be driven through a geared motor-speed-reducer drive, incorporating helical gears. Worm gears will not be considered. Gears shall be manufactured from the highest quality alloy steel, gas- carburized and accurately ground. All gears and pinions shall be manufactured by an approved process to AGMA 390.02 Class 12 or ISO. 1328 Class 6.

The belt drive arrangement shall provide positive drive for each filter belt. Either a single drive with a special gearbox direct coupled to the drive rollers or dual drives (one for each belt) shall be supplied. Each gear drive shall be driven by separate variable frequency converters. In case of dual drive design, the drives shall be synchronized via frequency converters and drive roller rpm encoders. The gear box shall be totally enclosed, oil tight and grease lubricated. It shall be possible to inspect all transmission components by removing the cover plate. It shall be possible to inspect or replace transmission components without disturbing rollers, and to simply drain and re-fill oil.

Gear drives with chain or belt load transmission is not acceptable

DC motors or AC variable frequency systems shall be acceptable for variable speed drives. The effective speed range of the configuration offered shall be clearly stated, together with over all transmission efficiencies over the speed range. Particular attention shall be paid to the cooling of the motors at low speeds. Geared motors shall be selected from a standard range, ideally from one of the following manufacturers who are well represented in South Africa: Flender, SEW or Bauer or similar approved.

The variable frequency inverter will be in the Dewatering Unit's control panel of the Motor Control Centre and is described in the applicable Electrical Project and Standard Specifications. The overall efficiency of the gearbox and final drive arrangement shall be more than 88%.

Filtrate Drainage System:

The Belt Press shall contain drainage pans and piping to collect and discharge filtrate from the gravity dewatering and pressure dewatering sections. The design of the collection system must be such that the filtrate from the gravity dewatering section and from the wedge dewatering zone can be collected separately from the rest of the filtrate and wash water. The flow of the filtrate shall be arranged to wash away any extruded sludge material en-route without permitting the extruded material to contact the roller surfaces or to become trapped between the belt and roller surface. Discharge of filtrate onto the dewatering room floor, or any arrangement whereby spillages can discharge onto the floor, is unacceptable.

Drainage Pans, cover plates, and any discharge chutes shall be constructed in minimum 2.0 mm thick grade 316 Stainless Steel. Drainage pans shall be fixed with robust support tubes.

Inspection Panels and Guards:

The linear screen shall be designed and constructed in accordance with the requirements of the Occupational Health and Safety Act, in such a way as to provide maximum protection for operational staff against injury from moving machinery and any harm to health from the bio-hazards present in air borne particles from sprays containing sewage sludge.

The linear screen shall be enclosed at the sides, ends and bottom to prevent splashing, aerosol and spray discharge from the units. Protection shall be provided against accidental contact with rolling assemblies, drives and pinch zones between roller and belt and other moving parts during operation, by the provision of hinged guard panels in the framework enclosure.

Tight lockable access hatches and panels shall be provided at all points on the linear screen where access would be required for inspection, maintenance and cleaning purposes.

For health and safety reasons and for convenient access to the sludge discharge side the linear screen shall be equipped with gas spring-loaded Stainless Steel covers.

Instrumentation:

The equipment shall include all limit switches and protection / operational / monitoring instrumentation, seen necessary by the Manufacturer to ensure the validity of the warrantee, to prevent damage to the equipment in overloading, etc conditions and to ensure automated operation.

14.2.6. Walkways, Platforms and Staircases

Walkways, platforms and staircases shall be provided for all equipment that require operators to work (for operating or maintenance purposes) at heights higher than 1.2 m above the NGL. These platforms, walkways, staircases and their respective support structures shall be constructed from GRP or epoxy coated hot dipped galvanised.

All walkways, platforms and staircases shall be equipped with suitable hand railings and all equipment and structures shall be in accordance with the applicable Standards and the Health and Safety Act.

14.2.7. Pipework, valves and ancillary equipment

The Contractor shall allow for the supply and installation of all pipework, feeding the product to the belt press / linear screen. This pipework shall be flanged and rated as per the pump installation feeding dewatering plant. All pipework shall be properly supported and anchored to handle all static and dynamic loads.

14.2.8. Civil requirements

The Contractor shall provide all detail of civil and building requirements around the installation of the equipment to the Engineer for incorporation into the structure. All measurements and dimensions shall be confirmed on site prior to manufacturing. The Contractor shall ensure that the design can accommodate a tolerance of ±40 mm for civil and building items constructed by other (unless a tighter tolerance is called for by the Contractor and approved by the Engineer).

14.2.9. Spare Parts

The following Spare Parts shall be included and supplied together with the equipment:

- All spares not available at the OEM equipment supplier in South Africa deemed critical for operation.

Spare parts shall be packaged with labels indicating the contents of each package and shall be delivered to Owner as directed.

14.2.10. Installation and Testing

The Contractor shall verify all dimensions in the field to ensure compliance of equipment dimensions with the drawings. Contractor shall notify the Engineer of significant deviations.

Installation of the equipment shall be in strict accordance with the contract documents and the manufacturer's instructions and shop drawings. Manufacturer shall supply equipment, including anchor bolts for the equipment. Contractors shall install the equipment in accordance with the manufacturer's recommendations.

Supplier shall furnish the services of a factory-trained Service Engineer for two (2) trip to inspect the installation, observe start up, and provide operator training.

Equipment shall not be energized, or "bumped" to check the electrical connection for motor rotation without the Service Engineer present.

The Service Engineer shall make all necessary adjustments and settings to the controls.

The Service Engineer shall demonstrate proper and sequential operation of the plant and demonstrate that the equipment achieved the requirements set out in the Specifications prior to the commissioning of the works.

All components forming the installation shall be tested simultaneously in order to achieve the guaranteed performance. The Contractor may execute testing on a variety of

polyelectrolytes, but only of these may be used during performance testing in order to achieve the guaranteed performance.

Performance Testing Requirements:

The performance test shall be executed after the Contractor has confirmed that the Linear Screen / Belt Press unit is operating successfully. The Contractor shall set up the Linear Screen / Belt Press and shall adjust the various parameters and commission the plant, submitting a test report to the Engineer with the below mentioned information before witness testing by the Engineer shall be done.

For the duration of the performance test, the Linear Screen / Belt Press being tested shall be loaded with the design sludge load (i.e. the specified dry solids loading and dry solids concentrations).

During the test, the Contractor will be permitted to make no more than two adjustments. The testing shall be cancelled should more adjustments or correction be needed.

The Linear Screen / Belt Press shall be tested for the performance requirements specified over a continuous period of 4 hours by taking hourly composite samples for the following tests:

- Feed % concentration of solids.
- Cake % solids.
- Filtrate % solids.

Four composite samples shall be tested. Each composite sample shall consist of four sub-samples taken at 15 minute intervals. The sludge flow to the Linear Screen / Belt Press and the polyelectrolyte consumption shall be recorded, with reading taken at 15 minute intervals.

The Contractor shall utilise an independent laboratory for the sample test measurements.

A final test report shall be submitted to the Engineer, with samples taken during the witness testing.

The Contractor shall submit reports for all specified tests to the Engineer prior to the equipment being delivered to Site.

15. GEARED MOTORS

15.1. Specific requirements for Geared Motors

The specific requirements for the equipment shall be in accordance with the applicable Project – and Standard Specifications where it calls for geared motors.

15.2. General requirements for Geared Motors

15.2.1. Scope of works

This specification covers the design, manufacture, testing and supply of geared electrical motors for the use in wastewater - and potable water treatment plants.

The construction shall be robust and simple and the design shall be such that it does not require regular maintenance and only equipment of proven ability shall be provided.

The Contractor shall ensure that the equipment offered comply or exceed the requirements set out in the specification and that it is suitable for the application. The Contractor shall make allowance for a fully functional and integrated system, including all interconnecting systems that may be required. This specification shall be read in conjunction with the other Mechanical Standard Specifications whether there are specific references or not.

A copy of the signed factory test certificate shall be bound in the in with the manual, while the original shall be handed to the Engineer. This shall include:

- Operating instructions
- Maintenance instructions
- Lubrication instructions
- Spare parts list
- Drawings
- Brochures.

15.2.2. General Design Criteria

The equipment shall meet the following requirements:

a) It shall be designed to facilitate the efficient manufacture, inspection, transportation, installation, maintenance, cleaning and repairs.
b) It shall be designed with a minimum expected life of 20 years of safe and satisfactory operation under the conditions prevailing at the site
c) The design shall prevent undue stresses caused the expansion and contractions due to temperature changes and other local natural manmade conditions.
d) The design shall keep maintenance costs to a minimum
e) It shall be designed to comply completely with the legal requirements in respect of safety and the prevention of environmental pollution.
f) It shall satisfy any specific requirements contained in the relevant statutory codes and legislation.
g) The design shall allow for 24-hour operation, 365 days a year under the specific design conditions.
h) The equipment installed shall be complete and fully operational as per the requirements set out in the Scope of Works.
i) All material used for the equipment shall be suitable for the operation and environment and compatible with the intended use.
j) The design shall allow for suitable treatment to prevent corrosion and erosion of the materials and equipment.
k) After approval by the Engineer, at the time of award of the Contract, the information stated in the Data Sheets shall be fully complied with, notwithstanding the specified scope of the Contract.
l) All electrical equipment, forming part of the specified equipment, as described in the Electrical Specification, shall be sealed against penetration by hose cleaning operations as well as being accessible for repairs and maintenance.

The design shall be done in accordance with DIN 19569.

All parts shall be designed for the duty required, but the minimum factor of safety against structural failure shall not be less than 3, based on the working stress of the material. In the design, due consideration shall be given to the thickness of materials with regard to corrosion and operating conditions. The force required at the handwheel or crank to raise the gate or open the weir shall be in the order of 100 N, and the design parameters must be submitted in the Technical Schedule.

15.2.3. Construction

Gearbox Assembly:

Each aerator shall be directly coupled to a suitably designed gearbox and directly driven by an electrical motor via a flexible coupling.

The gearbox / speed reducer shall be designed for continues operation over 24h per day. The mechanical power ratings (according to AGMA rating) shall be greater than 2.25 times the installed power and shall account for D.O.L. starting of the unit at full load conditions (maximum immersion). Thermal power ratings shall be based on an ambient temperature of 40°C.

Speed reducers units shall be specifically designed and selected for horizontally mounted surface aerator duties and shall use standardised components. Only units specifically designed and certified by the manufacturer to be used for aerators duties shall be considered (supporting documentation must be submitted at tender stage), non-compliance may lead to rejection of the tender. Tenderers will be required to provide a catalogue of the make of speed reducer offered and to indicate how the selection was done.

The helical and spur gears shall be manufactured from alloy steel and shall be thoroughly hardened and ground after machining. The gears shall have a high durability factor, maximum strength and low noise level. Worm gears shall not be considered.

All bearings shall be designed for a life of at least 100 000h at a L10 rating. In addition, the bearings on the output shaft shall be capable of withstanding the resultant forces caused by the combination of radial and axial loads, imposed by the aerator, acting simultaneously, and shall be selected such that the following condition is complied with:

$$\left(\frac{Actual\ Radial\ Load}{Permissible\ Radial\ Load}\right) + \left(\frac{Actual\ Axial\ Load}{Permissible\ Axial\ Load}\right) \leq 1$$

The Permissible loads are the manufacturer's figure for 5 000h at a L10 rating. Tenderers shall indicate what these forces are and how they are accommodated.

The casings shall be manufactured out of close grain cast iron and shall be designed such as to prevent moisture from entering the unit. A standard dry well for the vertical down shaft, low speed shaft bearing is required to avoid complete drainage of oil in the event of an oil seal failure. The housing shall be equipped with a breather, drain and oil level plugs which shall be accessible from above the mounting frame.

All speed reducers must be provided with jacking bolts of Stainless Steel, allowing at least 100mm adjustment up and down.

The motor shall be vertically mounted to the speed reducer via an accurately located lantern housing. A precision high speed flexible coupling, incorporating rubber buffers shall transmit power from the motor to the speed reducer.

Inspection of the speed reducer and gears shall be possible without dismantling the speed reducer. It shall have lifting lugs for lifting purposes. The coupling between the aerator and the speed reducer shall be such that the aerator can be easily removed without shifting the speed reducer.

The speed reducer shall be fitted with an effective and accessible oil filling plug, oil level indication mechanisms and drain plug. Speed reducers rated at more than 75kW shall have oil pressure indicators and oil pressure limit switches fitted for protection purposes.

Forces cooling and cooling fans shall not be permitted, and the thermal power rating of the speed reducer shall exceed the motor power after derating for 40°C ambient temperature.

All bearings shall be located within the speed reducer and shall be lubricated by means of a positive splash-action system. Where immersion or splash lubrication is not deemed adequate by the manufacturer, lubrication shall be achieved by a forced lubrication system directly driven by a reducer shaft. Oil levels shall be easily controlled. Should greasing of certain bearings be required, the grease pump shall be driven by the movement of the speed reducer.

The speed reducer shall be mounted on a suitable base plate. Each unit shall be fitted with a nameplate showing at least the following information:

- Speed reducer Manufacturer, type and model number
- Serial number
- AGMA rating
- Nominal ratio
- Approximate oil quantity required

<u>Electrical Motor:</u>

Electrical motors utilised to drive drywell pumps shall comply with the following requirements.

The electrical motor shall be a TEFC type motor, rated for 400 V, 50 Hz. The motor casing, dimensions and ratings shall comply with the SANS 1084. Testing of the motors shall be according to IEEE Standard 112-2004.

The motor casing shall be constructed from cast iron. It shall be equipped with cooling fins that is positioned in such a way that will not accumulate liquids and dust over the motor. The motor casing shall be equipped with a minimum of 2 eyebolts for lifting purposes. The motor shall be equipped with a directly coupled fan, with a fan cover, for cooling of the motor.

The motor terminal box shall preferably be placed on the side of the motor, with the electrical wiring entering from the bottom.

The motor shall be equipped with deep groove, ball bearings. Both drive-end - and non-drive-end bearings shall be insulated to ensure the motor is rated for use with Variable Frequency Drive (VFDs). Where applicable, motors must be adapted and rated to work with a VFD to be able to handle the voltage spikes, additional stresses, etc.

The motor shall have a IE3 level of efficiency (Premium Efficiency). The enclosure shall be IP55 rated according to IC411-TEFC and shall be foot-mounted. Where the installation or environment require a higher IP rating, the motor supplied shall comply with such requirements. Electrical motors installed at the ocean or close to the ocean, the motor shall be rated for marine applications.

The electrical motor shall be equipped, assessed based upon the respective motor sizing, with the following protection proposed:

a) Rating of 2.2kW to 22kW – Starter protection only
b) Rating of 22kW to 110kW – Motor overheat protection by means of thermistor protection in the motor winding (two per winding)
c) Rating of 132kW and greater – Motor protection by means of PT100's installed in the motor windings (two per winding) and at the motor bearings (drive and non-drive ends), as well as general vibration protection of the pump and motor respectively (drive and non-dive ends of both).

In situations where the motor operates at low speeds, forced cooling shall be provided by means of external forced ventilation kit. In such case the supplied base plate must have adequate space to place the kit.

Higher rated speed shall be considered in special conditions. The motor sizing shall be selected at least 15% larger than the shaft power required with the pump / speed combination at the design duty point. It shall also allow for at least 20% higher flow than the design point without overloading the motor. For a non-overloading power curve characteristic, the motor shall be sized at 10% above the maximum power required impeller / pump combination.

Operational speeds higher than 1450 rpm shall not be allowed in motor sizing larger than 90 kW.

STANDARD SPECIFICATION

SSE01 – MEDIUM VOLTAGE REV1

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1. BULK ELECTRICAL SUPPLY TO SITE

The Supply Authority must be identified per project. The following work is required under this section of the project:

- As per project specification requirements

1.1 STANDARDS

The installation must comply with all respective Standards as set out in Section 1 above, including but not limited to:

- SANS 780 /IEC 60076: Transformer
- SABS 555: Mineral oil for transformers and switchgear
- SANS 137: Bushings
- SANS 1507 / 1339 – 3.3kV and 6.6-22kV XLPE MV Cables
- NRS 003&006/SANS 1885&1874 and IEC 62271-100/200 – MV Switchgear standards
- NRS 022: Electricity distribution – stays and associated components
- NRS 033: Electricity distribution - guidelines for the application, design, planning and construction of medium voltage overhead power lines up to and including 22kV using wooden pole structures and bare conductors
- NRS 039: Surge arrestors for use in distribution systems

1.2 NEW OVERHEAD MV-LINES

This section of the scope comprises the construction of a new section of 11kV wooden-pole overhead-line.

1.2.1 Material

1.2.1.1 Poles

Poles must be of the wooden, Creosoted Eucalyptus type, with a total length of 12.3m and a planting depth of 2m. Pole top diameters may not be less than 160mm for intermediate poles and 185mm for termination and strain poles. Poles must be of the group strength ‘A’, comply with SABS 753 and must bear the SABS mark of quality.

1.2.1.2 Anchors and Stays

Stays must be used to anchor and support the overhead assembly and installation. Stay rods must supplied complete with all equipment required for a fully functional installation. This must include, but not limited to, rods, thimbles, washers and guy grip bow heads. All required anchors, baseplates, tensioning and excavations must be provided as part of the tender offer.

Stays rods must be made from mild steel and malleable cast iron and galvanised to SANS 763. Stay wires to be galvanised and of the stranded conductor type, with minimum conductor size of 22m for maximum breaking load.

1.2.1.3 Overhead Conductor

Conductors must be ACSR Fox type, with rates given for Weasel and Ferret. Conductors must comply with SABS 182 Part 2.

Note that for sake of pricing, conductor linear length will be measured and paid for. All sagging, off-cuts and terminations must be provided for in the final item rate. The BOQ length is provisional for tender only and final lengths must be confirmed by the Surveyor, as per Section 1.2.2 below.

1.2.1.4 Support Structure

1.2.1.4.1 A-Frame Configuration

A-frame configuration, including cross-arms, must be used for this installation, conforming to the Supply Authority's standards. All frames, nuts, bolts and cross-arms must be hot dipped galvanized.

Insulators must be rated for 11/22kV, compliant with SABS 177. Intermediate support insulators must be of the Cullinan Class A, 4kN porcelain or silicon line-post type. Strain insulators must be of the silicon (Elbroc) type. For a road crossing, the intermediate structures must be equipped with special road crossing twin ties on Class A 10 kN insulators.

Depending on the application, various configurations of A-frame and cross-arm assemblies are required for this installation, as per the attached layout drawing. The A-frame type is depicted by a letter, as set-out below:

- Type A: For an intermediate assembly, comprising A-Frame and three support insulators, complete with conductors tied in.

- Type B: For an intermediate strain assembly, comprising A-Frame and six strain insulators, one support insulator, conductors terminated (and tied-in) with through links.

- Type C: For an intermediate strain assembly, but with a 90-degree directional change, comprising A-Frame and three strain insulators, one cross-arm with three strain insulators and one support insulator, conductors terminated (and tied-in) with through links.

- Type D: For a line-end strain termination, comprising A-Frame and three strain insulators with conductors terminated. Note for a road crossing provision must be made for a yoke plate (six strain insulators total).

- Type E: Intermediate strain assembly for a road crossing, comprising A-Frame and nine strain insulators (includes yoke plates), conductors terminated (and tied-in) with through links.

1.2.1.5 Drop-out Fuses

The fuse links must be rated for the total load of equipment supplied from the new overhead line. The set must be mounted on a hot-dipped galvanized steel cross-arm, of estimated dimensions 1000mm x 160mm x 65mm, to be confirmed with the Engineer before ordering.

The price for the fuse link set must include fuse carrier and fuse, cross-arm fixed to the pole, all ancillary hardware and conductors links connected through.

1.2.1.6 Surge Arrestors

Surge arresters must be of the silicon-housed type, rated for distribution class at 11kV. The set must be mounted on a hot-dipped galvanized steel cross-arm, of estimated dimensions 1000mm x 160mm x 65mm, to be confirmed with the Engineer before ordering.

The surge arrester set must be suitably earthed to the ground at each point to create a low resistance in order to protect both the overhead line and the underground cable installation. Note the earthing cable must be protected against the pole in the same way as the MV cable.

1.2.2 **Surveyor**

As the MV overhead line route is provisional, it is imperative that a Local Surveyor be included with this project, before any construction work on site is started. The surveyor must will be responsible for surveying the complete new overhead line route, with the following main components required:

- Route selection and fixing
- Profiling
- Pole pegging
- Optimization of design
- Providing the Engineer with final route drawings (DWG and PDF), including geo-referencing and spanning-sheets
- Pricing to include all travel, material, labour and accommodation

Note that the responsibility remains with the Contractor to coordinate with the Engineer and Supply Authority regarding when going to site and determining the final route for surveying. No claims in this regard will be entertained due to a lack of coordination.

1.2.3 **Construction**

1.2.3.1 Conductor Work

1.2.3.1.1 Installation

Conductors must be run out using freely rotating drums on jacks and axles, but care must be taken to provide braking so as to not put unnecessary tension on the conductor. At no point may the conductor run on the ground.

Note that the manufacturer's installation requirements must be met at all times.

Tensioning and regulation of the conductors must be by means of suitably sized and rated line grips, with all lines tensioned simultaneously.

Note that the conductors may not be tensioned at more than 25% of their breaking strength.

1.2.3.1.2 Connection

Pistol-grips are the only means allowed for overhead conductor connections and terminations. Tying-in of conductors must be by means of a pre-made suited type binding for the conductor and insulator used.

No slipping or damage to the conductor is permitted in using tension clamps. The clamps must be suited for the thimble clevises to be utilised and no adaptors are permitted.

1.2.3.2 Structure Earthing

Only structures containing cable connections, fuses, surge arrestors and transformers must be suitably earthed. All metalwork on these structures must be bonded by $10mm^2$ bare stranded copper. One $35mm^2$ common bare stranded copper must run down the applicable pole, stapled every 500mm. two trenches of 10m in opposite directions must dug, with a 1.8m earth spike provided at each end. These spikes must be connected to the earth cable running down the pole, with all bonding to be provided to ensure a suitable earth.

1.2.3.3 Excavations

Excavation openings for all poles and stays must be open for as short a period as possible. Due to the depths of these excavations, H&S concerns are very real and must be treated with critical importance. All required signs, demarcation tape and lights at holes and spill piles must be provided.

Backfilling of the holes must be done at no more than 200mm at a time and each layer must be rammed as solidly as possible. In the instance where the backfill material does not properly consolidate, then a 1:8 ration of cement may be used, at the Engineer's approval.

Holes will be paid per unit, regardless of the soil type. Only in the instance where hard rock is encountered, will a pro-rate amount be paid, based upon the rate as included in the document. Note that suitable proof must be recorded and provided to the Engineer

regarding this hard rock claim (and applicable hole) and no work may commence if not approved. Failure to comply in this regard will result in no additional payment.

1.3 MV SWITCHGEAR

1.3.1 Configuration

The MV switchgear must be of the indoor, vacuum insulated type, similar or equal to the Actom or ABB type.

The switchgear configuration must be as per project specification requirements.

1.3.2 Technical Requirements

The switchgear must comply with the following minimum requirements, for a 3.3-11kV system:

- Voltage : As per project specification (3.3-11kV)
- Frequency : 50Hz
- Internal arc withstand AFLR (3s) : 21kA
- Nominal Current : 1250A (Busbar/Incomer), 630A (CB feed)
- Short time current r.m.s. : 31.5kA
- Peak withstand current : 65kA
- Insulation level : 24kV
- Peak lightning withstand : 95kV

All panels/sections must include integral cable earthing facilities and any access to the cable compartment must be interlocked with earthing switch and/or isolating circuit breaker or switch. The isolating device and earth switch may not be able to be closed at the same time (mechanical interlock). Note that all external operating devices/facilities that are capable of being switched must be lockable.

The status of each tier/panel must be displayed on the front by means of a mimic panel on the operating plate, taken from the actual switching contacts. Opening and closing pushbuttons must be provided for the circuit breakers, with the mechanism being of the wound-spring operated type. Note both electrical motor and manual spring charge facilities must be available for respective manual opening/closing and tripping condition.

Each circuit breaker must be provided with a lock-out pressure switch for insufficient gas pressure, with outputs for both alarm and lock-out conditions. All circuit breakers must be fitted with operation counters.

The cable boxes must further be air insulated to accommodate heat shrink terminations in accordance with the cable type specified below.

Each panel/tier must be provided with a clear indicator (neon or similar and equal), per phase, for live phase identification.

Note that provision must be made for a remote switch for opening and closing, with 10m cable and the necessary facilities provided accordingly on each tier/panel.

Each tier must be clearly and permanently labelled as to its feed and function.

1.3.3 Protection

All required CTs, VTs and protection relays must be provided for full protection of both the incomer and outgoing feeds. In principle, CTs must be installed for every phase, with VA rating no less than 15VA. VTs must be busbar mounted and must be separated by an earthed screen.

Provision must be made for transformer oil and winding over-temperature protection, as well as primary winding earth fault. The relay must be able to protect the system against over-current, short circuit and over/under voltage conditions.

The protection relay provided must be able to incorporate these necessary system and transformer protections and accordingly the protection design must be done by a specialist party and signed off by the Supply Authority, before final implementation. Special focus must be placed on CT/VT ratios, load burden and respective protection classes of CTs and VTs. The cost of this specialist activity must be included in the final price offer and no additional claims in this regard, including Supply Authority coordination, will be entertained.

1.3.4 DC Power and Batteries

A DC power supply with a nominal voltage of 110VDC must be provided, with a capacity to drive the base-load of the MV switchgear for at least one week.

The DC power supply (charger) system must be of the Blue Ginger type. It must be able to re-charge a depleted battery to 80% nominal within 7 hours, whilst supplying the running load. The system must further provide an alarm when the battery voltage is below 90%, when the AC supply fails or when there is a battery earth fault. Indications such as battery voltmeter and ampere meter for (dis)charge current must be provided, along with the functionality to test the system voltage. The unit must further be equipped with a boost function, with over voltage and current protection.

Batteries must be of the NiCad type, with latest technology designs applicable. The ampere hour rating must further be sized to be able to trip all CBs twice and open all of them once., as well as the base load requirement as mentioned above. Batteries must be protected by means of suitably rated fuses at both positive and negative supply rails. Note that dual-fuses must be used throughout, to provide redundancy to the system.

1.3.5 Alarm and Status Indication

The following status indications must be provided as voltage free contacts in the MV switchgear LV compartment, for potential future remote monitoring:

- AC Power Available / Fail

- DC Output Fail (common from charger)
- DC Voltage Low Alarm

1.4 DISTRIBUTION TRANSFORMERS

The oil-filled transformers offered must bear the SANS or IEC marks, in compliance with SANS 780 /IEC 60076 and nominally comply with the following requirements:

- Rating : As per project specification
- Rated (nominal) voltage ratio : 11 or 3.3kV / 400V
- Vector Group : DyN 11
- Cooling : ONAN
- Type : Hermetically sealed
- Neutral earthing : Solid
- Tap-changer (voltage control) : Manual off-load
- Cable Terminations : Air insulated cable boxes
- Mounting : Removable roller wheels

1.4.1 Material

The transformer must have copper windings and the tank made of sheet metal.

All surfaces (internal and external) must be properly treated to prevent corrosion, including approved paint or varnish for the internal tank against transformer oil corrosion. Zinc spray must also be applied before the final paint finish.

Any welding in the manufacturing process must be of the same or better quality than the base metal.

The final transformer finish must be achieved by means of using an electrostatic epoxy powder process, with the colour as mentioned above. All oil and air heat exchangers must be galvanized to SANS 763, with the paint finish as per above.

Provision must be made on all sides of the transformer, at a height of 500mm above the base of the tank, for earthing positions.

1.4.2 Core

The electrical continuity of the core laminations shall not be interrupted. Adequate mechanical strength must be provided in its design to withstand all potential mechanical forces acting on it during transport and the occurrence of electrical faults.

The noise and vibration levels may also not exceed the local authority's requirements, in conjunction with NEMA.

1.4.3 Oil

The transformer must be filled with oil in compliance with SANS 555.

1.4.4 Terminations

MV bushings must be of the type C.

1.4.5 Protection Components

- Oil and Winding Over-Temperature, with displays (if possible) and contacts
- Oil over-pressure relief valve
- Primary winding earth fault
- Buchholz relay (where specified)

1.4.6 Terminal Strip

The terminal strip, with voltage free contacts, must be securely mounted against the transformer for all alarm and trip signals. These signals must be taken across to the respective protection relays at the MV switchgear. 600V stranded conductors with PVC isolation must be used for this purpose, fully numbered at both ends and neatly tied together. Crimp lugs must be used for terminations at both ends.

1.5 MINIATURE SUB-STATION (M/S)

A new miniature substation in accordance with the project specification must be supplied and installed. The general specifications above also apply to the individual components, namely RMU switchgear and/or transformers.

The M/S must comprise a MV compartment, complete with 3-way Ring Main Unit (RMU), transformer and LV compartment, all manufactured from 3CR12 sheet steel. All ancillary equipment such as handles, hinges, locking mechanisms, nuts, bolts and washers must be made from 304 stainless steel. The unit must be suited to coastal conditions and be equipped with heating elements.

The unit colour must be avocado green, with all final paint touch-ups to be completed on-site in line with the manufacturer's recommendations.

Provision must be made for lifting of the unit by means of four lifting hooks and no tilting of the unit is allowed during this lifting process.

A suitably protected daylight photocell must be mounted on the outside of the M/S, wired to the street lighting section.

1.5.1 MV Switchgear

In compliance with standard specification above. Note that switchgear must be of the compact, non-withdrawable type, with SF6 insulation medium, similar and equal to the Schneider, Actom or ABB type.

Note that the switchgear must be arc vented to the top of the M/S, complete with type tested riser vent duct(s) and weatherproof flap, all forming part of the M/S design.

The switchgear configuration must be as per project specification requirements.

1.5.2 **Transformer**

Voltage and rating as per project specification.

1.5.3 **Low Voltage (LV) Compartment**

The LV compartment must be fitted with an adjustable main Circuit Breaker (CB), distribution CBs (motor starting-type moulded-case CBs) rated per project as well as site lighting feeds. CBs over 500A must be of the Air Circuit Breaker (ACB) type.

- Main CB (adjustable)
- Plant feeds (motor starting type, adjustable)
- Site lighting:
    - 20A Three Phase (TP) circuit breaker
    - 30A AC1 contactor complete with daylight photocell control and bypass switch
    - 3 x 15A Single Phase (SP) outgoing feeds
- Spare positions : 4 x 60A TP outgoing feeds

All circuits, CBs and cables must be clearly labelled. Adequate support must be provided for the cable to be secured against, as they must not 'hang' on the CB terminals.

1.5.4 **Ancillaries**

1.5.4.1 Signage

All signage as required by the OHS Act must be provided as part of the offer, both outside the MS and within. The unit must further clearly be marked by its designated name, weight, size (kVA) and voltage (V).

1.5.4.1.1 Name Plate

The transformer and tap changer must both be provided with clearly visible name plates in line with SANS 780/IEC 60076, mounted within the main LV compartment. The RMU name plate must clearly be mounted within its dedicated compartment.

1.5.4.1.2 Drawings and Installation

The following detailed drawings must be submitted as set out in Section 1 of this document:

- Dimensions of the M/S, all associated equipment and final civil requirements

- Plinth sizing and arrangement
- Single line diagrams of M/S
- RMU single lines, including protection configuration and equipment detail
- Transformer name plate details, including protections offered

1.5.5 **Plinth and Mounting**

A suitably sized pre-cast plinth must be provided as part of the tender offer, in line with the manufacturer's recommendations. All required soil excavation, preparation, levelling and compaction must be included within the plinth price.

The plinth must be supplied complete with either sleeves or pre-case openings, at suitable positions and in suited size for all required MV and LV cable installation.

1.6 **MV CABLE**

1.6.1 **Type**

The MV cables rated at 6350/11000V must be of the Cross-Linked Polyethylene (XLPE) type. The cable must consist of three insulated cores with copper conductors, in accordance with SANS 1339, Table 19, and must carry the SABS mark.

The MV cables rated at 1900/3300V must be of the Cross-Linked Polyethylene (XLPE) type. The cable must consist of three insulated cores with copper conductors, in accordance with SANS 1507 and must carry the SABS mark.

The cable must be rated for a high earth fault and must be of the armoured type. The armouring of the cable must be multi-wired galvanised steel.

The installation of the cable must be in-line with SANS 10198, NRS 013 and other Supply Authority requirements.

1.6.2 **Installation**

Cable drums must be carefully transported and offloaded to prevent damage to the cable. A suitable cable-drum trailer and horizontal beam must be used when installing the cable. The drum may not rotate freely when the cable is rolled off, as this could potentially twist the cable and loosen the windings and armouring.

Rollers must be used for the installation of the cable, with a suitable cable grip utilised. The maximum tension, as specified by the manufacturer, may not be exceeded.

A minimum 3.5m galvanised steel sleeve or pole must be securely fastened, with stainless steel bandit straps, to the bottom overhead line poles. At least 300mm of the pipe must be installed under final ground level, to protect the cable.

1.6.3 Connections

All MV cable work and connections must be done by a skilled, proven and approved artisan. Note that the electrical continuity, screening and armouring may in no way be affected by working, glanding, jointing or connecting a MV cable.

1.6.3.1 Supply Authority Overhead Line

The new MV cable must be connected to the new set of drop out fuses, mounted on the new cross-arm at the top of the pole. All overhead line work must be coordinated with the Supply Authority, as the connection must be done with them present. They are also the sole Authority for any switching and adequate notice must be given to them in this regard.

All required material, outdoor cable termination kit, lugs, cable support and labour required for the installation must be provided as part of the project scope and price offering.

Note that the outdoor termination kit must specifically be designed to prevent arching and water ingress under any pollution or weather conditions it may be subjected to.

1.6.3.2 Ring Main Unit

The MV cable must be provided with a heat shrink dry-type connection, with the cable properly earthed at both ends. Note that the cable shoe must be pressed onto the cable with a purpose made tool. The shoes must be encased in a heat shrink sleeve, of which the colour corresponds with the phase of each cable core.

Cable clamping blocks made of hardwood must be provided for the air-insulated cable connections.

1.7 EXCAVATIONS

1.7.1 General

The MV cable must be installed at a minimum depth of 1m, with the trench made wide enough that it does not fall in on itself while introducing the bedding, cable and backfilling and compaction.

No bedding may be provided until the trench has been approved by the either the Engineer or Municipality.

Note that all OHS Act requirements must be met, specifically relating to an open trench and barricading and signage for the public and other workers' protection and safety.

1.7.2 Cable Installation

A minimum of 150mm bedding must be provided for the cable, with the material having a low clay content and a maximum resistivity of 1.2Km/W. After the cable is installed, in as straight a line as possible, an additional 150mm cover must be provided.

Thereafter a 400mm backfilling section is to be provided, properly compacted.

Two runs of danger tape must be installed on top of this layer, ensuring that the tape is installed directly above the cable. The tape must be polyethylene, nominally 230mm wide and imprinted with a triangle and electrical flash symbol, as well as the words “DANGER”, at no more than 1m intervals.

The final round of backfilling must be provided and the entire trench properly compacted as per 1.5.4 below.

Cable route markers must be provided at every cable turn and every 100m along a straight run.

1.7.3 Bedding, Grading and Backfilling

Both the bedding and backfilling material must be free of all plant materials, stones and clots larger than 15mm and any other foreign objects that could potentially damage the cable. Sea and/or river side is not acceptable due to their high thermal resistivity values.

In light of the material requirements above, as much as possible of the excavated material must however still be used. The excavated material must be sifted to ensure compliance. Only in the instance where there is not enough suitably graded backfilling material on-site, can suitable imported material be sourced. Payment for bedding and backfill material will only be done for sourced material, with the excavated material paid as part of the cable excavation’s labour component.

1.7.4 Compaction

Note that backfilling must be done in sections of no more than 150mm at a time (after compaction). Compaction must be done to an AASHTO-density percentage of 98% and record must be kept and supplied to the Engineer for each layer of compaction done.

1.8 COORDINATION AND SHUT-DOWNS

1.8.1 Supply Authority

It is the responsibility of the Contractor to make all necessary connection, switching, installation and approval arrangements timeously with the Supply Authority. No switching may be done by the Contractor and all MV connections must be done in the presence of a Supply Authority representative. Once connected, the Contractor must ensure that the supply and connections in terms of earthing, voltage and conductivity are in order before requesting the Supply Authority to switch power onto the system. Damage claims as a result of non-compliance in this regard will not be entertained.

1.9 ROAD CROSSING

A detailed method statement must be compiled as part of this contract, to be approved by the Engineer, Supply Authority and traffic authority. The method statement must address the following items as a minimum:

- how the work will be done
- what up front preparation must be in place,
- how long the work will take

- what contingency plans are in place in case an unforeseen event occurs
- traffic management plan, including road closure and traffic department coordination

It must further be noted that this section of the work must be priced to take place over the weekend, either very early just after daybreak, or late before sundown, in order to impact the amount of traffic as little as possible.

1.10 EARTHING

All earthing must be done in-line with the applicable SANS and IEC standards.

The transformer and switchgear must be properly earthed at both its MV and LV points, to provide an earth resistance of not more than 1 ohm. The transformer neutral and cable armouring must also be connected to the respective transformer earthing points.

The transformer earthing must be done by means of a copper earth mat, with all joints Cadwelded. The mat must be a minimum of 1m x 1m in dimensions, comprising an internal grid of no more than 100mm x 100mm. All conductors must be 70mm2 bare copper, including the cable between the transformer earthing point and the earth mat.

Should the required earthing resistance be more than accepted, then additional 1.2m copper earth spikes (rods) must be installed, complete with cables and connections to the earth mat.

All required excavations, earth resistivity testing, compaction and final earth readings and certification proof must be provided as part of the Contractor's offer.

1.11 TESTING AND COMMISSIONING

The Contractor, by means of the manufacturer, must be provided all required type tests certificates, in line with the applicable SANS and IEC standards. These must be verified and tested, before confirming in writing to the Engineer that all documentation is in place and the testing can take place.

All the above-mentioned documentation must be included in the Operational and Maintenance Manuals.

1.11.1 MV Switchgear

The following tests must be conducted:

- Testing of all alarms, remote inputs and voltage free contact outputs (relay and transformer)
- Testing and checking of all status indications
- Operational tests of all isolator and circuit breakers switching and operation, including functional verification of the spring charge mechanism
- Polarity and phasing for all VTs
- Polarity and magnetizing curve tests for all CTs

- Secondary current injection, at rated current, for tripping time and operational confirmation of overcurrent and earth fault protections
- Low voltage circuit pressure test
- High voltage pressure tests between phase-phase and phase-earth, for all possible combinations

1.11.2 **Transformer**

The following tests must be conducted:

- Winding ratio
- Megger
- Tap changer mechanical operation
- Leakage current
- Vector group
- Oil and winding temperature indication and functional tests
- Current transformer (where specified)
- Buchholz functionality (where specified)

1.11.3 **MV Cable**

Phase identification tests must be done to confirm that the connections between the end points are correct. All cables must be phased out before being connect.

DC tests must be performed, at the rated voltage, in accordance with SABS 540 and SABS 97. All test results must be recorded on formal test certificates, which must be included with the final documentation manuals. Special attention must be given to any dangerous leakage currents.

1.12 **DRAWINGS AND MANUALS**

The Contractor must provide the Engineer with a draft manual for review, prior to any taking-over arrangements being done. Three final copies must be provided.

Operational and maintenance manuals must include, but not limited to:

- System description and diagrams
- Circuit diagrams, per component
- Detailed drawings of component
- Maintenance and setting up instructions

- All factory test certificates
- All routine site test certificates (cold and hot commissioning)
- Final As-Built drawings
- PVC laminated schematic diagrams, for substation wall-mounting

STANDARD SPECIFICATION

SSE02 – LV AND CONTROL

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1. MOTOR CONTROL CENTRES (MCCs)

1.1 STATUTORY REQUIREMENTS

MCCs must be provided as detailed below and fully conform to the requirements of SANS 10142-1 (latest edition). All material, components and equipment installed within the respective MCCs must also comply with SANS 10142-1, specifically Section 4.3, which details further specific compliance requirements per specific item.

Specific SANS standards such as 1973-1 and 1973-3/8 are applicable for MCCs above and below a 10kA fault rating. For SANS 1973-1 (MCCs above 10kA), a Type-Tested Assembly (TTA) must be provided and the populator of the assembly (if different entity from the one providing the TTA) must complete the work in strict accordance with the required standards of the TTA design. MCCs equal to or less than 10kA must strictly comply with SANS 1973-3 or 1973-8.

Note that the specifications and requirements in the document act as guidelines only in terms of legislative compliance. Final legislative compliance, in terms of the Act, remains that of the Contractor and in case of a conflict, the SANS requirements shall apply.

During the tender stage, the relevant tendering party must specify in the data sheets whether and how the MCCs and equipment offered comply with the legislative requirements. Note this is a legal requirement and the tenderer must categorically acknowledge that they have acquainted themselves fully with the applicable SANS standards and that the offered equipment will comply as such.

1.2 GENERAL

1.2.1 Ratings

The MCCs and associated equipment and switchgear must be rated for the applicable fault levels as indicated in each MCC's section below.

CB and busbar sizes are only provisional during tender stage, as some of the plant and field equipment could change in sizing, depending on the final equipment offering by the tenderer.

MCCs must be rated to operate under at least a maximum ambient temperature of 50°C and a minimum of -1°C, in relative humidity of 90%.

MCCs must be rated to a minimum protection degree of IP44 within buildings and IP54 for outdoor installations.

All MCC distribution sections must allow for 30% physical spare capacity in their design, for future expansions or changes during construction.

As such, any and all ratings provided for the MCCs must be seen as applicable for tender (quotation) stage only. All sizes must therefore be confirmed with the Engineer, before construction commences. Any changes during construction stage, due to a lack of compliance in this regard, will be for the Contractor's account.

1.2.2 General Construction

1.2.2.1 Material and configuration

The MCCs are intended for industrial application for control of motor loads such as pumps, compressors, conveyors and equipment typically encountered in the water and waste water industries, as well as distribution to sub-DBs and dedicated control panels provided by others.

The MCCs must be floor-standing units, manufactured from 3CR-12 sheet steel, not less than 1.6mm thick. Where trenches are provided over which the MCCs must be installed, and all required plinths (minimum 50mm x 100mm hot-dipped galvanized U-Channel) and supports to stabilize and install the MCC over the trench must be provided as part of the MCC pricing.

Painting of the complete unit must be done strictly in compliance with the manufacturer's recommendations, with uniform thickness without. The final coat must be orange B24 enamel baked or powder epoxy, to be confirmed by the Client and Engineer before manufacturing.

MCCs must be constructed in tiers, with all tiers and panels compartmentalized (above and equal to 10kA). All required doors must be hinged and fitted with rubber door seals, so as to provide a continuous sealing edge along the gasket. All panels and doors must be removable with square-key locks used for securing them and a minimum of two per door.

The grouping of the MCC and associated equipment and feeds must be structured in a logical way, taking both the process flow of the feeds into account, as well as the grouping of respective and associated equipment. The following main components are required for the general MCC layout:

- Incoming section, with main incoming Circuit Breaker (CB), separate copper neutral and earth bars, metering, E-Stop and indication light (I/L), surge arresters, phase failure relay and main incoming cable access.

- Dedicated and enclosed air-insulated busbar chamber (both vertical and horizontal, where required by the MCC manufacturer design philosophy), running the length of the MCC

- Outgoing feeds to motor driven equipment and various other each with dedicated door-interlock handle.

- Distribution section for feeds to sub distribution boards.

- Section for local lighting and power if required.

- Dedicated power and control terminal compartments for field-cable connections

- Where required, voltage-free terminal compartment for remote monitoring and control signals, fully enclosed (even in open-compartment construction). Monitoring must be provided of signals within the MCC such as selector switch status, indication lights, common trips (separate E-Stop), main and pump CB status (ON/OFF/TRIP) as well as incoming telemetry signals for monitoring and control and

other as specified in the Project Specification.

- Flashing, protected strobe light, activated by any common fault alarm (fixed to MCC on outdoor applications, and bracket wall-mounted on indoor MCCs)

All live parts must be arranged to allow for front-access only.

Note that all busbars, including the neutral, must be of solid copper. These busbar assemblies must be fully type tested and compliant along with the steelwork configuration, to form one fully compliant TTA. A dedicated copper earth bar must run the length of the MCC, with pre-drilled holes at each tier/panel section.

The MCC must be designed that for the purpose of transport, it would be easy to disassemble the unit into moveable parts. This includes providing multi-pin sockets at each panel split for control wiring between two sections.

1.2.2.2 **Motor control cubicles and equipment**

Motor control cubicle assemblies must be configured as described below. Any additional requirements will be stated in the Project Specification. The form of separation will be specified in the project Specification, but for MCCs rated at 10kA or higher, default will be Form 3b.

The assembly must be configured as described below. The standards and technical requirements of the various components are addressed under the relevant sections covering such equipment:

a) **Incoming circuit breaker**.

The circuit breaker must serve as isolator and provide overcurrent and short circuit protection for the outgoing feed circuit. The short circuit rating may not be less than the related MCC fault level. Short circuit and overcurrent tripping curves must be coordinated with the motor controller starting current characteristics and purpose designed for motor starting application.

It must be fitted with sufficient NO and NC auxiliary contacts to provide for the specified control and remote monitoring requirements. Contacts current rating must be adequate for the required control function burden at the control voltage specified in the Project Specification.

Note that separate NO contacts for circuit breaker isolated (off) and tripped condition must be provided.

The circuit breaker handle must be pad-lockable in the open position.

b) CT operated ampere meter, center phase;

c) 6-digit running hour meter;

d) Motor Controller as specified in the Project Specification. The detailed requirements are given in the section covering the various motor controller types.

e) Protection devices:

Protection devices directly related to a specific motor controller type are detailed in the motor controller section. The following is a brief summary of the protection facilities required:

- Phase failure (loss of phase, phase rotation).
- Motor overload with adjustable trip settings;
- Motor thermal protection (overheat) in accordance with the type specified in the Project Specification, thermistors (two per phase) and/or PT 100 temperature sensors, embedded in the motor windings.
- Earth leakage protection (350mA) for motors liable to flooding, i.e. installations below ground level and submersible pump motors.
- Moisture sensing probes for submersible pump motors in an oil bath (sewage type).
- Bearing over temperature and excessive vibration protection for large motors only as per Project Specification.
- Protection for driven equipment as per Project Specification.

Protection devices must trip the related motor with trip status indication by means of indication lights on the control panel as well as auxiliary contacts for remote status indication, wired to a PLC or direct remote indication. Devices which are not mechanically latched in the trip condition must be electrically latched with a manual reset push button.

f) **Control facilities**:

- Manual/Off/Automatic function selector switches as per Project specification.
- Manual start (green) and stop (red) spring return pushbuttons. Provision must be made for manual starting and stopping from a remote field control station.
- Terminals must be provided for an automatic start and stop control signals as per the Project specification.
- A red mushroom head push-lock twist unlock emergency stop switch.

g) **Status indication**:

Status indication lights must be provided for:

- Motor run status.
- Motor trip (individual for all protection facilities).
- Any other status indication as per Project Specification.

A lamp test push button must be provided to energize all indication lights simultaneously.

1.2.2.3 **Field and cable accommodation**

Adequate space must be provided between the MCC base, gland plate and main incoming CB terminals to accommodate the main supply incoming cable. The permissible bending radius of the cable must never be exceeded. The minimum distance between the base and gland plate may never be less than 300mm. Further note that the gland plate must be suited for the type of main supply cable being installed, with a non-ferrous metal gland plate to be used for single-core cables. In the case of parallel cables, or where required for the termination of a large incoming cable, then adequately pre-drilled busbar extension stubs must be provided, securely fastened to the CB. These stubs must be offset, so as to provide adequate space between them and allowing adequate space to install and fasten the cables and all requirements as such must be provided as part of the tender offer.

Each tier must be provided with a dedicated terminal compartment at the bottom off the tier, fitted with terminals above the gland plate (unless the tier is a dedicated feed for one drive). The terminals must be suitably sized for the equipment fed, and adequately labelled on the backplane and terminal itself. All cable connections from the field may be done in this terminal compartment only, with all wiring from the terminals to the respective CBs and other feeds done in the factory. All other spatial, height and material requirements as per the incoming section are also applicable here.

Wireways may also be utilised, but then these must be dedicated wireways the full height of the MCC, with a minimum of 250mm wide. Note that for fully compartmentalized MCCs wireways are a requirement as no through-wiring from one compartment to another is permitted. Should field terminals be installed within these wireways, then dedicated supports must be provided for securing the cables. No cable may simply 'hang' on its terminals, regardless of being glanded in the bottom. Terminals must further be staggered in the horizontal, so as to prevent cables lapping over one another when being installed from the field.

All wiring must be installed where possible within PVC trunking throughout the MCC, including the wireways. Trunking must run neatly in vertical and horizontal sections where required. Note that wiring not installed in trunking must be installed in wire looms laced together by means of cable ties or other similar and equal material and fixed to dedicated rails, with the rails being part of the steelwork design and construction. Note that no self-adhesive straps will be allowed within the panel and it is therefore critical that any potential support rails be accommodated during the design stage.

1.2.2.4 **Labelling**

Any and all MCC and/or plant labelling must be in ENGLISH ONLY.

Each MCC must be clearly labelled and fastened to the panel by means of screws. In addition, each section must be labelled with externally mounted labels, below the equipment served. All CBs (incoming and outgoing) and other plant feeds must be provided with labels depicting either where they are fed from or what loads they are feeding, and what the applicable supply and cable earth size is.

All internal equipment and switchgear must be labelled with plastic engraved labels in clearly identifiable positions, and not on the trunking itself.

The main point of isolation must be provided with adequate 'Main Point of Isolation' labels as well as required 'in case of emergency' label.

Note that all internal wiring, cables, terminals and relays must be numbered, with the numbering to match the final As-Built documentation.

1.2.3 Switchgear And Equipment

1.2.3.1 Phase-failure protection

A suitable phase-failure relay (with adjustable switching points and sensitivity) must be installed within the incoming section, for the protection of the equipment. The relay must be provided with an additional dedicated and adjustable delay-on timer. After the identification of a phase failure condition and after the condition has fallen away, the power onto the MC may not be energised until this dedicated timer has timed out.

The relay must provide protection against phase loss, phase rotation and under/over voltage.

1.2.3.2 Surge protection

The incoming section of the MCC must be equipped with surge protection in accordance with SANS 10142-1. Both Class 1 and Class2 coordinated protection must be provided, adjacent to one another. Curve C backup protection CBs must be provided, with final ratings and positions to be determined by the supplier of the surge arresters.

Note that Surgetek, ABB or similar and equal equipment must be provided, being of the clip-in type and having visual displays and contacts for remote monitoring. The arresters must be mounted in a vented, see-through enclosure.

1.2.3.3 Circuit breakers

As this application is industrial by nature, circuit breakers must be rated accordingly (moulded case type), with sizing, tripping curves and protections taking into account for the applicable motors. Residential type equipment is therefore not accepted, except within the dedicated small lighting and power distribution feeds.

All CBs must carry the SABS mark.

CBs must be equipped with thermal devices for tripping in over-current situations and magnetic devices for instantaneous tripping in fault current conditions.

Single and double pole CBs may be rated at no less than 240V, with 420V the minimum voltage for three-pole CBs.

1.2.3.4 Current transformers (CTs)

CTs must have Class C accuracy, suitable for a 10VA secondary load and comply with SANS 60644-1. Note that the final CT design must however be presented to the Engineer, as field equipment and loading could potentially change during final equipment offering stage.

CTs must be of the air-cooled type, with suited mounting facilities. Split-core units will not be accepted.

1.2.3.5 **Indication lights**

They must be of the LED type, with dedicated colours as follows:

- GREEN: General run, start demand and enable levels
- YELLOW: Suction low level, process signals not being faults
- RED: General trip, alarm and emergency levels
- BLUE: Special status such as SCADA CONTROL

1.2.4 **Metering And Indication Equipment**

All meters must be able to measure, display and record the following parameters as instantaneous and monthly averages:

- Line and phase voltages
- Line currents
- kW per phase
- kVA per phase
- kVar per phase
- Power factor
- Total energy demand (kWh)
- Voltage and current harmonics

The main incoming meter, where specified, must be provided with CTs and display module included as part of the final offer. The display must be flush mounted with the MCC front-plate, but care must be taken to remove this unit during transport and installation.

The meter must be equipped with storage capacity, either on-board or expandable, so as to log the usage of the site over a daily, weekly and monthly cycle.

The meter must be of the Landis & Gyr, Lovato, ABB or similar and equal type, with Class 1 accuracy.

1.2.5 **Ancillary Items**

1.2.5.1 **Drawings**

All drawings must be submitted to the Engineer in electronic format. All drawings must contain gridlines, or referencing grid-blocks, so as to be able to comment on specific sections.

Construction may not commence until drawings have been commented on by the Engineer. Any modifications as a result of failing to comply with this requirement will be for the account of the Contractor.

Note that all revision must be listed on the drawings as the revision process carries out. Note that no additional payment will be made for revising drawings.

1.2.5.2 **Civil requirements**

As part of the drawings stage in the project, detailed civil requirements as a result of the equipment must be provided as soon as possible. This relates to items such as cable

trench depths, width and location, sleeves and other entry/exit points from the MCC room (size, amount and location, where applicable), applicable MCC dimensions, ventilation and heat exchange, cable racking routes and any other electrical requirements that could have an impact on the civil design and construction.

1.2.5.3 **Payment**

As a MCC is considered a complete and functional unit, interim payments will not be made. Only after a factory inspection and test has been carried out on the unit, and it has been found satisfactorily in line with the specification, will payment be certified for the unit in line with the contractual arrangements.

2. PLC

2.1 General

Where specified, a PLC will be required for control and protection functionality. The system must still be functional in manual should the PLC be off or faulty.

The PLC must be of the compact rail-mounted type, provided with inline surge protection as well as a back-up in-line UPS to provide 'clean' power to the PLC. Care must be taken in the design that the control voltages and power are correctly designed so there is no back-feed and potential live parts even after normal power has been switched off for maintenance purposes. Any cooling requirements must be provided for in the design of the pump station.

The PLC power supply must be capable of dual voltage supply, namely 220V and 24VDC nominal.

All required I/O must be installed on a common networked back-plane. Spare capacity of at least 20% must be provided for all digital and analogue cards.

Provision must be made for remote network communication with the telemetry outstation, or on-site industrial network, via Ethernet and Modbus TCP. A RJ45 connection point (weatherproof) must be provided on the MCC door.

All field terminations must be brought to terminals at a dedicated terminal section at the back of the MCC. These terminals must be permanently wired through to the PLC, including all spares. All terminals and wires must be clearly numbered for tracing from PLC to source.

2.2 SYSTEM TIE-IN

The PLC, hardware and engineering software must be, complete with all ancillary equipment to communicate with the associated field equipment, Industrial PCs and telemetry RTU, on an Ethernet/Modbus network.

All I/O must be surge protected. Digital inputs must be galvanically isolated and both digital inputs and digital outputs must be fitted with buffer interface relays.

Communication with field devices must be via the Ethernet and/or Modbus TCP network and discrete digital and analogue I/O only used where devices are not equipped with network communication capabilities.

Remote I/O modules must be supplied from a 24VDC power supply with a secondary one hour battery backup. The DC power supply primary supply will be 230VAC from a CB within the related MCC PLC section. The power supply must be complete with battery charger and regulator, installed within a separate compartment of the main equipment enclosure or within a separate adjacent enclosure as applicable. The I/O must remain active after a power failure and shut down automatically when the battery driven DC supply voltage has dropped below a determined minimum threshold.

2.3 INDUSTRIAL PC

The touch-screen industrial PC must be specifically suited for abrasive conditions (IP65), being fan-less and stainless. The screen must be a minimum of 21", with PC equipped with 3rd Generation i7 Core processor, 16GB RAM and 500GB SSD drive. The operating system must be as per the central server working station, including all layout configurations.

For more detail refer Industrial Communication Network and SCADA Section.

2.4 TENDER OFFER

Note: That the above-mentioned equipment schedule is nominal and the Tenderer must provide for all ancillaries and equipment not listed above to suit his specific design and configuration.

The basic equipment configuration is shown on the Proposed System, Control and Communication Topology drawing. This layout is nominal, showing the functional requirements and may vary in detail between different vendors/equipment suppliers. It will be the responsibility of the system integrator to, provide a detailed system topology drawing for his proposed system design, in accordance with the specific hardware offered.

3. INDUSTRIAL NETWORKS

3.1 GENERAL

Where specified for plant control and monitoring, an Industrial Ethernet backbone must be provided, in compliance to the various sections below. The designed network must further be compatible with other network protocols for lower structure components, and be expandable without having to replace equipment.

3.1.1 COMPLIANCE

The design components must comply to all legislative standards, as well as those listed for electrical and surge protection purposes, including but not limited to:

- SANS 61000 – EMC
- SANS 60950 – IT Equipment Safety
- SANS 62103 – Electronic Equipment
- IEC 61158 – Industrial Communication Networks
- SANS 60793/4 – Fibre Optics

3.1.2 RESPONSIBILITIES

The Specialist Sub-Contractor (as an extension of the Main Tendering entity) is responsible for the implementation and communication between the MCCs, media converters, network switches, PLCs and SCADA system. Both copper and fibre networks must be installed in such a way that a ring is created, with self-healing capability according to the Rapid Span Tree Protocol (RSTP).

The network drawings provide as part of the tender document are in indication in terms of functional requirements relating to control required and established positions of the respective equipment. The Contractor however remains responsible for the full design of the network system in terms of the equipment sizes, types offered and overall design and functionality of the system. The Contractor must determine the exact amount of I/O cards (Digital/Analogue, as well as Inputs/Outputs), and the switch, media converter and patch panel sizing based upon all available information provided in the project specifications and respective drawings. Note the mechanical and process specifications must also be read and complied to in full.

3.1.3 POWER SUPPLIES

All PLCs, Industrial PCs, remote I/O modules and network switches must be supplied from a 230VAC point of supply within the MCC. 24VDC components and modules must be provided with additional power supply backup for at least an hour, from a central supply point (whether it be UPS or battery/inverter configuration). The complete network must remain live during a power failure (for at least an hour, or until the backup generator take over).

3.1.4 EARTHING AND BONDING

The network must be designed with a suitable and effective earthing and equipotential bonding system. This will ensure less static interference on the network and prevent any earth potential and unwanted current flows on the screens. Refer in detail the sections below relating to the earthing of cable sheaths and devices in line with manufacturer requirements.

3.1.5 FINAL DOCUMENTATION

Note the general specifications relating to documentation requirements that must be provided and complied with during the commissioning and taking-over period of the project. This includes, but is not limited to final As-Built drawings, testing and calibration documentation, operating and maintenance manuals, training compliance, etc.

Note that it is vital that all IP and gateway addressed are fully updated and included into the required documentation. All equipment information, part numbers, etc must also be included, so that in the event of a failure, the Client would be able to replace the part as a matter of urgency. As-Built cable and connection schedules must be provided for industrial network.

These requirements must be met prior to taking-over inspections of the Works commences.

3.2 COPPER (1000BASE-T)

3.2.1 CABLE WORK

All copper cable work required in the site network must be of the CAT5e overall shielded twisted-pair type (S/UTP), minimum IP65 and the colour grey. Note the importance of the bending radius of a minimum of 4 x times the cable diameter, which may not be exceeded. If not complied with during installation, a new cable for that complete run must be provided. No re-routing or splicing will be accepted.

The cable transmission performance must comply with TIA/EIA 568, and the cable marking requirements in compliance with the EC VERIFIED requirements.

No cable runs may exceed 90m in length. In the instance where there is a distance longer than that, an additional housing box and repeater/switch, as per 3.2.2 below, must be provided as part of the tender offer. No joints or splices will be accepted.

The exact final routing on-site will remain the Contractor' responsibility. The drawings provided indicate functional requirements and positions. Final routes must be carefully planned so that network and power cables do not run close to one another, and if at all possible, do not cross. In the instance where a power / network cable crossing must take place, it must be at right angles, and the network cable to run in a section of steel conduit (bosal). In all other instances, S/UTP cable must run on its own cable tray or steel conduit. All external cable tray routes against structures must be provided with additional cable tray cover, fastened with stainless steel bandit straps. No S/UTP cable may be buried in the ground.

For horizontal runs, S/UTP cables must be strapped together every 1m (max) on the cable tray. All vertical S/UTP cable runs must be securely strapped every 300mm (max). Care must be taken that the cables aren't strapped too tight, placing unnecessary strain on the cables.

All S/UTP cables must be clearly marked at both ends with both source and destination labels (for example, patch panel switch number as source and remote I/O module as destination). Cable connections at the various switches and modules must be via industrial RJ45 connections, in accordance with the TIA/EIA-568 standards. Only shielded RJ45 connectors may be used.

Note that the shielding must be connected to the network switch and not the field device, which in turn must be properly earthed in order to prevent any ground potential differences.

Any additional access openings must be communicated with the Engineer in writing, and no core-drilling may be done until approval has been provided. The Civil Contractor may decide to provide all access openings themselves. In this instance, all coordination for correct opening positions to form part of this tender offer.

3.2.2 SWITCHES

Switches must be of the managed, Level 2, Gigabit-Ethernet type, in order to provide for the RSTP, ring-redundancy functionality, in compliance to IEEE 802 and the applicable sub-regulations. Each switch must act as a ring-manager, checking the integrity of the

ring and opening and closing where required. Precise time synchronization of the network(s) must be possible. The switches offered must have an industry-high MTBF.

Switches must be of the industrial type, robust against rust, vibration and Electro Magnetic Interference (EMI). The amount and type of ports required must be evaluated by the Contractor in conjunction with the functional specifications and drawings, with an additional 20% spare capacity there after.

Where possible industrial switches must be installed within the respective MCC's dedicated PLC sections/tiers. Where there is no MCC and/or PLC, the switch must then be installed within the fibre patch panel (termination cabinet). A clear earth path must be created with the S/UTP cable, to prevent any ground potential differences. Switches must either be DIN-rail (MCCs), or rack-mounted (server/fibre cabinets). DIN-rail will also be accepted in the latter's case, provided that the switch is brought forward in the cabinet for ease of access and maintenance.

Note that should a switch and media converter be one combined unit, the same philosophy must be applied throughout the plant. Refer media converters below.

Switches must finally be labelled in a logical manner, in conjunction within the areas that they are located. These numbers must conversely correlate with the S/UTP cables running to and from.

3.2.3 REMOTE I/O

At certain sections within the plant, remote I/O modules must be provided (where specified). Remote I/O modules must be of the same manufacture and type as either PLC or network switches. These modules must be connected to a local switch via a S/UTP cable and must therefore be compatible in terms of communication requirements.

All field equipment must be wired to interface terminals within the enclosure housing the dedicated remote I/O module. These interface terminals must be permanently wired to the respective remote I/O cards, based upon the requirements as per the instrumentation and control specifications. Spare space provision of 20% must be allowed for at both the terminals and within the I/O modules. These spare terminals must be fully wired-through to the I/O modules.

All terminals and wires must be clearly and logically labelled. All wire numbering must be included onto the final wire diagrams, which must be submitted with the operating and maintenance manuals.

3.2.4 PLC INTERACTION

The various sections of the Works, where specified, must be provided with PLCs, to provide for the required monitoring and control as per the functional specifications. The interaction between the PLC and network backbone is critical in maintaining data integrity, to prevent loss of data through logging on the central SCADA system and for inter-connected control signal relaying.

3.2.5 TESTING AND CALIBRATION

Every live circuit (live and redundant) must be tested by the Contractor during the commissioning stage of the project. The testing must be carried out with a field tester conforming to TIA/EIA 568 criteria. Each circuit must be tested end-to-end, including all leads. All results must be clearly documented and included as part of the final manuals (system health check).

A full system diagnostic test and report must also be compiled, to confirm network speed complies with design, that redundancy and fall-back has been tested and that no interference (active harmonics with equipment running, EMC, etc) is present.

Note that all testers used must be accompanied by their respective calibration certificates from the manufacturer, to be presented to the Engineer (if so requested). No calibration certificate, at the time of cold commissioning, may be more than one year old.

3.3 FIBRE-OPTIC (1000BASE-SX)

3.3.1 CABLE WORK

3.3.1.1 Cables

Fibre-Optic (FO) cables must be of the 50/125µ armoured, multi-mode type consisting of a minimum of 4 pairs. Final cable sizing is however dependent upon the final site conditions and must be supplied and installed as specified and indicated in the BOQ. For cable lengths longer than 550m, single mode cables and associated equipment must be offered as part of the design solution.

3.3.1.2 Installation

All outdoor FO cable must be installed in a 110mm PVC sleeve, which in turn must contain micro-tubes for blowing the fibre cables through. All other FO cables must be installed on either a separate section of cable tray, or combined with the copper network tray. For horizontal runs, fibre cables must be strapped together every 1m (max) on the cable tray. All vertical fibre cable runs must be securely strapped every 500mm (max). Care must be taken that the cables aren't strapped too tight, placing unnecessary strain on the cables.

A manhole (draw-pit) must be provided at each bending point along the route, and after each 200m straight run along the route (Contractor to confirm maximum permissible distances between the manholes depending upon cable offered, and adjust the distances accordingly). The manholes must be min 600x600mm concrete ring-type structures, with lockable lids and completely sealed to any water or particle ingress. All manholes and associated civil works must be priced for under this contract, including construction design and monitoring. Final quality oversight must be provided by the FO installer. All civil designs must be submitted to the Engineer for approval before installation may commence.

The cable must be installed in maximum continuous lengths, to minimise joints, delivered in drum lengths. No joints will be accepted for cable runs less than permissible, depending on the cable type (multi-mode versus single-mode). The route drawings indicate functional routes on scale, from which distances can be determined

for tender stage. Final installed distances must be determined on-site, making provision for all required slack and loops. Remuneration will be for the installed length at the tendered rate per meter, measured linearly between points, including loops at agreed lengths per loop. Slack must be allowed for in the rate per meter.

All ancillaries such as cable tray, brackets and supports must be priced under the respective BOQ items. Note that the requirements in 3.2.1 above, relating to building, routes etc. applies in this instance.

All FO cables must be clearly marked at both ends with both source and destination labels (ie patch panel number #1, port 12 as source and patch panel number 2, port 9 as destination).

3.3.1.3 **Splicing**

Cable splices must be made within a purpose-made watertight jointing box, inside a jointing box. Splices may only be of the fusion splice type, complete with a protector, and no mechanical joints are allowed. Losses must be limited to 0.3dB or less.

The Contractor must provide the construction detail of this jointing chamber to the Engineer for approval, before construction. A 1m cable loop must be left at each draw-pit and 1.5m at each jointing chamber and end connection. Each manhole loop must be provided with a source and destination tag, as per the labelling requirements above. A warning label must also be provided, relating to access and possible danger of laser equipment.

Care must be taken, especially at the draw-pits and jointing chambers, when installing the FO cable. Minimum tension must be applied and rollers must be used, to prevent any damage to the outer sheath. The fibre installer must provide method statement for installation mechanism. Note the importance of the bending radius requirements of the supplier, which may not be exceeded. If not complied with during installation, a new cable for that complete run must be provided. No re-routing or splicing will be accepted.

An IP65 junction box for splicing and through-connection of the FO cables must be provided in each jointing chamber and wall-mounted against the chamber structure wall. A hanger must be provided for securing the redundant loop within the chamber.

3.3.1.4 **Inspections**

The cable must be inspected and quality tested at the factory prior to dispatch. After delivery on-site and prior to installation, the drum(s) must be visibly inspected for damage and OTDR drum tests must be done on all cores. The factory must provide the necessary quality and test certification and the Contractor/Installer must provide the on-site drum test certification. All certificates must form part of the formal submitted documentation.

Should any damage be detected then the drum must be replaced in whole. Protective caps must always be fitted to protect exposed fibres.

3.3.2 TERMINATION CABINETS

3.3.2.1 Patch panel and terminations

One patch panel (rack-mounted) must be provided per section of Works, as indicated in the functional specifications and drawings. Each patch panel must be installed within a dedicated fibre-optic termination cabinet (wall-mounted). The patch panel must be provided complete with adaptor plates suited to connectors, splice trays and fibre optic pigtails.

A minimum of a 0.5m un-jacked fibre optic pigtail must be provided at each fibre patch panel. The cables must be securely fastened, so that during maintenance, the cable cannot move. All the cores in the cables must be spliced and connected and all unused slots on the patch panel must be loaded with blanks so as to ensure the installation's IP rating. All unused fibres must be sealed with a mid-coupler end protection caps.

The ports in the panel must be numbered numerically from left to right. Each cable must be provided with a source/destination tag.

All patch panels must be assembled in the factory and inspected by the Engineer, before being taken to site. No assembly will be allowed on site.

3.3.2.2 Media Converter

The media converter must be of the DIN-rail type and spatial provision must be made within the termination cabinet. Switched media converter will not be accepted. Note that should a switch and media converter be a combined unit, then the same philosophy must be applied throughout the plant. Refer managed switches section above.

3.3.2.3 Cabinet

The cables must be terminated at each site/section onto a rack-mounted patch panel, housed within a purpose built wall-mounted steel cabinet, with lockable hinged glass door, IP65 rated. Long base brush panels must be installed at each cabinet. The mounting rails must be back and front adjustable. Two fans must be provided within the cabinet, with the Contractor design ensuring adequate airflow for the equipment. A main CB and the necessary distribution CBs provide for all equipment fed from the cabinet must be provided (note the COC requirements here in terms of SANS 10142-1).

Adequate space must be provided within the enclosure for ease of access and maintenance and all required equipment for that specific section of works. Note that an additional 25% spare space capacity must be allowed for in the final sizing of the cabinet. Note the requirements with regards to the housing of network switches, as per the section above, when there are no local MCCs in the area.

Each enclosure must be suitably and permanently labelled, with consistency provided throughout the works. In addition, each enclosure with a laser light warning label.

Size 0 compression glands must be used for fibre cable entry into the cabinets (onto gland plate), and size 00 for copper ethernet cables. All drilling and taping must take place on the backing/mounting plate of the enclosure. No double-sided-tape or side-panel taping will be allowed.

3.3.2.4 **Testing and calibration**

On completion of the installation, the final FO cable tests must be done for all the cores (for example, dB losses and ensuring optical continuity throughout), by means of a PMLS light source test. Note that cable and core testing must be done in both directions.

Note that all OTDR testers used must be accompanied by their respective calibration certificates from the manufacturer, to be presented to the Engineer (if so requested). No calibration certificate, at the time of cold commissioning, may be more than one year old.

4. SYSTEM INTEGRATOR

The system integrator (SI) responsible for the PLC, SCADA and Industrial PC programming, must have proven capabilities in this field and have a track record of work previously done similar to the work covered by this project. Detail of this experience must be given in the relevant data sheets.

It will be the responsibility of the SI to familiarise himself with the Employer's standards and software configuration if not already and no claims for additional payment in this regard will be entertained.

The (SI) must be present at the factory simulation testing of the MCC control system, as well as the onsite commissioning and final acceptance testing. The SI will be considered an employee of the Contractor and no cost claims in addition to the normal contractual claims to which the Contractor is entitled, will be entertained and provision for these activities must be made in the tender price.

5. MOTOR CONTROLLERS

5.1 General Scope

This section covers devices intended for the starting, stopping and speed control of three phase asynchronous induction motors. Generally motor controller (MC) will refer to a device for connection/disconnection of a motor to/from the electrical supply with or without speed control facilities. Fixed speed devices will be referred to as starters and variable speed devices as speed controllers. It relates to the motor controller referenced in the section *Motor Control Cubicles and Equipment.*

The MCs must be rated for operation on a three phase electrical supply system of 400V (nominal), 50Hz. Systems operated on other voltages will be stated in the project specification and references to rating and other electrical parameters must be amended accordingly.

Standard MC types are covered in the subsections below. The MC considered best suitable for a specific application will be specified in the Project Specification, based on pre-tender design considerations. The tenderer is responsible to verify the suitability of the specified MCs in terms of the driven equipment offered by him and if necessary, to qualify his tender accordingly with an alternative MC and related financial implications. Should the Tenderer fail to do so, any changes required later to best serve the application/duty of the equipment offered, will be at the Tenderer's cost.

MCs offered for tender must be rated at minimum for the motor full load rating (kW). Ratings given in the project specification are provisional for pre-tender design purposes and serve as default value for tender purposes. MCs offered must be rated in accordance with the actual motors offered for tender. No cost adjustment will be made in the case where the tenderer has to uprate offered equipment, whether from the default or offered value, except where the driven equipment requirements have been changed on instruction of the Engineer. A corresponding saving must be given where ratings have been reduced from the tender offer due to reduced driven requirements.

5.2 DIRECT ON LINE STARTERS

The general requirements for a drive cubicle assembly as per *Motor Control Cubicles and Equipment* will be applicable, and the motor controller referred to will be a direct on line (DOL) starter as described below.

5.2.1 Application

DOL starters will generally be used for manual and automatic starting of equipment operated at fixed speed driven by smaller motors, or larger motors where there are no supply constraints and/or high torque requirements.

DOL Starters covered below comprise three types:

- An assembly comprising discrete elements, being an isolating circuit breaker, electro mechanical contactor and motor protection relay, used for manual and automatic control of equipment.

- A two element assembly comprising a compact combined isolating circuit breaker for short circuit and motor overload protection with integral manual start/stop facilities (manual motor starter) and a separate electro mechanical contactor for manual and automatic control of equipment. The starter must be provided with or without facilities for fieldbus communication to a PLC, as specified in the Project specification.

- A one element compact assembly comprising a combined isolating circuit breaker for short circuit and dedicated motor overload protection with integrated manual start/stop facilities (manual motor starter) for manual control only of equipment. The starter must be provided with or without facilities for fieldbus communication to a PLC, as specified in the Project specification.

The **discrete element assembly will be the default option for general implementation,** with the compact type only to be used if specifically stated in the Project Specification**.**

The various elements must comply with the separate specification sections dealing with the specific individual components.

5.2.2 Discrete Element Starter Configuration

The starter assembly must comprise an upstream circuit breaker, discrete contactor and discrete motor protection relay.

5.2.2.1 **Circuit breaker**

The circuit breaker must comply with the relevant clauses in *Motor Control Cubicles and Equipment* above.

5.2.2.2 **Contactor**

The contactor must be of the electro mechanical type comprising a base with fixed contacts and a moving spring-loaded pole piece assembly with the switching contacts, operated by a magnetizing coil. The contacts must be rated for the motor rated continuous current, and fault/short circuit current for the time the upstream protection takes to operate.

The Contactor must be rated for AC 3 (normal) duty, type 1 coordination. AC 4 duty must be used for heavy duty applications (high torque/plugging/inching).

The contactor must be closed/opened by energising/de-energising the operating coil manually via push buttons or automatically from a PLC or field control signal, as specified in the Project Specification. The default coil voltage is 230V AC. Other voltages such as 24V DC or 48 V DC will be specified in the Project Specification. The coil must operate under the following control voltage (U_c) limits:

- Operational range : 0,85 U_c to 1,1 U_c
- Drop-out : 0,35 U_c to 0,55 U_c

The contactor assembly must be of modular construction to provide for easy maintenance with regard to coil replacement in situ, without removing the contactor base and wiring. Large frame contactors must have replaceable contacts.

Starters for motor rotation direction change (reversing) applications must comprise two identical contactors arranged that two supply phases are reversed to effect reversal of the motor rotational direction.

Phase rotation must be maintained with wiring sequence RWB. Power cable colour coding must be maintained throughout the starter assembly as well as the outgoing cable connection. Motor direction must be determined within the motor terminal box connection.

5.2.2.3 **Motor protection relay**

Motor protection relays must be modular of the thermal bi-metallic or electronic type, as specified in the Project specification, purpose made for motor protection. The motor protection parameter trip setting must be manually adjustable to suit the motor specific rating and duty.

<u>Thermal bimetallic type</u>

The relay must be of the same manufacture as the contactor and selected in combination with the contactor and motor rating as per the manufacturer's selection charts. It must provide protection against overload current and single phasing (indirectly via overcurrent) with tripping curve to suit the motor type and application.

The relay must be fitted with a *TEST* facility to provide for manual tripping of the relay for simulation purposes.

The relay must be directly connected to the contactor up to the power rating provided for by the manufacturer and via current transformers for higher power ratings.

Electronic type

The relay must preferably be of the same manufacture as the contactor or as specified in the Project Specification. It must provide comprehensive protection for the conditions specified below (minimum) with adjustable /selectable tripping curves to suit the motor type and application.

a) Phase fail (loss of phase, phase reversal).

b) Motor overload.

c) Motor underload.

d) Successive start limitation.

The relay must be fitted with a *TEST* facility to provide for manual tripping of the relay for simulation purposes. Note that in *TEST SIMULATION MODE* there must be no reset delay after successive starts resulting in a trip.

The relay for low power applications must have built in current sensing and directly connected to the contactor as per the manufacturer's directive. For higher power ratings the relay must be driven via current transformers.

5.2.2.4 **Auxiliary contacts**

Circuit breakers, contactors and motor protection relays must be fitted with sufficient NO and NC auxiliary contacts to provide for the specified control and remote monitoring requirements. Contacts current rating must be adequate for the required control function burden at the control voltage specified in the Project Specification.

Note that circuit breakers must be provide with separate NO contacts for circuit breaker isolated (off) and tripped condition.

5.2.2.5 **Operator interface**

The operator interface must comprise two local discrete start (green) and stop (red) spring return pushbuttons on the MCC panel door and remote starting/stopping from a field control station as specified in the Project Specification switching the contactor coil. An emergency stop must be hardwired to the contactor coil.

Higher level interface to a HMI or SCADA will be detailed in the Project Specification.

5.2.2.6 **Rating summary**

a) System voltage : 400V (+10%-15%).

b) Power (kW) : Driven motor rating (min).

c) Duty : AC 3, AC 4 as applicable.

d) Coordination : Type 1

5.2.2.7 **Standards**

SANS 60947-4-1, 2, 3 as applicable.

5.2.3 **Compact Starters**

Compact starters have the circuit breaker and overload relay combined in an integrated package with on board mechanically latched start/stop push control and must conform to the general functional requirements of the discrete element starter specified above.

It is intended for small power application only and will be specifically specified in the Project Specification.

5.3 SERIES REACTOR REDUCED VOLTAGE STARTERS

Not part of this specification

5.4 ELECTRONIC REDUCED VOLTAGE (SOFT) STARTERS

The general requirements for a drive cubicle assembly as per *Motor Control Cubicles and Equipment* will be applicable, and the motor controller referred to will be an electronic soft starter as described below.

5.4.1 **Application (general)**

Soft starters are used for fixed speed application, with controlled starting ramp-up acceleration and stopping ramp-down de-acceleration to reduce shock loading on driven equipment or prevent water surges in pumping systems. Some applications will mainly be for reduced motor starting current where there are electrical supply constraints.

5.4.2 **Starter Configuration**

The starter assembly must comprise an upstream circuit breaker and soft starter.

5.4.2.1 **Circuit breaker**

The circuit breaker must comply with the relevant clauses in *Motor Control Cubicles and Equipment* above.

5.4.2.2 **Starter module**

The starter is a reduced voltage type starter which uses solid state electronics to increase the output voltage to the motor gradually from a threshold value to full value where it remains until the motor is stopped, at which the output voltage is gradually decreased to zero. The effect is that the motor gradually accelerates during ramp up stage (soft start) to full speed (steady stage) and gradually decelerates during the ramp down stage to standstill (soft stop). The start-up threshold voltage must be adjustable

to increase the motor pull away torque as required. A start boost facility must be provided for short time application of full voltage for high starting torque applications.

The Starter must have a selector to disable the soft stop facility for an uncontrolled stop if so required, e.g. high inertia loads or emergency stop.

Torque control

Ramp up and ramp down slopes must be linear for general application and separately adjustable to suit the load application.

The speed response is load type dependant and linear voltage ramps will not be suitable for all applications, resulting in poor speed regulation. The torque in the motor must be regulated to match the load type during acceleration and deceleration, to prevent unwanted rapid acceleration/deceleration and the motor parameters (current and voltage) must be continuously monitored during ramp up/down for instantaneous adjustment of the starter output to allow for changes in load conditions and the soft starter must incorporate a closed loop torque control system to achieve this. The speed-up/down ramps are thus effectively torque (not voltage) ramps.

5.4.2.2.1 **Configuration**

The power electronics comprise two back to back silicone controlled rectifiers (SCRs)/thyristors per phase fired appropriately to vary the output voltage. The control electronics comprise a microprocessor controlled SCR firing control circuit for varying the firing angle to provide the voltage control.

The starter must be installed in line with the motor (inside delta will not be acceptable).

Bypass contactor

The starter must be fitted with a by-pass contactor, which closes automatically when full speed has been reached, bypassing the starter during steady state operation and opening again when the stop ramp commences. This contactor must be an integral part of the starter module. External contactors must be clarified with the Engineer prior to implementation.

Since the starter and motor protection is internal to the starter, care must be taken that the protection remains active during bypass, especially for externally fitted bypass contactors.

Power factor correction capacitors

If power factor correction is required in the Project Specification the switching implementation must be determined in conjunction with the soft starter vendor with separate switching/isolation contactors. The capacitors may not be switched to the starter output terminals which must be isolated by means of a dedicated isolation contactor. Specific care must be exercised that the motor protection is maintained with the starter output isolated.

5.4.3 **Functional Requirements**

The following facilities must be provided:

5.4.3.1 **Centrifugal pumping application**:

Acceleration and deceleration must be smooth, especially deceleration during stopping to prevent surges and bring the pumped water column to a controlled standstill. Torque or any other variance causing pressure pulses during stopping will not be acceptable and cause for the starter to be rejected. This requires torque ramps which are not linear, but purpose designed for pumping applications.

5.4.3.2 **Control and monitoring**

Provision must be made for control demands via discrete digital inputs, operator interface keyboard and communication network (PLC, HMI or SCADA system).

Refer to the *Interface* section below for access to these facilities.

5.4.3.2.1 **Starting**

a) Acceleration ramp: Adjustable 1-90 seconds from a fixed threshold voltage.

b) Threshold voltage: Adjustable from 0,33 rated voltage to 0,6 rated voltage.

c) Start voltage boost facility: Switch selectable full voltage short-time boost.

d) Current limit: Adjustable 2-5 times motor rated current.

5.4.3.2.2 **Stopping**

Switch selectable:

a) Uncontrolled free-wheel stop by shutting off the supply to the motor.

b) Controlled stop with deceleration ramp, adjustable 2-90 seconds.

c) Current limit: Adjustable 2-5 times motor rated current.

5.4.3.2.3 **Addressable inputs and outputs (I/O)**

Addressable I/O that can be configured to provide the following functionality:

a) External start and stop signals, remote manual and automatic control.

b) Emergency stop.

c) Starter inhibit (interlock).

d) Motor run status.

e) Motor fault.

f) Starter fault.

5.4.4 **Protection Facilities**

The soft starter must have integral starter and motor protection facilities that will trip the starter when activated. All trip settings must be adjustable. Note that protection facilities must remain functional in bypass mode. The specific trip condition must be given on the starter LCD display (refer operator interface).

The following are minimum requirements:

5.4.4.1 **Motor protection**.

a) Motor overload in accordance with integral motor thermal protection curves, by measuring the actual motor current, including locked rotor (stalled /jammed motor).

b) Motor underload.

c) Successive start limitation, by means of a thermal memory taking previous starts into account. Once the thermal capacity has been exceeded and the motor shuts down, restart must be prevented until the motor has cooled down sufficiently.

d) Larger drives must provide for direct connection of external protection devices such as PT 100 RTD temperature sensors and thermistors, as per Project specification.

5.4.4.2 **Starter protection**

a) Phase fail (loss of phase, phase reversal, phase imbalance).

b) Over and under voltage.

c) Short circuit protection by means of fast acting fuses in accordance with the manufacturer recommendation (additional to the upstream circuit breaker) for phase and earth fault.

d) Thermal protection of the starter against overload and over temperature.

e) Cooling fan fail.

f) The starter must have a self-diagnostic facility for checking internal component faults.

5.4.5 **Operator Interface**

The following facilities must be provided for purposes of control and monitoring.

5.4.5.1 **LED status display**

The starter must have LEDs supplementary to the navigation keypad display for status indication as described below. The combination of LED indication and text status display will be manufacturer specific.

The minimum LED status indication is as follows:

a) Power on.

b) Controller run.

c) Alarm.

d) Fault.

The balance of statuses must be displayed in the LCD text display unit.

Note that the status LEDs must be visible through a panel door window, or mounted on the navigation display unit.

5.4.5.2 **Keypad display unit**

The starter must be provided with an operator interface module comprising a menu driven navigation keypad and alphanumeric backlit LCD multiline display to serve as operator interface and access point to program parameters and select display of specific parameters. The module must have navigation keys for scrolling through the display and selection parameters/options. Text information must be in plain descriptive English. There must be a *Help* menu to assist the operator. Operator access to defined levels must be password protected.

This module must be removable for remote installation on the MCC panel door, with cable link to the controller. The module must be interchangeable between various models within a specific range.

The display must provide for the following text information:

a) Motor operational status:

- Starting/stopping.
- Run.
- Fault (individual trip identification).
- Cooling down.

b) Motor dynamic parameters:

- Line and phase voltages (all three phases).
- Line current (all three phases).
- kW, kVA, kVAr, PF.

c) Starter operational phase:

- Acceleration/deceleration.

- Top of ramp.
- Steady state.

d) Starter protection:

- Internal fault (individual faults).
- Starter thermal fault.
- Starter cooling fan fail.

e) Fault history.

f) Motor data.

g) Starter setup parameters.

5.4.5.3 **Manual control**

Start and stop facilities must be provided by means of:

a) The keypad.

b) Local discrete start (green) and stop (red) spring return pushbuttons on the MCC panel door and remote starting/stopping from a field control station as specified in the Project Specification and an emergency stop hardwired to the starter.

5.4.6 **System Interface**

The starter must have communication facilities for a multi drop serial Modbus link and Ethernet connectivity for communication with the controlling PLC and SCADA system. Provision must be made for control via the network from a PLC, HMI and SCADA system.

The Soft starter must have programmable digital and analogue inputs and outputs to provide the facilities specified under *Functional Requirements* above. Provision must be made for extendable facilities. Specific provision must be made as shown (minimum):

- Digital inputs : 4
- Analogue inputs : 2
- Analogue outputs : 2
- Relay outputs : 4

Temperature sensor inputs:

- PT 100 RTD inputs : 4
- Thermistor inputs : 3

5.4.7 **Specification And Ratings**

a) Supply voltage: 400 V (- 15%,+10 %) three phase at 50 Hz.

b) Power: motor continuous rated load plus 10%.

c) Power de-rating above 1000m above sea level: 2% per 100m.

d) Noise level: ≤65dB.

e) Starts per hour: 12.

5.4.8 **Accommodation And Cooling**

The starter must be able to operate under the conditions stated below

Ambient temperature : 0 °C to 40 °C.

Humidity : 93 % at 40 °C.

The starter assembly must be installed in a MCC enclosure and sufficient space must be provided around the starters to ensure adequate air flow in accordance with the manufacturer's requirements. Forced cooling by means of a fan (1*) must be provided and hot air may not circulate within the enclosure, but vented to the outside of the enclosure. Short circuiting of air to adjacent enclosures must be prevented. The enclosure door must be fitted with an air intake at low level and exit at high level with air flow deflected upwards (not towards the front). Fully enclosed compartments must be ducted to the back or top with an extraction fan if the normal circulation does not provide sufficient cooling. The intake louvre must be fitted with a removable filter element.

The MCC manufacturer is responsible to confirm the cooling methodology with the starter manufacturer to ensure compliance.

Note (1*): The fan must only run when the starter is in active drive operation and then only when the temperature exceeds safe levels.

5.4.9 **Standards**

The starters must comply with the following standards:

a) SANS 60947-4-1, 2, 3 as applicable.

b) Radio electrical interference : IEC 801-3

c) Vibration resistance : IEC 68-2-6

d) Shock resistance : IEC 68-2-27

5.5 VARIABLE FREQUENCY SPEED CONTROLLERS

5.5.1 General

The general requirements for a drive cubicle assembly as per *Motor Control Cubicles and Equipment* will be applicable, and the motor controller referred to will be an electronic variable frequency controller (VFC) as described below.

VFCs must provide smooth linear acceleration and deceleration during starting and stopping, by means of increasing the motor supply voltage and frequency from zero to the desired operational speed on an adjustable time ramp during run-up and the reverse on stopping to standstill.

5.5.2 Application (general)

VFCs are primarily used for:

a) Dynamic variable speed application, to maintain a parameter set-point. Starting and stopping are with controlled ramp-up acceleration and ramp-down deceleration to reduce shock loading on driven equipment or prevent water surges in pumping systems.

b) Fixed speed applications at discrete different speeds for phased implementation over time, or serving different duty points utilizing the same motor and pump.

VFCs can also be used for equipment powered from a standby generating set, because of the reduced starting current characteristic of VSDs.

5.5.3 VFC Configuration

5.5.3.1 Principle of operation

The VFC is uses solid state electronics to gradually increase the output voltage and frequency to the motor from standstill to a controlled speed until the motor is stopped, at which the voltage and frequency are gradually decreased to zero and the motor is at standstill. The effect is that the motor gradually accelerates during ramp up stage (soft start) to a controlled speed and gradually decelerates during the ramp down stage to standstill (soft stop). The voltage control limits the inrush current during run-up.

5.5.3.2 Topology and technology

The controller comprises a full wave diode bridge rectifier input section, DC link and inverter section to convert the DC to a variable AC frequency, operating at rated voltage at the system frequency. A microprocessor controls the power electronics to convert the fixed frequency AC to variable frequency AC.

The rectifier section thyristors can be configured as a six or twelve pulse (trigger) unit. The six pulse unit is supplied from a normal three phase supply, whereas the twelve pulse unit will require a special phase shift input transformer to provide for the twelve pulse configuration. The default supply will be a standard three phase system and six pulse units will be considered the norm for tender, unless specified otherwise in the Project Specification.

The inversion section comprises actively switched IGTBs and must use pulse width modulation (PWM) technique to approximate a sinusoidal output waveform. The power modules must be protected against overheat, overload and short circuit.

VFCs generate harmonics and mitigation measures must be provided such as filters, passive front ends or active front ends. Passive front ends comprise high order pulse rectifier sections such as 12 or 18 pulse units which have inherent lower harmonics. It may be offered if it offers a more economical solution than a six pulse units with matching additional mitigation measures, but the offer must include the phase shift input transformer. An active front end IGBT rectifier section in place of the thyristor rectifier, nominally in mirror of the invertor section, will significantly reduce harmonic generation (and footprint), but is generally only cost effective in high power drives. This is the preferred option for larger drives in a phased application, where motors will initially run at reduced load (refer to load effect in the section on Harmonics).

The VFC functional characteristics must be matched to the specific load, especially torque control during starting and stopping. VFCs main application for purposes of this specification will be for centrifugal pumping systems and VFCs must employ Vector torque control, in most cases single quadrant operation. If deceleration or reverse braking is required, four quadrant control must be used (active front end) and not resistors for braking energy dissipation.

5.5.4 **Functional requirements**

The following facilities must be provided:

5.5.4.1 **Control and monitoring**

Provision must be made for control demands via discrete digital inputs, operator interface keyboard and communication network (PLC, HMI, SCADA system).

Refer to the *Interface* section below for access to these facilities.

The following requirements must be met:

a) Starting and stopping acceleration and deceleration ramps must be separately adjustable.

b) Emergency stopping or stopping under fault conditions must be selectable as controlled, or freewheel stopping.

c) Sixteen (minimum) pre-programmable speeds for fixed speed operation.

d) Addressable inputs and outputs that can be configured to provide the following functionality:

- External start and stop signals, remote manual or automatic control.
- Emergency stop.
- Controller inhibit (interlock).
- Motor run status.

- Motor fault.
- Controller fault.

e) On loss of a controlling parameter, e.g. an analogue reference value, the VFC must revert to a user defined safe speed, with alarm.

f) A communication facility must be provided whereby the setting up of the controller can be done remotely and downloaded, as well as to provide for copying the drive set-up to external storage devices, such as a laptop.

5.5.4.2 **Selectable facilities**

a) Speed or torque ramp control.

b) Ramp torque curve profile selection best suited to the application (e.g. S, linear/custom torque curve).

Note for centrifugal pumping (variable torque) application:

Acceleration and deceleration must be smooth, especially deceleration during stopping to prevent surges and bring the pumped water column to a controlled standstill. Torque must be controlled to prevent pressure surges by means of Vector control with torque ramps purpose profiled for pumping applications.

c) PID control functionality for dynamic speed control to maintain a set-point value.

d) Master/slave functionality to allow multiple drives to be locked onto a specific frequency.

e) A frequency skip function that will prevent the controller to operate at resonant or other critical speeds.

f) PLC programming capability (*).

g) Short time power interruption ride through capability using the motor set rotating inertia.

h) Restart on the fly facility during stopping ramp down without first speeding down to standstill, to allow the motor to accelerate to a new operational speed synchronizing with the rotating motor.

i) Manufacturer Standardized Application algorithms and provision for User Configured algorithms.

The abovementioned requirements are nominal and must be amended to provide for additional facilities as per Project specification.

(*): The functional standards can be lowered for controllers <15kW to meet Project Specification requirements only, but must be qualified accordingly in the Tender Data Sheets or a covering letter as a deviation from the specification.

5.5.5 **Protection Facilities**

The VFC must have integral motor and controller protection facilities that will trip the controller when activated. The specific trip condition must be given on the controller LCD display (refer operator interface).

The following are minimum requirements:

5.5.5.1 **Motor protection**.

a) Phase fail (loss of phase, phase reversal, phase imbalance).

b) Motor current overload by means of entering the motor parameters and setting an alarm and trip values, matched to a motor thermal protection curve.

c) Motor current under-load, for low flow detection in centrifugal pumping application.

d) Successive start limitation, by means of a thermal memory taking previous starts into account. Once the thermal capacity has been exceeded and the motor shut down, restart must be prevented until the motor has cooled down sufficiently.

e) Input facilities (large drives, as per project specification) for direct connection of protective sensors for:

- Motor winding thermal protection by means of PT 100 RTD temperature sensors and/or thermistors.
- Bearing over-temperature by means of PT 100 RTD temperature sensors.

<u>External protection and precautions (not covered under this section):</u>

Note that PWM controllers can generate high frequency stray currents which can cause severe bearing damage if grounded through the bearings and proper preventative precaution must be taken. This is external protection covered under the section for motors.

Motor feed cable lengths must be kept as short as possible, since long cable runs can result in high voltage spikes that can damage motor insulation. Motors must be rated for inverter fed duty due to the higher voltage stresses on windings.

5.5.5.2 **Controller protection**

a) The controller must have a self-diagnostic facility for checking internal component faults prior to start-up and during running.

b) The controller must be protected against over-and under supply voltage for extended periods. It must be able though to provide continuous operation during short time voltage fluctuations without damage to the controller:

- Total loss of one or more phases for 300ms.

- Reduced voltage of up to 30%.

c) In addition to the assembly incoming circuit breaker protection, short circuit protection must be provided for the power electronics such as fast acting fuses in accordance with the manufacturer recommendation.

d) Thermal protection must be provided for controller overload by means of current sensing devices and over temperature with temperature sensing devices. Early detection must be given by means of an alarm and shutdown at the appropriate protection levels.

The controller must be fitted with a cooling fan with own motor protection. Failure of the fan must shut the controller down with remote alarm facilities and fault indication on the controller operator interface.

Refer to the section on accommodation requirements for further physical cooling requirements.

5.5.6 Operator Interface

The following facilities must be provided for purposes of control and monitoring.

5.5.6.1 Status LEDs

The controller must have LEDs supplementary to the navigation keypad display for status indication as described below. The combination of LED indication and text status display will be manufacturer specific.

The minimum LED status indication is as follows:

a) Power on.

b) Controller run.

c) Alarm.

d) Fault.

The balance of statuses must be displayed in the LCD text display unit.

Note that the status LEDs must be visible through a panel door window, or mounted on the navigation display unit.

5.5.6.2 Keypad display unit

The controller must be provided with an operator interface module comprising a menu driven navigation keypad with alphanumeric backlit LCD multiline display to serve as operator interface and access point to program parameters and select display of specific parameters. The module must have soft and hard navigation keys for scrolling through the display and selection parameters/options. Information, other than numerical parameters, must be in plain descriptive English text. There must be a *Help* menu to assist the operator. Operator access to defined levels must be password protected.

This module must be removable for remote installation on the MCC panel door, with cable link to the controller. The module must be interchangeable between various models within a specific range.

The typical drive will have numerous display parameters and navigation facilities as standard, of which only a few salient items are noted below as minimum requirement. No attempt will be made to give a comprehensive listing.

The display must provide for the following information:

a) Individual trip identification.

b) Fault history.

c) Input dynamic parameters:

- Line and phase voltages (all three phases).
- Line current (all three phases).

d) Motor dynamic parameters:

- Line and phase voltages (all three phases).
- Line current (all three phases).
- kW, kVA, kVAr, PF.
- Frequency.
- Speed (r.p.m).

e) Motor Status

- Starting/stopping
- Motor accelerating/decelerating
- Motor run at setpoint.
- Motor fault.
- Motor cooling down.

f) P & ID parameter setpoint and actual reference value.

g) Starter internal fault.

h) Starter thermal fault.

i) Starter cooling fan fail.

Note that the status display LEDs must be visible through a panel door window, or be on the keypad.

5.5.6.3 **Manual control**

Start and stop facilities must be provided:

a) On the keypad.

b) Discrete start (green) and stop (red) spring return pushbutton on the MCC panel door and remotely from a field control station as specified in the Project Specification.

c) An emergency stop hardwired to the controller.

5.5.7 **System Interface**

The VFC must have the following communication connectivity:

- Modbus TCP multidrop serial link for communication with controlling PLC and other VFCs.
- Ethernet IP for direct link to the Ethernet communication network.

Provision must be made for control via the network from a PLC, HMI and SCADA system.

The VFC must have programmable digital and analogue inputs and outputs to provide the facilities specified under *Functional Requirements* above. Provision must be made for extendable facilities. Specific provision must be made as shown (minimum), with extended facility in brackets (total):

- Digital inputs : 6 (14)
- Digital outputs : 4
- Analogue inputs : 2 (4)
- Analogue outputs : 2 (4)
- Relay outputs : 4

Temperature sensor inputs:

- Four PT 100 RTD inputs.
- Three thermistor inputs.

5.5.8 **Specification and Ratings**

The VFC must be rated as follows:

a) Supply voltage : 380V-460V (- 10%,+15 %) three phase, 400V nominal at 50 Hz.

b) Supply frequency : 48-63Hz.

c) Input power factor : 0,97.

d) Output voltage : 0 to supply voltage.

e) Output frequency : 0 to 60Hz, rated speed at 50Hz.

f) Power rating : connected motor rating plus 10%.

g) Overload capability : 110% x rated current for 60s every 10 min.

h) Over-torque capability: 170% of motor rated torque for 60s.

i) Starts per hour : 12

j) Protection class : IP54

5.5.9 **Harmonics**

The non-linear switching elements of VFCs generate voltage and current harmonics which are multiples of the fundamental (50Hz) voltage and current waveforms. This distortion effect is referred to as Total Harmonic Distortion (THD) expressed as a percentage value at a reference point. THD relates to voltage THDu or current THDi.

The harmonic currents cause additional heat losses in equipment such as transformers cables, motors and PF correction capacitors, which can lead to overheating and failure. It has a detrimental effect on the supply infrastructure and as such affect the Quality of Supply to other users connected to the supply system. Generation of harmonics must be controlled at source to ensure compliance with SABS 61000-3-4 upstream and downstream of the VFC installation. Measures must be taken to reduce the harmonic content generated in accordance with the guidelines in IEEE 519, tables 10.2 (voltage harmonic distortion) and 10.3 (current harmonic distortion).

Tenderers must guarantee compliance and state the measures taken. Various technologies are available, e.g. passive and active filters, passive and active front ends. Passive front end (higher order rectifier sections as noted under the *Technology* section above) will only be considered as an exception, unless otherwise noted in the Project Specification.

Note:

- Mitigation measures must be provided per individual controller and is considered part of the controller assembly, irrespective if supplied as an integral unit or modular assembly.

- For large drives the mitigation method has a direct impact on footprint (accommodation space). In choosing the most cost effective solution, space constraints and related cost implications must be taken into account.

Tenderers must guarantee the maximum harmonics at a reference point, which unless noted otherwise in the Project Specification will be the point of common coupling (PCC) to another network. In a LV distribution network shared by other consumers, it will be at the point of connection to the network (usually the Supply Authority metering point). Note that this also applies to a distributed network on a plant/site of a consumer where the PCC will be the distribution point feeding other MCCs.

Note that the relevant requirements of IEEE 519 must also be met downstream of the defined PCC at any point of consumption and the Contractor remains responsible to ensure that the harmonics generated by equipment provided by him does not detrimentally affect other users/equipment connected to the same internal network. The safe approach would be to use the relevant MCC busbars as the effective PCC, since if the harmonic limits are met at this point, it will also conform at the upstream defined PCC due to the added upstream circuit impedance.

Tenderers must determine the voltage and current harmonic limits from IEEE 519 tables 10.2 and 10.3 respectively and base their design on the supply system parameters given in the Project Specification.

The current harmonic content limits as per table 10.3 is referenced as Total Demand Distortion (TDDi), which is based on the full rated load of the drive motors. The duty point is usually less than the rating and tenderers must base their calculations on the duty load and the specific equipment such as transformers, offered. In the case where the project is built in phases, the mitigation measures must be designed for the ultimate load and calculations provided for the applicable values for the related phase duty load.

If all supply system parameters are not known at time of tender, Tenderers must use the information at hand and allow for the cost of redoing the calculations after appointment when the parameters are known. Allowance must be made in the overall price if there is no specific Price Schedule measurement item.

If no specific design guidelines are given in the Project Specification, the *GENERAL* Classification values in tables 10.2 for THDu (5%) and in 10.3 for TDDi (10%), will be applicable.

The Tenderer must guarantee that the mitigation measures offered will limit the harmonic distortion to the required values. To substantiate this claim, the Contractor will have to do a comprehensive harmonic analysis at the site after award of tender as part of the detail design, whether it is a Greenfield site or extension on an existing site and analysis on completion of the installation. This analysis must be done with calibrated instrumentation, by a party that specializes in this type of testing, certified as correct.

Should the maximum design load not be available on site at the time of testing, the Contractor will have to prove by theoretical analysis that the measured values applied to the design load will meet the requirements.

Tenderers must allow for these tests as part of the inclusive price if there is no specific price schedule item for this.

Capacitor banks:

Harmonics and harmonic mitigation measures, depending on the technology used, can detrimentally interact with capacitor banks and cause equipment failure. Caution must be exercised in the design and planning of harmonic mitigation and capacitor banks. Cognizance must be taken of existing capacitor banks where the installation is done on a site with existing plant.

5.5.10 **VFC Assembly: Components And Enclosure**

The VFC assembly must comprise the standard components as per *Motor Control Cubicles and Equipment* and the default assembly will be built into an enclosure forming an integral part of the MCC, comprising a single or multiple VFCs. As such the VFC is considered part of the MCC and subject to the requirements of SANS 10142 relating to MCCs.

In high power applications, or where each VFC is provided with its own transformer on a modular basis, the VFC can be a standalone unit, provided it complies with the requirements of SANS 10142. The MCC will then comprise an incoming section, feeding a distribution section in turn feeding the individual modular standalone VFCs. Each VFC feeder enclosure will comprise the standard assembly components referred to above, including control switches and indication lights. Each standalone unit must be provided with an incoming isolator. Single core cable connections can be used to link the MCC distribution and VFCs up to 450kW. Solid copper epoxy insulated enclosed busbar must be used for higher ratings. Note that this modular application must be covered by the COC and include the controller(s) as part of the MCC.

In the case of large VFCs where the harmonic mitigation equipment is housed in a separate adjacent enclosure with own door, the doors must be mechanically interlocked that the related VFC supply circuit breaker must be switched off to open any panel door. The specific arrangement must be approved by the engineer prior to implementation.

5.5.11 **Ventilation And cooling**

The controller must be able to operate under the conditions stated below.

Ambient temperature	:	-10 °C to 50 °C.
Humidity	:	93 % at 50 °C (no condensation).

The VFC assembly will be installed within an enclosure and sufficient space must be provided around the equipment to ensure adequate air flow in accordance with the manufacturer's requirements. Hot air may not circulate within the enclosure. The enclosure door must be fitted with an air intake at low level and exit at high level with air flow deflected upwards (not towards the front). Short circuiting of air to adjacent enclosures must be prevented. High power and/or multiple drive compartments must be ducted to the back or top with an extraction fan (additional to the VFC cooling fan). The exit air must be ducted to atmosphere with extraction fans at the point of exit, covered with a cowl facing downwards.

The MCC manufacturer is responsible to confirm the necessary cooling methodology with the controller manufacturer to ensure compliance with the above and to determine whether the heat load and/or specific site conditions will require air conditioning (AC). Provision for AC must be made in the tender price irrespective whether itemized in the price schedule or not, unless specifically excluded in the Project Specification. No cost adjustment in this regard will be made after award of tender.

The normal air cooling as described above must be provided by default and the AC is supplementary when ambient conditions exceed set parameters. I.e. the installation

must not be dependent on the AC for normal ambient conditions and only operate when required.

5.5.12 **Spatial Requirements**

Building spatial accommodation for MCCs is determined during design stage based on equipment to provide a workable solution. The footprint of large VFCs and associated harmonic mitigation equipment can be substantial. Due to the various mitigation technology options available, the pre-tender spatial provision made may be insufficient for the equipment offered. It is a requirement that tenderers confirm as part of the tender whether the spatial provision made is adequate for their equipment offered and must also provide the footprint of the offered equipment. This information must be given in the data sheets or separately as an addendum to tender.

This information with related financial implications forms part of the tender evaluation and the Contractor will be held accountable for any cost that need be incurred during construction to provide additional accommodation space not qualified at tender stage.

5.5.13 **Standards**

The VFCs must comply with the following standards:

a)	Vibration resistance	: IEC/EN 60068-2-6
b)	Shock resistance	: IEC/EN 60068-2-27
c)	EMC	: SANS 61800/61000 (latest editions), as well as NRS 048-2 (latest edition)
d)	Harmonics	: SABS 61000: Quality of Supply.
		:IEEE 519 1992 (as revised): Harmonic suppression.

6. **POWER FACTOR CORRECTION**

Power factor correction must be provided as stated in the Project specification, as either of the fixed capacitor type per individual drive, or the bulk variable capacitor type comprising capacitor banks with automatic stepped control.

6.1 **RATING**

The final design of the active PFC system remains that of the Contractor, conforming to the framework provided hereunder.

The rating of the equipment must be so as to provide a power factor of no less than 0.98 lagging at any time.

Assume that the equipment being installed will mostly be of the inductive motor type, with a combined power factor (PF) of 0.8. Note that there are numerous combinations in which motors can stop and start for the various areas of a plant, as well as possible phasing of the plant and all of this will have a dynamic effect on the actual PF of the plant and total capacitance.

6.2 CONTROL RELAY AND CTs

The reactive power control relay must be capable of on-line monitoring of the associated plant and automatically switch capacitor banks in and out to manage the plant power factor within a very narrow band.

The relay must be capable of measuring all main electrical components such as individual switch status and counter-mechanism, power factor (cos ø), voltage and current harmonics, and the respective active and reactive currents. An additional temperature input must be provided and wired to the control relay to prevent the compartment (and unit) from overheating.

The relay must be further be provided with the functionality to provide Supervision with advanced warning in the case where a safe number of switching actions has taken place at a specific bank. The amount of safe switching actions must be provided by the equipment supplier.

The control relay must be of the industrial type and must be solely and specifically designed for power factor correction. It must consist of a Led-display (minimum), capable of displaying most of the required on-line parameters on one page, including the PF setpoint parameter and number of banks in operation. It must be capable of automatic and manual control, with manual solely for the purpose of testing of individual banks.

The relay must be able to be programmed to provide several specific alarms outputs, with protections to be provided such as:

- System over-temperature from the internal temperature sensor
- Under-performance in terms of under-compensation (provisionally less than 0.92)
- CT fault (current too high or low)
- Harmonic alarm
- Switching counter high
- No-load condition (voltage)

Delay timers must further be adjustable within the unit, to adapt to the changing plant conditions and this must form part of the on-site commissioning and optimisation exercise by the Contractor.

The CTs must be installed directly downstream of the associated main LV supply main CB terminals, with ratio and final position to be confirmed by the PFC supplier. Note that the CT ratio and accuracy class must be compatible with the control relay offered.

6.3 CAPACITORS, SWITCHING AND DISCHARGING

The capacitors must be divided into dedicated capacitor banks, with the banks to differ in size (kVar) so as to increase the potential accuracy in meeting the PF setpoint at all times.

Capacitors must be of the industrial MKP-type, suitable for continuous operation at an r.m.s. line current of 1.3 times the fundamental current. They must also be rated for the required over-voltage withstand, as set-out in IEC 60831-1/2 and EN 60831-1/2, revised editions (national standards that the offer must fully comply to).

The capacitor temperature ratings must be a Class D (highest temperature), due to the location of the plant.

The various capacitor banks must be switched in and out by means of fuse-protected contactors. Fuses must be selected in-line with VDE 0100:523, at the same temperature constraints and Class as per the capacitors above. The contactors used must be purpose designed and built for multiple switching cycles, as required for this PFC application.

All required discharge resistors (note required discharge time period of less than 50V in less than one minute), cabling sizing (including derating factors), warning labels, fans and heat dissipation must be provided as part of the PFC compartment design.

7. GENERAL ELECTRICAL INSTALLATION

The general electrical installation covers the supply, installation and connection of equipment provided under this contract, as well as the connection of other MCCs and control panels provided by others.

All electrical work must be done in strict compliance to the OHS Act, with legislative standards such as:

- SANS 10142-1 – LV Wiring Code
- SANS 60204 – Safety of Machinery

7.1 CABLE WORK

7.1.1 Cables And Sundries

The Contractor must allow for the supply and installation of all required electrical and control cables outside and within the plant as per the schedule in the Bill Of Quantities (BOQ).

7.1.2 Technical Requirements

General LV cables must be of the 600 / 1000V PVC insulated, steel wire armoured, overall PVC contained type, in compliance and accordance with SANS 1574.

All unarmoured cable being installed in trenches must be provided with protective concrete slab, or similar and equal type, covers. The slabs must completely cover the length of the cable, installed a minimum of 300mm above the cable. The slabs must also extend a minimum of 100mm on either side of the final cable width.

7.1.3 Pricing

Note that the cable sizes and distances are provisional for pricing only. All final cable distances must be measured on-site by the Contractor, in line with the final agreed-upon cable route. Only after the final cable route distances have been provided to the

Engineer, can the final cable sizes for ordering and installation be determined. All cable distances are therefore re-measurable and payment will only be made for final installed distances measured from point to point. Allowance for slack along the routes must be made within the rates. Note that 1m cable slack must be provided for in the final measurement at each cable end and that the termination rates must include provision for any further wastage at these cable ends.

7.1.4 Installation Schedule

A detailed cable, wiring and tray schedule must be compiled and maintained by the Contractor. The purpose of the schedule is to log and monitor all re-measurable items. The schedule must be complete with sections stating to and from feeds and broken down into the specific components, so as to be able to trace and audit all re-measurable components installed. The schedule must remain live and up to date throughout the installation procedure.

7.1.5 Labelling

Every terminated cable must be provided with a robust and weatherproof label, fixed to the cable just below the panel gland, describing where the cable is fed from and where it is running towards.

7.1.6 Terminations

All cable terminations must be properly planned in terms of spacing on the respective gland plates. All cable ends must be properly made-off with cable glands to suit the cable type and size, with one gland per cable only. Note the bonding requirements of the armouring, that all cable ends must be sealed with colour-coded heat-shrink and the lugs must be properly rated for the final cable size. In the instances where CB stubs are too close together, or where the bending radius of the cable is exceeded due to space limitations, then offset busbar ‘stubs’ must be provided to suit the application requirements.

All gland openings not used must be properly closed-off.

All external glands must be of the Pratley Enviro (double seal) type and motor terminal boxes must be designed and cater accordingly.

7.1.7 Borehole Pump Connection

As per the tender drawings, sleeves must be provided between the MCC plinth and the borehole baseplate housing. Fixed cables must be provided between the MCC and the baseplate, which must be terminated at an IP67 Pratley cable box. The borehole power and control cables must be connected in this box, to facilitate any borehole removal, if and when required.

Note that the borehole cables must not be installed or operate under any tension and adequate compression glands and supports must be designed within the baseplate housing to accommodate the required cables. The baseplate must further be designed with adequate cable glands, sleeves and the Pratley box so as to leave adequate space for cable bending radii as well as free working space.

Note that the probe fixed cable must be of the twisted pair, individually screened type.

7.2 EXCAVATIONS

Cables must be installed at a depth of 0.75m.

The trench must be made wide enough that it does not fall in on itself while introducing the bedding, cable and backfilling and compaction.

No bedding may be provided until the trench has been approved by the either the Engineer or Municipality.

Note that all OHS Act requirements must be met, specifically relating to an open trench and barricading and signage for the public and other workers' protection and safety.

7.2.1 Cable Installation

A minimum of 150mm bedding must be provided for the cable, with the material having a low clay content and a maximum resistivity of 1.2Km/W. After the cable is installed, in as straight a line as possible, an additional 150mm cover must be provided.

Thereafter a 400mm backfilling section is to be provided, properly compacted.

Two runs of danger tape must be installed on top of this layer, ensuring that the tape is installed directly above the cable. The tape must be polyethylene, nominally 230mm wide and imprinted with a triangle and electrical flash symbol, as well as the words "DANGER, GEVAAR, INGOZI", at no more than 1m intervals.

The final round of backfilling must be provided and the entire trench properly compacted as per 2.5.4 below.

Cable route markers must be provided at every cable turn and every 50m along a straight run.

7.2.2 Bedding, Grading And Backfilling

Both the bedding and backfilling material must be free of all plant materials, stones and clots larger than 15mm and any other foreign objects that could potentially damage the cable. Sea and/or river side is not acceptable due to their high thermal resistivity values.

In light of the material requirements above, as much as possible of the excavated material must however still be used. The excavated material must be sifted to ensure compliance. Only in the instance where there is not enough suitably graded backfilling material on-site, can suitable imported material be sourced. Payment for bedding and backfill material will only be done for sourced material, with the excavated material paid as part of the cable excavation's labour component.

7.2.3 Compaction

Note that backfilling must be done in sections of no more than 150mm at a time (after compaction). Compaction must be done to an AASHTO-density percentage of 98% and record must be kept and supplied to the Engineer for each layer of compaction done.

7.3 CABLE TRAY

Cables must be installed on heavy duty hot dipped galvanized cable tray, with a minimum of 76mm depth. The tray widths will be dependent upon the final routes and positions, as well as the amount of cables running along a certain section. The provisional sizes as per the BOQ must be used for the purpose of pricing, with all final sizes and routes to be confirmed with the Engineer before ordering of equipment. Any modifications during construction stage due to a lack of coordination upfront will be for the Contractor's account.

Regardless of the route and installation type mentioned below, all cable tray will be measured and paid for final installed distance. The rate must include for all radius bends and changing in the Y- or X-axis. All directional changes must be of the pre-fabricated type and no bending or cutting of the tray will be accepted on-site.

The metre rate must further include all required ancillary, securing and fastening as well as spacer material, equipment and labour components for a fully compliant installation. Note at certain sections where the cable tray must connect to the control panels from the centre column, additional floor supports will have to be provided and this must be included as part of the tender price.

7.4 LOCAL CONTROL STATIONS

Local control stations must be equipped with a Start push-button and a Red mushroom-head push lock, pull unlock pushbutton. The control station must be installed within arms-reach of the motor and the emergency stop must be wired fail safe.

The control station stand must be manufactured from HDG channel, with the pushbuttons mounted flush onto a stainless steel, IP65 hinged housing cover, with min. 50mm roof overhang. The channel stand must be provided with slots so as to fasten the cables and be no less than 550mm high.

All ancillary equipment such as nuts, bolts, hinges, etc. must be manufactured from stainless steel.

7.5 REDUNDANT EQUIPMENT

All redundant equipment, in line with the installation program, must carefully be removed and taken to the Municipal stores for safe-keeping. A signed delivery receipt must be obtained for the equipment dropped-off and forwarded to the Engineer for record-keeping purposes.

8. EARTHING AND SURGE PROTECTION

8.1 MAIN EARTH

Each LV installation must be provided with a main earth point in accordance with SANS 10142-1, 2. An installation can be a single MCC/distribution board with related electrical installation, or multiple MCCs/distribution boards with related electrical installations on the same site, from the same LV source or distributed sources from separate transformers.

8.1.1 **LV Supply From A Supply Authority**

In the case of a LV supply from a supply authority, the earth connection from the supply authority will serve as the main earth point extended from the point of connection to the consumer's earth bar, which for the purposes of this specification will usually be the earth bar of the related MCC. The earth conductor from the point of connection will be specified in the Project Specification. The Supply Authority may require additional earthing in terms of the specific earthing system and the Contractor must verify this requirement with the Supply Authority, unless specified in the Project Specification.

It will remain the responsibility of the contractor to ensure that the earthing at this point complies irrespective and additional earthing, by means of earth electrodes or an earth mat as described below, must be provided as required.

Downstream installations fed from this main LV supply, must be linked to this main earth, but supplementary earthing in situ may be required.

8.1.2 **LV Point Of Connection Without An Earth Connection**

This could be a LV supply point from a Supply Authority without an earth connection, or a LV supply point from a transformer or distribution point on the consumer's site downstream of a Supply Authority connection without an earth connection.

It is the responsibility of the Contractor to provide a system earth installation at this point, unless provided by another party and stated as such in the Project Specification. The design and installation must be done by an earthing specialist appointed by the Contractor. The specialist must do a soil resistivity test to determine the most cost effective system of earth rods and/or earth mat.

Normative provision is made for purposes of tender comprising an earth mat measuring 1,0m x 1,0m constructed from 70 mm^2 stranded copper conductor cad-welded in a 100mm x 100mm grid and installed at a depth of 1,0m below ground level in close proximity of the related MCC. The earth mat must be linked to the MCC earth bar with a 70 mm^2 stranded bare copper conductor. All required excavations, connections and coordination must be included as part of the earth mat price.

This configuration can be used for construction, but need be endorsed by the abovementioned earthing specialist in terms of the actual soil resistance and amended as required to meet an earth resistance of ≤2ohm.

The result of the soil resistivity test and proposed design must be submitted to the Engineer. Any cost adjustment between the tender provision and the final accepted design will be accommodated by means of a variation order.

In the case of a site with multiple MCCs fed from a distribution point, each supply cable must be provided with its own earth conductor (from the main earth point), which at the point of connection can be considered as equivalent to (a) above. Notwithstanding, the earth resistance must still be ≤2ohm and additional earthing must be provided as described above if the earth resistance does not comply.

After completion and commissioning of the earthing installation, the Contractor must submit the test results and certify that the earthing installation has been done in accordance with the abovementioned requirements.

8.2 GENERAL EARTHING

Where specified and indicated on the drawings and in the BOQ, dedicated Bare Copper Earth Conductors (BCEC) must be installed alongside and strapped to its associated electrical supply cable. The size of the BCEC is provisional along with the supply cable size. BCEC must be terminated with crimped lugs and solidly bolted at both ends.

All required electrical points and paths along the installation must be solidly bonded, with the return path solidly connected to the MCC's main earth.

If there is a spare core in the supply cable, this may be used as an earth conductor for the final connection of equipment such as motors. Supply cables to MCCs are excluded since the BCEC forms part of the earthing system grid.

Note that for mechanical strength reasons no BCEC may be smaller than $4mm^2$.

8.3 LIGHTNING PROTECTION SYSTEM

Lightning surge protection is for purposes of this specification considered a specialist building installation and excluded from the normal scope, unless stated to the contrary in the Project Specification.

In such a case the Contractor will be required to appoint a specialist subcontractor to do the complete design and installation, against a provisional sum allowed in the Schedule of Prices in accordance with the applicable SANS standards (latest edition), as listed below but not limited to :

- SANS 10313
- SANS (IEC) 61643.1
- SANS (IEC) 62305-Full Suite

STANDARD SPECIFICATION

SSE03 - INSTRUMENTATION AND CONTROL DEVICES

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1. **SCOPE**

This section covers the technical requirements of the instruments and control devices referenced in the Project Specification.

Some terminology relating to instrumentation is often used loosely and interchangeably if specific differentiation is not intended. For purposes of this specification the terminology below will have the following general meaning, within the context of the application:

a) **Instrument:** A comprehensive device which measures a variable physical parameter (level, flow, pressure, turbidity etc.) and converts the physical property into an electrical signal, which is amplified, conditioned and processed to a standard formatted output signal proportional to the measured value. The instrument can have additional features such as programmable control and alpha numerical parameter display.

b) **Analyser:** A specific type of instrument to measure chemical/composition properties such as pH, chlorine content, density etc.

c) **Transmitter (1):** Per definition an instrument that interacts directly with the measured process entity and has a voltage output signal output proportional to the measured entity.

d) **Transmitter (2):** Within context, the operator interface and signal processing unit of an instrument, as referenced in the literature and in P & IDs.

e) **Transducer:** Per definition an instrument that interacts directly with the measured process entity and has a current output signal proportional to the measured entity.

f) **Sensor (1):** The term sensor is interchangeable with either transmitter or transducer and is generally used if there is no need for differentiation.

g) **Sensor (2):** Within context it refers to the sensing device of an instrument with voltage, current or digital communication output signal used in conjunction with transmitter (2).

h) **Probe:** Within context it generally refers to the wet end of an immersion sensor, being a protective tube containing the sensing elements.

i) **Meter:** Generic term for the comprehensive instrument as a single unit, usually used in conjunction with flow measurement.

j) **Analyser:** A specific type of instrument to measure chemical/composition properties such as pH, chlorine content, density etc.

k) **Signal Processor Controller:** The part of the instrument that acts as interface between the sensor and operator/control system. (Some literature references this as the Transmitter in the context of (d) above. It is microprocessor based for signal processing and conversion to a digital code for communicating over an industrial communication system and has some or all of the following features/facilities to provide the functionality specified in the Project Specification:

- Analogue outputs.
- Communication network connectivity.
- Operator keyboard and/or navigation buttons.
- LCD display unit.
- Programmable relays to provide selected switch-points from the measured value.
- Configurable digital outputs.

l) **Control device:** A device that monitors a parameter, with a digital (on/off) output signal reflecting a specific point status of the parameter, usually configured as a type of switch with open/closed state, e.g. a float level switch.

1.1 GENERAL APPLICATION:

When considering an instrument or control device for an application, the tenderer must offer the best option in terms of economy, suitability for the application and performance in terms of reliability and integrity of the measured value signal.

1.1.1 Transmitter

The transmitter has a voltage output and is a three or four wire device. It is more susceptible to electrical noise (EMI/RFI) than a Transducer. It has a low power demand but is limited in length of the signal cable.

This is the non-preferred option, only to be used if it offers distinct advantages over the equivalent transducer.

1.1.2 Transducer

The transducer has a current output and is a two wire loop powered device. It is less susceptible to electrical noise than a transmitter (EMI/TFI) and suitable for use over extended distances for the output signal cable. The power requirement is more demanding as for the transmitter, specifically with regard to a battery supply.

This the preferred option, unless there are specific reasons to use an equivalent transmitter.

2. LEVEL

2.1 FLOAT LEVEL DETECTOR (SWITCH)

Float level switches are control devices of the buoyancy contact type for surface level detection of liquids, with switched on/off potential free output.

There are many types of float level switches for specific applications, such as free suspended with adjustable switch-point, fixed single switch point, bar centred sliding float with adjustable switch-point, etc. and they will be referenced with a type designation.

2.1.1 Type A: Suspended

2.1.1.1 Application

The application will normally be liquid level point detection in large holding structures such as reservoirs, tanks, sumps etc. mainly in the water and sewage purification and transportation (pumping) industry, for level control and alarm purposes. This includes liquid chemicals used within these industries.

Float level switches may not be used for direct switching of motors, but via an intermediate relay or directly connected to a PLC. The only exception is if it is an integral part of the controlled equipment such as a drainage pump. Float level switches which are used for low level alarm or protection function must be wired fail safe.

2.1.1.2 Principle of operation and construction.

This type comprises a position sensitive switching element encased in a float element (referred to as the float). The float must be a moulded from an inert substance such as polypropylene. The switch lead out cable must be of the nitrile rubber type moulded into the body that the process fluid cannot enter the switch housing.

The float element is suspended from its lead out cable and when it comes into contact with the process fluid, the buoyancy of the float element will cause the float element to change its orientation angle from vertical (hanging) to an angle determined by the level of the fluid. The float element is weighted that once the level has risen sufficiently the float element will rotate through a 180° degree arc until it is in the inverse upright (floating) position. The weight must be adjustable to vary the swing of the arc.

The switching element must have a positive switching action with differential, i.e. the float element float must move through a specified angle (default is 90° degrees), before switching and the same when recovering from the floating to the hanging position. Once switched it must maintain the switched position, until rotated again through the differential angle. The switch must be a change-over type with a three wire lead out cable. The cable must be selectable in standard lengths and ordered with the correct length for the application. No joints will be allowed in the cable.

The switching element must be robust in construction and the preferred type is a fixed reed switch activated by a moving magnetic slug or a micro switch mechanically operated by the tilting action. Mercury tube switches will not be acceptable. The applied switching voltage must be 24V DC and the contacts must be rated at 0,5A min.

2.1.1.3 Installation

The installation method will vary, depending on the type of holding structure, but will generally require a sturdy stainless steel bracket of not less than 4mm thickness secured to the structure by means of suitable brass or stainless steel anchor devices. Brass must not be used in sewage sumps. This point must be easily accessible and positioned that the float switches and cable will not be damaged by the removal of equipment such as submersible pumps in a sump.

The float switch cable must be secured to this bracket by means of a PVC type compression gland. The float switch must be identified at this point with a label as to its

function, e.g. *HIGH ALARM*. The label must be an engraved plastic tag attached to the cable with cable ties.

The lead out cable must be terminated in a watertight cable box (IP 68), of the Pratley or CCG manufacture. This box must be installed in an easily accessible position and serve as connection point of the cable extension to the controlling MCC, or intermediate cable junction box. The extension cable must be installed in hot dipped galvanized steel conduit to the exit point from the holding structure. It must be 1,5mm² multicore cable of the PVC SWA PVC type for underground installation, or unarmoured if installed on a rack in a controlled environment or inside a building. All cable terminations must be with a watertight gland to suit the cable type.

The conductors within the electrode connection box and cable junction box must be numbered as per the schematic drawings with corresponding numbers on the terminals.

General points:

- In new concrete holding structures and large above ground steel tanks, purpose made openings must be made in the structure with removable cover plates for securing the bracket.

- Existing concrete structures must be core drilled and steel structures must be cut. Prior approval for core drilling/cutting must be obtained from the Engineer to prevent compromising the structure. If these methods are not viable, the fixing point of the suspension bracket must be inside the structure within easily accessible reach from an access opening.

- The float switch must not be subjected to turbulence and the point of installation must be away from sources of turbulence such as the incoming water/sewage. If turbulence is unavoidable, the float switch must be installed in a still chamber of custom design and adequate size to provide for the float swing.

- In sewage sumps the position must be selected to avoid getting caught up in a position where flotsam may gather.

- The float switch cables must be tied to a hot dipped galvanized steel chain or weighted down nylon rope, the last tie in close proximity of its operating point, to prevent drifting and potential entangling with structures such as access ladders.

2.1.2 Type B: Fixed point

Not applicable to this project.

2.2 ELECTRODE LEVEL DETECTOR

Electrode level detectors are of the submerged contact type for surface level detection of liquids.

2.2.1 Application

The application will normally be liquid level point detection in smaller holding structures such as tanks, channels, sumps, enclosed vessels etc., mainly in the water and sewage

purification and transportation (pumping) industry for control and level alarm purposes. This includes liquid chemicals used within these industries.

Electrode level detectors are used where it is unpractical, undesirable or impossible to use float level switches such as small tanks and boreholes. Electrodes may not be used in liquids with solids content such as raw sewage.

Fixed electrodes should not be used where level switch-point adjustments are anticipated.

2.2.2 Principle of operation and construction

Electrode type level detectors comprise a set of electrodes installed in the related liquid, which must be electrically conductive. There are two or more electrodes of different lengths to provide level differential and/or multi-level switching points. In multi-level application the longest electrode is common (reference) with the level electrodes at the detection point level. A low voltage is applied to the electrodes and as soon as the liquid level reaches a level electrode, a conductive path is established between the level electrode and the common electrode. Continuity is sensed by a remote electronic level control relay, with changeover switches corresponding to the number of point electrodes.

The conductivity of different liquids varies and the level control relay must have a sensitivity adjustment facility as well as an adjustable switching time delay. Specific care must be taken with low conductivity liquids such as borehole water with low impurity or dissolved mineral content.

The electrodes can be of two types, depending on the application:

a) **Rigid rod** :

The electrodes must be 304 stainless steel rods, with thickness primarily determined by the length to maintain rigidity (nominally 6mm ø to 10mm ø), for installation in relative shallow vessels (up to 4m deep).

The electrode rods must be secured to a sturdy electrode holder, with watertight lid to provide for the connections from the electrodes to the lead out cable. The holder must be fitted with a screw thread to be fixed to a bracket, fixed to the holding structure (usually an open tank) or flange mounted on a closed vessel. The electrodes must be adequately spaced to prevent short circuiting and provided with non-conductive spacers to maintain separation.

Rods installed in media which can cause build-up and bridging (to be avoided), must be coated (insulated) with suitable covering, leaving only the tips exposed.

b) **Flexible conductor**:

When the depth of the vessel makes the use of rigid rods unpractical, such as deep wells and boreholes, flexible insulated conductors must be used within the fluid suspended from a suitable sturdy bracket and fitted probe end capsules.

2.2.3 Installation

The installation method will vary, depending on the type of holding structure, and electrode type. For a screwed electrode holder base, a sturdy stainless steel bracket of not less than 4mm thickness must be secured to the holding structure by means of suitable brass or stainless steel anchor devices. In the case of closed or pressure vessels the electrode base must be provided with a flange and mounded on the corresponding vessel flange.

The lead out cable from the electrode base to the controlling MCC, or intermediate cable junction box must be installed in hot dipped galvanized steel conduit to the exit point of the holding structure. It must be 1,5mm² multicore cable, of the PVC SWA PVC type for underground installation or unarmoured if installed on a rack in a controlled environment or inside a building. It must be terminated on the electrode base with a watertight gland to suit the cable type.

The conductors within the electrode connection box or intermediate cable junction box must be numbered as per the schematic drawings with corresponding numbers on the terminals.

2.2.4 Technical Requirements:

Level control relay:

a) Power supply: 230VAC (+10%, -15%).

b) Output: one single pole double throw (change-over) potential free contact per level electrode.

2.3 ULTRASONIC LEVEL DETECTOR

Ultrasonic level detectors are of the non-contact type for continuous surface level detection of liquids, with analogue and digital code communication signal output.

2.3.1 Application

2.3.1.1 Level and volume

The application is for continuous surface level measurement for monitoring level and volume in large liquid holding structures such as reservoirs, tanks, sumps etc. mainly within the water and sewage purification and transportation (pumping) industry for control and level alarm purposes. This includes liquid chemicals used within these industries as well as chemical bulk storage hoppers filled with dry chemicals in powder/granular form. Reference will mainly be made to liquid surfaces, but is also applicable to bulk dry mass level. The effective range is nominally 1-30m.

Care should be taken with application in pressurised vessels due to the effect of density on the propagation speed. Radar level detectors are more suitable.

2.3.1.2 Flow

This application is for continuous surface level measurement for monitoring flow rate and totalised flow in open channels, flumes and weirs for flow recording and control purposes.

2.3.2 Principle of Operation and Configuration

2.3.2.1 Level function

An ultrasonic level detector makes use of the speed of sound in air in the ultrasonic frequency band (approximately 20kHz to 200kHz), based on the time of flight principle.

An ultrasonic pulse transmitter/receiver detection head is installed above the liquid surface level emitting a high frequency pulse burst, which is reflected back from the liquid surface to the detection head. The half time taken from transmission of the pulse burst to when the reflected echo is received is proportional to the distance from the sensor to the surface of the liquid. The signal processing must make corrections to the flight time to compensate for air temperature variance.

The transmission is directed in a cone shape with approximately 6° angle at the apex. The cone is not a sharp cut-off and there can be secondary echoes from nearby structures and disturbances in the liquid and the instrument must be designed to mask these unwanted signals and use only the high amplitude return signal for processing.

Some surfaces may have surface layers of foam, clumps of clogging substances or debris floating on the surface (as typically encountered in sewage sumps), subsurface rising bubbles or agitation turbulence, which may tend to absorb or scatter the signal, leading to false or no return signal at all. The instrument must have tuning facilities, such as (but not limited to) frequency or amplitude, selecting specific operating conditions, to counteract these conditions and deliver an accurate level reading. The instrument must have interchangeable detection heads, varying in shape (narrow/wide cone) to suit the specific application and maximum operating distance (bottom to soffit) and ensure limited and effective cone spread at maximum operating distance.

The instrument must be able to detect a loss of echo with a corresponding digital alarm contact (NO and NC), as well as provision in the setup to select the output signal to go to either minimum (empty) or maximum (full) value.

The level measurement must be selectable as distance up from the bottom of the holding structure or from the sensor down to the surface (taking cognisance of the dead band).

2.3.2.2 Flow function

The principles as described above will also be applicable for flow measurement relating water level to flow in standard profiled flow structures. The level must be linearized to calculate flow from level. The controller must have three selectable linearization algorithms to generate an output proportional to flow rate:

a) Pre-programmed flow curves.

b) Flow formula with freely selectable parameters.

c) Freely editable flow chart (table) with up to thirty two points.

The flow rate must be integrated to provide a total flow count (totalizer) for accumulated flow (not resettable) and daily flow count (resettable).

Both flow rate and totalized flow must be displayed in selectable engineering units (l/s, m^3/h) and (l, Ml and m^3) respectively.

2.3.3 **Configuration**

This specification provides for the following instrument configurations with type designation as shown. If the applicable type is not specified in the Project specification, the default option will be type B.

2.3.3.1 **Type A: Compact**

The compact type comprises the detection head, controller and display in an integrated compact configuration. The housing must have a threaded base, or fitted with fixing lugs for bracket mounting or flange adaptor for direct flange mounting. The setup of the software is done in situ via the navigation buttons and menu driven multiline LCD display in plain text (English).

The system interface is via 4-20mA output and fieldbus digital signal communication.

This type is to be used for external mounting to open structures (bracket mounted) or enclosed vessels (flange mounted) where in situ display and software setup is required. It may not be used within enclosed holding structures like tanks, reservoirs or sewage sumps.

Protection degree must be IP 68 and the electrical supply can either be two wire loop powered 4-20 mA or four wire AC/DC supply.

2.3.3.2 **Type B: Discrete**

The instrument comprises a discrete detection head with threaded base for bracket mounting and cable connection to a remote mounted signal processor controller, either within in a field housing or DIN rail mounted within the related MCC. The controller must be provided with navigation buttons and menu driven multiline LCD display in plain text (English) with level display and programmable level relays for control purposes, as per the Project Specification.

The detection head protection degree must be IP 68 and IP 66 for the field housing.

<u>Differential level:</u>

The controller will normally be a single channel device for single level detection. If two levels must be monitored, to calculate a differential level, a single two channel controller with provision for two detection heads must be provided.

2.3.4 Installation

2.3.4.1 Level function

The installation method will vary, depending on the type of holding structure and instrument. Flange mounted instruments must be bolted to the corresponding vessel flange. Sensors with threaded fixture or fixing lugs must be fixed as appropriate to a sturdy stainless steel bracket of not less than 4mm thickness, secured to the structure by means of suitable brass or stainless steel anchor devices.

- Sensors may not be installed within concrete or steel liquid holding structures such as tanks, sumps and reservoirs. Purpose made openings must be provided during construction in the structure soffit covered with a removable and lockable stainless steel access lid, properly sealed when closed to prevent ingress of water or escape of process fluid or sewage gas.

- Existing concrete structures must be core drilled as required and steel structures must be cut. Prior approval for core drilling/cutting must be obtained from the Engineer to prevent compromising the structure. If these methods are not viable, the fixing point of the suspension bracket must be inside the structure within easily accessible reach from an access opening.

- The sensor must not be installed close to other structures or a point of turbulence which can cause echo interference, including float level switches in close proximity.

- Sewage sumps often have dimensional constraints and specific care must be taken with regard to:

  - Float switches and weighting chains that is a clogging point for fatty material and foam.

  - The inflow of sewage causes foam and there usually is a drift pattern with foam and floating debris accumulating in a dead corner. The detection head must not be installed above such a position.

- For enclosed structures with limited head space there must be sufficient space between the bottom face of the detection head and the maximum level to be measured to accommodate the dead band (typically 400-600mm).

- In the case of an open structure, the bracket must preferably be fixed to a structure spanning the structure such as a walkway. If not possible the bracket must be extended from the structure side wall, close enough to be easily accessible but not too close to cause echo interference. If necessary, the bracket must be attached to a swing arm that extends sufficiently away from the side but can be swivelled close for maintenance access.

- The sensing head must be perpendicular to the surface for liquid level detection. In the case of solids, the head must be at a slight angle to the perpendicular.

The lead out cable from the instrument must be terminated in a watertight cable box (IP 67), of the Pratley or CCG manufacture. This box must be installed in an easily accessible position and serve as connection point of the cable extension to the

controlling MCC, or intermediate cable junction box or remote signal processor controller. The extension cable must be instrumentation and/or communication cable as required for the specific installation, installed in hot dipped galvanized steel conduit to the exit point from the holding structure. If the extension is done underground, it must be installed within a suitable sleeve and installed on a cable rack in a controlled environment or inside a building. All outdoor cable terminations must be done with a watertight gland to suit the cable type.

The conductors within the connection box and cable junction box must be numbered as per the schematic drawings with corresponding numbers on the terminals.

2.3.4.2 **Flow function**

The general considerations and requirements for *Level function* above also apply for flow measurement.

The sensor must be of the threaded type fixed to a sturdy U-channel section spanning the channel/flume/weir (structure) with the detector over the centre of the structure. The U-channel must be supported on vertical legs both sides and upstream of the measuring structure. The mounting height of the sensing head must be sufficient that the maximum water level will not enter the dead-band.

If the structure width is too wide for maintenance access to the detector, one leg must be a vertical bar which will allow the cross bar channel section to be swivelled to the side for access.

2.3.5 **Technical Requirements**

The following requirements relate to both compact and discrete types unless otherwise indicated.

a) Power supply:

- Compact instrument: Two wire loop-powered 4-20 mA from an external power source (to be included in the price).
- Discrete instrument (controller): 230 V AC (+10%, -15%) or 24V DC.

b) Measuring range: as per project specification for the application.

c) Output:

- 4-20mA**.**
- Fieldbus digital communication.
- Programmable relays (discrete controller): up to 4 no, as per Project Specification.

d) Controller operator interface:

- Menu driven multiline LCD display:

- Level selectable in (m) or (%).
- Holding volume calculated from standard holding structure configurations.
- Level reference selectable from bottom upwards or top reference downwards.
- Programmable relays switch levels.
- Flow rate.
- Flow count (Total flow and daily flow)

- Navigation keys.
- LED display:
  - Power on.
  - Alarm.
  - Fault.
  - Programmable relays *ON/OFF* status (Controller discrete).
  - Loss of Echo.

2.4 HYDROSTATIC LEVEL DETECTOR

Refer to the section for Pressure sensing instruments.

2.5 RADAR LEVEL DETECTOR

Radar level detectors are of the non-contact type (unguided) for continuous surface level detection of liquids and solids, with analogue and digital code communication signal output.

2.5.1 Application

2.5.1.1 Level and volume

The application is for continuous surface level measurement for monitoring level and volume in large liquid and solids holding structures such as reservoirs, tanks, sumps etc. mainly within the water and sewage purification and transportation (pumping) industry for control and level alarm purposes. This includes liquid chemicals used within these industries as well as chemical bulk storage structures filled with dry chemicals in powder/granular form. Reference will mainly be made to liquid surfaces, but is also applicable to bulk dry mass level. The effective range covered is nominally 1-40m.

Radar level detection is suitable for level measurement of high die-electric process fluids such as water and most chemical solutions. It is not suitable for low die-electric materials and less suitable for solids such as lime, or very turbulent surfaces. Where

turbulence is unavoidable, still wells need be used. They are suitable for use over a wide range of temperatures, pressures and within a gaseous or vapour environment.

Radar level sensors cost more than ultrasonic level sensors, but are very accurate and suitable for difficult applications, including dusty atmospheres and mainly used where ultrasonic level sensors are not viable. Protective measures must be taken against condensation, contamination and deposit build up.

2.5.2 Principle of Operation and Configuration

2.5.2.1 Level function

A radar level detector makes use of the propagation and reflection of electromagnetic radiation and reflection in the very high microwave (GHz) frequency band.

A high frequency transmitter/receiver antenna is installed above the measured surface level emitting a high frequency signal, which is reflected back from the surface to the antenna.

Two measurement principles are applied; pulse radar transmission and frequency modulated continuous wave (FMCW) transmission, referenced by type.

a) Type A

The pulse radar technique is based on the time of flight principle, making use of the known speed of propagation.

The signal is emitted as pulse bursts toward the measured level. The half time taken from transmission of the pulse burst to when the reflected signal is received is proportional to the distance from the antenna to the measured surface.

This type is commonly used for general application, liquids and solids level measuring range 0-30m and transmission frequency typically 6/25GHz

b) Type B

The FMCW continuously varies the frequency of the transmitted signal. The frequency of the reflected signal is slightly less than the transmitted signal and the difference in frequency between the transmitted and received signal is proportional to the distance from the antenna to the measured surface.

This type is mainly used for long distance measuring, mostly for solids with low dielectric level in a very dusty environment measuring range 1-60m with transmission frequency up to 80GHz.

The performance of the radar sensor for a given application is affected by frequency. Lower frequencies have a wider beam width and high frequencies a narrower more focused beam and the antenna size is inversely proportional to beam width. Lower frequencies is less affected by vapours and absorbent surfaces such as foam and antenna contamination than high frequencies, but more susceptible to disturbance from nearby structures. High frequency narrow beams are less susceptible to disturbance from nearby structures and can be optimally placed in this regard.

Radar sensors are little affected by variance in pressure and temperature but compensatory measures must be provided notwithstanding.

Antennas have various shapes to suit specific applications. This includes cones of different length, parabolic and rod type, manufactured from different materials such as stainless steel 316L, Tantalum or other suitable material. The electronics body must be cast aluminium and powder coated. The Antenna system exposed to the process in enclosed tanks subject to condensation, or used within a dusty atmosphere such as bulk silos, must be sealed from the process and enclosed with PTFE or similar material. Condensation, contamination or product build up must not affect the performance of the antenna and software algorithms must be used to filter out resultant interference or attenuation of the signal.

The transmission is directed in a cone shape with approximately 4° angle at the apex for a narrow beam antenna. The cone is not a sharp cut-off and there can be secondary reflections from nearby structures the instrument must have software signal processing algorithms to mask these unwanted signals.

The antenna transmission frequency, cone type and material must be selected to best suit the specific application and maximum operating distance (bottom to soffit) as per Project Specification and ensure limited and effective cone spread at maximum operating distance.

The instrument must be able to detect a loss of reflection with a corresponding digital alarm contact (NO and NC), as well as provision in the setup to select the output signal to go to either minimum (empty) or maximum (full) value.

The level measurement must be selectable as distance up from the bottom of the holding structure or from the sensor down to the surface (taking cognisance of the dead band).

2.5.3 **Configuration**

This specification provides for the following instrument configurations with type designation as shown. If the applicable type is not specified in the Project specification, the default option will be type B.

2.5.3.1 **Type A: Compact**

The compact type comprises the antenna and signal processor in an integrated compact configuration. The housing must have a threaded base, or be flanged for direct flange mounting. The setup of the software is done in situ via the navigation buttons and menu driven multiline LCD display in plain text (English).

The system interface is via 4-20mA output and fieldbus digital signal communication.

This type is to be used where in situ display and software setup is required. It may not be used within enclosed holding structures like reservoirs or sewage sumps or silos.

Protection degree must be IP 68 and the electrical supply can either be two wire loop powered 4-20 mA or four wire AC/DC supply.

2.5.3.2 **Type B: Discrete**

The sensor comprises a discrete antenna and related electronics housing with threaded or flanged base, cable connected to a remote mounted signal processor controller either within in a field housing or DIN rail mounted within the related MCC. The signal processor controller must be provided with navigation buttons and menu driven multiline LCD display in plain text (English) with level display and programmable level relays for control purposes, as per the Project Specification.

The sensor protection degree must be IP 68 and the field housing IP 66.

Signal processor controller:

The signal processor controller must have the following features:

a) Menu driven Multiline backlit LCD display.

b) Navigation buttons.

c) Setup and diagnostic software.

d) Stray reflection and unwanted signal filter.

e) Analogue output: 4-20mA proportional to level, configurable in meters or percentage.

f) Fieldbus system communication.

g) Programmable output relays.

2.5.4 **Installation**

The installation method will vary, depending on the type of holding structure and instrument. Flange mounted instruments must be bolted to the corresponding vessel flange. Sensors with threaded fixture or fixing lugs must be fixed as appropriate to a sturdy stainless steel bracket of not less than 4mm thickness, secured to the structure by means of suitable brass or stainless steel anchor devices.

Sensors may not be installed within concrete or steel holding structures such as tanks, sumps and reservoirs. Purpose made openings must be provided during construction in the structure soffit covered with a removable and lockable access lid, properly sealed when closed to prevent ingress of water or escape of process fluid or sewage gas. Prior approval for core drilling/cutting must be obtained from the Engineer to prevent compromising the structure. If these methods are not viable, the fixing point of the suspension bracket must be inside the structure within easily accessible reach from an access opening.

In enclosed structures with limited head space there must be sufficient space between the bottom face of the detection head and the maximum level to be measured to accommodate the dead band, specific to the sensor.

In the case of an open structure, the bracket must preferably be fixed to a structure spanning the structure such as a walkway. If not possible the bracket must be extended

from the structure side wall, close enough to be easily accessible but not too close to cause reflectance interference. If necessary, to meet this criteria the bracket must be attached to a swing arm that extends sufficiently away from the side but can be swivelled close for maintenance access.

- The antenna must be installed perpendicular to the measured surface.
- The antenna must protrude slightly from a guide tube or structural opening.
- The antenna head must not be installed close to other structures or a point of turbulence which can cause reflectance interference, including float level switches in close proximity.
- Sewage sumps often have dimensional constraints and specific care must be taken with regard to:
    - Float switches and weighting chains that is a clogging point for fatty material and foam.
    - The inflow of sewage causes foam and there usually is a drift pattern with foam and floating debris accumulating in a dead corner. The detection head must not be installed above such a position.
- Choose an antenna with largest possible diameter to concentrate (small beam angle) the beam for maximum strength and reflectance from surfaces with poor reflectance.

The lead out cable from the instrument must be terminated in a watertight cable box (IP 68), of the Pratley or CCG manufacture. This box must be installed in an easily accessible position and serve as connection point of the cable extension to the controlling MCC, or intermediate cable junction box or remote signal processor controller. The extension cable must be instrumentation and/or communication cable as required for the specific installation, installed in hot dipped galvanized steel conduit to the exit point from the holding structure. If the extension is done underground, it must be installed within a suitable sleeve and installed on a cable rack in a controlled environment or inside a building. All outdoor cable terminations must be done with a watertight gland to suit the cable type.

The conductors within the connection box and cable junction box must be numbered as per the schematic drawings with corresponding numbers on the terminals.

2.5.5 Technical Requirements

The following requirements relate to both compact and discrete types unless otherwise indicated.

a) Power supply:

- Compact instrument: Two wire loop-powered 4-20 mA from an external power source (to be included in the price).
- Discrete instrument (controller): 230 V AC (+10%, -15%) or 24V DC.

b) Measuring range: as per project specification for the application.

c) Operational frequency: process and distance dependable:

- Typically 6/26GHz, water and solids level measurement general application.
- Up to 80MHz, typically solids, long distance and harsh conditions.

d) Temperature:

- Ambient : -10 °C to 80°C.
- Process : 1°C to 60°C.

e) Pressure : 0 to 3bar.

f) Accuracy:

- Deviation ±3mm: general application.
- Deviation <3mm: as per Project Specification.

g) Output:

- 4-20mA/HART : x 2
  - Proportional to level.
  - Proportional to volume.
- Fieldbus digital communication.
- Programmable relays (discrete controller): up to 4no, as per Project Specification.
  - Contacts: SPDT 0,5A at 24V DC.

h) Controller operator interface:

- Menu driven multiline LCD display:
  - Level in (m) or (%).
  - Holding volume calculated from standard holding structure configurations.
  - Level reference selectable from bottom upwards or top reference downwards.
  - Programmable relays switch levels.
  - Fault diagnostics.
  - Instrument configuration.

- Navigation keys.
- LED display:
  - Power on.
  - Alarm.
  - Fault.
  - Programmable relays *ON/OFF* status (Controller discrete).
  - Loss of reflection.

3. FLOW

3.1 FLOW DETECTOR (SWITCH): PADDLE TYPE

3.1.1 Application

Paddle type flow detectors are control devices used to detect flow or no flow in a pipeline, used for protection of pumps against running dry, and in air lines for blower no flow protection, as mainly used in the water and sewage purification and transportation (pumping) industries.

Paddle type flow switches may only be used in clean water applications.

Air flow switches will normally be of the paddle type.

3.1.2 Principle of Operation and Construction

Water flow

This type is an electromechanical intrusive device comprising a paddle inserted in the water flow path linked to a micro switch or reed switch.

The composite unit comprises a threaded body from brass or stainless steel screwed into a corresponding threaded socket welded into the pipe. The body contains a switch coupled to a pivoted paddle protruding into the flow path. The coupling can be mechanical such as a metal bellows operating a micro switch, or magnetic whereby the paddle arm moves a magnet relative to a reed switch. The magnet can be an integral part of the paddle arm on the wet side or move a magnet within the switch compartment (dry side) via mechanical action. The switch compartment must be sealed that no water can enter from the wet side, which is under pressure.

The switch housing must be rated IP 66 and have a threaded entry for a cable gland cable termination.

The paddle must be from brass or stainless steel and screw fixed to the paddle arm available in different lengths and selected to provide the minimum flow restriction for effective operation. The paddle arm must be spring-loaded with a tension adjustment screw inside the housing to adjust the sensitivity.

The switch must be of the changeover type with snap action and differential switching O-C-O, configured to close under flow. The switching voltage must be 24V DC.

Flow switches used for small pipe diameters must be of the inline type with screwed pipe connection ends.

Air Flow:

Paddle type flow switches for flow detection in air (blower) lines are similar in operation and construction as described above for water flow application, but must be adapted as required to suit air flow characteristics.

Air flow switches installed indoors can be rated at IP 54.

3.1.3 Installation

Flow switches for water application will mostly be installed in indoors in pumps suction or delivery pipework. Sockets to suit the flow switches must be fitted prior to coating of the pipes. Sockets may not be installed on site in situ. Should a socket be required, the pipe section must be removed for drilling and welding in a workshop and the complete pipe section must re-coated, including hot dipped galvanized pipework.

Flow switches must be installed in the vertical position and on horizontal pipe sections only and may not be installed in close proximity (less than five pipe diameters) from sources of turbulence such as bends, T-pieces reducers etc.

Control cables must be 1,5mm² x 3 core PVC PVC for indoor installation and PVC SWA PVC for underground installation. The control signal cables must be terminated directly on the switch housing. Compression glands must be used for PVC PVC cables and double seal glands for armoured cable. The cable from the switch must be supported on a cable rack from the switch to the related cable wireway to ensure there is no tension on the termination.

3.1.4 Technical requirements

- Body : Brass or stainless steel.
- Paddle : Brass or stainless steel.
- Output : SPDT contact, rated 0,5A at 24V DC.
- Protection : IP 66.

3.2 FLOW MONITOR: CALORIMETRIC (THERMAL) TYPE

The scope covers calorimetric flow meters (flow rate, totalised flow and temperature), and flow switches, generically referred to as flow monitors.

3.2.1 Application

This type of flow monitor is an instrument used to monitor flow in a pipeline, and can be applied as comprehensive flow meter, or in its most basic configuration as flow switch for low/no flow protection of pumps against running dry.

It is of the minimal intrusive type whereby the sensor tip protrudes minimally into the flow path and can be used in clean water applications, as well as water containing impurities including sewage and slurries.

3.2.2 Principle Of Operation And Construction

The instrument is of the flow monitor type which operates on a calorimetric (thermal) principle. It comprises a threaded stainless steel body fitted into a socket on the pipeline. The body can either be threaded and screwed into the socket, or unthreaded flanged secured to an externally threaded socket with a union nut and O-ring seal.

The wet side of the body is a cylindrical probe protruding into the liquid flow path. Two temperature sensors and a heating element are integrated in the probe tip. One sensor is continuously heated and the other sensor is at the water temperature (reference), thus causing a temperature differential. The flow past the heated element cools the temperature element, decreasing the differential. The rate of cooling corresponds with the flow rate. I.e. the higher the flow, the smaller the differential is. This varying differential is processed by the detector electronics into a flow rate. An alternative approach used is to keep the temperature differential constant by varying the power to the heating element as flow varies. The applied power thus corresponds with the flow rate.

For sewage application the tip may not protrude more than 6mm into the flow stream.

The comprehensive instrument must have the following (not limited to) main features (*):

a) A digital display for flow rate and other parameters, selected via navigation keys.

b) An analogue output signal proportional to flow rate.

c) An output relay programmable with low and high limits which can be configured as the effective no flow signal for purposes of the application.

d) Frequency output for an external totalizer.

e) Status LEDs must be provided to indicate flow, error or out of range operation.

f) Higher order instruments used for flow monitoring must also be fitted with digital signal communication facilities, to interface with a laptop PC for setting and checking parameters and reading of measured values with software provided as part of the instrument package.

   The cable connection must be by means of a M12 cable connector and a M12/USB interface cable must be used for communication with the laptop.

(*) The project specification will state the minimum required features. If not stated, for purposes of tendering the default option will be the instrument meeting the minimum functional requirements only. I.e. if the functional application is flow/no flow detection only, the digital display, and frequency outputs need not be provided.

3.2.3 **Installation**

The instrument must be installed in the horizontal plane to ensure it is always immersed.

The control cable must be a four or five core instrumentation cable combined for the supply and output signals in accordance with the specific manufacturer's requirements. The cable must be connected to the instrument with a M12 connector or other as per the manufacturer's requirements. The cable from the instrument must be supported on a cable rack from the instrument to the related cable wireway to ensure there is no tension on the termination.

3.2.4 **Technical requirements**

a) Supply voltage : 24V DC.

b) Flow speed range : 0-2,0m/s.

c) Outputs :

- Analogue : 4-20mA (adjustable span).
- Digital output : programmable relay with hysteresis (1*).
- Frequency : to interface external totalizer (2*).
- Digital signal : laptop communication (2*).

d) Digital display (2*). : flow rate and other parameters as per Project Specification

e) LED status display :

- Power on.
- Flow.
- Out of range.
- Error.

f) Repeatability deviattion: <2%

g) Ambient temperature : -10°C to 60°C.

h) Material : Stainless steel

i) Protection : IP 65.

Note:

(1*) Not required if analogue output is used with a controlling PLC.

(2*) Optional as per Project Specification.

3.3 FLOW METER: ELECTROMAGNETIC TYPE

3.3.1 Application

Electromagnetic flow meters are instruments to measure flow rate and totalised flow in a pipe line for electrically conductive process fluids only. The conductivity of the process fluid must be more than six micro siemens per centimetre.

The application for purposes of this specification will be mainly as required in the water and waste water purification and transportation (pumping) industries, including associated liquid chemicals, at nominal ambient temperatures.

3.3.2 Principle Of Operation And Construction

The instrument must be of the inline flanged type. It operates on the electromagnetic induction principle, whereby two coils placed on opposite sides of a pipeline generates a magnetic field perpendicular to the process fluid flow path. The fluid is electrically conductive and a voltage proportional to flow rate is induced in two electrodes placed on both sides of the pipeline, perpendicular to the magnetic field. The electronics of the flow meter amplifies and converts this signal in an analogue signal proportional to flow rate and calculates totalized flow over a period of time.

The magnetic field covers the entire cross section of the meter. The magnetic field can also be generated with an insertion type probe whereby the magnetic field radiates outward from the probe position. This technology is not preferred for the intended application and may not be offered for tender unless specifically requested in the Project Specification. The magnetic field coils must use periodically pulsed DC to excite the field coils with a low frequency square wave to eliminate electrical noise associated with line frequency excitation systems.

The electrodes must be manufactured from 316L stainless steel for clean water application and nickel alloy 276 for higher corrosion resistance for acideous and abrasive pumping medium.

The internal lining of the metering tube must be suitable for the pumped media. If not specified in the Project Specification, selection must be done based on the following criteria:

a) Polyurethane: Reduced chemical resistance, excellent abrasion resistance Suitable for water and slurries with small to medium particles, fluid temperature -18°C to 60°C; typically clean water.

b) Neoprene: very good abrasion resistance, suitable for water and slurries with small to medium particles; better chemical resistance than polyurethane; typically applied for water with chemicals and seawater, fluid temperature -18°C to 60°C; the preferred lining for high pressure application.

c) PTFE: Highly chemically resistant and high temperature application.

Liners must be protected against separation from the metering tube under vacuum operation, collapsing and being sucked into the measuring tube. Process conditions that could even cause temporary vacuum conditions must be avoided. If such condition is

unavoidable the material must be carefully selected in conjunction with the manufacturer.

The signal processor operator interface can either be field mounted on the meter body, or remote mounted. Remote mounted interfaces must be installed within a polycarbonate box with hinged clear lid, or as specified in the Project specification. The interface must have a backlit LCD multiline display and navigation buttons for instrument setup and parameter access.

The coil and electrode sensing cable between the meter body and remote signal processer must preferably to be combined in one cable, but provided in accordance with the manufacturer's recommendation as well as the maximum allowable cable length.

Features:

The instrument must have the following salient features (but not limited to):

- Reverse flow measurement over the full flow range.
- Empty pipe detection.
- Zero flow detection.
- Programmable high and low alarms.
- Analogue output.
- Pulse output for totalizing volume flow in selectable engineering units. The pulse frequency and pulse width must be adjustable.
- Fieldbus communication connectivity.
- Fault self-diagnostic function.

3.3.3 Installation

The meter must be installed that it is not affected by disturbances and the pumping medium may not contain bubbles. It must be installed at least five pipe diameters downstream and three pipe diameters upstream of any sources of disturbance, such as bends, reducers, valves etc. This is a nominal (minimum) requirement and the manufacturer's installation instructions need be verified and followed if more strict. The meter inner diameter will normally be the same as the adjacent pipework. Should it be less, the reducers must be installed the required number of pipe diameters upstream and downstream and the pipework between the reducers and the meter must be of the same diameter as the meter.

The metering tube must always be fully filled and installed in the bottom leg of a U-shaped pipe configuration if there is any chance of partial filling. Vertical installation (upward flow direction) is preferred, especially with slurries and sewage or fluids containing solids prone to settling with no flow.

The meter sensing elements are sensitive to electrical noise and grounding rings with external tabs for grounding conductors must be installed both sides of the meter that the meter face on either side is separated from the pipe flanges. The grounding rings must be manufactured from 316L stainless steel or nickel alloy 276 depending on the pumping medium. Earthing straps will not be acceptable in lieu of grounding rings.

The control cable must be a four or five core instrumentation cable combined for the supply and output signals in accordance with the specific manufacturer's requirements. The cable must be connected to the instrument with a compression gland or other industry standard connection as per the manufacturer's requirements. The cable from the instrument must be supported on a cable rack from the instrument to the related cable wireway to ensure there is no tension on the termination.

3.3.4 **Technical requirements**

a) Power supply:

- 24 DC to a meter with field installed signal processor and interface.
- 230V AC or 24V DC to a remote installed signal processor
- Quick act fuses must be provided for the supply (in addition to a supply circuit breaker in the related MCC).

b) Degree of protection: IP 68 for the meter with remote mounted signal processor interface.

c) Electrode material:

- 316 L stainless steel for clean water and non-acideous chemical content.
- Nickel alloy 276 for sewage and slurries or oxidizing fluids.

d) Liner material :

- Clean water : Polyurethane, neoprene.
- Waste water and slurries : Neoprene.
- Other : Refer to manufacturer.

Liner material offered for potable water must be certified for drinking water.

e) Flow rate range: As per project Specification.

f) Meter diameter: To suit adjoining pipe work as per Project Specification.

g) Flanges: To SANS 1123 table as per Project Specification.

h) Flow speed range: 0,01 to 10m/s both forward and reverse flow; fully adjustable.

- Low flow cut-off adjustable 0,01-0,003m/s (zero flow display).

i) Accuracy (maximum error): :

- Flow rate : ± 0,5% of flow rate from 0,3-10m/s.
- Pulse : ±0,4% (max) of reading at 0,8m/s; 0,2% (max) of reading 2-10m/s).

j) Repeatability : ± 0,1% of reading max deviation.

k) Outputs:

- Analogue: 4-20mA proportional to flow rate; selectable full scale value.
- Frequency: 2-10kHz full scale.
  - Pulse on/off ratio 1:1, adjustable pulse width.
  - Pulse amplitude and polarity adjustable.
- Modbus, RS 485 connection.
- Discrete (switched):
  - Analogue output fail.
  - Empty pipe.
  - Zero flow.
  - Reverse flow.
  - Instrument error.
  - Flow limits (3 x programmable).
  - Totalizer limits (3 x programmable).

l) Discrete inputs: Totalizer zero (individual).

m) Diagnostics :

- Comprehensive self-test.
- Analogue output.
- Pulse output
- Coil circuit.

n) Ambient: -20°C to 60°C.

3.4 FLOWMETER: ULTRASONIC TYPE: OPEN CHANNEL

Refer to ultrasonic level sensor, flow application.

3.5 **FLOW METER: ULTRASONIC TYPE: TIME OF FLIGHT**

Not part of this specification.

3.6 **FLOW METER: ULTRASONIC TYPE: DOPPLER EFFECT**

Not part of this specification.

3.7 **FLOWMETER: AXIAL TURBINE TYPE**

Not part of this specification.

3.8 **FLOWMETER: VARIABLE AREA TYPE: ROTAMETER**

Not part of this specification.

4. PRESSURE

4.1 PRESSURE SWITCH

4.1.1 Application

Pressure switches are electro mechanical control devices used to detect a high or low pressure in a fluid within a pipe or enclosed vessel mainly for protection of pumps and other pressure sensitive devices by means of electrically switched contacts opening/closing at a pre-set pressure. Solid state pressure switches are not covered in this section.

The application for purposes of this specification will be mainly as required in the water and waste water purification and transportation (pumping) industries, including associated liquid chemicals, at nominal ambient temperatures.

4.1.2 Operating Principle And Construction.

Pressure switches comprise a threaded enclosure manufactured from stainless steel screwed into a socket in the pipework or container. It has two chambers, one open to the process side and the other sealed from the process side containing the switching element. The fluid pressure on the process side displaces or deforms a coupling/sensing device proportional to the pressure and this motion is transferred to the switch. The coupler must be spring-loaded to provide switch point adjustment.

The seal between the two chambers must ensure no cross leakage between the chambers. It can also act as coupler such as a metal bellows or diaphragm. For pressures higher >3bar, a piston type actuator must be used. The device must be configured that the switching contacts open/close on rise or drop of the pressure, in accordance with the application.

If the instrument is used in a viscous medium or fluid containing impurities or solids such as sewage, the pressure sensing aperture can become blocked. In such cases a flush diaphragm seal must be fitted to separate the medium from the sensing device. The pressure from the medium acts on the diaphragm in turn acting on a fill fluid between the diaphragm and sensing device. This diaphragm must preferably be an integral part of the pressure switch body or fitted as an adaptor to the pressure switch.

The switch must be of the snap action micro switch changeover type with switching differential (hysteresis), non-adjustable for general application.

The switch point must be adjustable on a calibration scale.

Pressure switch with adjustable hysteresis

For this pressure switch variant the switch point and hysteresis reset is separately adjustable for precise hysteresis control, such as a high switch point with low reset (changeover).

Differential pressure switch

This is a pressure switch that has two pressure inputs on either side of a diaphragm normally from upstream and downstream of a process element. The motion actuator linked to the micro switch moves in the direction of the greater pressure and transfers the motion to the output micro switch which is configured to change state when the pressure differential exceeds a pre-set value.

4.1.3 Installation

The switch must be threaded and screwed into a socket, or fitted into a socket with external thread, secured by means of a union nut and appropriate seal between the nut and switch body. Sockets to suit the switches must be fitted prior to coating of the pipes. Sockets may not be installed on site in situ. Should a socket be required, the pipe section must be removed for drilling and welding in a workshop and the complete pipe section must re-coated, including hot dipped galvanized pipework

The switch must be installed vertically on pipework in an easily accessible and visible position. All process connections must be fitted with an isolation valve.

Control cables must be 1,5mm² x 3 core PVC PVC for indoor installation and PVC SWA PVC for underground installation. The control signal cables must be terminated directly on the switch housing with an industry standard termination as per the manufacturer's provision. The termination may not compromise the instrument IP rating. If the lead out cable is moulded to the body, a disconnection point within a IP 67 cable junction box must be provided in close proximity of the switch that the cable is not twisted or damaged when removing screw-in switches and also allow removal of the switch only. The cable from the switch must be supported on a cable rack from the switch to the related cable wireway to ensure there is no tension on the termination.

4.1.4 Technical requirements

a) Operational range : As per project specification.

b) Rated overpressure : 2,0 x max. operational pressure.

c) Repeatability (set-point) : ±2% of full scale max. deviation.

d) Output switch contacts : SPDT.

e) Switching voltage : 24 V DC.

f) Contact rating : 0,5A at 24V DC.

g) Degree of protection : IP 65

4.2 PRESSURE SENSOR: FIXED INSTALLATION

This section covers fixed position threaded or flanged electronic pressure sensors. Electro mechanical instruments such as Bourdon tube pressure monitors are not covered in this section.

4.2.1 Application

Pressure sensors are used to monitor analogue pressure within a pipe or enclosed vessel mainly for pumps and process control and protection of pressure sensitive pipework and equipment.

The application for purposes of this specification will be mainly as required in the water and waste water purification and transportation (pumping) industries, including associated liquid chemicals, at nominal ambient temperatures and operating pressure 0- 40 bar (application for higher pressures will be detailed in the Project Specification). Application will mostly be for direct pressure measurement, but can also be used for level measurement in vessels and holding structures with associated calibration.

4.2.2 Operating Principle And Construction

Pressure sensors can be based on various technologies, depending on the application. For the application stated above the operating principle and construction will be similar to pressure switches described above, in that the process fluid pressure is transferred via a diaphragm to a pressure sensing element, instead of a micro switch, with output proportional to pressure. Various sensing elements can be used such as thin film, capacitance, piezo-resistive strain gauges, etc. Commonly used diaphragms include metal, ceramic and silicone.

For purposes of this specification, pressure sensors for general application must be of the ceramic capacitive (oil free) type with a ceramic process separation diaphragm for application 0 - 40bar. Other types and/or higher pressures will be detailed in the Project Specification.

The diaphragm displacement is applied to the sensing device capacitive elements imbedded in the separation diaphragm and a parallel ceramic disk. The applied force changes the capacitance, resulting in a variable capacitance proportional to pressure. This signal is processed by the instrument electronics to an analogue output signal proportional to pressure.

Three types of instrument configurations are type referenced below:

a) Type A: this comprises a loop powered sensor only with analogue current output to a remote control/display unit or PLC.

b) Type B: as for type A, but with LED flow display, navigation buttons for setup and programmable solid state digital output switches.

c) Type C: comprehensive in situ instrument with signal processing, analogue output, programmable digital outputs and fieldbus communication facilities. The operator interface /controller can be field mounted or remote mounted.

Tender prices must include the power supply for loop powered instruments.

The operator interface and control unit for type C must be of the menu driven type with:

- Multiline backlit LCD visual display.
- Navigation buttons for navigation through the menu and setting up of the instrument.
- Analogue output.
- Programmable relays for digital outputs.
- Fieldbus connectivity.

Differential pressure sensing:

Differential pressure measurement upstream and downstream of a process element must comprise two types A or B sensors, connected to a remote controller as described above, but with two channels for the two pressure inputs and a differential pressure analogue output.

4.2.3 **Installation**

The process connection will either be threaded (default) or flange mounted (special application). For threaded connection, the sensor must be threaded and screwed into a socket, or the sensor must be unthreaded and fitted into a socket with external thread, secured by means of a union nut and appropriate seal between the nut and sensor. Sockets to suit the flow switches must be fitted prior to coating of the pipes. Sockets may not be installed on site in situ. Should a socket be required, the pipe section must be removed for drilling and welding in a workshop and the complete pipe section must re-coated, including hot dipped galvanized pipework

The instrument must be installed vertically on pipework in an easily accessible and visible position. All process connections must be fitted with an isolation valve.

Power supply and signal cables must be provided in accordance with the type designation above and in accordance with the manufacturer's requirements.

The cables must be terminated directly on the instrument housing with a M12 socket or other approved industry standard connection in accordance with the manufacturer's provision. The termination may not compromise the instrument IP rating. If the lead out cable is moulded to the body, a disconnection point within a IP 67 cable junction box must be provided in close proximity of the switch that the cable is not twisted or damaged when removing screw-in switches and also allow removal of the switch only. The cable from the instrument must be supported on a cable rack from the sensor position to the related cable wireway to ensure there is no tension on the termination.

4.2.4 **Technical Requirements**

a) Case and threaded connection : Stainless steel.

b) Protection : IP 66.

c) Power supply : 24V DC.

d) Measurement range : As per project specification.

e) Overload : 2 x operating range.

f) Accuracy : Deviation <0,5 (% of span)*.

g) Linearity : Deviation < 0,1%*.

h) Outputs

- Analogue : 4-20mA, 0-10V (fully scalable) : Type A,B,C.
- Digital (2 x programmable contacts) : Type B, C.
- I/O link communication standard : Type B.
- Fieldbus (Modbus) : Type C.

i) Operator interface

- Display:
  - Type A: None.
  - Type B: LED.
  - Type C: Multiline backlit LCD.
- Navigation buttons: Type A and B.

j) Ambient temperature: -20°C to + 60°C

(*) : or as per Project specification.

4.3 **PRESSURE SENSOR: SUSPENDED INSTALLATION (HIDROSTATIC)**

This section covers suspended pressure sensors of the hydrostatic type for level measurement.

4.3.1 **Application**

Pressure sensors of the hydrostatic type are electronic instruments used to monitor analogue level within a deep well or borehole, where other type of level measurement is not suitable or non-preferred. The pressure sensor will be suspended from its signal cable, with additional strengthening material for very deep installation as required.

The application for purposes of this specification will be mainly as required in the water purification and transportation (pumping) industries, including associated liquid chemicals, at nominal ambient temperatures and operating pressure 0- 20 bar.

4.3.2 **Operating Principle And Construction**

The pressure sensor is of the ceramic capacitive type as described for fixed pressure sensors and conforms to the general operational principles as stated, with analogue 4-20mA current output.

The measuring element must be housed in a tubular stainless steel casing. For borehole application the casing must be of the slim-line type with outer diameter not more than 22mmø, to fit the inner diameter of the sensor sleeve down the borehole and referred to as the pressure probe. Probes for other applications such as deep well with no diameter constraints can be of larger diameter.

The suspension lead out cable must be moulded to the probe casing to ensure a watertight seal with continuous length to the surface connection box for extension to the controlling MCC, or junction box. It must be ordered to length for the applicable installation depth. The cable must be provided with an integral atmospheric pressure compensating tube from the sensing element to the cable end. The cable outer sheath must be of the nitrile rubber, neoprene or other suitable type purpose designed for the immersion fluid. The sensor must be fitted with temperature compensation only if so required in the Project Specification.

The probe 4-20mA signal must be connected to a PLC to determine switching levels, or a display/control unit with programmable relays for switching levels, as per Project Specification. It should be noted that the pressure at the probe is the water column pressure plus atmospheric pressure and the display must be calibrated that the water level is referenced to ground level; i.e. to either water column height above the probe or water level below ground level for boreholes (as per Project Specification).

4.3.3 **Installation**

Borehole installation:

The borehole has limited diameter with tight tolerances and must accommodate the submersible pump delivery pipe, electrical supply cable and level sensing equipment. Only the first section of the borehole will be lined and the probe must be installed within a continuous thick wall polycop sleeve of ø28mm ID that will not kink, to protect the probe from damage and snagging. The sleeve must be tied to the pump line every two meters and kept as straight as possible to prevent the probe from snagging and lowered into the borehole with the pump and pipework. Since the protection sleeve cannot be 100% straight, apart from the probe diameter, the probe length relative to the sleeve ID must be carefully considered to ensure smooth installation.

The probe default installation depth must be just above the pump, or at a depth stipulated in the project specification. Note that the borehole depth may be more than the pump initial installation depth and the pump cable must be supplied in accordance with the borehole total depth.

The cable must be suspended from a retaining plate across the access hole in the borehole baseplate by means of a compression gland or purpose made wedge clamp.

The installation depth must be marked with a cable tie at the fixing position. From the borehole baseplate the cable must be extended to an elevated above ground level vented (for atmospheric compensation) cable junction box at the borehole base and extended from this junction box to the controlling MCC. If this cable box is sealed, the extension cable must be of the same type as the lead out cable with compensation tube to the pump control panel. This installation must be done to enable removal of the probe without pulling extension cable back from the MCC. Any spare probe cable must be coiled within the borehole base mounting box which must be custom designed as per Project Specification.

Deep well installation:

The probe must be suspended from a sturdy stainless steel bracket of 3mm thickness (minimum) fixed to the holding structure with stainless steel or brass fasteners, in an easily accessible position. The probes may not be installed closed to sources of turbulence. If this is unavoidable, the probe must be installed within a still well manufactured from PVC sleeve perforated at the bottom end, or other suitable stilling structure. The probe must be installed just above the holding structure floor level. The lead out cable connections must be done as described above for boreholes.

4.3.4 **Technical Requirements**

a) Case material : Stainless steel.

b) Protection : IP 68.

c) Power supply : 24V DC, loop powered.

d) Measurement range : As per project specification.

e) Overload : 2 x the operational range (minimum 10bar).

f) Accuracy : Deviation <0,2 (% of span)*.

g) Linearity : Deviation < 0,1%*.

h) Output : Analogue, 4-20mA (fully scalable).

i) Temperature compensation : PT 100 temperature sensor (*).

j) Process temperature: -10°C to + 70°C

(*) Or as required as per Project specification.

5. **MASS MEASUREMENT**

Not part of this project.

6. TEMPERATURE

6.1 TEMPERATURE GAUGE: BIMETALLIC TYPE

Temperature gauges for the purposes of this specification are mechanically actuated instruments of the dial and needle type.

6.1.1 Application

Temperature gauges will normally be for temperature measurement of a process or equipment, where local indication only is required.

The application for purposes of this specification will be mainly as required in the water purification and transportation (pumping) industries, including associated liquid chemicals, at nominal ambient temperatures.

6.1.2 Principle of Operation and Construction.

The instrument comprises a round dial with indicating needle and tubular stem (probe) of different diameters and lengths, for immersion into the process media, being fluid or air. The stem must is threaded at the base for either direct connection to the process pipe/vessel or fitted within a thermowell.

The principle of operation is that the measuring element comprises a bimetallic strip, with different expansion coefficients. One end is fixed and the other linked to a rotational indication needle. When the temperature changes, the bimetallic strip bends proportional to the temperature change and this rotational movement is transferred to the indicating needle moving across the circumference of a calibrated dial. The bimetallic strip can be constructed helically or spirally wound.

If the application is subject to vibration, liquid damping must be provided.

If the process media is corrosive, under high pressure or inserted in a high flow application, the stem must be fitted into a thermowell, threaded or flanged to suit the application.

The stem and/or thermowell material must be stainless steel 316 or brass, to suit the application, threaded or flanged.

6.1.3 Installation

The stem must be screwed into a threaded receptacle and the probe must be fully immersed into the vessel or flow in a pipeline/duct. The length of the probe must be selected to be fully inserted in the process (i.e. not retracted in a raised boss) and of sufficient length that it will capture the process temperature.

When installed in a thermowell, care must be taken that the circumferential clearance between the stem and thermowell wall is minimum and the stem bottom must not contact the thermowell bottom due to different expansion rates of the stem and thermowell materials and the manufacturer specific clearance must be maintained.

6.1.4 Technical Requirements

Temperature range: As per project specification.

Dial size : 63mm nominal.

Window material : Glass or Plexiglas.

Bezel material : Stainless steel.

Case material : Stainless steel.

Accuracy : 2% of scale max. deviation.

Protection : IP 65

Thermowell :

- Material : Brass/stainless steel, best suited to the process medium.
- Pressure : As per Project Specification, default 6 bar.

6.2 THERMOCOUPLE

6.2.1 Application

Thermocouples are suitable for measuring over a large temperature range, from −200°C up to 2000 °C.

The application for purposes of this specification will be mainly as required in the water and waste water purification and transportation (pumping) industries, including associated liquid chemicals, at nominal ambient temperatures, for measuring temperature in vessels and pipes.

If the process temperature range is relative small and a high accuracy is required, RTDs will be more suitable.

6.2.2 Method Of Operation And Construction

A thermocouple is a junction of two dissimilar conductors (such as iron and copper) exposed to the temperature to be measured relative to a reference temperature. The thermo-electrical effect between the two dissimilar conductors generates a small potential difference approximately proportional to temperature difference, which is amplified at the two wire lead out and the resulting voltage reading is calibrated as temperature. The output voltage depends on the thermal characteristics of the conductors. For general application with temperatures ranging from -40°C to 800°C, type K (Chromel-Alumel) thermocouples must be used.

The thermocouple voltage output is not linear with temperature and must be linearized by the signal processing electronics. Digital instruments must be programmed with linearization tables for the specific thermocouple type.

The conductors must be insulated from each other with suitable material to withstand the temperature range and measured media for the application. Open junction thermocouples will generally not be acceptable and the junction must be fitted within a protective stainless steel enclosed tube (probe) constructed that the process temperature is transferred to the junction without affecting the reading and with length to suit the application. The probe must be fitted with a threaded process connection for direct installation in the process vessel or pipeline, or within a thermowell.

6.2.3 Installation

The thermocouple installation method will depend on the process to be measured, being directly inserted, or fitted inside a thermowell or pre-manufactured temperature pocket. The lead out connections must either be crimped or pressure connected by means of pressure pads and screws. Extension cables to the signal processing display and control unit must be of the same type as the thermocouple and installed in close proximity to limit the length of lead out cable.

The lead out conductors must be installed within a flexible sleeve to ensure that the conductor insulation is not damaged in any way.

6.2.4 Technical Requirements

Thermocouples must comply with the following,

Temperature range : -40°C to 800°C.

Thermocouple : Type K (ISA).

Accuracy : 1% deviation of the full scale range.

Housing : Cast aluminium, IP 65.

Probe : Stainless steel

6.3 RESISTANCE TEMPERATURE DETECTOR

Not part of this project.

7. ANALYTICAL

7.1 PH MEASUREMENT

pH measurement is based on the response of a sensor to the logarithmic concentration of hydrogen ions in solution and are a measure of the acidity or alkalinity of the solution. A neutral solution At 25°C has a pH of 7. Solutions with pH <7 are acidic and >7 is alkaline and the normal overall pH range for water solutions containing water solvents is 0-14pH.

7.1.1 Application

The pH of water is an important parameter of water quality and the application for purposes of this specification will be mainly for process monitoring as required in the water purification industry, whereby the pH is measured with the objective to correct

pH deviation for the specific application to relevant/statutory standard by the addition of appropriate chemicals.

The instrument will be used for online monitoring, or for periodic measurement of samples pumped with a sampling pump to a remote mounted combination analysing/testing station. Monitoring will be within open structures, enclosed vessels and inline piped flow application.

The application for the instrumentation described below will be for intermediate pH measurements as typically encountered within the above stated industries. pH measurement at the extreme ends of the scale (high acidity/alkalinity levels) must be done with conductivity based instrumentation.

7.1.2 **Operating Principle And Construction**

The measuring principle is based on the hydrogen ion (H+) activity of a solution of unknown (measured) pH relative to a solution of known pH (reference), measured as a electrochemical potential difference between the two solutions in pH units.

The sensor comprises a probe made up from two electrodes forming an electrical circuit, one being pH sensitive in contact with the measuring fluid and the other non pH sensitive acting as a reference, with circuit voltage output (proportional to pH) to a remote signal processor serving as operator and system interface. The pH of a solution is temperature dependent and a temperature sensing element such as a PT 100 must be included in the probe, providing a temperature signal to the pH analyser for temperature compensation.

The electrodes comprise two concentric glass tubes. The inner (measuring) tube is filled with a solution of known pH (such as potassium chloride buffered at pH 7) and the outer (reference) tube with a concentrated solution (such a potassium chloride). Both the tubes are fitted with suitable metal wire inserts (such as silver wire with silver chloride coating) serving as lead out for the electrical connection. The inner tube is the measuring tube fitted with a thin walled pH sensitive glass bulb manufactured from a manufacturer specific composition (containing metal salts) fused to the tube tip, in contact with the measuring fluid, allowing migration of hydrogen ions. The outer tube has a porous plug junction with the measured fluid to provide electrical continuity to the reference electrode, whilst keeping the measured and reference solutions separated.

The plug junction material must be selected on the performance objective such as long life (typically wood or equivalent) or chemical resistance (typically ceramic or equivalent).

The hydrogen (H+) ion activity (ion exchange) at the glass membrane is quantified as a logarithmic concentration. The concentration at the outside (variable) relative to the inside (fixed), creates an electrical potential difference across the glass membrane. The outer potential varies with change in pH of the measured solution whilst the potential on the inside remains constant due to the fixed pH of the fill solution.

The reference electrode completes the electrical circuit at a constant potential which provides a known reference to the measuring electrode. The resultant potential between the electrodes is a voltage signal proportional to pH, which is amplified,

temperature compensated and displayed on the transmitter as a pH value. The voltage signal is 0V for a pH of 7 at 25°C.

The probe pH proportional output can also be configured in a digital signal, *Memosense* protocol whereby the output is via contactless inductive coupling. This is an optional feature, to be provided in conjunction of other *Memosense* sensors within the system.

The probe comprises the combination electrode tube and housing for the on-board electronics and cable connection. The electrode tube is inserted within an outer protective plastic tube, easily removable for cleaning and maintenance of the probe. The specific configuration will depend on the process structure entry for mounting, being an open vessel, inline pipe with socket T-entry or enclosed vessel, with screw or flanged entry.

The probe must be threaded and screwed into a socket, or unthreaded and fitted into a socket with external thread, secured by means of a union nut and appropriate seal between the nut and sensor. Probes fitted to vessels must have a retraction enclosure that the probe can be removed without affecting the process or having to drain the vessel.

The lead out cable connection type must allow for easy removal of the probe, especially the threaded type, that the cable is not twisted in the process, either by removing the housing cover and disconnecting the cable, or having a short lead out to an intermediate junction box.

Maintenance and durability:

pH sensors require regular maintenance and cleaning and the choice of probe and features must take cognizance of the characteristics of the medium to be measured such as exposure to contaminants, deposits, air bubbles etc., to minimise maintenance and cleaning cost.

The measuring electrode is susceptible to long term deterioration and the analyser must have re-calibration facilities to compensate. Depending on the process fluid characteristics, the measuring electrode bulb can be contaminated or covered with deposits, requiring regular cleaning. By default online probes must be fitted with a self-cleaning facility whereby the electrode bulb is automatically washed periodically by means of a jet spray of clean water or cleansing fluid. Testing station probes can be hand cleaned and constructed for easy access.

The reference electrode fill will contaminate over time with migration across the junction plug and the chloride will also get depleted, thus requiring replenishment or total probe replacement. The electrode fill can be either liquid solution or aqueous gelled solution type. The liquid fill can be replenished/refilled as part of maintenance and have a relative long operational life, whereas the gel filled type is non-replaceable and disposable at end of life, typically six to twelve months. The specific type must be best suitable for the application and maintenance considerations as per the Project Specification. The default type for tender will be liquid filled. Gel type must be used for pressurized tanks and pipes.

The electrode impedance is an important parameter to monitor the condition of the probe. The measuring electrode bulb separation barrier is high impedance and low

impedance is indicative of a crack in the bulb or overall failure. The reference electrode junction is porous to allow the migration of ions for conductivity and is of relative high impedance. Very high impedance is indicative of junction plugging. The analyser must have a real time impedance diagnostic function with alarm when a fault is detected.

Transmitter

The pH sensor must be used in conjunction with a remote installed transmitter serving as operator and system interface and control unit, which must be of the menu driven type with:

- Backlit LCD multiline visual display (simultaneous).
  - pH measurement main display/data setup display.
  - Secondary display parameters such as temperature.
  - Error code.
  - Mnemonics for other functionality such as relay status.
  - Indicators for measuring, calibration and setup (configuration) mode and relays active status.
- LED status display (manufacturer dependent).
- Inputs from probe:
  - pH proportional voltage signal.
  - Temperature signal.
  - *Memosense (and or similar)* protocol digital signal.
- Outputs:
  - Analogue output: 4-20mA proportional to pH.
  - Alarm output relay configurable for specific or grouped alarms.
  - Programmable relays for digital outputs assigned to specific pH and temperature limits, error status, etc.

    Auto/manual selection: for auto operation the relay is controlled by the controlling parameter and in manual the relay can be manually switched.
  - Fieldbus connectivity for system communication.
- Functionality
  - pH measuring range selection (high/low limits).
  - Impedance fault diagnostic capability.

- Sensor calibration capability.
- Navigation buttons serving for navigation through the menu and setting up of the instrument.
- Temperature compensation with 25°C reference temperature.

7.1.3 **Installation**

The probe must be installed in an easily accessible position in view of frequent removal for maintenance.

The process connection will either be threaded (default) or flange mounted (special application). The sensor must be threaded and screwed into a socket, or fitted into a socket with external thread, secured by means of a union nut and appropriate seal between the nut and sensor. Sockets to suit the sensors must be fitted prior to coating of the pipes. Sockets may not be installed on site in situ. Should a socket be required, the pipe section must be removed for drilling and welding in a workshop and the complete pipe section must re-coated, including hot dipped galvanized pipework

The power supply and signal cables must be terminated directly on the instrument housing with an approved industry standard connection in accordance with the manufacturer's provision. The termination may not compromise the instrument IP rating. If the lead out cable is moulded to the body, a disconnection point within a IP 67 cable junction box must be provided in close proximity of the sensor that the cable is not twisted or damaged when removing screw-in probes and also allow removal of the probe only. The cable from the sensor must be supported on a cable rack from the sensor position to the related cable wireway to ensure there is no tension on the termination.

The electrode bulb must always be wetted and the probe may not be installed at an angle larger than 80° from vertical and not upside down, even with the bulb wetted, to prevent air bubbles forming in the bulb.

If installed in a flow application, the sensor must always be inserted in an inverted U-section pipe to ensure the bulb is always immersed in fluid. The sensor must always be provided with a bypass pipe and appropriate isolation valves, that the sensor can be removed for maintenance without interruption of the process. The flow should not exceed 3m/s (or to the manufacturer's instructions) to prevent leaching of the metal salts from the electrode bulb surface layer.

Sensors installed in a vessel must be fitted with a retraction facility that the probe can be removed without affecting the process or having to drain the vessel.

7.1.4 **Technical Requirements**

7.1.4.1 **Probe**

a) Power supply : 24V DC .

b) Electrodes : Refer Principle of Operation section.

c) Temperature element : PT 100 (or equivalent).

d) Process connection : Screwed or flanged as per Project Specification.

e) Output

- Voltage signal proportional to pH.
- Temperature signal.
- *Memosense (and or similar)* digital signal (optional as per Project Specification).

7.1.4.2 **Transmitter**

a) Power supply : 24V DC

b) Operator interface

- Menu driven.
- Backlit LCD multiline display for simultaneous parameter display.
- LCD status display (1*).
  - Normal/calibration mode.
  - Manual/Auto (relay) selection.
  - Relay active.
  - Error/alarm.

  (1*) manufacturer specific LED status/LCD text display.

c) System interface

- Fieldbus connectivity for system communication.

d) Inputs

- pH proportional voltage signal.
- Temperature signal.
- *Memosense* (and or similar) protocol digital signal.

e) Outputs:

- Analogue output: 4-20mA proportional to pH, HART.
- Relays: SPDT contacts 0,5A at 24V DC
  - Alarm output relay configurable for specific or grouped alarms.
  - Up to 4 no configurable, as per Project Specification.

- Functionality: Refer *Functionality* section narrative/Project Specification.

7.2 DISSOLVED OXYGEN (DO) MEASUREMENT

DO measurement, by means of optical based sensing, refers to the amount of free, non-compound oxygen present in water or other liquids, as a percentage of oxygen versus liquid (% saturation, or Parts Per Million (ppm)).

7.2.1 Application

The DO levels in water is an important parameter of water quality and the application for purposes of this specification will be mainly for process monitoring as required in the water purification industry, whereby the DO is measured to assist with the treatment process and adjustments.

The instrument will be used for online monitoring, or for periodic measurement of samples. Monitoring will be within open structures, enclosed vessels and inline piped flow application.

7.2.2 Operating Principle And Construction

The measuring principle can be done in two ways, namely through optical-sensing or the membrane-covered method. This specification will focus only the optical-sensing (luminescent) type.

The DO sensor is coated with a luminescent material. A LED light transmits blue light to the surface, which excites the material and in turn emits a red light. An internal referenced red light is also flashed, to act as the check. The time to emit the red light is measured and used as a function of DO saturation. The higher the DO concentration, the less time to relax and emit the red light, and vice versa.

DO saturation levels are subject to the salinity and temperature of the liquid measured. The salinity and temperature tables must be utilised in the setup and calibration of the equipment.

The probe DO proportional output can also be configured in a digital signal, *Modbus* protocol whereby the output is via contactless inductive coupling.

The probe comprises the combination electrode tube and housing for the on-board electronics and cable connection. The electrode tube is inserted within an outer protective SS316 housing, easily removable for cleaning and maintenance of the probe. The specific configuration will depend on the process structure entry for mounting, being an open vessel, inline pipe with socket T-entry or enclosed vessel, with screw or flanged entry.

The probe must be threaded and screwed into a socket, or unthreaded and fitted into a socket with external thread, secured by means of a union nut and appropriate seal between the nut and sensor. Probes fitted to vessels must have a retraction enclosure that the probe can be removed without affecting the process or having to drain the vessel.

The lead out cable connection type must allow for easy removal of the probe, especially the threaded type, that the cable is not twisted in the process, either by removing the

housing cover and disconnecting the cable, or having a short lead out to an intermediate junction box.

Maintenance and durability:

The DO sensor must be of the maintenance free type, with no calibration required (ie no drift accepted on the unit from factory calibration) nor membranes nor solution needing replacement.

Transmitter

The DO sensor must be connected to the field controller (either of the 2 or 6 way type), depending on Contractor design configuration and field equipment positions. Refer pH transmitter above for further detail. All devices connected to the transmitter/controller must be displayed and programmable. The manufacturer of the sensors and transmitter must be the same.

The transmitter must be Modbus-485 compatible, capable of networking to a wider industrial network, whether it be local or remote.

7.2.3 **Installation**

The probe must be installed in an easily accessible position in view of frequent removal for maintenance.

The process connection will either be threaded (default) or flange mounted (special application). The sensor must be threaded and screwed into a socket, or fitted into a socket with external thread, secured by means of a union nut and appropriate seal between the nut and sensor. Sockets to suit the sensors must be fitted prior to coating of the pipes. Sockets may not be installed on site in situ. Should a socket be required, the pipe section must be removed for drilling and welding in a workshop and the complete pipe section must re-coated, including hot dipped galvanized pipework

The power supply and signal cables must be terminated directly on the instrument housing with an approved industry standard connection in accordance with the manufacturer's provision. The termination may not compromise the instrument IP rating. If the lead out cable is moulded to the body, a disconnection point within a IP 67 cable junction box must be provided in close proximity of the sensor that the cable is not twisted or damaged when removing screw-in probes and also allow removal of the probe only. The cable from the sensor must be supported on a cable rack from the sensor position to the related cable wireway to ensure there is no tension on the termination.

The sensor must always be wetted and the probe may not be installed at an angle larger than 80° from vertical and not upside down. Refer project specification for further special mounting requirements, whether by a floating mount kit, pole-mount kit or in-line pipe mounted.

7.2.4 **Technical Requirements**

7.2.4.1 **Probe**

a) Power supply : 24V DC .

b) Wetted end : Acrylic sensor cap

c) Housing : SS316

d) Process connection : Screwed or flanged as per Project Specification.

e) Output : Saturation % proportional to DO.

f) Accuracy : 0.1ppm (mg/L), below 5ppm

g) Range : 0 – 20ppm (0 – 20mg/L)

7.2.4.2 **Transmitter**

- Refer pH for generic detail

7.3 SUSPENDED SOLIDS (SS) MEASUREMENT

SS measurement, by means of optical based sensing, refers to the amount of foreign particles (solids) present in water or other liquids, as a percentage of solids versus liquid (NTU for turbidity applications, or ppm for suspended solids).

The measurement and sensor principles apply to both Total Suspended Solids (TSS) as well as Mixed Liquor Suspended Solids (MLSS). The unit must be selected and calibrated for its specific application, depending on sludge thickness and process location.

7.3.1 Application

The SS levels in water is an important parameter of water quality and the application for purposes of this specification will be mainly for process monitoring as required in the water purification industry, whereby the SS is measured to assist with the treatment process and adjustments.

The instrument will be used for online monitoring, or for periodic measurement of samples. Monitoring will be within open structures, enclosed vessels and inline piped flow application.

7.3.2 Operating Principle And Construction

The measuring principle is by means of dual-beam optics and integrated photoreceptors. A dual-beam LED light source transmits light to the sensor face at an angle of 45°. Photoreceptors are then positioned at 90° as well as at 140° for backscatter light, to detect the transmitted light. The more backscattered light is detected, the higher the SS concentration, and vice versa.

The probe comprises the combination sensor and housing for the on-board electronics and cable connection. The electrode tube is inserted within an outer protective SS316 housing, easily removable for cleaning and maintenance of the probe. The specific configuration will depend on the process structure entry for mounting, being an open vessel, inline pipe with socket T-entry or enclosed vessel, with screw or flanged entry.

The probe must be threaded and screwed into a socket, or unthreaded and fitted into a socket with external thread, secured by means of a union nut and appropriate seal

between the nut and sensor. Probes fitted to vessels must have a retraction enclosure that the probe can be removed without affecting the process or having to drain the vessel.

The lead out cable connection type must allow for easy removal of the probe, especially the threaded type, that the cable is not twisted in the process, either by removing the housing cover and disconnecting the cable, or having a short lead out to an intermediate junction box.

Maintenance and durability:

The unit must be provided complete with integrated wiper mechanism, to assist with accurate readings. The wiper components must be made from stainless steel, with the blade made of silicon.

Transmitter

The SS sensor must be connected to the field controller (either of the 2 or 6 way type), depending on Contractor design configuration and field equipment positions. Refer pH transmitter above for further detail. All devices connected to the transmitter/controller must be displayed and programmable. The manufacturer of the sensors and transmitter must be the same.

The transmitter must be Modbus-485 compatible, capable of networking to a wider industrial network, whether it be local or remote.

7.3.3 Installation

The probe must be installed in an easily accessible position in view of frequent removal for maintenance.

The process connection will either be threaded (default) or flange mounted (special application). The sensor must be threaded and screwed into a socket, or fitted into a socket with external thread, secured by means of a union nut and appropriate seal between the nut and sensor. Sockets to suit the sensors must be fitted prior to coating of the pipes. Sockets may not be installed on site in situ. Should a socket be required, the pipe section must be removed for drilling and welding in a workshop and the complete pipe section must re-coated, including hot dipped galvanized pipework

The power supply and signal cables must be terminated directly on the instrument housing with an approved industry standard connection in accordance with the manufacturer's provision. The termination may not compromise the instrument IP rating. If the lead out cable is moulded to the body, a disconnection point within a IP 67 cable junction box must be provided in close proximity of the sensor that the cable is not twisted or damaged when removing screw-in probes and also allow removal of the probe only. The cable from the sensor must be supported on a cable rack from the sensor position to the related cable wireway to ensure there is no tension on the termination.

The sensor must always be wetted and installed as per supplier recommendations. All required brackets, shafts, adaptors and couplings must be provided to install the sensor at the correct process location. Sensors installed in pipeline applications must be

provided with either flanged connections or else safety armatures for securing of the sensor.

Care must be taken to access the sensor, for maintenance and cleaning purposes. All installation material in sewage applications to be SS316.

Note that the unit cannot be installed in a high flow area (greater than 3m/s) and not in a pipeline of pressure greater than 6bar.

7.3.4 **Technical Requirements**

7.3.4.1 **Probe**

a) Power supply : 24V DC .

b) Housing : Stainless steel

c) Process connection : Screwed or flanged as per Project Specification.

d) Output : NTU or mg/L

e) Accuracy : <1% with calibration

f) Range : 0.001mg/L to 500g/L

7.3.4.2 **Transmitter**

- Refer pH for generic detail

STANDARD SPECIFICATION

SSE04 – TELEMETRY AND SCADA

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1. GENERAL SCOPE

This section of the Project Works requires a dedicated and specialist sub-contractor to execute the required Works. Close cooperation is critical between the Main Contractor, specialist sub-contractor as well as MCC manufacturer and no claims in this regard will be entertained.

The project specification covers the related design, construction, supply, delivery, installation, testing, commissioning and site optimisation of a radio telemetry and central SCADA system in line with the Client's current supplier, contract and standard of operations. The current supplier must be utilized as the specialist sub-contractor so as to ensure continuity of service and modifications of the central and critical SCADA control system.

This project's scope of works is summarised as follows:

- Telemetry outstations and central SCADA implementation in line with the project specifications

2. TELEMETRY OUTSTATIONS

2.1 ENCLOSURE

The enclosure must be wall-mounted in close proximity of the applicable MCC.

The outstation must be manufactured from 1.6mm^2 mild steel with an epoxy power coated finish. It must be fitted with a hinged door and be of the lockable type by either square-key type locks or quarter turn coin slot screws. The door must be equipped with a limit switch, connected to the I/O module, so the Client can see and trend when the door is opened on the SCADA system.

A dedicated gland plate and opening must be provided at the bottom of the enclosure, with pre-drilled holes and glands to suit the small cable and wiring sizes, leaving a tight seal.

A dedicated terminal strip for all incoming and outgoing cables must be provided above the gland plat, with all signals wired through to the RTU and I/O configuration cards.

The battery must be installed in such a position that it does not have to be moved in order to gain access to any equipment, terminals or cables. Any required supporting brackets or holders must be included into the original enclosure design.

The enclosure must be securely mounted, at all four corners, against the dedicated MCC backplane. Note that final MCC spatial, door and backplane sizing remains the responsibility of the specialist sub-contractor and must be coordinated with the MCC supplier during the drawing stage. All door openings and other considerations in terms of operations and maintenance must be taken into account.

2.2 RADIO

Offered radios must be of the digital type. Any additional ICASA licensing applications must be provided for as part of the tender offer.

Note that a preliminary path analysis between the various sites and the central station must be done as part of the tender offer and any additional provisions in terms of repeaters, digipeating configuration or 'boosting' of signals must be provided for as part of tender pricing and offering. No additional claims during construction stage will be entertained.

2.3 CONFIGURATION

The telemetry RTU configuration must be housed on a dedicated backplane within the enclosure. The CPU, both digital and analogue I/O cards as well as counters must be provided in line with the project specifications and requirements. Special attention must be placed upon the system control and how the SCADA, outstation and MCC must work together for a fully functioning system. The RTU must be equipped with serial and network communication and be of the programmable type, to comply to the control and monitoring requirements as set out below in Section 3.

All field I/O must be galvanically isolated and provided with surge protection.

A two-line digital display keypad must be flush-mounted on the enclosure hinged door. All required analogue values, as well telemetry controlled parameter values, must be displayed. Note that the unit must be able to be locked and any changes must require a password prompt, which must be included into the manuals.

Provision must be made to house the final single line diagram in a door-mounted pouch. Note that a generic drawing will not be accepted and all applicable I/O, with corresponding descriptions, must be indicated on the drawing (applicable to the manuals as well).

2.4 ANTENNA

The detailed path analysis will determine the size and type of outstation antenna to be installed and the final design remains that of the specialist sub-contractor.

In the case where a 'whip-antenna' is suited for the application, the final installation must be done either internally within the enclosure, or a more secure antenna installed on the outside of the canopy. All cabling, glanding and securing of the antenna must be coordinated with the MCC manufacturer so as to not drill unnecessarily into the canopy and introduce a potential weak point for rust.

Should a higher antenna be required then a suitably sized mast made from minimum 3mm HDG steel tubing must be provided (less than 9m of the flagpole type, else of the lattice type). The mast must be provided with robust footing, complete with four securing points capable of being chemically bolted and anchored to the concrete plinth.

It is very important to note that the plinth is sized according to the MCC dimensions only. If a floor-standing mast is required, as per above, then a larger plinth must be provided as part of the tender price. an additional plinth section cast alongside the MCC plinth will not be accepted, as the original plinth design must make provision for all installation requirements (including sleeves to antenna, of the slow bend type, as well as earthing).

The antenna cable must be of the co-axial type, suited to the specific strength and application required. No visible cables will be accepted.

2.5 EARTHING

It is important to note that the antenna mast must be separately earthed from the telemetry outstation, so as to not create a potential lighting path back to the outstation and MCC. The earthing must be done by means of a minimum 35mm^2 BCEC cable (PVC insulated) to a 1.2m earth rod, installed in close proximity to the plinth. The ground resistance must be measured with a value of no more than 1ohm to be obtained. If higher then additional rods must be installed until the value is reached. This value must be included into the commissioning data submitted as part of the operating and maintenance manuals.

Note that the co-axial cable between the antenna and outstation must also be adequately earthed so as to create an equi-potential, but the path of least resistance must be down to earth via the rods.

Note that dedicated surge protection must be provided for all field cables and signals, including the earth and power cables.

2.6 POWER SUPPLY

The outstation will be provided with a 10A SP(230V) circuit breaker point of supply in the MCC's distribution section. The power supply and earth cable from the CB to the outstation must be provided as part of the telemetry contract.

The outstation power supply must be of the dual-supply type, incorporating the normal MCC supply as well as a backup battery supply. The unit must be rated to be able to supply twice the total peak demand of the system.

The battery supplied must be of the maintenance-free, sealed type, capable of providing 12 hours-worth of backup supply to the telemetry outstation, operating at peak capacity. The battery must be provided with a battery charger that operates on a trickle-charge principle, prolonging the life of the battery and not over-charging the battery at any point. The battery charger must be capable of fully recharging the battery within 6 hours and be equipped with an automatic boost function.

3. SYSTEM CONTROL

3.1 OVERVIEW

The overall scheme description as well as monitoring and control requirements are set-out in Section 3, part 4. This section must be studied in detail by the specialist sub-contractor and a final I/O list, as well system control responsibility, must be deduced from here. The I/O list below is a general indication only and tenders cannot determine their final bid on this list alone.

The overall scheme will be described in the project specifications.

3.2 I/O SCHEDULE

The indicative system I/O schedule is as follows:

	PARAMETER	I/O TYPE
A	Telemetry door	Digital In
B	Power failure	
C	Communication failure	
D	Pump/Blower/Mixer Status	
	• CB On/Off/Trip • Manual/Off/Auto • Run • Common Fault • E-Stop • Low and Enable levels	Digital In and Out Analogue In and Out
E	Reservoir Levels	
	• Reservoir level display • Start/stop levels • High level alarm • Low level alarm	Digital In and Out Analogue In and Out
F	Flow	
	• Flow rate • Totalised flow count	Digital In and Counter Analogue In and Out
G	Pressure	
	• Analogue display • High Pressure	Digital In and Out Analogue In and Out
H	Temperature	
	• Analogue display (winding, pump bearing, motor bearing) • High Limit	Digital In and Out Analogue In and Out

3.3 MONITORING AND CONTROL SPECIFICS

3.3.1 Primary Monitoring

Refer project specification for full monitoring description.

3.3.2 Local Display

Refer 2.3 above.

The local telemetry keypad and display must be utilised to indicate all required telemetry signals that have a bearing on the control of the pump.

3.3.3 Remote Reset

Refer electrical project specification for full control description and requirements, where applicable.

4. CENTRAL SCADA

4.1 OVERVIEW

This section of the standard specifications relates to the design and implementation of a central SCADA system, to act as a monitoring, trending and historian-based system for a Client's water, sewer or industrial system.

The design of the various SCADA-system components must be done such that the system is easily scalable at a later stage, that the system is not restricted to a single-supplier or programming entity and that remote access is readily available for off-site assistance.

It remains the responsibility of the Contractor to determine that the current software version can handle the additional outstations and that adequate scan points are available. If the available capacity is to be exceeded by this contract then it must be qualified with all financial implications stated and included as part of the tender offer.

4.2 SOFTWARE, LICENSING AND SCAN POINTS

The SCADA package proposed must be the latest version of either the Siemens SIMATIC or Emerson Electric type, capable of operating on the latest Windows package, with scan point capacity for:

- The complete WTW and WWTW plant installation as specified in the various sections of the electrical project specifications
- The bulk water scheme pump stations (both water and sewer)
- Providing for an additional 20% spare capacity.

Tenderers must state the offered and spare utilisation of the package under this contract.

The various electrical sections within the electrical portion of the tender document relate to the monitoring and control signals and functions of the new plants and pump stations as a whole. As such, it is the responsibility of the contractor to design and incorporate all the necessary digital, analogue, monitoring and control process parameters, for a fully working system, into the newly proposed SCADA system. It will be assumed that the other sections have been fully read and studied and that no additional claims will be entertained for process parameters not included into the tender offer.

The system must be configured for the monitoring and control functions as specified for the networked plant, new outstation and existing bulk water scheme, all in accordance with the various electrical specification sections.

The SCADA system must run on the central server, with the view node desktop the interface between the operator and the server. Note the SQL database requirements, as listed under the specific section. The SCADA system must write all data into this

independent database, which will be used as the main data storage point, but which will also provide a solid platform from which to compile reports.

The tender offer must include all required software and licencing up-front costs, as well as covering the licence costs for a period of two years after taking over has been established. The contractor must further sate in the Bill of Quantities what the applicable licencing costs are per year, as a rate, to enable the client to properly budget for this cost in their upcoming financial years.

4.3 SERVER AND DATABASE

4.3.1 SERVER

In order to provide a degree of reliability and data security, a rack-mounted data server must be provided to act as the backbone for the SCADA system. The server must of the Dell or HP type.

The server will be responsible for running the new SCADA package, with view node capability to be provided on the local control room computer.

In addition, the server must maintain a SQL server database, into which the SCADA system must write all specified plant and bulk water scheme data. A separate reporting tool, as specified under Reporting, must be provided to assist the client in managing the plant.

4.3.2 DATABASE

A SQL server database must be provided as part of the complete central station offer. The database software offer must be of the generic and independent type (in other words, the proposed SCADA software database is not acceptable for this purpose), similar and equal to Microsoft SQL Server.

The tender offer must include all required software and licensing up-front costs, as well covering the license costs for a period of two-years after taking-over has been established. The contractor must further state in the BOQ what the applicable licensing costs are, per year, as a rate, to enable the client to properly budget for this cost in their up-coming financial years.

The programming and composition (structure) of the database is very important and must be designed in detail and discussed during the initial stages of the project, to allow for data integrity and future expansion capability, if so required. A sub-set must be created for each type of tag within the plant database. In other words, all levels must be written to one specific sub-set. Consistency in data recording is of paramount concern here, allowing the client to be able to accurately compile reports and assess plant trends with ease, to prevent either data loss or data inconsistencies.

The SCADA system will remain responsible for writing all the required data into the independent SQL database. Data must be logged per event change, and data updates must be established for each type of digital and analogue tag, both on the plants and remotely from the bulk water schemes. At present, allow for an update every 5 minutes, in order to accurately size the equipment required.

Any OPC allowance must be provided for between the central telemetry outstation (RTU) and SCADA system. The database must be able to accurately communicate with the proposed front-end reporting structure. Note the reporting requirements below, as well as the provision or additional reports during construction stage.

4.4 SECURITY

As there will only be one access/interface point to the SCADA and server system, different levels of access/security need only be provided at this one point. Three levels of access must be provided for on the server:

- Level 1 (lowest level of access) will be for the daily operator who will access the SCADA system for monitoring, fault finding and basic trending.
- Level 2 (process level) will be for the plant manager to be able to adjust process parameters, as set out below in the SCADA section.
- Level 3 (highest level of access) is for the server administrator, to perform diagnostic tests, perform any updates required, compile additional reports, database programming, etc.

Any operator that wishes to log-on to the server (ie, level 1), via the view node, must do so by means of a biometric fingerprint scanner. This recognition process must create an event stamp as to who it is that logged-on, and for how long the applicable party was online.

In order for a level 2 or level 3 individual to perform their required functions, additional password prompts must be requested, before that access can be granted.

It will be contractor's responsibility to supply and install the biometric scanner, including all required software, including the loading of the client's identified operators onto the system, all during the training and commissioning stage of the project. The level 2 operator must further be granted the responsibility and capability to manage (ie, delete and add users) this security feature.

4.5 HARDWARE

4.5.1 SERVER BACKBONE

The offered server must of the industrial, rack-mounted, floor-standing type. The server must be fully equipped, as a minimum, with the following specifications:

- Dual power supply capability (ports for normal and UPS-backup power)
- Newest available processor (quad core)
- DDR3 Memory (min 8GB)
- Two solid state drives (minimum 1TB), with hot plug-in, to cater for zero data-loss and backup redundancy
- All necessary network and controller cards required, including management software, to fully operate the required SCADA and independent database

- All other USB and connection ports required

It will be the responsibility of the contractor's System Integrator (SI) to determine the final server rack size. The rack must be provided with lockable, see-through door, with an industry standard server IP rating. Note that the fibre-optic patch panel, network switch, server and UPS must all be installed within this rack. Ventilation and heating requirements from the individual devices must be considered to determine the eventual size. The rack must be provided with an integral power distribution unit, synchronized with the in-line UPS, to provide seamless power to the various sections of equipment. Note the requirements of the local electrical installation regulations and compliance must be guaranteed at all times.

4.5.2 VIEW-NODE

The minimum requirement for the new central station interface (desktop) is an Intel dual core I7 processor with 2TB hard disk, 8Gb extendible RAM, minimum of three USB ports, DVD writer, wireless keyboard and mouse, 1 x 23" LCD flat screen and two 49" wall-mounted LED displays. Secure locking mechanisms, with pin-code functionality, must be supplied and installed for each screen and desktop body.

The computer must be pre-loaded with the latest Windows and Microsoft Office packages, complete with all certification and licensing costs included as part of the tender offer. An anti-virus program, fully licensed, must further be loaded.

Any additional software required to fully operate with the SQL server must be provided as part of the tender offer, with all licensing costs included.

Access to the desktop must be via a biometric fingerprint scanner, to be provided as part of the tender offer. The scanner must be provided with all required software pre- loaded (including licensing costs) and fully commissioned. The scanner must have visual indication for acceptance/rejection after a scan, minimum IP54 rated, with built-in network capability and up to date high-performance algorithm. The scanner must be installed in a fixed position, within arms-reach of the desktop. Event logging, per scanning event, must be included into the server database.

4.5.3 NETWORK SWITCH

A network switch of the managed type must be included as part of the server design, to integrate with the telemetry outstation RTU as well as view node computer.

The switch must be of the managed type, complete with two fibre ports and a minimum of 4 RJ45 copper ports. The switch must also be dual-supply connected.

4.5.4 UPS

A new single phase in-line UPS must be provided for the central station, with a backup time of at least of one hour. The UPS must be sized to handle the complete load of the central SCADA and server system, including ancillaries, as well as an additional 20%. The UPS must be installed within the server rack and all heating and ventilation requirements must be incorporated into the rack design.

4.6 MENUS AND STRUCTURE

The graphical design and representation is key to the overall functionality and operator understanding. As such, the menu and display structure is very important, and movement between pages and sections must be intuitive and simple.

On each page provision must be made to view the overall main menus, to easily transfer between various main sections and sub-menus.

The following menus and graphic screen layouts are proposed as a holistic system, with only the specific sections required applicable to a specific project:

a) Screen 1: Main Menu

To provide an overview of the scheme, including the Water and Sewer sections, MV supply, emergency generators, housekeeping, alarm page, trending and reporting.

b) Screen 2: Bulk Water Scheme

To provide an overview of the applicable water scheme, complete with Water Treatment Plants, Pump Stations, boreholes, reservoirs and reticulation.

c) Screen 3:

To provide an overview of the applicable waste water scheme, complete with Waste Water Treatment Plants and Sewage Pump Stations.

d) Screen 4: General WTP

This screen displays:

- A schematic line diagram of the plant and associated equipment
- General fault page
- Overall Basic Pump/Motors status
- System analogues status

Screen 4.1: Inlet Works

This screen displays:

- A schematic line diagram of this section of the plant and associated equipment
- Pump/Motors status
- Valves status
- System analogues status
- Plant pH
- Emergency stop active.

Screen 4.2: De-Sludging

This screen displays:

- A schematic line diagram of this section of the plant and associated equipment
- Valves status (per de-sludge tank)

- System analogues and timing status
- Emergency stop active.

Screen 4.3: Filter Plant

This screen displays:

- A schematic line diagram of this section of the plant and associated
- equipment
- Backwash pump/ motors status
- Blowers status
- Each filter's valves status
- System analogues and timer status
- Filters' turbidity
- Emergency stop active
- Clearwater tank.

Screen 4.4: Chlorination Plant

This screen displays:

- A schematic line diagram of this section of the plant and associated equipment
- Pump/motors status
- Chlorination rates
- System analogues status
- Scrubber plant status
- Emergency stop active.

e) Screen 5: General Bulk Water Scheme

This screen displays:

- A schematic line diagram of the scheme as a whole
- General fault page
- Overall Pump/Motors status
- System analogues status

Screen 5.1: Lift Pump Station

This screen displays:

- A schematic line diagram of this section of the scheme and associated equipment
- Pump / motors status
- Protection status
- System analogues (flow, pressure, temperatures) and timer status
- Emergency stop active
- Reservoir levels

Screen 5.2: Bulk Reservoirs

This screen displays:

- A schematic line diagram of this section of the plant and associated equipment
- Level status
- Flows

f) Screen 6: Medium Voltage Sub-station

This screen displays:

- A schematic line diagram of this section of the plant and associated equipment
- MV switchgear status
- Transformer status
- System analogues status
- Power failure

g) Screen 7: Generating set

This screen displays:

- A schematic line diagram of this section of the plant and associated equipment
- Generator status
- Bulk fuel tank and day tank status, including fuse link valve status
- System analogues status
- Power failure
- Main Incomer and MCC CB positions

h) Screen 8: Alarming

This screen must provide a detailed list of all warning and alarms that have been triggered on the system, of all connected remote sites. An alarm must be depicted as Red on the screen and only become yellow once the alarm has been acknowledged. The alarm indication can only become green once the fault causing the alarm has been rectified.

Alarms must be displayed on a scrollable page, with the last week's alarm to be able to be accessed. Alarms older than that must be written into the specific database section, for retrieval and reporting where required.

4.7 GRAPHICAL DISPLAY

Graphic display of status and analogue parameters monitored, as well as trend screens, must be provided as detailed below. Minimum guidelines are given below and allowance must be made within the tender price for liaison with the client and Engineer in this regard. The System Integrator (if separate entity) must make themselves familiar is familiar with the Employer's standards, requirements and software configuration and no claims for additional payment in this regard will be entertained.

Plant Status/Signal	Graphic Depiction / Position	Colour
Telemetry door	Outstation Housekeeping Block	Red when open, else grey
Power failure	Outstation Housekeeping Block	Red on failure, else green
Communication failure	Outstation Housekeeping Block	Red on failure, else green
Pump/Blower/Mixer Equipment	**In process sequence**	
• CB On/Off/Trip	• Below equipment	• Off: White, Trip: Red
• Manual/Off/Auto	• Below equipment	• Healthy: Yellow
• Run	• Visual colour	• Green
• Common Fault	• Visual colour	• Red
• E-Stop	• Pop-up	• Red
Reservoir Levels	**In process sequence**	
• Reservoir level display	• % on reservoir	• Black on white
• Reservoir dimensions	• Height (m)	• Black on white
• Start/stop levels	• On reservoir	• Black on white
• Low and High levels	• On reservoir	• Red
• Enable levels	• On reservoir	• Red
Flow	**Flow meter in piping**	
• Flow rate	• l/s or m^3/hr, at sensor	• Black on white
• Totalised flow count	• m^3, at sensor	• Black on white
• High flow (limit)	• Block around values	• Red
Pressure	**Pressure sensor in piping**	
• Analogue display	• Bar, at sensor	• Black on white
• High Pressure (limit)	• Block around values	• Red
Temperature	**Motor winding / bearings**	
• Winding analogue	• °C, at motor	• Black on white
• High Temp (limit)	• Block around values	• Red
• Motor bearing analogue	• °C, at motor (DE/NDE)	• Black on white
• High Temp (limit)	• Block around values	• Red
• Pump bearing analogue	• °C, at pump (DE/NDE)	• Black on white
• High Temp (limit)	• Block around values	• Red

Provision must be made in the graphical presentation to the Client for an iterative back and forth approval process. Provision must be made in the design stage for a three-stage approval process, including presentations and face to face meetings with the Client.

4.8 TRENDING

Each analogue value, by clicking on the value, must produce a pop-up screen that shows a trend of that specific tag. The general trend page (applicable to all sections), must be provided with scalable functionality, to enable the operator to select the viewing period. Note that level 1 access is adequate for this section.

Each sub-section page, whether it be a pump station or section of plant, must be provided with a trending push-button, which creates a separate pop-up, to a trending page that depicts all the main components from that specific sub-section page. At a pump station for example, the following must be shows, each with a dedicated colour and description at the bottom:

- Pump Run
- Pump Trip
- Reservoir Level
- Pump Flow
- Pump Pressure

Additional trend screens must be created where (including but not limited to):

- The operator will be able to see the raw water inflow, the main lift pump station outflow and calculated plant wastage flow, all on the same screen. Each analogue parameter must be clearly distinguishable and the screen must display monthly data, with the previous history averages summarised in tabular format, for system and process efficiency analysis;
- All the filters' backwash sequences are plotted next to one another, to indicate when a sequence has started and stopped. This will assist the operators in analysing and modifying their spacing and programming of when to backwash the filters;
- As the chemical and chlorination dosing will be manually adjusted according to the set flow of the plant, the operator must be able to monitor the inflow of the plant versus the dosage rates of the dosing and chlorination systems. Therefore, at, for example, a certain time within a certain day, the inflow will be x and the operator will be able to analyse what the various dosage rates were for each of these chemical dosing sections. Seasonal process adjustments can then be made more accurately, if and when required;
- All the reservoirs within the bulk water scheme (Clearwater reservoir included) must have their analogue values displayed on one screen, in order to assess the balancing of the scheme as a whole, including being able to call up the trending data of previous months, for a more detailed comparison.
- All high lift pumps, per site, are trended against one another, per analogue process variable (ie, bearing temperatures, vibrations, pressure per duty pump, flow per duty pump, etc).

The Engineer and Client reserve the right to request or amend pages during the working drawing stage and the contractor must make provision for these changes as part of the tender offer (3 iterations as a minimum).

4.9 REPORTING

A front-end reporting software package must further be provided as part of the tender offer. The software must also run on the main central server, with all required reports to be designed, modified through an iterative approval process and automatically provided to the client on a monthly basis.

The tender offer must include all required software and licencing up-front costs, as well as covering the licence costs for a period of two years after taking over has been established. The contractor must further sate in the Bill of Quantities what the applicable licencing costs are per year, as a rate, to enable the client to properly budget for this cost in their up-coming financial years.

The reports are generally taken a few steps further in terms of detailed information and complexity than the additionally requested trend screens, as stated above. The reports must indicate daily, monthly and yearly data, they must consist of graphs, bar-charts and must be structured in such a way so as to include dates, introductions, purpose of the report and provide technical summaries.

As part of this scope of works, the contractor must make provision for the following types and amounts of reports, with provision for further reports to be requested by the client during construction stage:

- Plant total flow reports, taking into account the raw water inlet, pumped water out and backwash/waste water. These values must be processed to provide total wastage of the plant, incorporating filter backwash and desludging frequency.

- Bulk water scheme balance report, indicating how many times the pumps at each pump station starts, how the pumping cycles and the levels of the reservoirs coincide with one another and a general view on the balance of the system.

- Bulk sewage scheme balance report, indicating how many times the pumps at each pump station starts, how the pumping cycles and the levels of the sumps change and a general view on the balance of the system.

- Generator usage report, highlighting the amount of times the generator has run, what the fuel usage is and how the plant is adapted to when the generator runs (limited inflow to the plant, main pump flow delivery, other interlock statuses as per Section 3)

Note that provision must be made for an additional three reports which the client will detail during the construction stage of the project. The reports will consist of nominally the same amount of information and calculations as per the three reporting requests above.

4.10 ANCILLARIES

Any ducting, power-skirting and power supply points required for the creation of the new central SCADA station must be provided for as part of the offer. Assume that single phase power is available at a Local DB.

A L-shape operator table must be provided, complete with executive swivel chair.

The wall-mounted displays must be mounted by means of adjustable brackets, to adjust tilt and rake.

5. GENERAL

All preliminary and general matters must be referred to Section 1 for detailed descriptions and requirements, in-line with the Main Contractor's tender offer.

Additional and specific items are detailed below.

5.1 TESTING AND COMMISSIONING

Provision must be made for a fully automated factory test at the premised of the MCC manufacturer, before site implementation can commence. Only after the system has been functionally tested and found to be in-line with the specification can the site work commence.

Site commissioning not only relates to installation and testing of the system on-site, but also to running and optimising of the system in-line with the general requirements as set-out in the general project specifications.

Note that all drawings, approvals, construction, testing and site commissioning must be in accordance with the program of the Main Contractor. It remains the responsibility of the specialist sub-contractor to confirm said program and fall in-line accordingly.

5.2 MANUALS

Note the general project specifications relating to all manuals requirements. Further note the detailed layout that must be included at each telemetry outstation, as detailed in 2.3 above.

The following items must specifically be included:

- Overall system layout (graphical)
- I/O schedules
- Wiring diagrams (with applicable I/O descriptions)
- Cable and connection schedules
- Software I/O configuration
- Technical hardware description

- SCADA screenshots
- Trending examples, including specific requests

5.3 TRAINING

Note the general project specifications relating to the training and induction of operators. Part of this offer must include the training of the various levels of applicable operators and managers on the system. The Contractor must liaise with the Client to determine who the applicable parties are that will be a part of the system.

Training must encompass a continual process of demonstration and supervision, against signed training registers for all applicable members.

Appendix A – Health and Safety Specification GUIDELINES

Refer Civil Contractor for requirements and specifications.

DEPARTMENT LAND REFORM AND RURAL DEVELOPMENT

CONTRACT NO.: SSC WC 01 (2026/2027) DLRRD

THE APPOINTMENT OF A CONTRACTOR FOR THE CONSTRUCTION OF A SEWER AND STORMWATER PIPE IN NDULI, CERES, UNDER WITZENBERG MUNICIPALITY, IN THE WESTERN CAPE PROVINCE

C4: SITE INFORMATION & SUPPLEMENTARY DOCUMENTS

SITE INFORMATION

AREA : **NDULI**

MUNICIPALITY : **WITZENBERG MUNICIPALITY**

DISTRICT : **CAPE WINELANDS DISTRICT MUNICIPALITY**

GPS COORDINATES: : **LATITUDE 33°21'12.02"**

LONGITUDE 19°20'45.66"E



SUBSOIL INVESTIGATIONS: A geotechnical report is included below.

KANTEY & TEMPLER
CONSULTING ENGINEERS
ESTABLISHED 1953

REPORT ON GEOTECHNICAL INVESTIGATION ALONG THE ROUTE OF THE PROPOSED NDULI BULK SEWER IN CERES

SEPTEMBER 2023

K&T PROJECT REFERENCE: 16871GG

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Details of this report

Client Name	MNE Oak
Document Title	REPORT ON GEOTECHNICAL INVESTIGATION ALONG THE ROUTE OF THE PROPOSED NDULI BULK SEWER IN CERES
K&T Project Reference	168715GG
File Name	16871GG Nduli Bulk Sewer
Prepared By	Leroi Celliers
Reviewed By	Frank Du Plessis

Report Revision Record

Revision	Date	Description
0	13/09/2023	First Draft
1	19/09/2023	Final Report

This report has been prepared by Kantey & Templer (Pty) Ltd, with all reasonable skill, care and diligence within the terms of the Contract with the client, incorporating our General Terms and Conditions of Business and taking account of the resources devoted to it by agreement with the client.

We disclaim any responsibility to the client and others in respect of any matters outside the scope of the above.

This report is confidential to the client and we accept no responsibility of whatsoever nature to third parties to whom this report, or any part thereof, is made known. Any such party relies on the report at their own risk.

For and on behalf of Kantey & Templer (Pty) Ltd

For and on behalf of

Kantey & Templer (Pty) Ltd

Approved by: F. Du Plessis

Signed: 

Position: Associate Director

Date: 13/09/2023

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REPORT ON GEOTECHNICAL INVESTIGATION ALONG THE ROUTE OF THE PROPOSED NDULI SEWER IN CERES

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APPENDICES

Appendix A - Trail hole profiles

Appendix B - Laboratory Tests Results

REPORT ON GEOTECHNICAL INVESTIGATION ALONG THE ROUTE OF THE PROPOSED NDULI BULK SEWER IN CERES

1. TERMS OF REFERENCE

In terms of written instructions, Kantey & Templer was requested by MNE Oak, on behalf of the client, the Witzenberg Municipality to investigate and advise on subsoil conditions along the route of the new bulk sewer to be installed adjacent to the Onder-Swaarmoed Road east of Nduli outside Ceres.

In particular Kantey & Templer was required to advise on:

- the nature of the subsoils,
- excavation conditions,
- groundwater conditions
- stability of the excavation sidewalls down to the proposed trench invert level,
- materials utilisation potential.

2. INFORMATION AVAILABLE

The following information was provided or referred to:

- Drawings provided were as follows:
    - 1:1000 scale layout drawing (Number P1174-L01 Rev A) prepared by MNE Oak indicating the proposed route of the new sewer line as well as the existing sewer, level contours and roadways.
    - Drawing (Number P1174-L02 Rev A) presenting the longitudinal cross section of the pipe route, also indicating existing ground level, pipe diameter, pipe invert level and manholes.
    - 1:500 scale drawing titled “Existing Services Layout – Sheet 4 of 4” prepared by Bosch Projects (Drawing number 9004-007-GGL-0007) depicting the existing services at the junction of the Onder-Swaarmoed road and the R46.

- 1:125 000 Geological Survey Series Map (Number 3319A, Ceres) with legends.
- Available Google Earth and Farmmapper Imagery of the site.
- Geotechnical reports of investigations undertaken previously by Kantey & Templer in the area.

From the available information, the new sewer line will:

- be constructed at levels ranging from about 1,50m to 3,40m below existing ground level,
- be constructed using open cut excavation,
- comprise a 200mm diameter PVC pipe some 613m long.

3. SCOPE OF INVESTIGATION

3.1 Field Investigation

Following a walkover inspection of the investigation area and identification of positions free of services, five (5) machine dug trial holes were put down at pre-selected locations for exposure of the subsoil profile to depths of up to 2,10m below ground level.

The trial holes were excavated using a Tractor-Loader-Backhoe (TLB). The presence of a well stratified rock formation at shallow depth often resulted in machine refusal before reaching the proposed pipe invert level.

Disturbed soil samples were extracted from selected soil horizons in the trial holes and submitted to Messrs Steyn-Wilson Laboratories for testing.

The trial hole positions are indicated on the attached layout diagram (number 16871GG/01) whilst the trial hole profiles are given in Appendix A attached.

3.2 Laboratory Investigation

Disturbed soil samples were taken from selected horizons in the trial holes for laboratory testing and further geotechnical analysis specifically aimed at determining the material utilisation characteristics.

The laboratory tests were undertaken in accordance with the South African Standard, Technical Methods for Highways (TMH), British Standards (BS) and/or other recognised Standards.

- Soil Specimen Preparation, according to:
  TMH1:1986 and B.S. 1377: Part 1:1990

- Particle Size Distribution, according to:
  TMH1:1986 Test Method A1 and A6

- PH according to:
  TMH 1; 1986 Test Method A20

- Conductivity according to:
  THMH 1: 1986 Test Method A21.

- Compactability according to:
  SABS 0120 Part 3

The laboratory results are not available yet and will be submitted as an addendum to this report upon receipt.

4. SITE DESCRIPTION

The proposed bulk sewer will be located on the southern side of the Onder-Swaarmoed Road at the northern boundary of Nduli. The line will extend from Eluxolweni Avenue in the east to 3rd Street approximately 600m west.

The proposed sewer is located close to the existing sewer which is of insufficient capacity as sewerage overflow collects in the surface drainage ditch running along the road.

Land use of the area ranges from agricultural north of Onder-Swaarmoed Road to residential south of the road. The residential area comprises densely populated informal structures, some of which are located on the edge of the road and over the existing sewer line (servitude).

Vegetation over the pipe route is virtually non-existent with sporadic low grass occurring over isolated areas.

The terrain has a slight to moderate fall from the east to the west.

5. ANALYSIS OF RESULTS

5.1 Site Geology and Soils Profile

Based on published geological data and the results previous geotechnical investigations carried out by Kantey & Templer the Ceres area, the site is known to be situated in terrain composed of and underlain at shallow depth by weathered metasedimentary strata (shales) of the Bokkeveld Formation. The shale is mantled by a thin cover of naturally transported and residual soils.

The trial holes confirmed the presence of the residual soils and bedrock, no transported soils however intersected during our field investigation. The trial holes indicated a fairly consistent profile across the site.

The subsoil profile was generally found to comprise the following distinctive horizons:

Fill: The fill material mantles the pipe route and ranges from as little as 0,20m over the area of trial hole 2 to a maximum of 0,55m at trial hole 5; was to be highly variable ranging from firm shattered clayey sandy silt to loose to medium dense slightly silty fine to medium grained sand all containing scattered to occasional gravel, hard rock boulders and cobbles, bitumen fragments, grit, plastic and rock fragments.

Residual Soils Underlying the fill and intersected to depths of 0,85 to 1,75m below existing ground level; derived from the in-situ weathering and decomposition of the shales below, typically presenting as a firm to very stiff clayey silt often reflecting remnant bedding structure and locally containing zones of less weathered very soft rock.

Over the area of trial holes 2, 3 and 4, the upper 200 to 400mm of the residual material has been reworked presenting as a shattered material with scattered grit.

Shale bedrock: Encountered in all the trial holes with the exception of trial hole 5 and intersected from depths of 0,85 to 1,20m below existing ground level; the shales comprised completely to highly weathered highly fractured and jointed very soft to soft, to locally medium hard rock shale.

An idealized geological long section based on the investigations carried out on site and which reflects the various soils intersected, is presented in drawing 16871GG/02. Please note that the layer depths /thickness recorded at the trial hole and borehole positions represent actual subsoil conditions but that the sections in-between represent inferred soil boundaries which may vary from that depicted.

The soils encountered are illustrated as follows in the geological section:

Fill	-	Hatched pink
Residual Soils	-	Hatched orange
Bedrock Shales	-	Hatched blue

5.2 Groundwater Conditions

Groundwater occurring in the form of strong seepage flows was only encountered within trial holes 4 & 5 at 0,95 and 0,50m depth respectively, soil moisture conditions in the other trial holes ranging from slightly moist to moist.

The groundwater encountered is representative of a temporary seasonal water table with the water perched on the impermeable residual soils and bedrock.

Given the permeable nature of the fill as well as the sloping nature of the terrain, significant subterranean and surface flows can be expected. This can lead to

flooding of excavation trenches if not controlled. Allowance must accordingly be made for the collection and removal of water in the pipe trench excavation.

All designs and solutions required for the construction of the pipeline should be undertaken with due allowance for the fact that during periods of high rainfall, a substantial rise in water head could develop.

5.3 Excavation Conditions

Given the non-cohesive and 'unconsolidated' nature of the fill and the bulk of the residual soils likely to be encountered within the pipe trench excavations, conventional earthmoving equipment will be entirely suitable for the excavation of these soils. In terms of SANS 1200D, the site soils will classify as "Soft" excavation.

The underlying soft rock shales would require significantly more effort to remove requiring heavy excavation plant and hydraulic/pneumatic tools for cost effective removal, this material classifying as "Intermediate" excavation in terms of SANS1200D.

5.4 Materials Utilisation Potential

The following specifications extracted from SANS1200LB are applicable for the materials utilisation potential classification of the various site soils:

Selected Granular Material

Selected Granular Material shall be material of a granular, non-cohesive nature that is singularly graded between 0,6mm and 19mm, is free draining, and has a compactibility factor not exceeding 0,4 or such other value as is laid down in the project specification.

Selected Fill Material

Selected fill material shall be material that has a PI not exceeding 6 and that is free from vegetation and lumps and stones of diameter exceeding 30mm.

Backfill Material

Material excavated from trenches may be used as backfill in all areas, provided only that it contains little or no organic material, that it excludes stone of average dimension exceeding 150mm, and that it can be placed without significant voids and so compacted as to avoid significant settlement. Material containing more than 10% of rock or hard fragments that are retained on sieve of nominal aperture size 50mm, and material containing large clay lumps that do not break up under the action of the compaction equipment being used, will be regarded as unsuitable for use in backfilling.

Based on our observations on site and experience assessing similar soils, none of the site soils can be utilised as either Selected Granular Material, Selected Fill Material or Backfill Material. These soils would accordingly have to be imported from commercial sources.

For reinstatement of trenches, it is important to note that the use of heavy vibratory compaction equipment in close proximity to existing services and structures can trigger consolidation of the subsoils and effect movement. Reinstatement close to existing pipelines, cables, manholes, roads, houses, etc. should accordingly be undertaken in a well-controlled manner with the fill placed in thin layers compacted either by way of light equipment with vibration carefully controlled or alternatively, static rolling using heavier machines.

5.5 Temporary Removal of Groundwater

Whilst the sump-and-pump method of groundwater removal will provide a satisfactory solution along the bulk of the open trenches, there is no doubt that should construction not be programmed for the summer months when groundwater conditions will be most favourable, excessive flooding of trenches will occur. Allowance will thus have to be made for standby/backup pumps at all times and suitable discharge areas identified in advance of construction.

Given the shallow presence of rock, the installation of dewatering well points will

require special percussive equipment the use of which is likely to prove prohibitively expensive.

5.6 Slope Stability Implications for Trenches

The predominantly non-cohesive fill is considered to be of low shear strength. The shear strength is likely to be further compromised under saturated groundwater conditions with the risk of catastrophic collapse of all unfavorably steep excavation sidewalls considered high where cuttings are formed in the fill.

Where battered to 45° (or flatter), adverse collapse of the trench sidewalls will be of limited extent. Of significance however is the fact that where completely saturated, the non-cohesive sands can be expected to flow and slump, *even where battered to 45*°, unless retained. Trenches cut to 45° may accordingly need further support in the form of shoring/sandbags, benching etc. where taken into completely saturated soils at depth.

Although the clayey residual soils are of high cohesion, the structure is shattered to fissured. Care must accordingly be taken when forming excavations in this material. As it is difficult to determine the failure surfaces in the fissured clayey soils it is suggested that the recommendations given for fill also be applied to the clayey residual soils.

The stability of cut slopes in rock will be determined by the inclination and spacing of the discontinuities (bedding planes and joints). The trial hole investigation was unable to determine the orientation and frequency of the discontinuities.

Given the above and the fact that the rock mass was found to be highly fractured locally, it is recommended that excavations cut into the rock be battered to 60 degrees or flatter.

Where space constraints, proximity of roads and servitudes will prevent battering of deep excavation sidewalls, the sidewalls will have to be laterally supported (temporarily).

Allowance will at all times (irrespective of the solution finally adopted) have to be made for the presence of strong groundwater seepages in the permeable portions (fill) of the profile and dewatering solutions implemented accordingly.

The ground vibration generated during construction and the risk of damage to adjoining manholes/services etc., are further issues which will have to be considered when the various trench support solutions are assessed.

It is recommended that the above support solutions and others on offer (such as sheet piling) be discussed and detailed/designed in consultation with a specialist Geotechnical Contractor and that the risk of movement of adjoining manholes/services etc., be carefully considered prior to finalizing the preferred solution(s).

6. CONCLUSIONS AND RECOMMENDATIONS

- The pipe route is located in clayey residual soils and weathered shales of the Bokkeveld Formation. A 0,20 to 0,55m thick layer of highly variable fill mantles the naturally deposited soils.

- Groundwater, in the form largely of a shallow seasonally fluctuating perched water table, can be anticipated at depths of from 0,5m below existing ground level during periods of intense rainfall.

- The fill is of low shear strength. All excavation and trench sidewalls in the fill will accordingly require either battering (to 45° or flatter) or lateral support. The fissured clayey residual soils, although of high cohesion must also be battered to 45º to ensure safe working conditions. The rock can be battered to 60 degrees.

- In terms of materials utilisation, none of the soils encountered on site are suiteable for use as Selected Granular Material, Selected Fill Material and Backfill Material. These soils must be imported from commercial sources.

- The fill and residual soils will classify as “Soft” excavation in terms of SANS1200D whilst the very soft to soft rock will classify as “Intermediate” excavation.

7. GENERAL

The above observations and recommendations are based on the project as described with the assumption that geological conditions will not vary significantly from those encountered during our investigations. Although every effort has been made to ensure the accuracy of the information contained in this report, the results of our investigation are based upon our field work and subsoil profiles exposed in five (5) trial holes. We can not be held responsible if localized soil conditions at variance to those described in the report are encountered.

FOR KANTEY & TEMPLER



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LEGEND

TH1 — Approximate location of Trial Hole

KANTEY & TEMPLER CONSULTING ENGINEERS

CLIENT: WITZENBERG

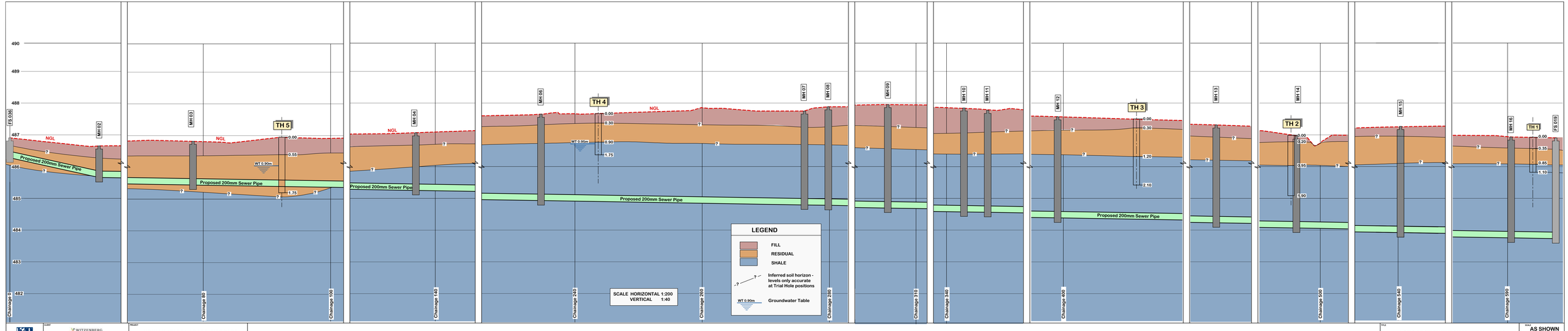
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TITLE: TRIAL HOLE LOCATION PLAN

SCALE: 1:2000

16871GG-01

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KANTEY & TEMPLER CONSULTING ENGINEERS

CLIENT: WITZENBERG

PROJECT: NDULI MAIN SEWER LINK UPGRADE

TITLE: LONG SECTION THROUGH TRIAL HOLES

SCALE: AS SHOWN

16871GG-02

Appendix A

Trial Hole Profiles

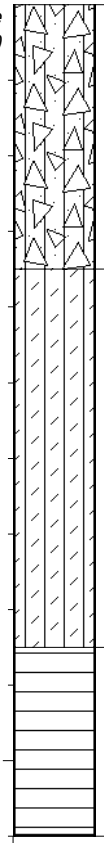
KANTEY & TEMPLER
CONSULTING ENGINEERS

LYNERS
NDULI BULK SEWER, CERES

HOLE No: TH01
Sheet 1 of 1

JOB NUMBER: 16871GG

Scale 1:10



0.00 Slightly moist light brownish olive firm shattered clayey sandy SILT with scattered very soft to soft rock fragments and occasional gravel, plastic and wire; FILL.

0.35 Moist brownish olive to olive yellow and locally light grey mottled reddish orangestiff to very stiff fissured clayey SILT with remnant bedding structure becoming completely weathered vey soft rock shale; RESIDUAL.

0.85 Light olive grey locally dark grey completely to highly weathered jointed very soft to soft rock locally medium hard rock SHALE; BOKKEVELD GROUP.

Completely weathered material tends to be a soil-like stiff clayey silt.

1.10

NOTES

1) No groundwater encountered

2) Refeusal at 1.10m depth.

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Y-COORD :

HOLE No: TH01
MH15/MH16

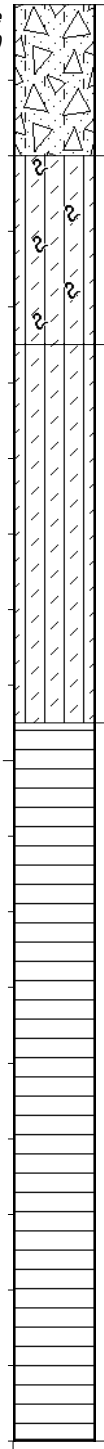
KANTEY & TEMPLER
CONSULTING ENGINEERS

LYNERS
NDULI BULK SEWER, CERES

HOLE No: TH2
Sheet 1 of 1

JOB NUMBER: 16871GG

Scale 1:10



0.00 Moist light brownish orange loose to medium dense slightly silty fine to medium grained SAND with scattered gravel, cobbles occasional posckets of clayey silt, bitumen fragments and plastic; FILL.

0.20 Moist to very moist light olive brown stiff shattered slightly clayey SILT with occasional fine grit and roots; REWORKED RESIDUAL.

0.45 Moist olive brown to greyish olive and locally light grey mottled reddish orangestiff to very stiff fissured clayey SILT with remnant bedding structure becoming completely weathered vey soft rock shale; RESIDUAL.

0.95 Light olive grey locally dark grey completely to highly weathered jointed very soft to soft rock SHALE; BOKKEVELD GROUP.

Completely weathered material tends to be a soil-like stiff clayey silt.

1.90

NOTES

1) No groundwater encountered.

2) Excavation side walls stable.

3) Machine refusal at 1.90m depth.

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PROFILED BY : LC

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DIAM :
DATE :
DATE : 6/09/2023

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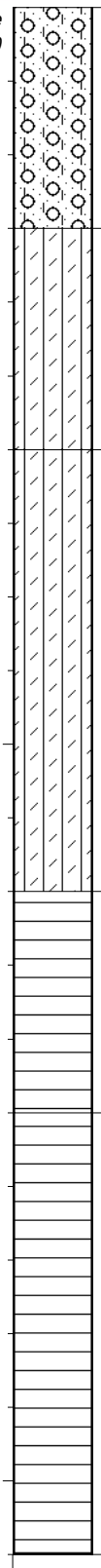
KANTEY & TEMPLER
CONSULTING ENGINEERS

LYNERS
NDULI BULK SEWER, CERES

HOLE No: TH3
Sheet 1 of 1

JOB NUMBER: 16871GG

Scale 1:10



0.00 Orange brown, yellowish orange and black sub-angular GRAVEL with scattered bitumen fragments densely packed in a matrix of dry slightly silty fine to medium grained sand with occasional plastic; FILL.(LAYERWORKS)

0.30 Moist to very moist light olive brown stiff shattered slightly clayey SILT with occasional fine grit and roots; REWORKED RESIDUAL.

Upper 50mm of horizon extensively reworked containing plastic and gravel.

0.60 Moist brownish olive to greyish olive stiff to very stiff fissured clayey SILT with remnant bedding structure becoming completely weathered very soft rock shale; RESIDUAL.

1.20 Light olive grey stained orange brown completely to highly weathered jointed very soft rock SHALE; BOKKEVELD GROUP.

1.50 Light olive grey locally dark grey highly weathered jointed very soft to soft rock SHALE; BOKKEVELD GROUP.

2.10

NOTES

1) No groundwater encountered.
2) Excavation side walls stable.
3) Machine refusal at 2.10m depth.

CONTRACTOR :
MACHINE :
DRILLED BY :
PROFILED BY : LC

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DIAM :
DATE :
DATE : 6/09/2023

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HOLE No: TH3
MH12

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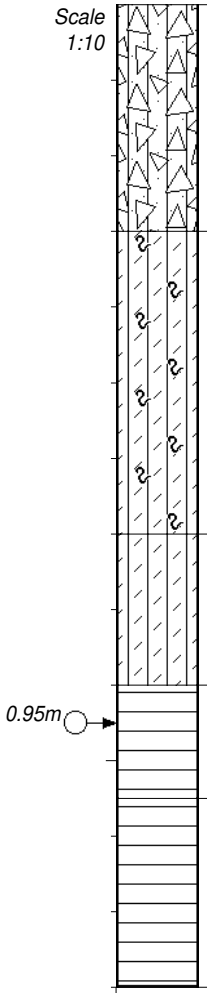
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KANTEY & TEMPLER
CONSULTING ENGINEERS

LYNERS
NDULI BULK SEWER, CERES

HOLE No: TH4
Sheet 1 of 1

JOB NUMBER: 16871GG



0.00 — Moist to very moist dark olive brown to brown firm shattered sandy SILT with scattered gravel, occasional cobbles, boulders (up to 330mm in dia.) occasional pockets of sand, bitumen fragments, roots and plastic; FILL.

0.30 — Very moist olive brown firm shattered clayey SILT with scattered grit and roots; REWORKED RESIDUAL.

0.70 — Very moist light brownish olive becoming light greyish olive blotched to mottled brownish yellow firm to stiff, fissured to shattered clayey SILT with remnant bedding structure locally becoming completely weathered vey soft rock shale; RESIDUAL.

0.90 — Light greyish olive highly weathered highly fractured very soft to soft rock SHALE; BOKKEVELD GROUP.

1.05 — Light olive grey to dark grey highly weathered jointed soft to locally medium hard rock SHALE; BOKKEVELD GROUP.

1.30

NOTES

1) Strong water seepage at 0.95m depth.
2) Excavation side walls only partially stable.
3) Machine refusal at 1.30m depth.

CONTRACTOR :
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DRILLED BY :
PROFILED BY : LC

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DATE :
DATE : 6/09/2023

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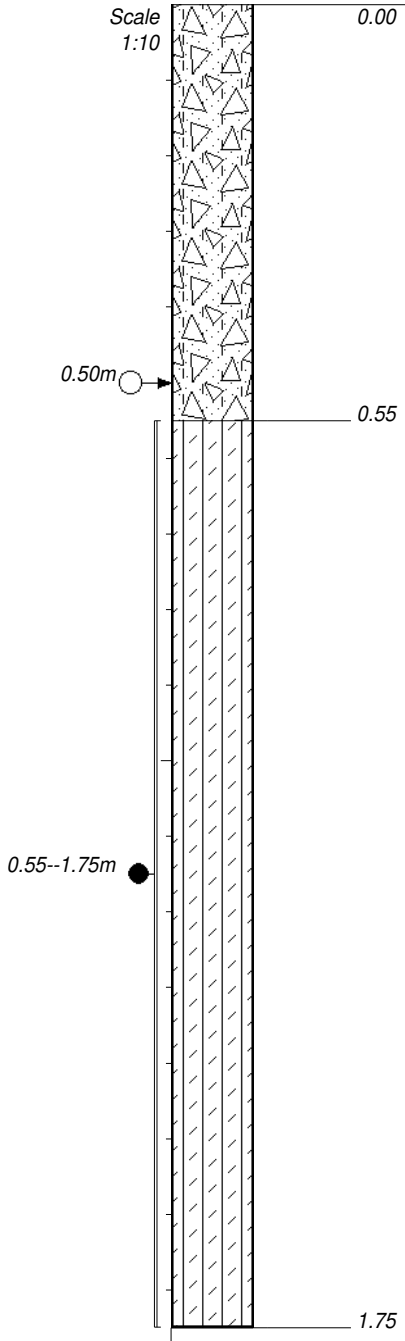
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KANTEY & TEMPLER
CONSULTING ENGINEERS

LYNERS
NDULI BULK SEWER, CERES

HOLE No: TH5
Sheet 1 of 1

JOB NUMBER: 16871GG



Moist to wet olive brown loose silty SAND with scattered gravel, grit occasional bitumen fragments (Up to 400mm in dia.), medium hard rock boulders, lumps of clayey silt with scattered concentrations of roots; FILL.

Very moist light brownish olive becoming light greyish olive blotched to mottled brownish yellow firm to stiff fissured to shattered clayey SILT with remnant bedding structure locally tending to completely weathered vey soft rock shale; RESIDUAL.

NOTES

1) Strong water seepage at 0.50m depth.
2) Disturbed soil sample extracted from 0.55--1.75m deoth.
3) Excavation side walls only partially stable.

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HOLE No: TH5
MH3/MH4

DEPARTMENT LAND REFORM AND RURAL DEVELOPMENT

CONTRACT NO.: SSC WC 01 (2026/2027) DLRRD

THE APPOINTMENT OF A CONTRACTOR FOR THE CONSTRUCTION OF A SEWER AND STORMWATER PIPE IN NDULI, CERES, UNDER WITZENBERG MUNICIPALITY, IN THE WESTERN CAPE PROVINCE

C5: HEALTH AND SAFETY SPECIFICATIONS

safe working practice
OCCUPATIONAL HEALTH AND SAFETY GROUP

Project Health and Safety Specification

In terms of Construction Regulations 2014

Project Client

Witzenberg Municipality

Description of Project Works

Construction of Bulk Sewer and Stormwater Pipelines

Project Location

Nduli, Ceres

Preparation Date

August 2023

Project Health and Safety Specification developed by:

Safe Working Practice Worcester
Tel: 023 342 0332
Cell: 082 323 3911
Email: johnm@safepractice.co.za

PROJECT HEALTH AND SAFETY SPECIFICATION

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1.0 SPECIFIC PROJECT INFORMATION

1. *1 INTRODUCTION AND DEFINITIONS*

THE REQUIREMENTS OF THE CONSTRUCTION REGULATIONS 2014 (AND GUIDANCE NOTES OF 2017) HAVE BEEN IN EFFECT SINCE 7TH AUGUST 2014. THE REGULATIONS PLACE LEGAL DUTIES UPON PRINCIPAL CONTRACTORS AND CONTRACTORS. ALTHOUGH THIS HEALTH AND SAFETY SPECIFICATION INCLUDES MUCH OF THE CONTENT OF THE REGULATIONS, THE CONTRACTOR WILL BE DEEMED TO BE FAMILIAR WITH THE REQUIREMENTS OF THESE REGULATIONS, AND OTHER ASSOCIATED HEALTH AND SAFETY REGULATIONS, AND TO HAVE FACTORED IN ALL THE DUTIES PLACED UPON CONTRACTORS AND PRINCIPAL CONTRACTORS IN THE TENDER. A COPY OF THE REGULATIONS CAN BE VIEWED ON THE DEPARTMENT OF LABOUR'S WEBSITE.

PLEASE NOTE THAT THE TERMS "CONTRACTOR" AND "PRINCIPAL CONTRACTOR" HAVE THE SAME MEANING AS THAT IN THE CONSTRUCTION REGULATIONS AND ARE USED INTERCHANGEABLY IN THIS DOCUMENT, I.E., REFERENCES TO "CONTRACTOR" REFER TO PRINCIPAL CONTRACTOR AND/OR CONTRACTOR AS THE REGULATIONS PERTAIN TO THEIR FUNCTIONS.

This Health and Safety Specification contains clauses that are generally applicable to construction activities, as well as imposing pro-active controls associated with activities that impact on Health and Safety as it relates to work on site. Compliance to the requirements of the Occupational Health and Safety Act 1993 is an additional requirement of this Health and Safety Specification and is part of the Contractor's responsibility. The Client, and/or their agents, will monitor that all Contractors comply with the requirements of such legislation.

ALL REFERENCES TO CLIENT IN THIS HEALTH AND SAFETY SPECIFICATION ALSO REFER TO SAFETY AGENT, WHERE SO APPOINTED.

Definitions (as per the Construction Regulations 2014) applicable to this Health and Safety Specification:

"agent" means a competent person who acts as a representative for a Client;

"angle of repose" means the steepest angle of a surface at which a mass of loose or fragmented material will remain stationary in a pile on the surface, rather than sliding or crumbling away;

"bulk mixing plant" means machinery, appliances or other similar devices that are assembled in such a manner so as to be able to mix materials in bulk for the purposes of using the mixed product for construction work;

"client" means any person for whom construction work is being performed;

"competent person" means a person who has, in respect of the work or task to be performed, the required knowledge, training and experience and, where applicable, qualifications, specific to that work or task: Provided that where appropriate qualifications and training are registered in terms of the provisions of the National Qualification Framework Act, 2000 (Act No.67 of 2000), those qualifications and that training must be regarded as the required qualifications and training; and is familiar with the Act and with the applicable regulations made under the Act;

"construction manager" means a competent person responsible for the management of the physical construction processes and the coordination, administration, and management of resources on a construction site;

"construction site" means a workplace where construction work is being performed;

"construction supervisor" means a competent person responsible for supervising construction activities on a construction site;

"construction vehicle" means a vehicle used as a means of conveyance for transporting persons or material, or persons and material, on and off the construction site for the purposes of performing construction work;
"construction work" means any work in connection with -

- the construction, erection, alteration, renovation, repair, demolition or dismantling of or addition to a building or any similar structure; or
- the construction, erection, maintenance, demolition or dismantling of any bridge, dam, canal, road, railway, runway, sewer or water reticulation system; or the moving of earth, clearing of land, the making of excavation, piling, or any similar civil engineering structure or type of work;

"construction work permit" means a document issued in terms of regulation 3;

"contractor" means an employer who performs construction work;

Note:
a) Includes organisations and or self-employed person that contracts with a client, principal contractor, or a contractor to carry out construction work.

"demolition work" means a method to dismantle, wreck, break, pull down or knock down of a structure or part thereof by way of manual labour, machinery, or the use of explosives;

"design" in relation to any structure, includes drawings, calculations, design details and specifications;

"designer" means a competent person who-

- prepares a design;
- checks and approves a design;
- arranges for a person at work under his or her control to prepare a design, including an employee of that person where he or she is the employer; or
- designs temporary work, including its components;
- an architect or engineer contributing to, or having overall responsibility for a design;
- a building services engineer designing details for fixed plant;
- a surveyor specifying articles or drawing up specifications;
- a contractor carrying out design work as part of a design and building project; or
- an interior designer, shopfitter, or landscape architect;

"ergonomics" means the scientific discipline concerned with the fundamental understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data, and methods to design in order to optimise human well-being and overall system performance;

"excavation work" means the making of any man-made cavity, trench, pit or depression formed by cutting, digging or scooping;

"explosive actuated fastening device" means a tool that is activated by an explosive charge and that is used for driving bolts, nails, and similar objects for the purpose of providing fixing;
"fall arrest equipment" means equipment used to arrest a person in a fall, including personal equipment, a body harness, lanyards, deceleration devices, lifelines, or similar equipment;

“falsework” means a combined system of formwork and support work;

“formwork” means temporary or permanent shutters used to form wet concrete into elements of a structure, and includes both horizontally and vertically placed shutters;

"fall prevention equipment" means equipment used to prevent persons from falling from a fall risk position, including personal equipment, a body harness, lanyards, lifelines or physical equipment such as guard-rails, screens, barricades, anchorages or similar equipment;
"fall protection plan" means a documented plan, which includes and provides for -

- all risks relating to working from a fall risk position, considering the nature of work undertaken;
- the procedures and methods to be applied in order to eliminate the risk of falling; and
- a rescue plan and procedures;

"fall risk" means any potential exposure to falling either from, off or into;
"health and safety file" means a file, or other record containing the information in writing required by these Regulations;

"health and safety plan" means a site, activity or project specific documented plan in accordance with the Client's health and safety specification;

"health and safety specification" means a site, activity or project specific document prepared by the Client pertaining to all health and safety requirements related to construction work;
"material hoist" means a hoist used to lower or raise material and equipment, excluding passengers;

"medical certificate of fitness" means a certificate contemplated in regulation 7(8);

"mobile plant" means any machinery, appliance or other similar device that is able to move independently, and is used for the purpose of performing construction work on a construction site;

"National Building Regulations" means the National Building Regulations made under the National Building Regulations and Building Standards Act, 1977 (Act No. 103 of 1977), and promulgated by Government Notice No. R. 2378 of 30 July 1990, as amended by Government Notices No's R. 432 of 8 March 1991, R. 919 of 30 July 1999 and R. 547 of 30 May 2008;

"person day" means one normal working shift of carrying out construction work by a person on a construction site;

"principal contractor" means an employer appointed by the Client to perform construction work;

"Professional Engineer or Professional Certificated Engineer" means a person holding registration as either a Professional Engineer or Professional Certificated Engineer in terms of the Engineering Profession Act, 2000 (Act No. 46 of 2000);

"Professional Technologist" means a person holding registration as a Professional Engineering Technologist in terms of the Engineering Profession Act, 2000;

"provincial director" means the provincial director as defined in regulation 1 of the General Administrative Regulations, 2003;

"scaffold" means a temporary elevated platform and supporting structure used for providing access to and supporting workmen or materials or both;

"shoring" means a system used to support the sides of an excavation and which is intended to prevent the cave-in or the collapse of the sides of an excavation;

"structure" means:

- any building, steel, or reinforced concrete structure (not being a building), railway line or siding, bridge, waterworks, reservoir, pipe or pipeline, cable, sewer, sewage works, fixed vessels, road, drainage works, earthworks, dam, wall, mast, tower, tower crane, bulk mixing plant, pylon, surface and underground tanks, earth retaining structure, or any structure designed to preserve or alter any natural feature, and any other similar structure;

- any falsework, scaffold or other structure designed or used to provide support or means of access during construction work; or
- any fixed plant in respect of construction work which includes installation, commissioning, decommissioning, or dismantling and where any construction work involves a risk of a person falling;

“support work” means the temporary structure erected to support the formwork before the casting of a concrete element of a structure.

"suspended platform" means a working platform suspended from supports by means of one or more separate ropes from each support;

"temporary works" means any falsework, formwork, support work, scaffold, shoring or other temporary structure designed to provide support or means of access during construction work;

"the Act" means the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993);

"tunnelling" means the construction of any tunnel beneath the natural surface of the earth for a purpose other than the searching for or winning of a mineral.

Tender documents
Drawings

Reference should be made to the following documentation in conjunction with this Safety Specification (including existing surveys, drawings, and reports):
IMPORTANT NOTE:
This Health and Safety Specification has been prepared to comply with the requirements of the Construction Regulations 2014.

1.2 BACKGROUND TO THE HEALTH AND SAFETY SPECIFICATION

Historically, the Construction Industry has had a poor health and safety record. Due to the complex and potentially dangerous operations being undertaken, there is a high risk of incidents, accidents, and injuries. In many instances poor adherence to the Act and Regulations has resulted in severe consequences for Health and Safety performance. The Client is determined that the highest Health and Safety standards will prevail throughout the Contract and that there will be full commitment from all parties involved.

To achieve this goal the Client has arranged for the preparation of this Health and Safety Specification. The Health and Safety Specification sets out guidelines and minimum levels of awareness and guidance for Health and Safety requirements for the project. Contractual responsibility for adhering to these requirements rests with the Contractors. All employees are encouraged to be pro-active in compliance.

The Client is committed to ensuring the highest Health and Safety standards for all work undertaken within the Contract.

Contractors as employers are fully responsible and accountable for compliance with all Health and Safety requirements.

IMPORTANT NOTE:

Compliance with the Occupational Health and Safety Act and Regulations shall not be limited to this Health and Safety Specification and definitions contained in this document.

Contractors shall be conversant with the requirements and effects of Health and Safety legislation upon their activities, in particular the Construction Regulations, 2014, and the Occupational Health and Safety Act, 1993, and to have made

adequate resource in their tender submission to comply with all legislative requirements.

Failure to comply with the requirements of this Safety Specification will result in severe sanction and the severity of the sanction will depend on the severity of the non-compliance.

The Contractor's personnel will be responsible for the auditing of the implementation of the Health and Safety Specification and maintaining the document control and record systems associated with the Health and Safety Specification. The Client will arrange for Health and Safety audits to be conducted on site on their behalf to monitor health and safety compliance by contractors.

1.3 PURPOSE OF THE HEALTH AND SAFETY SPECIFICATION

The purpose of this site-specific Health and Safety Specification is to comply with legal requirements and to provide health and safety information about specific project risks known by the Client, Designer and Safety Agent to be applicable to this project. This document also provides minimum health and safety requirements, standards, and expectations that the contractor must adhere to.

The Contractor must take into account all information in this specification and ensure that their tenders include adequate resource and competence to deal with the matters detailed herein so that all relevant contents are dealt with in a way which is in compliance with legislation and the ethical concerns for the safeguarding of employees, contractors and other persons affected by the construction activities. Please note that a detailed OHS bill of quantities must be provided by the contractor on all Construction Work Permit projects. The Bill of Quantities will form part of the Construction Work Permit application presented to Department of Labour for approval.

The Health and Safety Specification will be implemented during construction of the works and any construction activity that the Client has control over.

This will also assist in ensuring that all the costs related to the compliance with Occupational Health Act 85 of 1993 and the Construction Regulations 2014, as well as this Health and Safety Specification, are taken into consideration at Tender stage.

No advice, approval of any document required by the Health and Safety Specification such as hazard identification and risk assessment action plans or any other form shall be construed as an acceptance by the Client of any obligation that absolves the Contractor from achieving the required level of performance and compliance with legal requirements.

Further, there is no acceptance of liability by the Client which may result from the Contractor failing to comply with the Health and Safety Specification unless the Client has issued an instruction to any requirement, i.e., the Contractor remains responsible for achieving the required performance levels.

1.4 IMPLEMENTATION OF THE HEALTH AND SAFETY SPECIFICATION

This Health and Safety Specification forms an integral part of the Contract, and Contractors shall make it an integral part of their Contracts with other Contractors and Suppliers. Contractors employed by the Client are to ensure that the provisions of the Health and Safety Specification are applied both on the site and in respect of all off site activities relating to the project, in particular in transport activities and project dedicated off site fabrication works.

The Contractor shall enforce the provisions of the Health and Safety Specification amongst all Contractors and suppliers for the project.

The Contractor shall sign the acknowledgment on the last page of this safety specification that he/she has familiarised him/herself with the content of the Health and Safety Specification and shall comply with all obligations in respect thereof.

The successful Contractor will be required to compile a Health and Safety Plan based on the requirements of the Occupational Health Act 85 of 1993 and these Specifications, which will need to be approved by Client (or their appointed safety agent) prior to commencement with construction work.

1.4.1 Client Duties

In terms of the Construction Regulations 2014 the Client (or their Agent, where appointed) has legal duties. Where an Agent (refer to "definitions" section of this document) is appointed in terms of this project, these Health and Safety duties assigned will also apply.

All references to "Client" will apply to their appointed "Safety Agent", where so appointed, in this Health and Safety Specification.

The Client must:

- Prepare a baseline risk assessment for the construction work
- Prepare a suitable, sufficiently documented, and coherent site-specific Health and Safety specification for the intended construction work, based on the baseline risk assessment
- Include the health and safety specification in the tender documents
- Ensure that potential principal contractors submitting tenders have made adequate provision for the cost of health and safety measures
- Ensure that the principal contractor to be appointed has the necessary competencies and resources to carry out the construction work safely
- Take reasonable steps to ensure co-operation between all contractors appointed by the Client to enable each of those contractors to comply with the regulations
- Ensure, before work commences, that every principal contractor is registered and in good standing with the compensation fund, or with a licensed compensation insurer as contemplated in the Compensation for Occupational injuries and Diseases Act, 1993 (Act no 130 of 1993)
- Appoint each principal contractor in writing for the project, or part thereof
- Discuss and negotiate with the principal contractor the contents of the principal contractor's safety plan and thereafter finally approve that plan for implementation
- Ensure that a copy of the principal contractor's health and safety plan is implemented and maintained
- Ensure that periodic health and safety audits and document verification are conducted at intervals mutually agreed upon between the principal contractor and any contractor, but at least once every 30 days
- Ensure that a copy of the health and safety audit report is provided to the principal contractor within 7 days after the audit
- Stop any contractor from executing a construction activity which poses a threat to the health and safety of persons which is not in accordance with the principal contractor's health and safety plan for site
- Where changes are brought about to the design or construction work, make sufficient health and safety information and appropriate resources available to the principal contractor to execute the work safely
- Ensure that the health and safety file is kept and maintained by the principal contractor.
- Where the Client requires additional work to be performed as a result of a design change or error in construction due to the actions of the Client, the Client must ensure that sufficient safety information and appropriate additional resources are available to execute the required work safely.

- Where more than one principal contractor is appointed, the Client must take reasonable steps to ensure co-operation between all principal contractors and contractors to ensure compliance with the Regulations
- Where the Client has appointed a Safety Agent for the project, their details for this project are contained in the Project Directory section of this health and safety specification.

1.4.2 Designer Duties

It must be noted that the Designer also has Health and Safety duties assigned in terms of the Construction Regulations. Where the contractor fulfils a design function in terms of this project (refer to “definitions” section of this document), these duties will also apply. Please refer to Regulation 6 of the Construction Regulations 2014.

Please note that the designer of temporary works must ensure that:

- all temporary works are adequately designed so that it will be capable of supporting all anticipated vertical and lateral loads that may be applied;
- the designs of temporary works are done with close reference to the structural design drawings issued by the contractor, and in the event of any uncertainty consult the contractor;
- all drawings and calculations pertaining to the design of temporary works are kept at the office of the temporary works designer and are made available on request by an inspector; and
- the loads caused by the temporary works and any imposed loads are clearly indicated in the design.

1.5 PROJECT DIRECTORY		
Project Client	Witzenberg Municipality	**Company Tel:** 023 316 1854
Project Manager **Contact Person**	Neil Lyners & Associates 23 Patriot St, Hoog-En-Droog, Paarl, 7646 Derick Carosini	**Company Tel:** 021 872 0622
Consulting Engineer **Contact Person**	MNE Oak 22 Andries Pretorius Street Oakdale Cape Town, 7530 Thinus Brink	**Company Tel:** 021 300 3224
Construction Safety Agent **Contact Person**	Safe Working Practice Worcester 14b Bergsig Avenue Worcester, 6850 John McGregor	**Company Tel:** 023 342 0332

OTHER PARTIES DIRECTORY	
Department of Labour for submission of Annexure 2: Notification of Construction Work WESTERN CAPE – Fezeka Ngalo	**Tel:** 021 441 8158 **e-mail:** fezeka.ngalo@labour.gov.za
Department of Labour 90a Durban Street, Worcester 9850 Khayalethu Songelwa	**Tel:** 023 346 5200 khayalethu.songelwa@labour.gov.za

Telecommunications Contractor to refer all queries on location and nature of existing services to the Project Manager / Client, etc. **OR** Contractor to apply for and refer to wayleave information from service providers for the nature and location of services. Refer all queries Project Manager. **Company:** Telkom	**Company Tel:** 10210
Water **Company:** Witzenberg Municipality	**Company Tel:** 023 316 1997 / 8
Electricity **Company:** Witzenberg Municipality	**Company Tel:** 023 316 1997 / 8

1.6 PROJECT DETAILS

Description of Works

This description of the works is not necessarily complete and shall not limit the work to be carried out by the Contractor under this Contract.
The scope of works are as follows:

(a) The construction of a bulk sewer of approximately 550 m length of 200 mm diameter uPVC pipes and manholes.

(b) Connections of existing sewers into the new bulk sewer.

(c) The construction of a stormwater pipe of approximately 505 m length of 600 mm diameter reinforced concrete pipes, manholes and outlet structures.

(d) The replacement of existing sewer manhole covers and frames with lockable covers and frames.

The maximum depth of the pipework is 3.5 m

Anticipated Construction Duration
3 months

Provisional Start Date
October 2023

Provisional Completion Date
December 2023

Construction Work Permit Required for the Project?
No

1.7 EXISTING ENVIRONMENT

Hazards particular to this project by virtue of location:
WM employees, members of the public. Extreme cold and / or heat, depending on the season. Civil unrest.

Overhead, Above Ground and Underground Services crossing the site:

Overhead: To be confirmed on site

Underground: Water and sewer lines; electricity lines; Telkom lines

Ground level: Roads, pavements, buildings

Service Drawings available: Refer to Engineer

Wayleaves required: Yes, refer to municipality and Telkom, as and where applicable

Permits required: No

Isolations required: Yes, connection of sewer and water lines

Existing structures on site and surrounding land use (with a significant impact on Health & Safety):
Houses
Farms, immediately adjacent to Nduli

Existing ground conditions and ground survey report:
Refer to engineer

Existing Traffic Systems

Condition: Good municipal roads; tarred and gravel

Restrictions to access: None

Speed restrictions: 60km/h, or as indicated by the local authorities

1.8 AVAILABLE DRAWINGS

Refer to tender documentation.

1.9 PROJECT HEALTH AND SAFETY REQUIREMENTS

Significant health and safety hazards identified by Client, Designer and Safety Agent:

Excavations
Fire
Hazardous Substances
Members of Public
Snakes
Working with Effluent

Other construction hazards that the contractor can reasonably expect are as follows:

Bricklaying
Compacting and Filling
Compactor Operations
Hand tools
Manhole Rings and Pipes Storage
Manual Handling of General Items
Noise and Dust
Plant/Vehicle and Equipment Operation
Plastering
Skipping of Concrete
Steel Fixing

NOTE: Please refer to end of this Health and Safety Specification for the baseline risk assessment for these hazards and risks.

ACTIVITIES REQUIRING APPROVED METHOD STATEMENTS

N/A

ACTIVITIES REQUIRING PERMITS (FOR HEALTH AND SAFETY PURPOSES)

N/A

CONTRACTOR SAFETY OFFICER PROVISION

Records of safety audits undertaken by the Contractor's Safety Officer must be kept on site in the safety file and non-conformances reported by the Safety Officer to the Contractor's management team. All non-conformances identified by the Safety Officer and Client's Safety Agent must be investigated and corrective action taken by the Contractor to prevent re-occurrence.

Please note that as from 7th August 2018 the safety officer must be professionally registered with the SACPCMP. Proof of registration with the SACPCMP must be provided.

If registered as a Candidate proof of mentorship and weekly visits by mentor must be available on site.

The requirement for this site is that a part time Safety Officer be appointed by the Contractor. Part time Safety Officer must visit site at least monthly.

MEDICAL CERTIFICATE OF FITNESS (ANNEXURE 3)

The contractor must ensure that their employees on site have a valid medical certificate of fitness, specific to the construction work being performed, issued by an occupational health practitioner in the form of an Annexure 3 template.

MANAGEMENT AND SUPERVISION OF CONSTRUCTION WORK

A principal contractor must, in writing, appoint one full-time competent person as the construction manager with the duty of managing all the construction work on a single site, including the duty of ensuring occupational health and safety compliance, and in the absence of the construction manager an alternate competent person must be appointed by the principal contractor. Proof of an all-inclusive assessment by the Principal Contractor of the Construction Manager's Competency in construction management and health and safety competency must be available in the Safety File.

The Construction Manager, Alternate Construction Managers, Assistant Construction Managers, and designated construction supervisor/s must, as a minimum, have training in Legal Liability, Construction Regulation 2014 and the OHS Act and Regulations.

TRAFFIC MANAGEMENT AND TRAFFIC SAFETY OFFICER PROVISION

The Traffic Management Plan must be approved by the Project Manager and as required, the Traffic Chief as per the National Road Traffic Act, No. 93 of 1996. The Traffic Safety Officer must have training as per Unit Standard 14561 or similar.

ENVIRONMENTAL CONDITIONS

Contractor must take into account adverse weather conditions on site activities and implement control measures to mitigate risk. This includes risk of exposure to excessive heat, cold, rain, lightning, and wind.
The open nature of the site works will not preclude any of the above.

ARRANGEMENTS FOR ACCESS, PARKING, DELIVERIES, ETC.

Access to site by Construction Vehicles: Municipal Roads

Access to site by Construction Workers and Visitors: Municipal Roads

All service providers must sign a 37.2 Mandatory Agreement and must be inducted before they can be allowed on site.

ARRANGEMENTS FOR SITE CAMP, ABLUTIONS AND YARD

Site camp location and set up

- **Restrictions / requirements:**
- **Storage areas:**
- **Security:**

} Contractor to advise in consultation with Engineer / Professional Team

Ablutions and Welfare Arrangements

Contractor to supply ablutions and facilities in line with the Construction Regulations 2014, refer to section 2.31 of this health and safety specification regarding the below. Toilets should be provided with built in facilities for hand washing.

- **Toilets:**
- **Washing facilities:**
- **Drinking Water:**
- **Shelter:**
- **Showers:**

} Contractor to provide as per Regulations

Mobile site facilities requirements:

A camping toilet/mobile toilet will be required for sites that cannot facilitate a permanent location for ablution units and must be available for each gender per location.

The use of a camping toilet must be prepared and set-up correctly with additional anchors and available toiletries prior to each working day and to be first priority when changing location of works along a set working path.

Teams are to ensure that the toilets are cleaned correctly and suitable for easy and hygienic uses and recorded on a daily register.

PROTECTION OF SITE AGAINST UNAUTHORISED ACCESS BY PUBLIC

Excavation Fencing: Note that excavations accessible to public, or adjacent to public roads / thoroughfares, must have (1) barrier / fence of at least 1m in height, and (2) warning illuminants at night or when visibility is poor, or have other suitable precautionary measures if of both these are not practicable.

General Fencing of Site: Note that construction sites in built up areas adjacent to public walkway must be fenced off and have controlled access points with the correct signs to indicate the site office for any relevant enquiries.

Warning Notices: "Danger – Construction Site", "Danger – Open Excavations". "Report to Site Management", signs indicating PPE required, position of fire extinguishers and first aid box; any other signs that may be required and / or indicated by the safety agent.

Look Outs: n/a

PERSONAL PROTECTIVE EQUIPMENT (PPE)

The Client requires the Contractor to ensure that employees (and others under his/her control) wear the following minimum PPE:

Overalls: Yes

Reflective Vests: Yes

Hard Hats: Yes

Goggles / gloves / ear defenders / respiratory protection: Task specific

Safety Footwear: Yes

Specialist Equipment: As identified by the contractor's risk assessment; task specific

Note: Every employer must check regularly on the websites of the National Department of Health (www.health.gov.za), National Institute of Communicable Diseases (www.nicd.ac.za) and the National Institute for Occupational Health (www.nioh.ac.za) whether any specialised PPE for COVID-19 is required or recommended in any guidelines based on the nature of the workplace or the nature of the duties and the associated level of risk.

HAZARDOUS SUBSTANCES

The following materials and substances have, or may have, to be used in the works and are identified as potentially posing special health and / or safety hazards during the project. Appropriate measures will need to be specified for their control:
Cement, petrol, diesel, oils

1.10 INTERFACE AND RESTRICTIONS BY CLIENT

Contractor must note that the following Client activities will continue during construction: Use of public roads

The following Client safety rules and/or requirements are to be observed:
All workers are to receive induction prior to commencement of work on site.

Other safety rules and requirements to be advised at induction.
Please also refer to tender document.

Restrictions on times, access, or other restrictions by Client
Please refer to tender document.
Other restrictions may be advised at induction.

1.11 PROJECT CLOSE OUT

The Health and Safety files for the Principal Contractors and all Contractors require closure and handover to the Client at the completion of the project in the form of a consolidated safety file. The following list is an example of what should be included but is not exhaustive. The Safety Agent or the Client may require further information at the time of completion and the Principal Contractor is to ensure that all instructions are responded to. Documentation would include all health and safety related records from the start of the project. All records to be in hard copy or electronic format and submitted to the Safety Agent for approval in adequately formatted lists and folders. Layout should be logical and in the same order as in the site files.

Consolidated Health and Safety close out file requirements include:

- Health and safety specification (most recent version)
- Principal Contractor's health and safety plan/s
- Site safety organograms
- Legal appointments - All OHS appointments to be cancelled at project completion
- Notification to Department of Labour of commencement of work / Construction Work Permit
- Workman's Compensation Letters of Good Standing for the project
- Full safety files for all contractors as well as their close out reports
- List of all contractors who worked on site
- Letters of safety plan approval of contractors by the Principal Contractor
- Mandatory agreements (section 37.2 agreements)
- Incident and accident records / Occupational Disease records
- Contractor Non-conformance records
- Safety agent's audit reports
- Safety Officer reports
- Method Statements
- Risk assessments
- Safe work procedures
- Medical surveillance certificates of fitness. Medical records are to be kept according to the Occupational Health and Safety Act, as amended.
- All temporary works drawings (suspended beams/scaffolds, etc.)
- Copies of test results, policies, and procedures for environmental monitoring (silica, noise, dusts, etc.)
- Detailed registers of all material used
- Copies of all Checklists completed

1.12 SAFETY FILE RETURN TO CLIENT

The consolidated Health and Safety Files for the Project is to be handed over by the Principal Contractor to the Client upon Project Completion in either hard copy or electronic format.

2.0 FURTHER REQUIREMENTS

2.1 Duties of Principal Contractor / Contractor in terms of Construction Regulations 2014

A Principal Contractor must:

- provide and demonstrate to the Client a suitable, sufficiently documented and coherent site-specific health and safety plan, based on the Client's documented health and safety specifications, *which* plan must be applied from the date of commencement of and for the duration of the construction work and which must be reviewed and updated by the principal contractor as work progresses;

- open and keep on site a health and safety file, which must include all documentation required in terms of the Act and these Regulations, which must be made available on request to an inspector, the Client, the Client's Safety Agent, or a Contractor; and

- on appointing any other contractor, in order to ensure compliance with the provisions of the Act -

    - provide contractors who are tendering to perform construction work for the principal contractor, with the relevant sections of the health and safety specifications pertaining to the construction work which has to be performed;

    - ensure that potential contractors submitting tenders have made sufficient provision for health and safety measures during the construction process;

    - ensure that no contractor is appointed to perform construction work unless the principal contractor is reasonably satisfied that the contractor that he or she intends to appoint, has the necessary competencies and resources to perform the construction work safely;

    - ensure prior to work commencing on the site that every contractor is registered and in good standing with the compensation fund or with a licensed compensation insurer as contemplated in the Compensation for Occupational Injuries and Diseases Act, 1993;

    - appoint each contractor in writing for the part of the project on the construction site

    - take reasonable steps to ensure that each contractor's health and safety plan is implemented and maintained on the construction site;

    - ensure that the periodic site audits and document verification are conducted at intervals mutually agreed upon between the principal contractor and any contractor, but at least once every 30 days;

    - stop any contractor from executing construction work which is not in accordance with the Client's health and safety specifications and the principal contractor's health and safety plan for the site or which poses a threat to the health and safety of persons;

- where changes are brought about to the design and construction, make available sufficient health and safety information and appropriate resources to the contractor to execute the work safely;

- discuss and negotiate with the contractor the contents of their health and safety plan and finally approve that plan for implementation;

- ensure that a copy of both the principal contractor and contractor's health and safety plan is available on request to an employee, an inspector, a contractor, the Client, or the Client's Safety Agent;

- hand over a consolidated health and safety file to the Client upon completion of the construction work, to include a record of all drawings, designs, materials used and other similar information concerning the completed structure;

- in addition to the documentation required in the health and safety file include and make available a comprehensive and updated list of all the contractors on site accountable to the principal contractor, the agreements between the parties and the type of work being done;

- 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.

A contractor must prior to performing any construction work-

- provide and demonstrate to the principal contractor a suitable and sufficiently documented health and safety plan, based on the relevant sections of the Client's health and safety specification and provided by the principal contractor, which plan must be applied from the date of commencement of and for the duration of the construction work and which must be reviewed and updated by the contractor as work progresses;

- open and keep on site a health and safety file, which must include all documentation required in terms of the Act and these Regulations, and which must be made available on request to an inspector, the Client, the Client's Safety Agent or the principal contractor;

- before appointing another contractor to perform construction work be reasonably satisfied that the contractor that he or she intends to appoint has the necessary competencies and resources to perform the construction work safely;

- co-operate with the principal contractor as far as is necessary to enable each of them to comply with the provisions of the Act;

- as far as is reasonably practicable, promptly provide the principal contractor with any information which might affect the health and safety of any person at work carrying out construction work on the site, any person who might be affected by the work of such a person at work, or which might justify a review of the health and safety plan.

Where a contractor appoints another contractor to perform construction work, the duties that apply to the principal contractor will apply to the contractor as if he or she were the principal contractor.

A principal contractor must take reasonable steps to ensure co-operation between all contractors appointed by the principal contractor to enable each of those contractors to comply with these Regulations.

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 and such records must be made available on request to an inspector, the Client, the Client's Safety Agent or the Principal Contractor.

A 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 (a template of which can be found in the Construction Regulations, 2014).

2.2 *Management and Supervision of Construction Work*

A principal contractor must, in writing, appoint one full-time competent person as the construction manager with the duty of managing all the construction work on a single site, including the duty of ensuring occupational health and safety compliance, and in the absence of the construction manager an alternate must be appointed by the principal contractor. Proof of all-inclusive assessment of the Construction Manager's Competency in construction management and H & S competency must be available in the Safety File. The Construction Manager must, as a minimum, have a Construction Regulation course. No contractors may be left unsupervised on site by the principal contractor.

A principal contractor must upon having considered the size of the project, in writing appoint one or more assistant construction managers for different sections thereof: Provided that the designation of any such person does not relieve the construction manager of any personal accountability for failing in his or her management duties in terms of this regulation.

Where the construction manager has not appointed assistant construction managers, or, in the opinion of an inspector, a sufficient number of such assistant construction managers have not been appointed, that inspector must direct the construction manager in writing to appoint the number of assistant construction managers indicated by the inspector, and those assistant construction managers must be regarded as having been appointed.

No construction manager appointed in terms of the Regulations may manage any construction work on or in any construction site other than the site in respect of which he or she has been appointed.

A contractor must, after consultation with the Client and having considered the size of the project, the degree of danger likely to be encountered or the accumulation of hazards or risks on the site, appoint a full-time or part-time construction health and safety officer in writing to assist in the control of all health and safety related aspects on the site: Provided that, where the question arises as to whether a construction health and safety officer is necessary, the decision of an inspector is decisive.

No contractor may appoint a construction health and safety officer to assist in the control of health and safety related aspects on the site unless he or she is reasonably satisfied that the construction health and safety officer that he or she intends to appoint is registered with a statutory body approved by the Chief Inspector and has necessary competencies and resources to assist the contractor

A construction manager must in writing appoint construction supervisors responsible for construction activities and ensuring occupational health and safety compliance on the construction site. Proof of all-inclusive assessment of the Construction Supervisor's competency in construction supervision and H&S competency must be available in the Safety File. The Construction Supervisor must, as a minimum, have a supervision course as per Unit Standard 262845 (Civil Engineering), 119080 (Building Construction) and 262884 (Civil Engineering).

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,

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 such employee does not relieve the construction supervisor of any personal accountability for failing in his or her supervisory duties.

Where the contractor has not appointed such an employee, or, in the opinion of an inspector, a sufficient number of such employees have not been appointed, that inspector must instruct the employer to appoint the number of employees indicated by the inspector.

No construction supervisor appointed may supervise any construction work on or in any construction site other than the site in respect of which he or she has been appointed: Provided that if a sufficient number of competent employees have been appropriately designated on all the relevant construction sites, the appointed construction supervisor may supervise more than one site.

2.3 Notification of Intention to Commence Construction Work

The Contractor shall notify the Provincial Director of the Department of Labour of the intention to commence construction work at least 7 days prior to the works commencing if the intended construction work will:

- Include excavation work
- Include work at height where there is a risk of falling
- Include the demolition of a structure, or
- Include the use of explosives to perform construction work.

If the construction work involves construction of a single storey dwelling for a Client, and such Client will be residing in such dwelling upon completion, the contractor must also notify the Provincial Director of the Department of Labour at least 7 days before the works commence.

This must be done on a form similar to an Annexure 2 (template of which can be found in the Construction Regulations, 2014). A copy of the notification letter to the Provincial Director shall be forwarded to the Client for record purposes.

2.4 Construction Work Permit

Not applicable to this project.

2.5 Assignment of Contractor's Responsible Persons to Manage Health and Safety on Site

The Contractor shall submit management and supervisory appointments as well as any relevant appointments in writing (as stipulated by the Construction Regulations 2014 and the Occupational Safety and Health Act 1993), prior to commencement of work (refer to **Annexure B** at the end of this Health and Safety Specification).

2.6 Competency for Contractor's Responsible Persons

The Contractor's responsible persons shall be competent in health and safety and be familiar with the Occupational Health and Safety Act 1993, and applicable regulations. Valid proof of pertinent health and safety courses attended by such persons will be required to be presented to the Client.

2.7 Compensation of Occupational Injuries and Diseases Act 130 of 1993 (COIDA)

The successful Contractor shall submit to the Client a valid letter of good standing with the Compensation Insurer prior to appointment.

2.8 *Occupational Health and Safety Policy*

The Contractor shall submit their Health and Safety Policy, prior to construction commencement, signed by the Chief Executive Officer. The Policy must outline objectives and how they will be achieved and implemented within the company operations. The Policy must be communicated to all employees and proof thereof must be available in the Safety File.

2.9 Health and Safety Organogram

The Contractor shall submit an organogram, prior to construction commencement, outlining the Health and Safety Site Team that will be assigned to the project, if successful with the tender. In cases where appointments have not been made, the organogram shall reflect the position. The organogram shall be updated when there is a change in the site team.

2.10 Risk Assessments

Baseline Risk Assessment

The Client shall cause a baseline risk assessment to be conducted by a competent person before the design process and tender process commence, and the assessed risks shall form part of the health and safety specifications.

The Contractor must, before commencement of any construction work, and during construction work, have risk assessments performed by a competent person appointed in writing, which risk assessments form part of the health and safety plan to be applied on the site and must include:

- The identification of the risks and hazards to which persons may be exposed to;
- An analysis and evaluation of the risks and hazards identified; based on a documented method
- A documented plan and applicable safe work procedures to mitigate, reduce or control the risks and hazards that have been identified;
- A monitoring plan; and
- A review plan

The Contractor must ensure that, as far as is reasonably practicable, ergonomic related hazards are analysed, evaluated, and addressed in a risk assessment.

The Contractor must ensure that all employees under his control are informed, instructed, and trained by a competent person regarding any hazard and the related work procedures and/or control measures **before any work commences** and thereafter **at the times determined in the risk assessment monitoring and review plan of the relevant site.**

The Principal Contractor must ensure that all contractors are informed regarding any hazard that is stipulated in the risk assessment **before any work commences** and thereafter **at the times determined in the risk assessment monitoring and review plan of the relevant site.**

The Contractor must consult with the health and safety committee or with a representative trade union or representative group of employees if no health and safety committee exists, on the monitoring and review of the risk assessments for the site.

The Contractor must ensure that copies of risk assessment for this site are available on site for inspection purposes by interested parties (inspector, the Client, Client's Safety Agent, any contractor, any employee, a representative trade union, a health and safety representative or safety committee member.

A Contractor must review the relevant risk assessment where changes are effected to the design and/or construction that result in a change to the risk profile, or when an incident has occurred.

Preventative measures must first address the elimination of the hazard or risk. Should PPE be required to reduce risk, the equipment or clothing to be used must be SABS approved.

In general, the Contractor must ensure that the Risk Assessment involves identifying the hazards present in a work activity on site. This is followed by an evaluation of the extent of the risk involved taking into account those precautions already being taken.
The following general principle should be followed when conducting a risk assessment:

- All relevant risks and/or hazards should be systematically addressed;
- The risk assessment should address what actually happens in the workplace during the work activity;
- All employees and those who may be affected must be considered, including maintenance staff, security guards, visitors, and Contractors;
- The risk assessment should highlight those groups and individuals who may be required to work alone or who have disabilities;
- The risk assessment process should take into account the existing safety measures and controls.
- The level of detail on a risk assessment should be appropriate to the level of risk.

2.11 Health and Safety Representative(s)

The Contractor shall ensure that Health and Safety Representative(s) is/are elected and trained to carry out his / her functions. The Safety Representative(s) must be democratically nominated, elected, and appointed in writing. The Health and Safety Representative(s) shall carry out regular inspections, keep records and report to the supervisor to take appropriate action. The Safety Representative(s) shall attend Health and Safety Committee Meetings. The Health and Safety Representative shall be part of the team that will investigate incidents, accidents, and non-conformances. The Safety Representative(s) must be (a) full time employee(s) who is/are acquainted with conditions and activities at that workplace or section thereof. The Safety Representatives must have Safety Representative training and must be capable of performing their duties.

2.12 Health and Safety Committee

Where two or more health and safety representatives have been appointed on site, the Contractor shall ensure that monthly health and safety meetings are held with such representatives and minutes are kept on record. Meetings must be organized and chaired by the Contractor's Health and Safety Committee Chairperson. Minutes of these meetings must be available for the employees of the contractor to refer to.

PLEASE NOTE THAT THE SAFETY AGENT MAY REQUIRE THAT THE PRINCIPAL CONTRACTOR CONVENES A SAFETY COMMITTEE MEETING ON SITE IN THE INTERESTS OF HEALTH AND SAFETY ON SITE. SUCH COMMITTEE MEETING MAY REQUIRE ATTENDANCE OF CONTRACTORS SAFETY OFFICERS/SAFETY REPRESENTATIVES, CONSTRUCTION SUPERVISION AND THE SAFETY AGENT.

2.13 Medical Certificate of Fitness

The contractor must ensure that their employees on site have a valid medical certificate of fitness, specific to the construction work being performed, issued by an occupational health

practitioner in the form of an Annexure 3 template (refer to the Construction Regulations 2014 on the Department of Labour website for a sample of this form).

Employees required to perform work at heights or from fall risk position must be medically fit to perform such work, such employee's medicals must specify “Fall Risk” or “Working at heights” in the exposure section of the annexure 3 template.

2.14 Health and Safety Training

The Contractor shall quarterly conduct a training needs analysis to ascertain what health and safety training is required. A plan of action should be devised and forwarded to the Client for records. Once the identified people have attended the training, the Contractor must provide the Client with copies of certificates obtained.

2.14.1 Induction

No Contractor may allow or permit any employee or person to enter site unless they have undergone health and safety induction training pertaining to the hazards prevalent on site at the time of entry. This includes visitors to site. The Contractor must ensure that visitors to site have the necessary protective equipment (PPE). A copy of attendance registers of all employees who attend inductions shall be kept.

2.14.2 Awareness

The Contractor shall conduct periodic toolbox talks on site, weekly or before any hazardous work takes place. The talks shall cover the relevant activity and an attendance register must be signed by all attendees. This record of who attended and the content of the topic will be kept on the site health a safety file as evidence of training.

2.15 Competency

After the Contractor has identified the training to be conducted as part of the competency requirement, and based on Risk Assessment, he shall send the relevant persons on appropriate courses and keep certificates of training for reference. Familiarity with the Health and Safety Act and Regulations is an integral part of the definition of competence. All training must be conducted by an accredited training provider and the certificates must display the applicable unit standards and the expiry dates thereof.

2.16 General Record Keeping

The Contractor shall keep and maintain Health and Safety records to demonstrate compliance with the Health and Safety Specification and the Occupational Health and Safety Act. The contractor shall ensure that all records of incidents, spot fines, training, etc. are kept on site. All documents shall be available for inspection by the Client, or the Department of Labour’s Inspectors.

2.17 General Inspection, Monitoring and Reporting

The Contractor shall carry out inspections as required by this Health and Safety Specification, as well as by health and safety legislation.

2.18 Emergency Procedures

The Contractor shall submit a detailed Emergency Procedure for approval by the Client prior to commencement on site. The procedure shall detail the response plan including the following:

- List of key personnel;
- Details of emergency services;
- Actions or steps to be taken in the event of the emergency; and
- Information on hazardous materials / situations, including each material's hazardous potential impact or risk on the environment or human and measures to be taken in the event of an accident.

Emergency procedure(s) shall include, but shall not be limited to, fire, spills, accidents to employees, use of hazardous substances, dangers as a result of riot / service delivery protests / intimidation, etc. The Contractor shall advise the Client in writing of any on-site emergencies, together with a record of action taken, within 24 hours of the emergency occurring. A contact list of all service providers (Fire Department, Ambulance, Police, Medical and Hospital, etc.) must be maintained and available to site personnel.

2.19 First Aid Box and First Aid Equipment

The Contractor shall provide first aid box/es and appoint, in writing, First Aider(s) for this project in line with the results of the Contractor's risk assessment for the project, this health and safety specification as well as the provisions of the General Safety Regulations. The appointed First Aider(s) are to be sent for accredited first aid training before starting on site. Valid certificates are to be kept on site.

- First Aid box/es must be adequately stocked at all times, accessible and be controlled by a qualified First Aider.
- Perishables to be checked and replaced when expired.
- Stock per content list as per the General Safety Regulations Annexure.
- Signage to be in place.
- To be numbered and sealed with name of first aider on or above the First aid box.
- Dressing logbook to be available in the first aid box.
- If more than 5 employees are present, there must be a first aid box available.
- Register to be checked by a Competent person.

If required by the Client, the Contractor shall have a stretcher on site to be used in case of a serious incident.

2.20 Accident / Incident Reporting and Investigation

The Contractor shall, in addition to the prescribed requirements of the Occupational Health and Safety Act and General Safety Regulations, investigate, record, and report all Section 24 reportable incidents to the Client within 24 hours of the incident occurring. Incident investigations shall be conducted by the Contractor's appointed Accident Investigator – this Investigator must be a competent person or persons who have sufficient knowledge to carry out an investigation.

In the event of a fatality or a permanent disabling injury the Contractor must submit proof of reporting of incident to Department of Labour as well as proof of preventative measures to the Client. The Client reserves the right to conduct investigations into any incidents that they deem fit, and the Contractor is required to provide full co-operation in this regard.

2.21 Hazards and Potential Situations

The Contractor shall immediately notify other Contractors of any hazardous or potentially hazardous situations, which may arise during performance of the activities.

2.22 Occupational Health and Safety Signage

The Contractor shall ascertain and provide adequate on-site health and safety signage. This signage shall include, but shall not be limited to, Hard Hat / Helmet Area; Safety Shoes to be worn on site; Dust Masks to be worn in areas where there might be exposure to excessive dust; Ear Plugs / Muffs to be worn where there might be noise exposure over 85 dB; Gloves; Safety Goggles; Safety Harness, Workers in Excavation, traffic management, etc. The Contractor shall be responsible to maintain the quality and replacement of signage. Signage must comply with the requirements of SABS.

2.23 Management of Contractors by Principal Contractor

The Principal Contractor shall ensure that all contractors under his control are complying with the respective Health and Safety Plans, as well as Health and Safety Legislation.

2.24 Stacking of Materials

In addition to the provisions for the stacking of articles in the General Safety Regulations, 2003, the contractor must 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.

2.25 Housekeeping and General Safeguarding on Construction Sites

A contractor must, in addition to compliance with the Environmental Regulations for Workplaces, 1987, promulgated by Government Notice No. R. 2281 of 16 October 1987, ensure that suitable housekeeping is continuously implemented on each construction site, including-

- the proper storage of materials and equipment;
- the removal of scrap, waste, and debris at appropriate intervals;
- ensuring that materials required for use, are not placed on the site so as to obstruct means of access to and egress from workplaces and passageways;
- ensuring that materials which are no longer required for use, do not accumulate on, and are removed from the site at appropriate intervals;
- ensuring that waste and debris are not disposed of from a high place with a chute, unless the chute complies with the requirements set out in the regulations;
- ensuring that construction sites in built-up areas adjacent to a public way are suitably and sufficiently fenced off and provided with controlled access points to prevent the entry of unauthorized persons; and
- ensuring that a catch platform or net is erected above an entrance or passageway or above a place where persons work or pass under or fencing off the danger area if work is being performed above such entrance, passageway, or place so as to ensure that all persons are kept safe in the case of danger or possibility of persons being struck by falling objects.

2.26 *Construction Vehicles and Mobile Plant*

A contractor must ensure that all construction vehicles and mobile plant -

- are of an acceptable design and construction;
- are maintained in a good working order;
- are used in accordance with their design and the intention for which they were designed, having due regard to safety and health;
- are operated by a person who-
  - has received appropriate training, is certified competent and in possession of proof of competency and is authorised in writing to operate those construction vehicles and mobile plant;
  - has a medical certificate of fitness to operate those construction vehicles and mobile plant, issued by an occupational health practitioner in the form of Annexure 3.
- have safe and suitable means of access and egress;
- are properly organized and controlled in any work situation by providing adequate signalling or other control arrangements to guard against the dangers relating to the movement of vehicles and plant, in order to ensure their continued safe operation;
- are prevented from falling into excavations, water, or any other area lower than the working surface by installing adequate edge protection, which may include guard-rails and crash barriers;
- are fitted with structures designed to protect the operator from falling material or from being crushed should the vehicle or mobile plant overturn;
- are equipped with an acoustic warning device which can be activated by the operator;
- are equipped with an automatic acoustic reversing alarm;
- are equipped with fire extinguishers (2.5 – 4.5 kg); and
- are inspected by the authorised operator or driver on a daily basis using a relevant checklist prior to use and that the findings of such inspection are recorded in a register kept in the construction vehicle or mobile plant.

A contractor must ensure that -

- no person rides or is required or permitted to ride on a construction vehicle or mobile plant otherwise than in a safe place provided thereon for that purpose;
- every construction site is organized in such a way that, as far as is reasonably practicable, pedestrians and vehicles can move safely and without risks to health;
- the traffic routes are suitable for the persons, construction vehicles or mobile plant using them, are sufficient in number, in suitable positions and of sufficient size;
- every traffic route is, where necessary, indicated by suitable signs;
- all construction vehicles and mobile plant left unattended at night, adjacent to a public road in normal use or adjacent to construction areas where work is in progress, have appropriate lights or reflectors, or barricades equipped with appropriate lights or reflectors, in order to identify the location of the vehicles or plant;
- all construction vehicles or mobile plant when not in use, have buckets, booms, or similar appendages, fully lowered, or blocked, controls in a neutral position, motors stopped, wheels chocked, brakes set, and ignition secured;
- whenever visibility conditions warrant additional lighting, all mobile plant are equipped with at least two headlights and two taillights when in operation;
- tools, material, and equipment are secured and separated by means of a physical barrier in order to prevent movement when transported in the same compartment with employees;
- vehicles used to transport employees have seats firmly secured and adequate for the number of employees to be carried; and
- all construction vehicles or mobile plant travelling, working, or operating on public roads comply with the requirements of the National Road Traffic Act, 1996.
- all plant and vehicles are be fitted with amber rotating beacons and reverse alarms.
- ALL construction site vehicles must be inspected daily especially if it has dangerous “items” (fuel, explosives, etc.) on vehicle, completed inspection registers must also

be available for inspection.
- the vehicles must resemble the original manufacturer's product. Levers, alarms, and amber lights to be fitted to construction vehicle for notification of vehicle.
- fire extinguishers, signage, and licence disc to be correctly mounted and displayed.
- when the vehicle is stationary no key to be left in or on vehicle or plant.
- Drip tray must be present when stationary.

2.27 Electrical Installations and Machinery on Construction Sites

Not thought to be applicable to this project.

2.28 Use and Temporary Storage of Flammable Liquids on Construction Sites

A contractor must, in addition to compliance with the provisions for the use and storage of flammable liquids in the General Safety Regulations, 2003, ensure that –

- where flammable liquids are being used, applied, or stored at the workplace concerned, it is done in a manner that does not cause a fire or explosion hazard, and that the workplace is effectively ventilated;
- no person smokes in any place in which flammable liquid is used or stored, and the contractor must affix a suitable and conspicuous notice at all entrances to any such areas prohibiting such smoking;
- an adequate amount of efficient fire-fighting equipment is installed in suitable locations around the flammable liquids store with the recognized symbolic signs;
- only the quantity of flammable liquid needed for work on one day is taken out of the store for use;
- all containers holding flammable liquids are kept tightly closed when not in actual use and, after their contents have been used up, are removed from the construction site, and safely disposed of;
- where flammable liquids are decanted, the metal containers are bonded and earthed; and
- no flammable material, including cotton waste, paper, cleaning rags or similar material is stored together with flammable liquids
- proper containers are to be used for fuel. Marked and labelled as per the content.
- diesel on site; more than 800 litres must have a certificate, fire safe certificate. Locked in a ventilated, secure area with a drip tray and have a designated, responsible person to use it.

2.29 Water environments

Not thought to be applicable to this project.

2.30 Fire precautions on Construction Sites

A contractor must, in addition to compliance with the Environmental Regulations for Workplaces, 1987, ensure that –
- all appropriate measures are taken to avoid the risk of fire;
- sufficient and suitable storage is provided for flammable liquids, solids, and gases;
- smoking is prohibited and notices in this regard are prominently displayed in all places containing readily combustible or flammable materials;
- in confined spaces and other places in which flammable gases, vapours or dust can cause danger-
  - only suitably protected electrical installations and equipment, including portable lights, are used;
  - there are no flames or similar means of ignition;
  - there are conspicuous notices prohibiting smoking;
  - oily rags, waste, and other substances liable to ignite are without delay removed to

a safe place; and
- adequate ventilation is provided;

- combustible materials do not accumulate on the construction site;
- welding, flame cutting, and other hot work are done only after appropriate precautions have been taken to reduce the risk of fire;
- suitable and sufficient fire-extinguishing equipment is placed at strategic locations or as may be recommended by the Fire Chief or local authority concerned, and that such equipment is maintained in a good working order;
- the fire equipment contemplated above is inspected by a competent person, who has been appointed in writing for that purpose, in the manner indicated by the manufacturer thereof;
- a sufficient number of workers are trained in the use of fire-extinguishing equipment;
- where appropriate, suitable visual signs are provided to clearly indicate the escape routes in the case of a fire;
- the means of escape is kept clear at all times;
- there is an effective evacuation plan providing for all -
  - persons to be evacuated speedily without panic;
  - persons to be accounted for; and
  - plant and processes to be shut down; and
- a siren is installed and sounded in the event of a fire.

2.31 *Construction Employees' Facilities*

A contractor must, in terms of the Construction Regulations 2014, provide:

- Shower facilities after consultation with the employees or employees' representatives, or at least one shower facility for every 15 persons;
- at least one sanitary facility for each sex and for every 30 workers;
- Toilets to be within walking distance
- Hygiene registers to be completed
- Proof of safe disposal of effulgent waste disposal certificates to be obtained
- changing facilities for each sex;
- and sheltered/shaded eating area.
- Protection from the Elements and raised off the ground.
- Every employer shall provide sanitary facilities at the workplace in accordance with the provisions of Parts F, P and Q of the National Building Regulations.
- Sufficient clean water for all employees. 500ml to each employee every hour.

A contractor must provide reasonable and suitable living accommodation for the workers at construction sites who are far removed from their homes and where adequate transportation between the site and their homes, or other suitable living accommodation, is not available.

2.32 Fall protection

The Contractor must:
- designate a competent person to be responsible for the preparation of a fall protection plan
- ensure that the fall protection plan contemplated above is implemented, amended where and when necessary and maintained as required; and
- take steps to ensure continued adherence to the fall protection plan.

A fall protection plan contemplated above must include-
- a risk assessment of all work carried out from a fall risk position and the procedures and methods used to address all the risks identified per location;
- the processes for the evaluation of the employees' medical fitness necessary to work at a fall risk position and the records thereof;
- a programme for the training of employees working from a fall risk position and the records thereof;

- the procedure addressing the inspection, testing, and maintenance of all fall protection equipment; and
- a rescue plan detailing the necessary procedure, personnel and suitable equipment required to affect a rescue of a person in the event of a fall incident to ensure that the rescue procedure is implemented immediately following the incident.

A contractor must ensure that a construction manager appointed under regulation 8(1) is in possession of the most recently updated version of the fall protection plan.

A contractor must ensure that all unprotected openings in floors, edges, slabs, hatchways, and stairways are adequately guarded, fenced, or barricaded or that similar means are used to safeguard any person from falling through such openings;

Also that no person is required to work in a fall risk position, unless such work is performed safely as contemplated in above and fall prevention and fall arrest equipment are approved as suitable and of sufficient strength for the purpose for which they are being used, having regard to the work being carried out and the load, including any person, they are intended to bear; and securely attached to a structure or plant, and the structure of plant and the means of attachment thereto are suitable and of sufficient strength and stability for the purpose of safely supporting the equipment and person who could fall, and fall arrest equipment is used only where it is not reasonably practicable to use fall prevention equipment.

2.33 Temporary works

A contractor must appoint a temporary works designer in writing to design, inspect and approve the erected temporary works on site before use.

A contractor must ensure that all temporary works operations are carried out under the supervision of a competent person who has been appointed in writing for that purpose.

A contractor must ensure that-

- all temporary works structures are adequately erected, supported, braced and maintained by a competent person so that they are capable of supporting all anticipated vertical and lateral loads that may be applied to them, and that no loads are imposed onto the structure that the structure is not designed to withstand;
- all temporary works structures are done with close reference to the structural design drawings, and where any uncertainty exists the structural designer should be consulted;
- detailed activity specific drawings pertaining to the design of temporary works structures are kept on the site and are available on request to an inspector, other contractors, the Client, the Client's Safety Agent, or any employee;
- all persons required to erect, move, or dismantle temporary works structures are provided with adequate training and instruction to perform those operations safely;
- all equipment used in temporary works structure are carefully examined and checked for suitability by a competent person, before being used;
- all temporary works structures are inspected by a competent person immediately before, during and after the placement of concrete, after inclement weather or any other imposed load and at least on a daily basis until the temporary works structure has been removed and the results have been recorded in a register and made available on site;
- no person may cast concrete, until authorization in writing has been given by the competent person contemplated above;
- if, after erection, any temporary works structure is found to be damaged or weakened to such a degree that its integrity is affected, it is safely removed or reinforced immediately;
- adequate precautionary measures are taken in order to–

    - secure any deck panels against displacement; and
    - prevent any person from slipping on temporary works due to the application of release agents;
- as far as is reasonably practicable, the health of any person is not affected through the use of solvents or oils or any other similar substances;
- upon casting concrete, the temporary works structure is left in place until the concrete has acquired sufficient strength to safely support its own weight and any imposed load, and is not removed until authorization in writing has been given by the competent person
- the foundation conditions are suitable to withstand the loads caused by the temporary works structure and any imposed load in accordance with the temporary works design.
- provision is made for safe access by means of secured ladders or staircases for all work to be carried out above the foundation bearing level;
- a temporary works drawing, or any other relevant document includes construction sequences and methods statements;
- the temporary works designer has been issued with the latest revision of any relevant structural design drawing;
- a temporary works design and drawing is used only for its intended purpose and for a specific portion of a construction site; and
- the temporary works drawings are approved by the temporary works designer before the erection of any temporary works.

No contractor may use a temporary works design and drawing for any work other than its intended purpose.

2.34 Excavation

A contractor must-

- ensure that all excavation work is carried out under the supervision of a competent person who has been appointed in writing for that purpose; and
- evaluate, as far as is reasonably practicable, the stability of the ground before excavation work begins.

A contractor who performs excavation work-

- must take reasonable and sufficient steps in order to prevent, as far as is reasonably practicable, any person from being buried or trapped by a fall or dislodgement of material in an excavation;
- may not require or permit any person to work in an excavation which has not been adequately shored or braced: Provided that shoring and bracing may not be necessary where-
    - the sides of the excavation are sloped to at least the maximum angle of repose measured relative to the horizontal plane; or
    - such an excavation is in stable material: Provided that-
        - permission has been given in writing by the appointed competent person contemplated above upon evaluation by him or her of the site conditions; and
        - where any uncertainty pertaining to the stability of the soil still exists, the decision from a professional engineer or a professional technologist competent in excavations is decisive and such a decision must be noted in writing and signed by both the competent person and the professional engineer or technologist, as the case may be;
- must take steps to ensure that the shoring or bracing contemplated above is designed and constructed in a manner that renders it strong enough to support the sides of the excavation in question;
- must ensure that no load, material, plant, or equipment is placed or moved near the edge of any excavation where it may cause its collapse and consequently endangers

the safety of any person, unless precautions such as the provision of sufficient and suitable shoring or bracing are taken to prevent the sides from collapsing;

- must ensure that where the stability of an adjoining building, structure or road is likely to be affected by the making of an excavation, steps are taken to ensure the stability of such building, structure or road and the safety of persons;
- must cause convenient and safe means of access to be provided to every excavation in which persons are required to work, and such access may not be further than six metres from the point where any worker within the excavation is working;
- must ascertain, as far as is reasonably practicable, the location and nature of electricity, water, gas, or other similar services which may in any way be affected by the work to be performed, and must before the commencement of excavation work that may affect any such service, take the steps that are necessary to render the circumstances safe for all persons involved;
- must ensure that every excavation, including all bracing and shoring, is inspected-
    - daily, prior to the commencement of each shift;
    - after every blasting operation;
    - after an unexpected fall of ground;
    - after damage to supports; and
    - after rain,

  by the competent person, in order to ensure the safety of the excavation and of persons, and those results must be recorded in a register kept on site and made available on request to an inspector, the Client, the Client's Safety Agent, any other contractor or any employee;
- must cause every excavation which is accessible to the public or which is adjacent to public roads or thoroughfares, or whereby the safety of persons may be endangered, to be –
    - adequately protected by a barrier or fence of at least one metre in height and as close to the excavation as is practicable; and
    - provided with warning illuminants or any other clearly visible boundary indicators at night or when visibility is poor, or have resort to any other suitable and sufficient precautionary measure where this is not practicable;
- must ensure that all precautionary measures stipulated for confined spaces as determined in the General Safety Regulations, 2003, are complied with by any person entering any excavation;
- must, where the excavation work involves the use of explosives, appoint a competent person in the use of explosives for excavation, and must ensure that a method statement is developed by that person in accordance with the applicable explosive's legislation; and
- must cause warning signs to be positioned next to an excavation within which or where persons are working or carrying out inspections or tests.

2.35 *Demolition Work*

Not thought to be applicable to this project.

2.36 *Tunnelling*

No person may enter a tunnel which has a height dimension of less than 800 mm.

2.37 Scaffolding

A contractor must appoint a competent person in writing who must ensure that all scaffolding work operations are carried out under his or her supervision and that all scaffold erectors, team leaders and inspectors are competent to carry out their work as per the SANS 10085 of 2004.

A contractor using access scaffolding must ensure that such scaffolding, when in use, complies with the safety standards incorporated for this purpose into these Regulations under section 44 of the Act and SANS 10085. Scaffold must be;

- Level and balanced upon the correct footing such as base jacks, U-Jacks, and mobile wheels
- Have the correct Ledgers and bracing methods to secure the frames and Standards
- To be fully boarded with the correct edge protection on both the 0.500m and 1 metre height per working platforms.
- Working platforms to be in accordance with the Tables 4 and 5 of the SANS 10085 for weight restrictions
- Have the correct access that is fitted within the scaffold and grants access to the working platforms and must be fitted with a trap door system.
- Secured with fastening methods such Reveal and fixed ties according to table 7 of SANS 10085. Buttresses to be used when required.
- signage must be displayed to indicate if the scaffold is safe or unsafe to use.
- Trestles to be built in accordance with section 10.16.1 of the SANS 10085 and safety requirements to be met by the scaffolding inspector and scaffold supervisors on site.

2.38 *Bulk mixing plant*

Not thought to be applicable to this project.

2.39 *Rope Access Work*

Not thought to be applicable to this project.

2.40 Hazardous Chemical Substances (HCS)

In addition to the requirements in the HCS Regulations, the principal contractor must provide proof in the Health and Safety Plan that:

- Material Safety Data Sheets (MSDS's) of the relevant materials / hazardous chemical substances are available prior to use by the contractor. All MSDS's shall be available for inspection by the agent at all times.
- Risk assessments are done at least once every 6 months.
- Exposure monitoring is done according to OESSM and by an Approved Inspection Authority (AIA) and that the medical surveillance programme is based on the outcomes of the exposure monitoring.
- How the relevant HCS's are being/going to be controlled by referring to:
  - Limiting the amount of HCS
  - Limiting the number of employees
  - Limiting the period of exposure
  - Substituting the HCS
  - Using engineering controls
  - Using appropriate written work procedures
- The correct PPE is being used.
- HCS are stored and transported according to SABS 072 and 0228.
- Training with regards to these regulations was given.

The Health and Safety plan should make reference to the disposal of hazardous waste on classified sites and the location thereof (where applicable).

The First Aider must be made aware of the MSDS and trained in how to treat HCS incidents appropriately.

2.41 Noise Induced Hearing Loss

Where noise is identified as a hazard the requirements of the NIHL regulations must be complied with and the following must be included / referred to in the Health and Safety Plan:

- Proof of training with regards to these regulations.
- Risk assessment done within 1 month of commencement of work.
- That monitoring carried out by an AIA and done according to SABS 083.
- Medical surveillance programme established and maintained for the necessary employees.
- Control of noise by referring to:
- Engineering methods considered
- Admin control (number of employees exposed) considered
- Personal protective equipment considered/decided on
- Describe how records are going to be kept for 40 years.

2.42 *Explosives and Blasting*

Not thought to be applicable to this project.

2.43 Personal Protective Equipment (PPE)

The Contractor shall carry out PPE or clothing needs analysis in accordance with his risk assessment, to determine the necessary PPE or clothing to be used during construction. The Contractor shall make provision to keep adequate quantities of appropriate, SABS approved PPE or clothing on site at all times.

The Contractor must ensure that personnel are trained in the correct use of PPE to be used.

The Contractor must ensure that lost, stolen, worn out or damaged PPE is replaced as required and receipt signed for by employees on site.

2.44 Asbestos

Not thought to be applicable to this project.

2.45 Pressure Equipment (Including Gas Bottles)

The Contractor shall comply with Pressure Equipment Regulations, including:

- Providing competency and awareness training to the operators;
- Providing PPE or clothing;
- Providing and maintain appropriate signage in areas where pressure equipment is used, as applicable;
- Inspect equipment regularly and keep records of inspections;
- Providing appropriate firefighting equipment (Fire Extinguishers).
- Under pressure equipment to have the following in place;
  - Service date
  - Seals on valves with no leaks and not broken
  - flash arrestors
  - Should be stored and chained together
  - Oxygen / Acetylene bottles to have clips
  - Signage to be visible
  - Gauges in working condition and be visible
  - Permits for use

- Pressure equip Regs 6. (1) The user shall ensure that the pressure equipment is operated and maintained within its design and operating parameters.

2.46 Fire Extinguishers and Fire Fighting Equipment

The Contractor shall provide adequate, regularly serviced fire extinguishers located at strategic points on site. The Contractor shall keep spare serviced portable fire extinguishers. The Contractor shall have adequate persons trained or competent to use the Fire Fighting Equipment.

Safety signage shall be posted up in all areas where fire extinguishers are located.

2.47 Lifting Machinery and Tackle

The Contractor shall ensure that lifting machinery and tackle is inspected before use and on a monthly basis. The Contractor shall have lifting machinery and tackle inspector who will inspect the equipment at intervals required by the Driven Machinery Regulations, taking into account that:

- All lifting machinery and tackle have a safe working load clearly indicated
- Regular inspection and servicing are carried out
- Records are kept of inspections and of service certificates
- Thorough examinations are carried out by competent personnel at the frequencies required by legislation
- There is proper supervision in terms of guiding the loads which includes a trained banks man to direct and check lifting tackle if it is safe for use
- Forklift to be inspected every year and lift plan every 2 years
- Load test certificate to be no older than 6 months
- Sufficient props to be used and max weight to be displayed
- Slings to be checked regarding integrity, chains, serial numbers, checked for tears, cuts links and all other materials
- Hooks to be oiled, not in a fixed position and closed to prevent materials from slipping/falling off
- Lifting equipment must be used for the scope of work carried out

2.48 Ladders and Ladder work

The Contractor shall ensure that all ladders are numbered and inspected regularly keeping record of inspections. It should be noted that Aluminium ladders are preferred to wooden ladders.

2.49 General Machinery

The Contractor shall comply with the Driven Machinery Regulations, which include inspecting machinery regularly, appointing a competent person to inspect and ensure maintenance, issuing PPE or clothing and training those that use machinery and enforce compliance.

2.50 Portable Electrical Tools

The Contractor shall ensure that use and storage of all explosive actuating fastening devices and portable electrical tools are in compliance with relevant legislation.

The Contractor shall consider that:

- A competent person undertakes routine inspections;
- Only authorised persons use the tools;
- There are safe working procedures applied;
- Awareness training is carried out and compliance is enforced at all times; and

- PPE and clothing are provided and maintained.

2.51 High Voltage Electrical Equipment

Not thought to be applicable to this project.

2.52 Public Health and Safety

The Contractor shall ensure that each person working on or visiting a site, and the surrounding community, shall be made aware of the dangers likely to arise from onsite activities and the precautions to be observed to avoid or minimize those dangers. Appropriate health and safety signage shall be posted at all times.

2.53 Night Work

The Contractor shall not undertake any night work without prior arrangement and a written permit from the Client. The Contractor shall ensure that adequate lighting is provided for all night work and failure to do so shall result in work being stopped.

2.54 Environmental Conditions and Flora and Fauna

The Contractor must be mindful of adverse weather conditions upon the health and safety of the workforce. This includes inclement weather, strong wind, heat stress, extreme cold, etc. The Contractor's risk assessment process must take into account the risks associated with such weather conditions. The same is true when working in an environment where there is a risk to employees' health and safety from presence of poisonous flora, or wildlife (including bees, snakes, etc.). The Contractor's risk assessment process must take these risks into account.

2.55 Occupational Health

Exposure of workers to occupational health hazards and risks are quite common in any work environment, especially in construction. Occupational health hazards and risks exposure is a major problem, and all Contractors are to ensure that proper health and hygiene measures are put in place to prevent exposure to these hazards and risks.

The occupational hazards and risks may enter the body in three ways:

- Inhalation through breathing e.g., cement dust;
- Ingestion through swallowing maybe through food intake;
- Absorption through the skin (pores) e.g., painting or use of thinners.

The contractor is required to ensure that all his personnel are medically fit prior to being allowed onto the work site.

All Contractors should ensure that Occupational Hygiene surveys are conducted as per the Occupational Health and Safety Act to ensure employees are not exposed to hazards. Risk Assessments should identify areas where surveys are to be conducted.

2.56 Suspended Platforms

Not thought to be applicable to this project.

2.57 Material Hoists

Not thought to be applicable to this project.

2.58 Explosive Actuated Fastening Device

No contractor may use or permit any person to use an explosive actuated fastening device, unless-

- the user is provided with and uses suitable protective equipment;
- the user is trained in the operation, maintenance and use of such a device
- the explosive actuated fastening device is provided with a protective guard around the muzzle end, which effectively confines any flying fragments or particles; and
- the firing mechanism is so designed that the explosive actuated fastening device, will not function unless-
  - it is held against the surface with a force of at least twice its weight; and
  - the angle of inclination of the barrel to the work surface is not more than 15 degrees from a right angle.

A contractor must ensure that-

- only cartridges suited for the relevant explosive actuated fastening device, and the work to be performed, are used;
- an explosive actuated fastening device is cleaned and examined daily before use and as often as may be necessary for its safe operation by a competent person who has been appointed for that purpose;
- the safety devices of an explosive actuated fastening device are in good working order prior to use;
- when not in use, an explosive actuated fastening device and its cartridges are locked up in a safe place, which is inaccessible to unauthorized persons;
- an explosive actuated fastening device is not stored in a loaded condition;
- a warning notice is displayed in a conspicuous manner in the immediate vicinity wherever an explosive actuated fastening device is used; and
- the issuing and collection of cartridges and nails or studs of an explosive actuated fastening device are-
  - controlled and done in writing by a person having been appointed in writing for that purpose; and
  - recorded in a register by a competent person and that the recipient has accordingly signed for the receipt thereof as well as the returning of any spent and unspent cartridges.

2.59 Confined Spaces

Confined space work must be closely monitored by a competent person appointed by the contractor, to include, but not restricted to, ensuring that the confined space is sufficiently ventilated prior to entry. Oxygen levels to be tested in confined space to ensure that it is safe for entry. Permit system to be in place to declare confined space safe for entry prior to entry. PPE must be worn (such as proper masks) if air supply is insufficient or not of sufficient quality.

Sufficient training must take place in use of all confined space monitoring and access equipment prior to any works commencing in such confined space. It is strongly recommended that a tripod and winch system be in place to afford easy access and egress and for emergency evacuation from the confined space (manholes and chambers). Please also refer to GSR5 on safety requirements for Work in Confined Spaces.

General safety Regulations 5.

(1) An employer or a user of machinery shall take steps to ensure that a confined space is entered by an employee or other person only after the air therein has been tested and evaluated by a person who is competent to pronounce on the safety thereof, and who has certified in writing that the confined space is safe and will remain safe while any person is in the confined space, taking into account the nature and duration of the work to be performed therein.

(2) Where the provisions of sub regulation (1) cannot be complied with the employer or user of machinery, as the case may be, shall take steps 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-- (a) subject to the provisions of sub regulation (3), 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 (b) 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.
(3) Where the provisions of sub regulation (2)(a) cannot be complied with, the employer or user of machinery shall take steps to ensure that the confined space in question is entered only when the employee or person entering is using breathing apparatus of a type approved by the chief inspector and, further, that—
(a) the provisions of sub regulation (2) (b) are complied with;
(b) 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);
(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
(d) effective apparatus for breathing and resuscitation of a type approved by the chief inspector is available immediately outside the confined space.

(4) An employer or user of machinery shall take steps to ensure that all persons vacate a confined space on completion of any work therein.

(5) Where the hazardous gas, vapour, dust, or fumes contemplated in sub regulation (2) are of an explosive or flammable nature, an employer or user of machinery shall further take steps to ensure that such a confined space is entered only if –
(a) the concentration of the gas, vapour, dust, or fumes does not exceed 25 per cent 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
(b) 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.

2.60 Alcohol and drugs (GSR 2)

1. A contractor shall not permit any person who is or who appears to be under the influence of intoxicating liquor or drugs, to enter or remain at a site.

2. No employee shall be under the influence of or have in his or her possession or partake of or offer any other person intoxicating liquor or drugs.

2. An employer or a user, as the case may be, shall, in the case where a person is taking medicines, only allow such person to perform duties at the site if the side effects of such medicine do not constitute a threat to the health or safety of the person concerned or other persons at such site.

2.61 General Practices when Working at Heights

- No Home-made structures or ladders will be permitted on the project.
- Trestle tables are not to be fully extended and must be fully boarded, no drums to be used.
- Surroundings to be clear of rubble.
- Fall protection, fall prevention, and fall rescue plans to be in place and communicated to site employees.
- Ladders to be structurally sound and not broken and in accordance with GSR 13A.
- Only competent persons may be allowed to work at heights
- Correct personal protective equipment to be used (safety harness and lanyard) and edge protection / lifelines to be used.
- Anchor points to be in place and determined by an engineer. Anchor points must be pull tested prior to use.
- GSR (6) 6. No employer shall require or permit any person to work in an elevated position and no person shall work in an elevated position, unless such work is performed safely from a ladder or scaffolding, or from a position where such person has been made as safe as if they were working from scaffolding.
- Construction regulation 10 of 2014 to be implemented when working at heights and to prevent any person from falling from heights.
- Employees required to perform work at heights or from fall risk position must be medically fit to perform such work, such employee's medicals must specify “Fall Risk” or “Working at heights” in the exposure section of the annexure 3 template.

2.62 Traffic Accommodation

All traffic signs must be displayed as per the traffic management plan drawings.
Size of signs used must be as per the traffic management drawings and all signs to be visible and in good condition.

- Traffic management Plan issued per Road and Traffic act (chapter 13). Must be approved by the Traffic Chief and professional team.
- Plans for signage deployment must be in order and must be placed correctly.
- Traffic management plan must be submitted and must be suitable for the tasks being performed.
- Traffic plan must be implemented and controlled by the sites Traffic safety officer and flag persons.
- Jersey barriers, where used, to be linked.
- No signs to be obstructed.
- STOP/GO structures must be protected against being struck by vehicles (e.g., new jersey barriers)
- Road marking buggies/vehicles must be protected by escort vehicles front and rear.
- Displayed traffic signs must be maintained in a daily register to be checked morning and evenings after works have been finalised.

Night work:

- Signage, traffic accommodation and personnel must be visible (reflective / illuminated).
- Certified, competent traffic officer and flag persons to be used during night operations.

2.63 Ventilation and Lighting in the Workplace

Every employer shall cause every workplace in his undertaking to be lighted in accordance with the illuminance values specified in the Schedule to the General Safety Regulations:

Provided that where specialised lighting is necessary for the performance of any particular type of work, irrespective of whether that type of work is listed in the Schedule or not, the employer of those employees who perform such work shall ensure that such specialised lighting is available to and is used by such employees.

The Contractor must ensure that:

- the average illuminance at any floor level in a workplace within five metres of a task is not less than one fifth of the average illuminance on that task;
- glare in any workplace is reduced to a level that does not impair vision;
- lighting on rotating machinery in such that the hazard of stroboscopic effects is eliminated; and
- luminaires and lamps are kept clean and, when defective, are replaced or repaired forthwith.

With a view to the emergency evacuation of indoor workplaces without natural lighting or in which persons habitually work at night, every employer shall, in such workplaces, provide emergency sources of lighting which are such that, when activated, an illuminance of not less than 0.3 lux is obtained at floor level to enable employees to evacuate such workplaces: Provided that where it is necessary to stop machinery or shut down plant or processes before evacuating the workplace, or where dangerous materials are present or dangerous processes are carried out, the illuminance shall be not less than 20 lux.

The contractor must ensure that the emergency sources of lighting prescribed above:

- are capable of being activated within 15 seconds of the failure of the lighting prescribed by subregulation (1);
- will last long enough to ensure the safe evacuation of all indoor workplaces;
- are kept in good working order and tested for efficient operation at intervals of not more than three months; and
- where directional luminaires are installed, these are mounted at a height of not less than two metres above floor level and are not aimed between 10° above and 45° below the horizontal line on which they are installed.

The contractor must ensure that all rooms, stairways, passageways, gangways, basements, and other places where danger may exist through lack of natural light, to be lighted such that it will be safe.

The contractor must ensure that every workplace in his undertaking is ventilated either by natural or mechanical means in such a way that –

- the air breathed by employees does not endanger their safety;
- the time-weighted average concentration of carbon dioxide therein, taken over an eight-hour period, does not exceed one half per cent by volume of air;
- the carbon dioxide content thereof does not at any time exceed three per cent by volume of air;
- the prescribed exposure limits for airborne substances therein are not exceeded; and
- the concentration therein of any explosive or flammable gas, vapour or dust does not exceed the lower explosive limit of that gas, vapour, or dust.

2.64 Nuclear Density Gauge (Troxler)

The use of a Troxler on site must be in line with the SANS 3001 of March 2014. The SANS consists of 5 sections

The in-situ density of road construction materials is only determined in civil engineering using indirect methods such as the nuclear density gauge and sand replacement methods.
This method forms part of a set of methods used to operate nuclear gauges, and includes the following:
a) administration, handling, and maintenance (see SANS 3001-NG1);
b) validation of standard calibration blocks (see SANS 3001-NG2);
c) calibration of a nuclear gauge (see SANS 3001-NG3);
d) verification of a nuclear gauge (see SANS 3001-NG4):
e) in situ density determination using a nuclear gauge (see SANS 3001-NG5)

When used Troxlers must be:

- Stored in a dedicated, lockable area and must have a warning signage displayed.
- Must only be transported in a dedicated vehicle with the required signage displayed and by an authorised employee that has been appointed in writing.
- Must have a Troxler Calibration Certificate in place.
- Must have a Troxler Technician Appointment on file and signed and proof of competency within the safety file.

2.65 Ergonomics Regulation of 2019

“competent person**”** in relation to ergonomics, means a person who– *(a)* has in respect of the work or task to be performed the required knowledge, training and experience in ergonomics and, where applicable, qualifications specific to ergonomics: provided that where appropriate qualifications and training are registered in terms of the provisions of the National Qualifications Framework Act, 2008 (Act No. 67 of 2008), those qualifications and that training must be regarded as the required qualifications and training; and *(b)* is familiar with the Act and the applicable regulations made under the Act;

"ergonomic risk" means a characteristic or action in the workplace, workplace conditions, or a combination thereof that may impair overall system performance and human well-being;

"ergonomic risk assessment" means a programme, process, or investigation to identify, analyse, valuate and prioritise any risk from exposure to ergonomic risks associated with the workplace;

"ergonomics" means the scientific discipline concerned with the fundamental understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimise human well-being and overall system performance;

The ergonomics regulations will apply to any employer or self-employed person who carries out work at the workplace who may expose any person to an ergonomic risk in the workplace and any designer, manufacturer, importer or supplier of machinery, plant, or work systems for the work place.

An employer must, before the commencement of any work that may expose employees to ergonomic risks, have an ergonomic risk assessment performed by a competent person.

The ergonomic risk assessment must be done at intervals not exceeding two years and must include the following;

- a complete hazard identification and all persons who may be affected by the ergonomic risk.
- how employees may be affected by the ergonomic risks;
- the analysis and evaluation of the ergonomic risks;
- the prioritisation of ergonomic risks.

An employer must review the relevant ergonomic risk assessment if:

- such assessment is no longer valid;
- control measures are no longer effective;
- technological or scientific advances allow for more effective control methods;
- there has been a change in –
  - the work methods;
  - the type of work carried out; or
  - the type of equipment used to control the exposure; and
  - an incident occurs or medical surveillance reveals an adverse health effect, where ergonomic risks are identified as a contributing factor.

An employer must ensure that an employee is placed under medical surveillance, which is overseen by an occupational medicine practitioner, if–

- the ergonomic risk assessment referred to in regulation 6 indicates the need for the employee to be placed under medical surveillance; or
- an occupational health practitioner recommends that relevant employees must be under medical surveillance, in which case the employer may call upon an occupational medicine practitioner to ratify the appropriateness of such recommendation.

An employer must ensure that the medical surveillance consists of–

- in the case of a new employee, an initial health examination before the employee commences employment or within 30 days of commencement of such employment;
- a periodic health examination informed by the ergonomic risk assessment, at intervals specified by an occupational medicine practitioner, but not exceeding two years; and
- an exit health examination informed by the ergonomic risk assessment.

Both the Client and the Contractor have a duty in terms of health and safety legislation to do all that is reasonably practicable to make members of the public and others being affected by the construction processes aware of possible risks and put preventative measures in place to mitigate the risks. The public and/or visitors shall go through a brief health and safety induction detailing hazards and risks they may be exposed to and what measures are in place to control these hazards and risks.

OTHER HEALTH AND SAFETY SPECIFICATION REQUIREMENTS

The contractor must be aware of the following additional requirements:

What	When	Output
Awareness training (Toolbox Talks)	At least weekly and before hazardous work is carried out	Attendance Register
Health and Safety Committee Meetings	Monthly	Minutes signed by the employer (Contractor) covering: a) Health and Safety Representative Checklist b) Safety report from Safety Officer and Safety Agent
Health and Safety Reports	Monthly	Report covering: a) Incidents/Accidents and Investigations b) Non-conformance c) Health and Safety Training d) HIRA Updates e) Internal and External Audits
General Inspections	As per Health and Safety Specification and OHSA	Report on Health and Safety Specification and OHSA compliance: a) Scaffolding b) Lifting Machinery c) Excavation
General Inspections	Monthly	Covering: a) Firefighting Equipment b) Portable Electrical Equipment c) Ladders
Record keeping	Ongoing	Covering: a) General complaints b) Fines c) General incidents d) MSDS e) Surveillance Medicals f) Inspection Register g) Dept of Labour Notices
Permits	Before commencement with certain activities	As stipulated by the Health and Safety Specification and the OHSA / Construction Regulations

Key:

OHSA – Occupational Health and Safety Act, 1993

ANNEXURE A – REQUIREMENTS FOR THE SAFETY PLAN ASSESSMENT

The Contractor must note that the information below is pertinent to the compilation of their safety plan response to this site-specific safety specification and it would be preferred if the Safety Plan is
written in the order of the assessment documented below.

No	Item	Notes
1	**Project Directory**	Please state details of Project Client, Project Manager / Principal Agent, Safety Agent, Consulting Engineer, etc. (Name, address, contact details).
2	**Contractors Directory**	Please indicate if you will be using Contractors on this project, if yes, include their details, trade, and FEM details.
3	**Other Parties Directory**	Please indicate contact details for any services applicable (electricity, water, etc.) as well as Department of Labour and Emergency Services.
4	**Project Safety Statement**	The Project Safety Statement must be included in the Safety Plan.
5	**Health and Safety standards for the project (OHS Act, construction regulations, basic conditions of employment, etc.)**	Health and Safety standards must be included in the Safety Plan.
6	**Project Particulars**	Scope of works must be included in the Safety Plan. This is critical.
7	**Existing environment – Structures and Surroundings, Services (Electrical, Water, Sewerage, etc.), Traffic Arrangements, Parking, Access to Site, Storage of Plant and Materials**	Please include these items in the plan. The items must be Site Specific, the location of services and services that will be affected must be mentioned.
8	**Management Structure for safety on the Project**	A structured organogram with names of the responsible people must be included.
9	**Appointed Persons, Supervision**	The required appointments must be identified. A list of the appointed persons must be included in the Safety Plan.
10	**Security Procedures**	Please indicate if a security company will be appointed and include the contact information in the Safety Plan.
11	**Registers list and inspection frequency**	A list of the Inspection Registers that will be on file must be included in the Safety Plan.
12	**Design Co-ordination**	Please indicate your procedure for implementation of design changes by designer on the project, and the procedures for liaison and implementation of temporary works design on the project.
13	**Contractor Co-ordination**	Mention must be made of how Contractors will be co-ordinated on site to ensure that they work together

No	Item	Notes
		and not adversely affected health and safety.
14	**Housekeeping, stacking and storage**	Housekeeping policies and procedures must be included in the Safety Plan.
15	**Waste Disposal Arrangements**	Waste disposal arrangements procedures must be included in the Safety Plan.
16	**Noise and dust control**	Please indicate if any noisy operations (more than 85 decibels) will be carried out and what measures will be used to reduce noise exposure to workforce.
17	**Training Requirements**	Training requirements must be identified and recorded.
18	**Plant and Equipment**	A list of plant and equipment to be used on site must be included in the Safety Plan.
19	**Safety Monitoring Arrangements**	The name, contact details and SACPCMP registration status of the Safety Officer must be included in the Safety Plan. State how often the Safety officer will be on site (note safety specification requirement in section 1.7).
20	**Information for Contractors**	State how information will be given to Contractors on site.
21	**Consultation/communication arrangements with Employees**	State how information will be given to employees e.g., notice board.
22	**Selection of Contractors Procedures**	Principal contractor must state what health and safety procedures they will use to assess the competence and resources of their contractors on site.
23	**Activities with risk to Health and Safety (Risk Assessment)**	A Baseline Risk Assessment must be included in the Safety Plan, it must address the Risks identified in the Safety Specification as well as the risk of any other hazards that the Principal Contractor is aware of that are relevant to the site.
24	**Hazardous Substances**	Must be listed in the Safety Plan and addressed in the Risk Assessment.
25	**First Aid and Medical Procedures**	Please indicate name of first aider, position of first aid box, location of nearest medical facility and emergency numbers.
26	**Fire and Emergency Procedures**	List of emergency telephone numbers must be drawn up and included in the Safety Plan. The position of Fire Extinguishers, Assembly Point location, fire drill frequencies, numbers of fire marshals, etc.
27	**Accident and Incident Reporting and investigation**	State the Accident and Incident Reporting and investigation procedures of your company.
28	**Welfare and Site Facilities**	Elaborate on toilets and eating areas, water provision, how will workers be protected during wet weather conditions etc.
29	**Site Rules**	The Site Rules must be included in the Safety Plan.

No	Item	Notes
30	**Personal Protective Equipment**	The necessity must be identified by Risk Assessments.
31	**Health & Safety File arrangements**	Please indicate arrangements for the return of the Health and Safety File to the safety agent at the end of the project.
No	**Item**	**Notes**
32	**Method Statements/Safe System of Works**	A list of Method Statements/Safe System of Works must be included in Safety Plan for all High-risk activities
33	**Permits and wayleaves**	List of activities that Principal Contractor anticipates will require permits and wayleaves (including those stated in the safety specification) to be included.
34	**Fall Prevention and Protection Plan and Fall Rescue Plan**	A copy of the Fall Prevention and Protection Plan, fall rescue plan and fall risk assessment must be included in the Safety Plan.
35	**Demolition method statement**	A copy of the Demolition Method Statement must be included in the Safety Plan.
36	**Confined spaces**	The Principal Contractors' procedures for managing access, egress and work in confined spaces must be specified in the Safety Plan. Includes permit procedures, air monitoring, PPE, etc.
37	**Safety Representatives and Safety Committees**	When a project has more than 20 employees a designated employee must be chosen by the labourers to represent them. A safety committee must be established if 2 or more safety representatives are appointed. Please note Safety Specification requirements regarding this section (section 2.12).
38	**Have the significant hazards from the safety specification been addressed?**	See section 1.9 of the Specifications and ensure practical measures have been detailed in the safety plan.
39	**Safety File - Safety Policies in File and Signed by 16(1) CEO.**	Safety Policies must be signed and explained to employees.
40	**Safety File - A copy of the valid Letter of Good standing from FEM / Workman's Compensation must be on file.**	A copy of the valid Letter of Good standing from FEM / Workman's Compensation must be on file.
41	**Safety File - Signed copy of the 37.2 Mandatary Agreement**	A 37.2 Mandatary Agreement needs to be signed between the Client and the Principal Contractor.
42	**Safety File - Appointment letter from Client (as well as 5.1.K)**	The Client must appoint the Principal Contractor in writing.
43	**Safety File – Notification / Permit**	A copy of the Annexure 2 Notification (and proof of submission) to Department of Labour must be available. This can be in the form of a Department stamp, email, or copy of Construction Work Permit.

ANNEXURE B – LEGAL APPOINTMENTS
The contractor shall make the following appointments, as required:

Chief Executive Officer (OSH Act 16(1)
Contract Director/Manager (OSH Act 16(2)
Construction Manager (CR 8(1)
Construction Supervisor (CR 8(7)
Assistant Construction Supervisor (CR 8(8)
Construction Safety Officer (CR 8(5)
Safety Representative (where > 20 employees on site)
Construction risk assessor (CR 9(1))
Excavation Supervisor (CR13(1)(a)
Scaffold Supervisor (CR16(1)
Controller of Explosive Actuated Fastening Devices Nails, Cartridges or Studs Issue and Collection (CR21(2)(g)(1)
Construction Vehicle and Mobile Plant Operator (CR23(1)(d)(i)
Stacking Supervisor (CR28(a)
Fire Extinguishing Equipment Inspector (CR29(h)
Fall Protection Plan Developer (CR 10(1)(a)
Incident Investigator (OSH Act 9(2)
Competent Person – Confined Spaces (GAR 5(1)

ANNEXURE C - BASELINE RISK ASSESSMENT FOR PROJECT

Irrespective of the risk presented on site, it will be ensured that sufficient supervision is in place on site, that personnel are trained in accordance with legislation, including the requirement for site specific inductions on site to inform personnel on site of the risks and hazards applicable to the site. Site supervision is responsible for ensuring that the control measures required below are implemented on site.

	HAZARD	RISK	MINIMUM CONTROL MEASURES
1.	Bricklaying	Caustic contamination with mortar Contact with sharp bladed tools	• Use only trained personnel • Safe means of access to be provided • Safe/Suitable working platform required where working at height • PPE for mortar to include gloves where practicable and goggles/ masks where there is a risk of contamination
2.	Compacting and Filling	Contact with tipping materials Contact with moving plant Vehicles/personnel falling into excavations Contact with underground services	• Trained banksman to control vehicles movement • Only trained personnel use plant • Personal Protective Equipment to be worn • Personnel to stand clear as materials are being tipped • Use stop blocks and signs to warn vehicles of excavations, where applicable • Stand clear of plant whilst materials are being compacted • Establish position of underground services and protect services from damage
3.	Compactor Operations	Crushing of feet	• Only trained and competent personnel to use the machine • Ensure operative wears steel toe cap shoes or boots at all times
4.	Confined Spaces	Suffocation Fumes	• Ensure that confined space is sufficiently ventilated • Wear personal protective equipment such as proper masks if air supply insufficient or not of sufficient quality • Test oxygen levels in confined space to ensure that is safe for entry • Ensure that emergency procedures in place
5.	Demolition	Falling materials Premature collapse of structure	• Ensure there is a current method statement in place • Ensure all emergency procedures are in place and all details are displayed • Ensure that structural demolition has been approved by the designer and site management • Personnel must be competent • Ensure at all times there is a safe means of access and egress • All personnel must wear suitable and sufficient Personal Protective Equipment, including head, eye, and skin protection
6.	Excavations (Working in and around)	Toxic fumes Collapse of trench walls/trapping Falling into excavation Collapse of adjacent structures	• Deep excavations / monitor air for toxic fumes • Prevent collapse by battering back sides to a safe angle or install temporary support • Protect vehicles from falling into excavations – provide barriers, signage, etc. as necessary • Beware of undermining of other structures (e.g., buildings, scaffolds) • Record excavation inspections by competent person on daily basis • Provide suitable means of access/egress in case of emergency. • Excavations formed by explosives must be accompanied by method statement approved by Client •

	HAZARD	RISK	MINIMUM CONTROL MEASURES
7.	Fire	Injuries to workers, pedestrians, residents, road users, damage to property through fire	• No littering on site which could become fire hazard, maintain site in clean condition. • No fires to be lit on site. Have a working fire extinguisher at hand at all times. • No smoking or naked flame near flammable substances or in unauthorised areas • Ensure proper storage/use of Petrol/diesel/flammable substances – post warning notices
8.	Flammable Liquids and Gases (Use of)	Fire Explosion	• No littering on site which could become fire hazard, maintain site in clean condition. • Have a working fire extinguisher at hand at all times. • No smoking or naked flame near flammable substances or in unauthorised areas • Ensure proper storage/use of Petrol/diesel/flammable substances – post warning notices • Equipment must be in good condition, maintained • Personnel using substances must be trained in safe use and risks
9.	Hand tools	Injuries caused by use of hand tool Impact with the tool Falls due to access problems Contamination with substance being worked	• Ensure: • Tool is correct for job • Tool is in good order and suitably sharp • Personnel must be competent/instructed in tool usage and tool safely • Lighting is sufficient • Access is safe, working platform is secure, leading edge is guarded • Operative is wearing all necessary PPE
10.	Hazardous Substances	Injuries to workers through use of hazardous substances, e.g. injuries to eyes, skin, etc.	• Use substances in accordance with data sheet, particularly reference protective clothing required (example: gloves, goggles, etc.) • Know what First Aid measures are • Have welfare facilities available for washing of hands, etc.
11.	Lifting Operations	Falling material Crushing by materials Hand injuries to the slinger Toppling crane	• Check test certificate • Check examination certificate • Check inspection have been carried out • Check certificates for lifting equipment (chains, slings, shackles, etc.) • Ensure lifting gear is rated to carry load (SWL) • Ensure materials being lifted are properly packaged and slung. • Be aware that there should be a minimum clearance of 600mm between any slewing parts of a crane and any fixed installation to prevent being trapped. • Access to the work area during lifting operations is to be restricted to those involved with and trained in the work in hand. Do not allow members of the public to gain access to the area. • Only trained banksmen to be used. • The crane driver and the banksman are to ensure that the signals given are clearly understood.
12.	Manhole Rings and Pipes Storage	Rolling of rings Collapse of pipes Crushing of persons Stockpile collapse	• Manhole rings must be stored flat to prevent them being rolled. • Banks of pipe stockpiles are not to be broken until they are ready for use. • Personnel must stand to the side when breaking bands so as not to be hit by falling pipes. • Pipes must be wedged to prevent rolling

	HAZARD	RISK	MINIMUM CONTROL MEASURES
13.	Manual Handling of General Items	Muscular skeletal injuries if the load is too heavy or awkward Operative falling/ tripping Contamination from the substance being carried Fall of material being carried	• Personnel should be aware of safe manual handling techniques • Personnel to wear Personal Protective Equipment when carrying items, e.g. safety footwear and gloves. • Ensure good housekeeping against tripping/fall hazards. • Operative to get assistance if load too heavy- team lift if necessary. • Utilise mechanical lifting and carrying aids where possible. • Personnel to ensure access equipment, ladders will take weight of operative and load being carried. • Personnel to ensure item being carried is properly bonded or is not liable to break apart whilst being manually handled.
14.	Members of Public – Protection of	Injury to member of public and road users from site works	• Barriers and signage to be in place • Workers must warn away any members of public from the works • Footpaths and bridges which are open to public must be closed off if in area of works or otherwise made safe so that no injury occurs to members of public • Traffic turning into site – traffic management and signage as required. • Signage to be on road at site entrance warning motorists that construction traffic turning into/out of site access. Keep roads free of mud where possible • Refer to plant risk assessment for details on plant safety precautions • NOTE: SIGNAGE TO BE POSTED ON SITE TO WARN OF CONSTRUCTION TRAFFIC MOVEMENTS. SAFE MEANS OF ACCESS FOR BOTH CONSTRUCTION TRAFFIC TO SITE AND PRIVATE HOMEOWNERS MUST BE AGREED.
15.	Mobile Crane Erection and Dismantling and Use	Collapse of structure Overturning of structure Falling materials	• Ensure emergency procedures are in place and all operatives are aware of the details • Only use trained and competent operators for the erection and dismantling and use of cranes • Ensure crane driver is trained and holds certification as proof. Must have valid medical certificate of fitness. • Ensure there is safe means of access available at all times • Ensure the mobile crane driver has 360˚ vision if not ensure a fully trained banksman is used • Banksman to wear reflector vest to identify himself to the crane driver • Ensure all personnel wear suitable and sufficient personal protective equipment • Consider creating exclusion areas
16.	Night Work	Security Lighting	• The Contractor shall not undertake any night work without prior arrangement and a written permit from the Client. • The Contractor shall ensure that adequate lighting is provided for all night work and failure to do so shall result in work being stopped.
17.	Noise and Dust	Breathing in dust can cause long term health problems, noise can damage hearing	• Wear respiratory and hearing protection • Dampen down and minimise dust where possible.
18.	Overhead Services (Working near)	Contact with live services causing injury to personnel Damage caused to services	• Maintain safe clearance levels • Establish presence of any services via proper walk-through survey of site and/or means of service drawings

	HAZARD	RISK	MINIMUM CONTROL MEASURES
			• Wear personal protective clothing • Ensure height of plant/vehicles does not compromise or exceed clearance levels for overhead services • Obtain information on clearance levels from service provider
19.	Plant or Vehicles and Equipment Operation	Workers injured by passing traffic Road users and pedestrians at risk from plant operation Noise	• Implement traffic protection measures • Trained and competent operators must be used • Check plant and vehicles on daily basis before use and record inspections. Maintain vehicles in safe condition. • Medical certificates of fitness required for construction plant. • Crossing of road by construction vehicles or machines must be limited to the practical minimum • Plant and vehicles must be fitted with amber rotating beacons and reverse alarms. • Wear appropriate protective clothing/equipment, e.g., goggles, gloves, ear defenders, etc. as appropriate.
20.	Plastering	Falling materials Fall from height Contact with materials	• Ensure standard safety procedures are followed • Ensure there is a safe working area • Ensure safe access and egress • Ensure competent personnel are used
21.	Scaffold Erection/ Dismantling	Personnel falling from a height Items of scaffold falling onto personnel Scaffold collapsing onto those below	• Ensure • scaffold is designed to take the imposed loads • scaffolding is constructed properly • scaffold is not overloaded • scaffolders are fully trained • scaffolding is regularly checked by competent person and record of inspection retained. Written inspections to be recorded on weekly basis • scaffolders must adhere to the safe systems of work. • all fall arrest equipment to be checked and certified in good working order • that ALL understand the safe system of work
22.	Snakes	Snake bite	• Qualified first aider required for site who can treat snakebite • Snake bite kit to be on hand • Check area before working • Find out nearest hospital and get emergency telephone numbers.
23.	Steel Fixing	Back injuries caused by manual handling Eye injuries from tie wire Trips / falls Falling form height	• PPE must include safety boots and goggles • Manual handling training may be required • Care to be taken when working near overhead lines • Use only trained personnel • Provide safe means of access • Maintain and regularly inspect all lifting appliances and equipment • Cap starter bars to prevent injuries where feasible • Construct scaffold walk ways to cross reinforcing mesh, as required
24.	Troxler – use of	Radiation exposure Transportation and storage of nuclear equipment Working in road	Ensure • Training of Troxler gauge operators in basic radiation safety and correct operating procedure to satisfactory level of competence • An enclosed vehicle must be used for transport of the gauge • After use and before storing the gauge, a visual check to be carried out to confirm shutter is

	HAZARD	RISK	MINIMUM CONTROL MEASURES
			properly closed • Warning signage to be displayed at entrance to store indicating presence of radioactive material • Wear reflective vests when working in or near the road or road shoulder as well as any other required personal protective clothing.
25.	Underground Services	Striking of buried services	• Make all necessary enquiries to establish what services are in the area. Consult drawings and advice from service provider (e.g., Municipality or ESKOM) when planning work. • Assume all service to be live (Unless confirmation is received to confirm that services are isolated or otherwise made safe). Do not work near live services without authorisation from site management. • Comply with the requirements of the safe system of work for underground services. • Where available, locate services with a locator • Hand dig around services
26.	Working with Effluent	Contact with effluent causing sickness or disease	• ensure good hygiene facilities • personnel to be competent in work activity • personnel to wear appropriate personal protective equipment such as goggles, overall, gloves and goggles

ANNEXURE D – GUIDELINES TO HEALTH AND SAFETY BILL OF QUANTITIES

DESCRIPTION	UNIT	QTY	RATE	AMOUNT	
				R	C
Preparation of principal contractor's site-specific health and safety plan, safety file, risk assessments, fall prevention/protection plan, Annexure 2 notification to Dept of Labour, demolition method statement, other method statements requested to be prepared for safety reasons, permits, amendments to safety plan during course of project, traffic management / accommodation plans, and any other legally required health and safety documentation	Lump sum	Lump sum			
Provision of safety documentation required of the principal contractor for Construction Work Permit application by the safety agent of Dept of Labour, if applicable (note section 2.4 of this safety specification document)	Lump sum	Lump sum			
Provision of current workman's compensation cover for employees for the project, and ensuring that contractors appointed have such cover too	Lump sum	Lump sum			
Health and safety management of principal contractor's employees, visitors, and contractors' employees on site.	Lump sum	Lump sum			
Provision of full time Construction Manager for site, provision of Alternate Construction Manager in absence of Construction Manager and provision of sufficient safety supervision on site	Lump sum	Lump sum			
Provision of full time/ part time SACPCMP registered Construction Health & Safety Officer for site (refer to safety specification for full time / part time requirement) and preparation of safety reports after each safety inspection	Lump sum	Lump sum			
Competence assessment, appointment and required competence and safety training of all principal contractor's legally required appointments for site	Lump sum	Lump sum			
Maintenance of principal contractor's plant and equipment on site so as to be in safe condition, including inspection registers, inspections by competent persons, thorough examination certificates, hand over certificates and related documentation	Lump sum	monthly			
Provision of general safety signage (e.g., first aid, firefighting, traffic safety, excavations, PPE, Assembly Point, noise zones, etc.)	Lump sum	monthly			

DESCRIPTION	UNIT	QTY	RATE	AMOUNT	
				R	C
Provision of medical certificates of fitness for employees on site (Annexure 3)	Lump sum	Lump sum			
Provision of personal protective equipment (PPE) by principal contractor to employees and, as applicable, visitors to site, incl. • reflective vests • hard hats • protective footwear • hearing protection • respiratory protection • safety eyewear • gloves • overalls • Safety harnesses and lanyards • Sunblock • UV Protective clothing / hats / eye wear • Protective thermal wear (heat / wind / cold / rain) • Protective firefighting clothing • Arc flash and electrical protective clothing	Lump sum	Lump sum			
Provision of Fall Prevention and Protection Equipment including. • Rope • Lifelines & Self-Retracting Lifelines (SRL) • Anchor Points • Warning Lines & Area demarcation • Fall Arrest Accessories • Fall Rescue Equipment • Passive Fall Protection Equipment • Confined Space Rescue and Retrieval (In elevated work situations) • Etc.	Lump sum	Lump sum			
Provision of Confined Space work equipment & Training • Training • Air Monitoring Equipment • Ventilation Equipment • Entry Equipment • Personal Protective Equipment • Confined Space Rescue and Retrieval Equipment • Communication Equipment • Etc.	Lump sum	Lump sum			
Holding of safety meetings with safety representatives and safety officers on site on at least monthly basis	Lump sum	monthly			

DESCRIPTION	UNIT	QTY	RATE	AMOUNT	
				R	C
Principal contractor construction safety management attendance at health and safety meetings called by client, professional team, or safety agent	Lump sum	monthly			
Provision of site-specific health and safety induction training for all on site	Lump sum	Lump sum			
Conducting of toolbox talks to employees on health and safety issues on a weekly basis	Lump sum	Lump sum			
Provision of sufficient First Aiders for site as per legal requirements	Lump sum	Lump sum			
Provision of First Aid Boxes for site as per legal requirements	Lump sum	Lump sum			
Provision of sufficient fire extinguishing equipment for site	Lump sum	Lump sum			
Fire drills on site at least 6-monthly basis for duration of project	Lump sum	Lump sum			
Provision of welfare facilities for site (drinking water, toilets, soap, means of drying hands, toilets paper, sheltered eating areas, etc.)	Lump sum	Lump sum			
Provision for safe disposal of waste, spill kits, safe housekeeping, and storage practices	Lump sum	Lump sum			
Provision of leading-edge protection, covers to prevent falls	Lump sum	Lump sum			
Provision of fencing at site camp and to protect excavations	Lump sum	Lump sum			
Compilation of consolidated Safety File at Close Out stage and handover of file to safety agent in hard copy or digital format	Lump sum	Lump sum			
Supply of safety caps on all exposed re-bar	Lump sum	Lump sum			
Any other compliance item in site specific safety specification issued by project client/ safety agent with potential cost implication	Lump sum	Lump sum			
• Item 1					
• Item 2					
• Item 3					
• Item 4					
• Item 5					
Principal contractor's general compliance with respect to the Occupational Health and Safety Act, Construction and other health and safety Regulations apart from other provisions in this bill.	Lump sum	Lump sum			
SUMMARY TOTAL OHS COST PROVISION					

ANNEXURE E – SAFETY SPECIFICATION AND BASELINE RISK ASSESSMENT ISSUE REGISTER

Date of Original Safety Specification Compilation	Compiled By	Issue Date
30 August 2023	John Mcgregor	30 August 2023

Revision Summary	Revised By	Revision Date

Acknowledgement:

I, _____representing

_____(Contractor), have satisfied myself with the content of this Health and Safety Specification and shall ensure that our employees and contractors on site comply with the requirements of this document, our safety documentation and health and safety legislation.

_____ _____

Signature of Contractor Date

Comments:

_____

_____

_____

_____

_____

_____

_____

DEPARTMENT LAND REFORM AND RURAL DEVELOPMENT

CONTRACT NO.: SSC WC 01 (2026/2027) DLRRD

THE APPOINTMENT OF A CONTRACTOR FOR THE CONSTRUCTION OF A SEWER AND STORMWATER PIPE IN NDULI, CERES, UNDER WITZENBERG MUNICIPALITY, IN THE WESTERN CAPE PROVINCE

C6: ENVIRONMENTAL SPECIFICATIONS

THE CONSTRUCTION OF A BULK SEWER AND STROMWATER PIPES IN NDULI, CERES

ENVIRONMENTAL MANAGEMENT PROGRAMME (EMPr)

(INCLUDING THE WASTE, WATER USE AND ELECTRICITY CONSUMPTION MINIMIZATION AND MANAGMENT PLAN)

Prepared for:

Witzenberg Local Municipality

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24 August 2023

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ABBREVIATIONS

BAR ..... Basic Assessment Report

CBA ..... Critical Biodiversity Area

CEMPr ..... Construction Environmental Management Programme

DEA&DP ..... Department of Environmental Affairs and Development Planning

DWS ..... Department of Water Affairs and Sanitation

EA ..... Environmental Authorisation

EAP ..... Environmental Assessment Practitioner

ECO ..... Environmental Control Officer

EIA ..... Environmental Impact Assessment

EMPr ..... Environmental Management Programme

EO ..... Environmental Officer

ESO ..... Environmental Site Officer

GNEC ..... Guillaume Nel Environmental Consultants

I&AP ..... Interested and Affected Parties

NEMA ..... National Environmental Management Act

NWA ..... National Water Act

RE ..... Resident Engineer

DEFINITIONS

Alien species - Plants and animals which do not arrive naturally in an area - they are brought in by humans. Alien plants often force indigenous species out of the area. Rooikrans is a good example of alien species in the Cape.

Alternative - A possible course of action, in place of another, that would meet the same purpose and need defined by the development proposal. Alternatives considered in the EIA process can include location and/or routing alternatives, layout alternatives, process and/or design alternatives, scheduling alternatives or input alternatives.

Aspect – Element of an organisation's activities, products, or services that can interact with the environment.

Auditing - A systematic, documented, periodic, and objective evaluation of how well the environmental management programme is performing with the aim of helping to safeguard the environment by: facilitating management control which would include meeting regulatory requirements. Results of the audit help the organisation to improve its environmental policies and management systems.

Biodiversity - The rich variety of plants and animals that live in their own environment. Fynbos is a good example of rich biodiversity in the Cape.

Built environment - Physical surroundings created by human activity, e.g. buildings, houses, roads, bridges and harbours.

Client – Entity which applies for environmental approval and is ultimately accountable for compliance to conditions stipulated in the Environmental authorisation (EA) and requirements of the EMPr.

Conservation - Protecting, using, and saving resources wisely, especially the biodiversity found in an area.

Contamination - Polluting or making something impure.

Corrective (or remedial) action - Response required addressing an environmental problem that is in conflict with the requirements of the EMPr. The need for corrective action may be determined through monitoring, audits, or management review.

Degradation - The lowering of the quality of the environment through human activities, e.g. river degradation, soil degradation.

Ecology - The scientific study of the relationship between living things (animals, plants, and humans) and their environment.

Ecosystem - The relationship and interaction between plants, animals and the non-living environment.

Environment - Our surroundings, including living and non-living elements, e.g. land, soil, plants, animals, air, water, and humans. The environment also refers to our social and economic surroundings, and our effect on our surroundings.

Environmental Impact Assessment (EIA) - An Environmental Impact Assessment (EIA) refers to the process of identifying, predicting, and assessing the potential positive and negative social, economic, and biophysical impacts of a proposed development. The EIA includes an evaluation of alternatives; recommendations for appropriate management actions for minimising or avoiding negative impacts and for enhancing positive impacts; as well as proposed monitoring measures.

Environmental Management System (EMS) - Environmental Management Systems (EMS) provide guidance on how to manage the environmental impacts of activities, products and services. They detail the organisational structure, responsibilities, practices, procedures, processes, and resources for environmental management. The ISO14001 EMS standard has been developed by the International Standards Organisation.

Environmental policy - Statement of intent and principles in relation to overall environmental performance, providing a framework for the setting of objectives and targets.

Fynbos - Low-growing and evergreen vegetation found only in the south Western Cape. Fynbos is known for its rich biodiversity.

Habitat - The physical environment that is home to plants and animals in an area, and where they live, feed and reproduce.

Hazardous waste – Waste, even in small amounts, that can cause damage to plants, animals, their habitat and the well-being of human beings, e.g. waste from factories, detergents, pesticides, hydrocarbons, etc.

Impact - A description of the potential effect or consequence of an aspect of the development on a specified component of the biophysical, social, or economic environment within a defined time and space.

Indigenous species - Plants and animals that are naturally found in an area.

Infrastructure - The network of facilities and services that are needed for economic activities, e.g. roads, electricity, water, sewerage.

Integrated - Mixing or combining all useful information and factors into a joint or unified whole. See Integrated Environmental Management.

***Integrated Environmental Management (IEM)* -** A way of managing the environment by including environmental factors in all stages of development. This includes thinking about physical, social, cultural, and economic factors and consulting with all the people affected by the proposed developments. Also called "IEM".

***Land use* -** The use of land for human activities, e.g. residential, commercial, industrial use.

Mitigation - Measures designed to avoid, reduce, or remedy adverse impacts

***Natural environment* -** Our physical surroundings, including plants and animals, when they are unspoiled by human activities.

Over-utilisation - Over-using resources - this affects their future use and the environment.

***Policy* -** A set of aims, guidelines, and procedures to help you make decisions and manage an organisation or structure. Policies are based on people's values and goals. See Integrated Metropolitan Environmental Policy.

***Process* -** Development usually happens through a process - a number of planned steps or stages.

Recycling - Collecting, cleaning, and re-using materials.

***Resources* -** Parts of our natural environment that we use and protect, e.g. land, forests, water, wildlife, and minerals.

***Scoping Report* -** A report presenting the findings of the scoping phase of the EIA. This report is primarily aimed at reaching closure on the issues and alternatives to be addressed in the EIA (in the case of a full EIA process).

***Stakeholders* -** A subgroup of the public whose interests may be positively or negatively affected by a proposal or activity and/or who are concerned with a proposal or activity and its consequences. The term includes the client, authorities, and all interested and affected parties.

***Storm water management* –** Strategies implemented to control the surface flow of storm water such that erosion, sedimentation, and pollution of surface and ground water resources in the immediate and surrounding environments are mitigated. This is specifically important during the construction and decommissioning phases of a project.

***Sustainable development* -** Development that is planned to meet the needs of present and future generations, e.g. the need for basic environmental, social, and economic services. Sustainable development includes using and maintaining resources responsibly.

***Sustainability* -** Being able to meet the needs of present and future resources.

Waste Management – Classifying, recycling, treatment, and disposal of waste generated during construction and decommissioning activities.

Wetlands **-** An area of land with water mostly at or near the surface, resulting in a waterlogged habitat containing characteristic vegetation species and soil types e.g. vleis, swamps.

Zoning - The control of land use by only allowing specific type development in fixed areas or zones

REFERENCES

DEAT (1992) Integrated Environmental Management Guideline Series, Volumes 1-6, Department of Environmental Affairs, Pretoria.

Department of Environmental Affairs and Development Planning Generic Environmental Management Plan Guideline, prepared by Strategic Environmental Focus, 2007

National Environmental Management Act 107 of 1998 (NEMA)

National Environmental Management Act, EIA Regulations, 2014 GN No. 982 (as amended)

1. INTRODUCTION AND BACKGROUND

All other approvals must be used in conjunction with this EMPr.

Guillaume Nel Environmental Consultants (GNEC), as independent environmental consultants and impact assessors, has been appointed by Witzenberg Local Municipality, hereafter referred to as the Client, to draft an Environmental Management Programme (EMPr) for the proposed construction of a bulk sewer and stormwater pipes in Nduli, Ceres. The Client will use this Planning, Construction, and Operational Phase Environmental Management Programme as a tool in managing the impacts of the activities.

This document is based on the EMPr Guideline provided by DEA&DP which was compiled in accordance with the Integrated Environmental Management (IEM) philosophy which aims to achieve a desirable balance between conservation and development (DEAT, 1992). IEM is a key instrument of the National Environmental Management Act [NEMA] (Act No. 107 of 1998). NEMA promotes the integrated environmental management of activities that may have a significant effect on the environment, while IEM prescribes a methodology for ensuring that environmental management principles are fully integrated into all stages of the development process. It advocates the use of several environmental and management tools that are appropriate for the various levels of decision-making. One such tool is an Environmental Management Programme.

The IEM guidelines intend encouraging a pro-active approach to sourcing, collating, and presenting information in a manner that can be interpreted at all levels. The basic principles underpinning IEM are that there be:

- informed decision-making;
- accountability for information on which decisions are taken;
- accountability for decisions taken;
- a broad meaning given to the term environment (i.e. one that includes physical, biological, social, economic, cultural, historical and political components);
- an open, participatory approach in the planning of proposals;
- consultation with interested and affected parties;
- due consideration of alternative options;
- an attempt to mitigate negative impacts and enhance positive aspects of proposals;

- an attempt to ensure that the 'social costs' of development proposals (those borne by society, rather than the Clients) be outweighed by the 'social benefits' (benefits to society as a results of the actions of the Clients);
- democratic regards for individual rights and obligations;
- compliance with these principles during all stages of the planning, implementation and decommissioning of the proposals (i.e. from 'cradle to grave'), and
- The opportunity for public and specialist input in the decision-making process.

These principles are in line with National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) and is focussed primarily on co-operative governance, public participation and sustainable development. The Environmental Impact Assessment Regulations GN No. R. 982, R. 983, R. 984, and R. 985 (as amended), are to regulate the procedures and criteria for the submission, processing, consideration and decision on applications for environmental authorisation of listed activities.

1.1 SCOPE AND TERMS OF REFERENCE

The general principles contained within this document apply to all **PRE-CONSTRUCTION, CONSTRUCTION AND OPERATIONAL** activities.

Principles of this EMPr

This EMPr is compiled using the following concepts and implementation requirements so that the higher principles of sustainable development are realised:

- ***Continuous improvement***. The project client (or implementing organisation) must be committed to review and to continually improve environmental management, with the objective of improving overall environmental performance.
- ***Broad level of commitment***. A broad level of commitment will be required from all levels of management as well as the workforce in order for the development and implementation of this EMPr to be successful and effective.
- ***Flexible and responsive***. The implementation of the EMPr must be responsive to new and changing circumstances, i.e. rapid short-term responses to problems or incidents. The EMPr is a dynamic "living" document and thus regular planned review and revision of the EMPr must be carried out.
- ***Integration across operations***. This EMPr is integrated across existing line functions and operational units such as health, safety, and environmental

departments in a company/project. This is done to change the redundant mindset of seeing environmental management as a single domain unit.

- ***Legislation***. It is understood that any development project during its construction phase is a dynamic activity within a dynamic environment. The Client, Engineer, Contractor, and sub-contractor must therefore be aware that certain activities conducted during construction may require further licensing or environmental approval, e.g. river or stream diversions, bulk fuel storage, waste disposal, etc. The Contractor must consult the RE, EO and ECO on a regular basis in this regard.

2. PROPOSED ACTIVITY AND LOCAL CONTEXT

The development entails the construction of a bulk sewer and stormwater pipes in Nduli, Ceres The scope of works involves the following:

- The construction of a bulk sewer of approximately 550m in length of 200mm diameter uPVC pipes and manholes.
- Connections of existing sewers into the new bulk sewer.
- The construction of a stormwater pipe of approximately 505m length of 600mm diameter reinforced concrete pipes, manholes and outlet structures.
- The replacement of existing sewer manhole covers and frames with lockable covers and frames.

2.1. SUMMARY OF IMPACTS ASSOCIATED WITH THE PROPOSED ACTIVITIES

Fauna Impact:

No direct impacts are expected on fauna during the construction or operational phases of the proposed development.

Animals will usually move away from sources of disturbance without human intervention. In an instance where animals are present on site the following must be adhered to:

• Trapping, poisoning and/or shooting of animals is strictly forbidden.

• All fauna encountered should be allowed to escape to suitable habitat away from the disturbance. No animal should be intentionally killed, caught, or collected during any phase of the project.

If animals do not move away from the site and their removal is required e.g. a dangerous species or there is a risk to the animal from construction activities, the following must be adhered to:

• Any animals rescued or recovered must be relocated to the closest suitable habitat away from the work site in consultation with the ECO and relevant authorities.

• Dangerous animals such as venomous snakes must only be handled by a suitably trained and qualified person.

Noise Impact:

There may be some noise impacts during the construction phase, but these will only be temporary. No additional noise impacts are expected during the operational phase.

Heritage impact:

No heritage impacts are expected during the construction and operational phases of the proposed activities.

Dust Impact:

Dust suppression must be applied to the disturbed areas where construction activities are currently active. Dust suppression is of high importance. Alternative measures for dust suppression must be used other than using potable water.

2.2 [CLIENT'S] ENVIRONMENTAL MANAGEMENT POLICY AND COMMITMENTS

The client understands the importance of conserving the environment, and will endeavour to apply all necessary mitigation measures to conserve and maintain sensitive areas and prevent environmental degradation.

2.3 INTERPRETATIONS

The implementation of the EMPr is not an additional or "add on" requirement. The EMPr is legally binding through NEMA and the relevant EA. This EMPr is to be used during the planning and construction phases of the proposed project. The Environmental Control Officer, appointed by the Client after environmental approval, must use this EMPr during the ECO audits to determine the Client's compliance to it.

Further on, the client is to ensure that through the project tender process the EMPr forms part of the Project Construction Contract Document to be incorporated in line with:

- General project specifications; and/or
- SANS 1200 A or SANS 1200 AA, as applicable.

The client is also to ensure that through any tender or appointment process, the operational EMPr forms part of the management contract with all service providers and contractors, for a period of time as stipulated by the DEA&DP during which the development will be audited for compliance to the operational EMPr. This EMPr is compiled in line with relevant legislation and general construction project specifications. However, to ensure sound environmental practice, the measures as described in the operational EMPr should be implemented for the full operational life of the development.

2.4 PROJECT PHASE

The first part of this EMPr is specifically compiled for the ***period of time prior to commencement of activities associated with construction of the above-mentioned activity***.

If and when applicable, where specific activities of the proposed development fall outside of the general principles contained herein, the Department will attach further 'activity – specific' EMPr's as appendices to this document.

2.5 ROLE PLAYERS AND RESPONSIBILITY MATRIX

In order for the EMPr to be successfully implemented, all the role players involved in the project need to co-operate. For this to happen, role players must have a clear understanding of their roles and responsibilities in the project, must be professional, form respectful and transparent relationships, and maintain open lines of communication. The EMPr therefore clearly defines the role players involved and indicates their role in the implementation of the generic EMPr.

Typically, these role players or the project team may include the Authorities (A), Other Authority (OA), Client (C), Consulting Engineers (CE), Resident Engineer (RE), Environmental Officers (EO), Environmental Site Officer (ESO), Environmental Control Officer (ECO), Project Manager (PM), Contractors (C), Environmental Assessment Practitioner (EAP) and Property Owners Association (POA). Further, landowners, interested and affected parties and the relevant environmental and project specialists are also important role players.

3 ENFORCEMENT, MONITORING AND AUDITING

3.1 PRE-CONSTRUCTION AND CONSTRUCTION PHASE

The Client must appoint, at his own cost, an ECO (as part of the construction team) who will oversee the implementation of the EMPr.

DEA&DP must be informed of the appointment of the ECO prior to construction activities if an Environmental Authorisation was granted. Please note that the responsibility of the

particular ECO may end at the end of the construction period. In the event that an ECO is appointed during the operational phase, it must be noted that this ECO may be different from the original ECO and DEA&DP must be notified of this appointment again.

The independent ECO is responsible for fortnightly audits on compliance to relevant environmental legislation, conditions of the Environmental Authorisation (EA) (if applicable), and the EMPr for the project.

The ECO shall at the request of the Department forward audit reports to the Department at a frequency determined by the Department which shall be stipulated in the Environmental Authorisation (EA) (if appliable).

Evidence of the following as **key performance indicators,** must be included in the audit reports:

- Complaints received from landowners and actions taken.
- Environmental incidents, such as oil spills, concrete spills, etc. and actions taken (litigation excluded).
- Incidents leading to litigation and legal contraventions.
- Environmental damage that needs rehabilitation measures to be taken.

A copy of all ESO and EO monitoring reports, contractor method statements, and pro forma documentation must be held by the ESO and/or the EO on site and be made available to the Department and or the ECO upon request.

FORMAL ENVIRONMENTAL COMMUNICATION CHANNELS

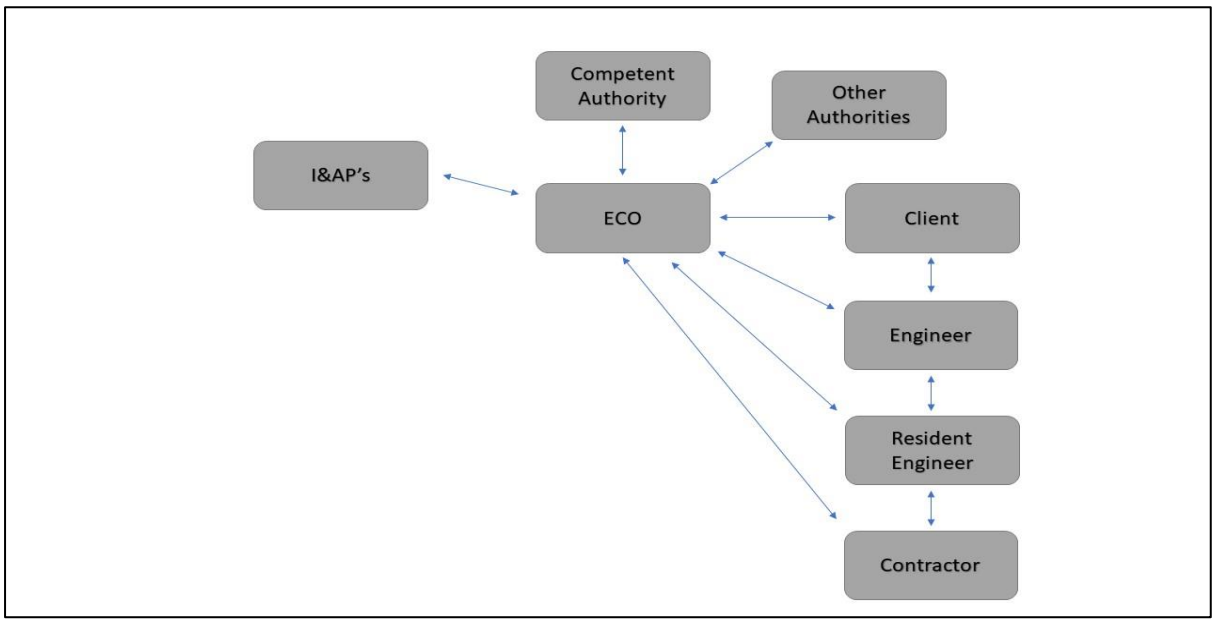


Figure 1: Reporting structure and role players involved in the implementation of the EMPr.

Please note that due to the timeline of the project as well as the coming and leaving of consultants and contractors, as well as the many crossed channels of communication in the DEAD&DP EMPr Guideline, it was decided by the project team to use the GACP-channels of communication whereby the Project Manager remains the central pivot between all the disciplines. All instructions and reports shall flow through the Project Manager (PM). In the environmental matters the PM becomes the Project Environmental Officer (PEO).

3.2 OPERATIONAL PHASE

The ECO shall conduct, at a frequency as determined by the DEA&DP and stipulated in the relevant Environmental Authorisation (EA) (if appliable) for the project, independent environmental audits. The audits are to verify the developments compliance with the operational EMPr and conditions of the EA (if appliable).

The ECO shall at the request of the DEA&DP forward audit reports to the Department at a frequency determined by the Department which shall be stipulated in the EA (if appliable).

The following **Key Performance Indicators** must be included in the audit reports:

- Complaints received from landowners and actions taken.
- Environmental incidents, such as oil spills, fires etc., and actions taken.
- Incidents possibly leading to litigation and legal contraventions.
- Environmental damage that needs rehabilitation measures to be taken.

The minutes of site meetings, to which the ECO will have unrestricted access to, shall be the official record of environmental activities, complaints, and communications. These minutes will be circulated to the entire project team. A copy of the standard site meeting agenda is available on request.

3.3 MEASUREMENT AND PAYMENT

It is understood that environmental requirements included in this EMPr will entail costs over and above those of the civil requirements. These include provision for: mitigation and enhancement actions; training and environmental awareness requirements; monitoring; auditing; and corrective actions. The client shall recognise this and make provision for it in the tender. Costing for management action should be done with inputs and advice from appropriate technical members of the project team and relevant EAP who have knowledge of the management actions being recommended as well as practical experience in implementing similar measures and techniques.

A lump sum must be allocated for the management of Environmental Specifications where it is not possible to cost requirements of the EMPr.

3.4 GENERAL GUIDELINES

Guidelines as per standardised construction documentation must be used.

3.5 AWARENESS (INDUCTION) TRAINING

3.5.1 CONSTRUCTION PHASE

The EO or ESO, or ECO are responsible in ensuring everyone on site is given an environmental awareness induction session which not only clearly defines what the environment is and specifics detailing the local environment but outlines the requirements of the EMPr as a management tool to protect the environment.

Refresher courses must be conducted as and when required. The EO or ESO must ensure daily toolbox talks include alerting the workforce to particular environmental concerns associated with the tasks for that day or the area/habitat in which they are working. Awareness posters and a hand out must be produced to create awareness throughout the site.

3.5.2 OPERATIONAL PHASE

The ECO is responsible in ensuring everyone involved in the operation of the development at ground level receives an environmental awareness induction which not only clearly defines what the environment is and specifics detailing the local environment, but outlines the requirements of the EMPr as a management tool to protect the environment. Awareness posters and a handout must be produced to create awareness throughout the site.

3.6 SITE DOCUMENTATION

3.6.1 CONSTRUCTION PHASE

The following is list of documentation that must be held on site and must be made available to the ECO and/or DEA&DP on request.

- Records of all remediation / rehabilitation activities
- Copies of EO reports (management and monitoring)
- Environmental Management Programme (EMPr)
- Environmental Authorisation (EA) (if appliable)
- Complaints register
- Waste removal slips
- Method Statements

3.6.2 OPERATIONAL PHASE

The following is list of documentation must be held on sight and must be made available to the ECO and/or DEA&DP on request.

- Environmental monitoring reports (if required)
- Records of all remediation / rehabilitation activities (if required)
- Environmental Management Plan (EMPr)
- Complaints register

3.6.3 PRO FORMA DOCUMENTATION

3.6.3.1 Prior to the commencement of construction activities

The following attached pro forma documentation is to be filled out and is binding to the EMPr and project contract and includes, but not limited to, the following:

- Declaration of understanding by the Engineer
- Declaration of understanding by the Contractor

3.6.3.2 During construction activities

The following attached pro forma documentation is to be filled out and maintained. These are binding to the EMPr and project contract. They include, but are not limited to, the following:

- Environmental incidents
- Records of all remediation / rehabilitation activities

3.6.3.3 During the Operational Phase

The following attached pro forma documentation is to be filled out and is binding to the EMPr and project contract and includes, but not limited to, the following:

- Environmental incidents

3.7 TOLERANCES AND NON-COMPLIANCE

The independent ECO is responsible for fortnightly audits on compliance to relevant environmental legislation, conditions of the Environmental Authorisation (EA) (if appliable), and the EMPr for the project.

Should the contractor show repeated non-compliance in terms of the audits, a range of fines may be issued to the contractor. These fines are included at the end of this document. The Engineer, in conjunction with the ECO, shall be the judge as to what constitutes a transgression in terms of this clause, subject to the General Conditions of Contract.

4. GENERIC CONSTRUCTION PHASE EMPR - IMPLEMENTATION

4.1 PREAMBLE

The point of departure for the EMPr is to empower a pro-active rather than re-active approach to environmental performance by addressing potential problems before they occur. This will limit corrective measures needed during the construction phase of the project. Therefore, the purpose of this EMPr is to provide management measures that must be implemented by all contractors and sub-contractors alike to ensure that the potential impacts of the proposed project are minimised. It must also be ensured that the *EMPr is maintained and upheld as a dynamic document* in order for the *project team to add or improve on issues* that might be considered left out or not relevant to the project. In such instances the DEA&DP may authorise the ECO to make such changes.

The following tables form the core mitigation measures appropriate to the pre-construction and construction phase. The tables present, the objectives to be achieved, and the management actions that needs to be implemented in order to mitigate the negative impacts and enhance the benefits of the project. Associated responsibilities, criteria/targets, and timeframes are clearly specified.

The **'pre-construction'** section of this generic EMPr, refers to the period of time leading up to and prior to commencement of construction activities, and is included to ensure pro-active environmental management measures with the goal of identifying avoidable environmental damage at the outset and sustain optimal environmental performance throughout the construction phase. Most impacts will occur during the construction phase and must be mitigated through the contingency plans identified in the pre-construction phase.

The bulk of environmental impacts will have immediate effect during the 'construction' phase (e.g. noise, dust, and water pollution). If the site is monitored on a continual basis during the construction phase, it is possible to identify these impacts as they occur. These impacts will then be mitigated through the measures outlined in this section, together with a commitment to sound environmental management from the project team.

The "construction" section refers to all construction and its operation-related activities that will occur within the approved area and access roads, until the project is completed. This "construction" section is divided into three functional areas, namely "materials"; "plant"; and "construction". Each of these functional areas within the EMPr contains specific generic mitigation requirements and requested contractor method statements stipulated where required.

Many potential environmental impacts will have immediate or long-term effects during the 'operational' phase (e.g. noise, waste management, and water pollution). If the development is monitored on a continual basis during operations, it is possible to identify these impacts as they occur. These impacts will then be mitigated through the measures outlined in this section, together with a commitment to sound environmental management from the client and management team.

It must be noted that the responsible party for the majority of the mitigation measures is that of the Management body, unless otherwise stipulated. The names of the responsible parties must be made available to DEA&DP for record purposes.

The management body must ensure that a maintenance team is employed with the correct equipment and skill to maintain boardwalks, pathways, fences etc. The following tables will refer to the responsible party as "Management body: 'to be announced' and "maintenance crew".

4.2 STRUCTURE AND CONTENTS OF THE TABLES

The table consists of seven parts as follows:

"Phase of development" - This row will identify either pre-construction (planning) or actual construction phase.

"Impact / issue" - This row will identify the issue being addressed, e.g. Materials, site demarcation, heritage, etc.

Mitigation Measure - This column will include all the necessary mitigation measures for each impact/issue'.

Management objectives - This column will indicate what the management objectives to be achieved for each mitigation measure are.

Measurable targets - This column will indicate what evidence is to be used as an indication to whether or not the 'Management objectives' have been implemented and hence achieved.

Responsible party - This column will provide information as to which role player, e.g. ECO, RE, etc. is responsible for the implementation and or management of each mitigation measure.

Frequency of action - These columns provide time guidelines for the 'Responsible party' by which he/she is to action or manage the required mitigation.

4.2.1 SPECIALIST RECOMMENDATIONS

4.2.1.1 Pre-Construction and Construction Phases

The last part of the table provides space for the EAP to add specialist recommendations that need to be addressed during the pre-construction and construction phases.

4.2.1.2 Operational Phase

Additional requirements may need to be added to the table pending conditions required in the Environmental Authorisation (EA) (if applicable). The last part of the table provides space for such conditions, which must be added before the "declaration of understanding" is signed by the client and ECO.

TABLE 1: PRE-CONSTRUCTION (PLANNING) PHASE EMPR

Phase of development	**PRE-CONSTRUCTION (PLANNING)**
Impact / issue	**GENERAL**

MITIGATION MEASURE	MANAGEMENT OBJECTIVES	MEASURABLE TARGETS	RESPONSIBLE PARTY	FREQUENCY OF ACTION
Public Liaison The Contractor is responsible for erecting public information boards at key locations where public access may be affected by construction activities. All public information boards to be erected must comply with the Witzenberg Municipality Outdoor Advertising and Signage By Law, and written approval prior to the erection may be required. The content of the boards will essentially be to advise the public of the construction activities to be undertaken, or being undertaken and to advise of the prohibition of entering demarcated "no-go" areas. The Contractor shall make allowance for the supply, erection, maintenance, and removal of the information boards. Information boards shall also provide the name and contact number of the ECO, to ensure that the public has access to the ECO to request information and/or to lodge any complaints.	• To advise the public of the construction activities to be undertaken, and to advise of the prohibition of entering demarcated "no-go" areas	• Erection of info boards	Contractor	During Site Establishment

Phase of development	PRE-CONSTRUCTION (PLANNING)
Impact / issue	GENERAL

MITIGATION MEASURE	MANAGEMENT OBJECTIVES	MEASURABLE TARGETS	RESPONSIBLE PARTY	FREQUENCY OF ACTION
Project contract and programme The EMPr must be included as part of the tender documentation thereby making it part of the enquiry document to make the recommendations and constraints, as set out in this document, enforceable under the general conditions of contract. A copy of this EMPr must be available on site. The Contractor shall ensure that all the personnel on site, sub-contractors, suppliers, etc. are familiar with and understand the specifications contained in the EMPr.	• Contingencies for minimising negative impacts anticipated to occur during the construction phase. • Ensure environmental awareness and formalise environmental responsibilities and implementation.	• Contract records. • Signed declaration pro forma's.	Project team.	Prior to tender
Site demarcation and development The surveys for the overall project area and construction footprint as approved in the Environmental Authorisation (EA) (if appliable) must be complete and clearly demarcated before the contractors set up their crew camps or begin construction. All areas outside of the site boundary are no-go areas. The EO and ECO must be on site in order to make sure the correct areas are fully demarcated.	• Contingencies for minimising negative impacts anticipated to occur during the construction phase	• Demarcated area's • Filled in section of this document	EAP specialist, Engineer, contractor	As and when required

Phase of development	**PRE-CONSTRUCTION (PLANNING)**
Impact / issue	**GENERAL**

MITIGATION MEASURE	MANAGEMENT OBJECTIVES	MEASURABLE TARGETS	RESPONSIBLE PARTY	FREQUENCY OF ACTION
Emergencies, non-compliance and communication The contractor **must provide method statements** (if applicable) on the protocols to be followed, and contingencies to be put in place for the following, before construction may begin: • Emergency spills procedures for the contamination of soils from spills and fire • Handling & storage of oils and chemicals • Cement and concrete batching, which includes the location, storage, washing, & disposal of cement, packaging, tools, and plant • Diesel tanks and refuelling procedures (if required) • Crew camps and construction lay down areas • Workshop maintenance and cleaning of plant (if required) • Topsoil Management and handling • Erosion management	• Contingencies for minimising negative impacts anticipated to occur during the construction phase	• Method statements	Contractor, Engineer	As and when required

Phase of development	PRE-CONSTRUCTION (PLANNING)
Impact / issue	GENERAL

MITIGATION MEASURE	MANAGEMENT OBJECTIVES	MEASURABLE TARGETS	RESPONSIBLE PARTY	FREQUENCY OF ACTION
• Dust control • Bitumen handling (if applicable) Communication in emergencies must follow the suggested lines of communication as stipulated figure 1.				
Traffic Impact Comply with road rules and signs. Possible traffic disturbances as a result of the activity should be minimized as far possible. Efficient road markings must be available to inform motorists should they prefer to travel a different route. Roads must be swept on a daily basis to prevent sand/mud being a danger to road users.	• To reduce possible traffic impact to expectable standards.	• The existing level of traffic.	Project team.	Design and implementation.
Fauna and Flora All possible sensitive faunal species present on the site (if applicable) must be rescued and relocated to another suitable location prior to the commencement of construction activities. Consult the ECO.	• To protect possible fauna and flora species on the site from being exterminated.	• Should sensitive species be present on the site, the correct re-establishment of these species	Contractor and Client	Before construction commences
Topsoil	• Minimise scarring of the soil surface and land features.	• No visible erosion scars once construction is completed.	Contractor	Daily

Phase of development	PRE-CONSTRUCTION (PLANNING)
Impact / issue	GENERAL

MITIGATION MEASURE	MANAGEMENT OBJECTIVES	MEASURABLE TARGETS	RESPONSIBLE PARTY	FREQUENCY OF ACTION
All alien vegetation needs to be removed from site before the construction activities commence. The topsoil needs to be properly stored on the construction site. Stored topsoil must not be higher than 2m.	• Minimise disturbance and loss of soil. • Minimise construction footprint. • Maintain the integrity of topsoil's for landscaping and rehabilitation. • Containment of invasive plant growth by means of topsoil monitoring. • Minimise contamination of storm water run-off.	• The footprint has not exceeded the agreed site in terms of EA etc. • Minimal invasive weed and grass growth. • No signs of sedimentation and erosion.		
Appointments and duties of project team The contact details for the ECO, RE, EO, Contractor, ESO shall be completed on the attached pro forma, and a copy kept on site. This document must be made available to the DEA&DP on request. Before construction activities commence, role players must have a clear indication of their role in the implementation of this EMPr. Subcontractor(s) contracts with the principle contractor must contain a clause to the effect that the disposal of all construction-generated refuse / waste to an officially approved	• Contingencies for minimising negative impacts anticipated to occur during the construction phase.	• Contract records. • Signed declaration pro forma's.	Project team.	-

Phase of development	**PRE-CONSTRUCTION (PLANNING)**
Impact / issue	**GENERAL**

MITIGATION MEASURE	MANAGEMENT OBJECTIVES	MEASURABLE TARGETS	RESPONSIBLE PARTY	FREQUENCY OF ACTION
dumping site is the responsibility of the subcontractor in question and that the subcontractors are bound to the management activities stipulated in this EMPr.				

TABLE 2: ADDITIONAL CONDITIONS CONTAINED IN THE EA

Phase of development	**PLANNING**	**EA reference number**	
Impact / issue	**EA Conditions**		**……**

MITIGATION MEASURE	MANAGEMENT OBJECTIVES	MEASURABLE TARGETS	RESPONSIBLE PARTY	FREQUENCY OF ACTION
	•	•		
	•	•		

TABLE 3: CONSTRUCTION PHASE EMPR (MATERIALS).

Phase of development	**CONSTRUCTION**
Impact / issue	**Materials**

MITIGATION MEASURE	MANAGEMENT OBJECTIVES	MEASURABLE TARGETS	RESPONSIBLE PARTY	FREQUENCY OF ACTION
Handling				
Stockpiles All stockpiled material must be easily accessible on site without any environmental damage of the surrounding properties. All temporarily stockpiled material must be stockpiled in such a way that the spread of materials are minimised. In the case of strong wind and/or rain all stockpile material must be covered with a tarpaulin in order to prevent erosion. The stockpiles may only be placed within the demarcated areas the location of which must be approved by the RE, EO or ECO. Storm water runoff from the stockpile sites and other related areas must be filtered before entering stormwater system. Stockpiles are to be stabilised if signs of erosion are visible.	• Minimise scarring of the soil surface and land features. • Minimise disturbance and loss of soil. • Minimise construction footprint. • Maintain the integrity of topsoil's for landscaping and rehabilitation. • Containment of invasive plant growth by means of topsoil monitoring. • Minimise contamination of storm water run-off.	• No visible erosion scars once construction is completed. • The footprint has not exceeded the agreed site in terms of EA etc. • Minimal invasive weed and grass growth. • No signs of sedimentation and erosion.	Contractor	Daily

Phase of development	**CONSTRUCTION**
Impact / issue	**Materials**

MITIGATION MEASURE	MANAGEMENT OBJECTIVES	MEASURABLE TARGETS	RESPONSIBLE PARTY	FREQUENCY OF ACTION
Soils from different horizons must be stockpiled such that topsoil stockpiles do not get contaminated by sub-soil material. Topsoil stockpiles must be monitored for invasive exotic vegetation growth. Contractors must remediate as and when required in consultation with the EO, RE and ECO. The Contractor shall ensure that subsoil and topsoil are not mixed during stripping, reinstatement, and rehabilitation. No plant, workforce, or any construction related activities may be allowed onto the topsoil stockpiles. Topsoil stockpiles may not be higher than 2m to avoid compaction thereby maintaining the soil integrity and chemical composition. No topsoil stockpiles stored within the extent of a watercourse.				
Oil and chemicals The contractor **must provide method statements** for the "handling & storage of oils and chemicals", "fire", and "emergency spills procedures".	• Prevention of pollution of the environment. • Minimise chances of transgression of the acts controlling pollution.	• No pollution of the environment. • No litigation due to transgression of pollution control acts.	Contractor	Daily

Phase of development	**CONSTRUCTION**
Impact / issue	**Materials**

MITIGATION MEASURE	MANAGEMENT OBJECTIVES	MEASURABLE TARGETS	RESPONSIBLE PARTY	FREQUENCY OF ACTION
These substances must be confined to specific and secured areas within the contractor's camp, and in a way that does not pose a danger of pollution even during times of high rainfall. These areas must be imperviously bunded with adequate containment (at least 1.1 times the volume of the fuel) for potential spills or leaks Drip trays (minimum of 10cm deep) must be placed under all machinery and vehicles. The surface area of the drip trays will be dependent on the vehicle and must be large enough to catch any hydrocarbons that may leak from the vehicle while standing. The depth of the drip tray must be determined considering the total amount / volume of oil in the vehicle. The drip tray must be able to contain the volume of oil in the vehicle. Any spills larger than 100ℓ should be reported to all local authorities. Spill kits must be available on site and in all vehicles that transport hydrocarbons for dispensing to other vehicles on the construction site.		• No complaints from I & AP's. • Method statements.		

Phase of development	**CONSTRUCTION**
Impact / issue	**Materials**

MITIGATION MEASURE	MANAGEMENT OBJECTIVES	MEASURABLE TARGETS	RESPONSIBLE PARTY	FREQUENCY OF ACTION
Spill kits must be made up of material/product that is in line with environmental best practice (sunsorb is a recommended product that is environmentally friendly). All spilled hazardous substances must be contained in impermeable containers for removal to a General & Hazardous Waste Landfill site, (this includes contaminated soils, and drenched spill kit material). No refuelling or placement of generators etc. may be done or placed within the extent of the watercourse.				
Cement **It is suggested that ready-mix cement be used as far as possible to minimize the possible impact on the surrounding environment.** Cement batching areas must be located in consultation with the RE, EO or ECO to ensure residues are contained and that the proposed location does not fall within sensitive areas such as drainage lines, storm water channels, etc. The contractors **must provide and maintain a method statement** for "cement and concrete batching" which includes the storage, washing & disposal of cement, packaging, tools and plant.	• Minimise the possibility of cement residue entering into the surrounding environment. • Minimise pollution of soil, surface and ground water resources	• No evidence of contaminated soil on the construction site • No evidence of contaminated water resources • Method statement	Contractor	Monitored daily

Phase of development	**CONSTRUCTION**
Impact / issue	**Materials**

MITIGATION MEASURE	MANAGEMENT OBJECTIVES	MEASURABLE TARGETS	RESPONSIBLE PARTY	FREQUENCY OF ACTION
The mixing of concrete shall only be done at selected sites on mortarboards or similar structures to contain run-off into natural vegetation, soils, and streams. Cleaning of cement mixing and handling equipment shall be done using proper cleaning trays. No cement wash water may enter stormwater systems or watercourses. All empty containers must be stored in a dedicated area and later removed from the site for appropriate disposal at a Licensed Landfill site. All empty cement bags are to be picked up immediately to ensure that cement dust is not blown away. All empty cement bags must be stored in a weather and scavenger proof bin. Cement dust is poisonous and will be detrimental to the environment and especially to the river. The visible remains of concrete, either solid, or from washings, shall be physically removed immediately and disposed of as waste to a Licensed Landfill site. Washing of the remains into the ground is unacceptable.				

Phase of development	CONSTRUCTION
Impact / issue	Materials

MITIGATION MEASURE	MANAGEMENT OBJECTIVES	MEASURABLE TARGETS	RESPONSIBLE PARTY	FREQUENCY OF ACTION
No washing of concrete truck chutes will be allowed on site.				
DANGEROUS AND TOXIC MATERIALS **Provision of storage facilities** Materials such as fuel, oil, paint, herbicide, and insecticides must be sealed and stored in bermed areas or under lock and key, as appropriate, in well-ventilated areas. Storage facilities should be bunded, roofed, secure, rain, wind and tamper proof. Storage areas shall display the required safety signs depicting “no smoking”, No ‘’Naked lights” and “Danger” containers shall be clearly marked to indicate contents as well as safety requirements. Sufficient care must be taken when handling these materials to prevent pollution. Training on the handling of dangerous and toxic materials must be conducted for all staff prior to the commencement of construction. In the case of pollution of any surface or groundwater, the Regional Representative of the Department of	• Prevention of pollution of soil, surface and ground water resources in the immediate and surrounding environments • Minimise chances of transgression of the acts controlling pollution	• No visible signs of pollution • No litigation due to transgression of pollution control acts	Contractor	Monitor daily

Phase of development	CONSTRUCTION
Impact / issue	Materials

MITIGATION MEASURE	MANAGEMENT OBJECTIVES	MEASURABLE TARGETS	RESPONSIBLE PARTY	FREQUENCY OF ACTION
Water and Sanitation (DWS) must be informed immediately. Empty containers shall be removed to a Hazardous Waste Landfill site.				
Bulk storage of fuels and oils The contractors must **provide and maintain a method statement** for "Diesel tanks and refuelling procedures". Bulk fuel storage tanks on the site shall be on an impervious surface that is bunded and able to contain at least 110% of the volume of the tanks. A Flammable Liquid License must be obtained for diesel volumes greater than 200 litres. As no application was lodged for this activity, it should be noted that Environmental Authorisation is required for the storage of Diesel and/or Petrol with volumes greater than 30 000 litres. Bulk fuel storage tanks shall be located in a portion of the construction camp where they do not pose a high risk in terms of water.	• Prevention of pollution of soil, surface and ground water resources in the immediate and surrounding environments. • Minimise chances of transgression of the acts controlling pollution.	• No visible signs of pollution. • No litigation due to transgression of pollution control acts. • Method statement.	Contractor.	Once off, as required.

Phase of development	**CONSTRUCTION**
Impact / issue	**Materials**

MITIGATION MEASURE	MANAGEMENT OBJECTIVES	MEASURABLE TARGETS	RESPONSIBLE PARTY	FREQUENCY OF ACTION
Bulk fuel storage tanks shall be placed so that they are out of the way of traffic, so that the risk of the tanks being ruptured or damaged by vehicles is minimised. Bulk fuel storage should be covered during the rainy season.				
Use of dangerous and toxic materials The contractor shall keep the necessary materials and equipment on site to deal with spills/ fire of the materials present should they occur. The contractor shall set up a procedure for dealing with spills/ fire, which will include notifying the ECO and the relevant authorities prior to commencing with construction. These procedures must be developed in consultation and approval by the appointed EO. All staff should receive some form of fire training. Fire buckets and hoses shall be in good working order and easily accessible on site. A record must be kept of all spills and the corrective action taken.	• Prevention of pollution of soil, surface and ground water resources in the immediate and surrounding environments • Minimise chances of transgression of the acts controlling pollution	• No pollution of the environment • No litigation due to transgression of pollution control acts	Contractor	As required

TABLE 4: CONSTRUCTION PHASE EMPR (PERSONNEL & PLANT)

Phase of development	**CONSTRUCTION**			
Impact / issue	**PERSONNEL & PLANT**			
MITIGATION MEASURE	**MANAGEMENT OBJECTIVES**	**MEASURABLE TARGETS**	**RESPONSIBLE PARTY**	**FREQUENCY OF ACTION**
Eating areas and camp followers The contractors **must provide and maintain a method statement** for "Crew camps and construction lay down areas". The Contractor shall in conjunction with the EO, designate the restricted eating area for eating during normal working hours. Two refuse bins with lids must be provided and cleaned on a daily basis. The bins are to be secure, wind, weather, and scavenger proof. Designated areas for smoking must be provided. The feeding, or leaving of food, for stray or other animals in the area are strictly prohibited. Camp followers/informal traders must not be allowed to congregate on pavements or outside the construction site. However, at the contractors discretion facilities can be made available within the designated eating area. Litter (even if originating outside the camp) and concrete bags etc. must be picked up and put into suitably closed bins.	• Control potential influx of vermin and flies • Neat work place and hygienic environment • Minimise negative social impacts to local businesses and residences.	• No visual sign of vermin and flies • No complaints from I & AP's	Contractor, EO	Once off, monitor daily
Toilets and ablution facilities	• Ensure proper sanitation is achieved which will encourage the workforce to	• Workforce use toilets provided	Contractor, RE or EO	As and when required

Phase of development	CONSTRUCTION			
Impact / issue	PERSONNEL & PLANT			
MITIGATION MEASURE	**MANAGEMENT OBJECTIVES**	**MEASURABLE TARGETS**	**RESPONSIBLE PARTY**	**FREQUENCY OF ACTION**
The contractor will be responsible for providing all sanitary arrangements for his and the sub-contractors team. **A minimum of one chemical toilet shall be provided per 15 persons.** Sanitary arrangements shall be to the satisfaction of the ECO and the local authority. The contractor shall keep the toilets in a clean, neat, and hygienic condition. **The contractor shall supply toilet paper at all toilets at all times.** Toilet paper dispensers shall be provided in all toilets. Toilets provided by the contractor must be easily accessible and a maximum of 150m from the works area to ensure they are utilised. All toilets will be located within the contractor's camp. Should toilets be needed elsewhere, their location must first be approved by the RE, EO or ECO. The contractor (who must use reputable toilet-servicing company) shall be responsible for the cleaning, maintenance and servicing of the toilets. The contractor (using reputable toilet-servicing company) shall ensure that all toilets are cleaned and emptied before the builders' or other public holidays. Toilets out on site must be secured to the ground and have a sufficient locking mechanism operational at all times. If workforce is found not using toilet facilities or for an insufficient amount of toilets on site a penalty will be issued.	utilise toilets provided and not the surrounding habitat • Minimise potential of diseases on site • Minimise potential to pollute soils, water resources and natural habitats	• No complaints received from I & AP's as well as members of the workforce • No visible or measurable signs of pollution of the environment (soils, ground and surface water)		

Phase of development	CONSTRUCTION			
Impact / issue	PERSONNEL & PLANT			
MITIGATION MEASURE	**MANAGEMENT OBJECTIVES**	**MEASURABLE TARGETS**	**RESPONSIBLE PARTY**	**FREQUENCY OF ACTION**
Waste management **Please refer to the waste minimization plan as part of this EMPr** Any illegal dumping of waste will not be tolerated. Proof of legal dumping must be able to be produced on request. All refuse bins must have a lid secured so that animals cannot gain access. Sufficient closed containers must be strategically located around the construction site to handle the amount of litter, wastes, rubbish, debris, and builders wastes generated on the site. Subcontractor(s) must contain a clause to the effect that the disposal of all construction-generated refuse / waste to an officially approved dumping site is the responsibility of the subcontractor in question and that the subcontractors are bound to the management activities stipulated in this EMPr. Proof of this undertaking must be issued to the ECO. All solid and chemical wastes that are generated must be removed and disposed of at a licensed waste disposal site. The contractor is to provide proof of such to the EO and ECO. Chemical containers and packaging brought onto the site must be removed for disposal at a suitable site.	• Sustainable management of waste by recycling. • To keep the site neat and tidy. • Minimise litigation and complaints by I&AP's. • Reduce visual impact. • Control potential influx of vermin and flies thereby minimising the potential of diseases on site and the surrounding environment. • Minimise potential to pollute soils, water resources and natural habitats.	• Disposal of rubble and refuse in an appropriate manner with no rubble and refuse lying on site. • Site is neat and tidy. • No complaints from surrounding residents and businesses. • Sufficient containers available on site. • No visible or measurable signs of pollution of the environment (soils, ground and surface water). • Method statement.	Contractor, EO.	Daily.

Phase of development	CONSTRUCTION			
Impact / issue	PERSONNEL & PLANT			
MITIGATION MEASURE	**MANAGEMENT OBJECTIVES**	**MEASURABLE TARGETS**	**RESPONSIBLE PARTY**	**FREQUENCY OF ACTION**
A skip must be used to contain refuse from campsite bins, rubble, and other construction material. **No rubble (concrete, bricks, asphalt etc.) may be spoiled on site. Concrete rubble must be disposed at a Registered General Waste Facility and bitumen rubble must be disposed at a Registered Hazardous Waste Facility.**				
Dust The contractors must **provide and maintain a method statement for "dust control".** The method statement must provide information on the proposed source of water to be utilised and the details of the licenses acquired for such usage. **Water abstraction for dust control from any river is strictly prohibited without prior approval.** Potable water cannot be used as a means of dust suppression, alternative measures must be sourced. The use of 'grey' water must be investigated as an alternative. The contractor will be responsible to source this water and obtain the required approvals. The construction camp shall be watered during dry and windy conditions to control dust fallout.	• Reduce dust fall out. • Reduce visual impact. • Minimise loss of valuable soil material.	• No visible signs of dust. • No complaints from Interested and Affected Parties. • No incidences reported to ECO. • No visible evidence of dust contamination on the surrounding environment. • Method statement. • Baseline targets not exceeded during regular monitoring of dust counts.	RE, Contractor, EO.	Monitored daily.

Phase of development	CONSTRUCTION			
Impact / issue	PERSONNEL & PLANT			
MITIGATION MEASURE	**MANAGEMENT OBJECTIVES**	**MEASURABLE TARGETS**	**RESPONSIBLE PARTY**	**FREQUENCY OF ACTION**
At the end of construction, the site camp must be fully rehabilitated by removing the temporary surface, ripping the area to loosen the soil. All vehicles transporting material that can be blown off (e.g. soil, rubble etc.) must be covered with a tarpaulin, and speed limits of 20 km/h must be adhered to. Excessive dust conditions shall be reported to the ECO.				
Workshop equipment, maintenance and storage The contractors must **provide and maintain a method statement for "workshop maintenance and cleaning of plant".** All maintenance and washing of vehicles and equipment shall be done off-site as far as possible. During servicing of vehicles or equipment, a suitable drip tray shall be used to prevent spills onto the soil. Leaking equipment shall be repaired immediately or be removed from site to facilitate repair. Workshop areas shall be monitored for oil and fuel spills and such spills shall be cleaned and remediate to the satisfaction of the EO or RE. Cleaning and remediation must be done with products that are in line with best environmental practice i.e. Sunsorb. The Contractor shall be in possession of an emergency spill kit that must be complete and available at all times on site. The	• Prevent pollution of the environment • Minimise chance of transgression of the acts controlling pollution • Disposal of hazardous substances to a General & Hazardous Waste Landfill site.	• No pollution of the environment • No litigation due to transgression of pollution control acts • Method statement	RE, Contractor, EO	Monitor daily

Phase of development	CONSTRUCTION			
Impact / issue	PERSONNEL & PLANT			
MITIGATION MEASURE	**MANAGEMENT OBJECTIVES**	**MEASURABLE TARGETS**	**RESPONSIBLE PARTY**	**FREQUENCY OF ACTION**
Contractor must ensure that senior and the other relevant members of the workforce are trained in dealing with spills by using emergency spill kits. All spills of hazardous substances must be reported to the ESO, EO, RE or ECO. The contractor must comply with the regulations of the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993) as well as specific specifications set forth by the health and safety agent.				
Noise All construction vehicles must be in a good working order to reduce possible noise pollution. Work hours during the construction phase shall be according to the Municipal guidelines on working hours. Noise reduction is essential, and Contractors shall endeavour to limit unnecessary noise, especially loud talking, shouting or whistling, radios, sirens or hooters, motor revving, etc. The use of silent compressors is a specific requirement. All machinery to be muffled where possible. Noisy activities shall take place only during working hours. The EO must inform the residents of houses and businesses adjacent to the development in writing 24 hours prior to any planned	• Maintain noise levels below "disturbing" as defined in the National Noise Regulations. • Minimise the nuisance factor of the development.	• No complaints from surrounding landowners or I&APs.	Contractor, EO.	As and when required.

Phase of development	CONSTRUCTION			
Impact / issue	PERSONNEL & PLANT			
MITIGATION MEASURE	**MANAGEMENT OBJECTIVES**	**MEASURABLE TARGETS**	**RESPONSIBLE PARTY**	**FREQUENCY OF ACTION**
activities that will be unusually noisy or any other activities that could reasonably have an impact on the adjacent sites. These activities could include, but are not limited to use of pneumatic jackhammers and compressors etc. No noise louder than 70dB from the ambient noise level. Machinery and equipment on site must be maintained so as to avoid any unnecessary noises.				

TABLE 5: CONSTRUCTION PHASE EMPR (CONSTRUCTION)

Phase of development	**CONSTRUCTION**
Impact / issue	**GENERAL CONSTRUCTION**

MITIGATION MEASURE	MANAGEMENT OBJECTIVES	MEASURABLE TARGETS	RESPONSIBLE PARTY	FREQUENCY OF ACTION
Crew camps Accommodation for members of the workforce will not be permitted on site unless authorisation has been given in terms of the Environmental Authorisation issued for the site. If accommodation is to be provided for workers, details need to be provided as to the location and facilities to be provided for the workers. Dedicated wash areas must be situated away from any surface water sources and natural areas. The contractor's camp shall be monitored for dust fallout and dust suppression applied as required. This may include the laying of gravel, the use of grey water can be considered as an option if the required permits have been acquired. The contractor's camp, offices and storage facilities shall be located within the site boundaries. If this is not feasible an alternative should be designated in consultation with the ECO.	• Minimise water pollution. • Minimise dust fallout. • Minimise unwarranted environmental damage outside the footprint. • Maintain a clean and healthy working environment. • Minimise visual impact to surrounding environment.	• No signs of water or soil pollution. • No complaints from surrounding landowners or I&APs. • No visible signs of litter. • Method statements.	Contractor, EO, ESO.	Monitor daily.

The contractor shall provide labourers to clean up the contractor's camp and construction site on a daily basis. These areas shall then be inspected by the contractor or his/her ESO to ensure compliance with this requirement. The contractor shall be responsible for cleaning the contractor's camp and construction site of all structures, equipment, residual litter and building materials at the end of the construction period and, the topsoil restored in areas where landscaping is to take place.				
Fires The Contractor shall ensure that there is appropriate fire-fighting equipment available on site at all times. No litter or construction related rubble may be burned on site. Fires are only allowed at pre-approved areas to prevent veldt fires.	• Minimise risk of veldt fires. • Minimise destruction of natural fauna and flora. • Maintain safety on site.	• No veldt fires started by the contractor's workforce. • No claims from landowners for damages due to veldt fires. • Method statement.	Contractor, EO, ESO.	Monitor daily.

Erosion and sedimentation To reduce the loss of material by erosion, the contractor shall ensure that disturbance on site is kept to a minimum. The contractor shall be responsible for rehabilitating all eroded areas in such a way that the erosion potential is minimised after construction has been completed. After construction all disturbed areas needs to be landscaped with indigenous species or use the stripped topsoil.	• Minimise erosion damage. • Minimise scarring of the soil surface and land features. • Minimise disturbance and loss of topsoil. • Re-growth of disturbed areas.	• No erosion scars. • No loss of topsoil. • No interference with the natural flow of water. • No visible erosion scars once construction is completed. • The footprint has not exceeded the agreed boundaries. • All damaged areas successfully rehabilitated.	Contractor, EO, ESO.	As and when required.
Fauna <u>All activities on site must comply with:</u> The regulations of the Animal Protection Act, 1962 (Act No. 71 of 1962); and Marine Living Resources Act, 1998 (Act No. 18 of 1998). All construction workers must be informed that the intentional killing of any animal is not permitted as faunal species are a benefit to society. Poaching is illegal and it must be a condition of employment that any employee caught poaching will be dismissed. Employees must be trained on how to deal with fauna species as intentional killing will not be tolerated. In the case of a problem animal e.g. a large snake a specialist	• Minimise disturbance to animals. • Minimise destruction of habitat.	• No complaints from Nature Conservation. • No litigation concerning applicable animal protection acts. • No measurable or visible signs of habitat destruction.	RE, Contractor, EO, ESO.	Monitor daily.

must be called in to safely relocate the animal if the EO or ECO is not able to. All possible sensitive faunal species present on the site must be rescued and relocated to another suitable location prior to the commencement of construction activities. (Consult the ECO in this regard)				
Heritage No heritage features are present on site. In terms of the National Heritage Act, 1999 (Act No. 25 of 1999), should any archaeological artefacts be exposed during construction activities, work on the area where the artefacts were found shall cease immediately and the ECO as well as the Local Council shall be notified within 24 hours. Upon receipt of such notification, the ECO will arrange for the excavation to be examined by an Archaeologist. Under no circumstances shall archaeological artefacts be removed, destroyed or interfered with. Any archaeological sites exposed during demolition or construction activities must not be disturbed prior to authorisation by the Heritage Western Cape and/or the South African Heritage Resources Agency on the appropriate provincial heritage resource agency.	• Limit the destruction of the country's heritage resources. • The preservation and appropriate management of new archaeological finds should these be discovered during construction.	• No destruction of or damage to known archaeological sites.	Contractor, EO, RE, ESO.	Monitor Daily.

No-go / sensitive areas All construction activities must remain within the boundaries of the development area, as demarcated at the start of the construction phase. The construction footprint must be kept to a minimum by constructing boundaries and demarcated around areas not to be disturbed.	• Minimise the potential for the spread of the construction footprint. • Reduce loss of fauna and flora habitat. • Minimise the potential for loss of protected and or endangered fauna and flora species.	• No sign of movement through "no go" areas. • Containment of footprint.	RE, Contractor, ESO, EO.	Monitor daily.
Access routes/haul roads Access roads for earthmoving-equipment must be clearly designated and be positioned as close as possible to the proposed development site. No driving off from the marked roads is permitted and designated parking areas must be identified and demarcated with applicable signage. Neither the site nor its access roads must be utilised for recreational activities, this includes but is not limited to quad bikes, 4x4's and dirt bikes. Security personnel must be informed and ensure that this is enforced.	• Minimise loss of topsoil and enhancement of erosion. • Minimise fauna and flora displacement by destruction of natural habitats.	• No erosion on access roads after completion of construction. • No loss of topsoil due to runoff water on access roads.	Contractor, RE or EO.	As required, monitor daily.
Crime, safety and security No site staff, other than security personnel and skeleton staff shall be housed on site unless otherwise stipulated in the Environmental Authorisation. Security personnel and skeleton staff shall be supplied with adequate protective clothing, ablution facilities, water	• Reduce the risk of potential incidences. • Minimise the potential impact on the environment. • Reduce the risk of possibly fatal incidents occurring on site.	• No incidences reported.	RE, Contractor, ESO, EO.	Monitor daily.

and refuse collection facilities. A boundary fence will serve to prevent public access to the site, for public safety and security reasons. The access to the site must be controlled so as to restrict unauthorised personnel from entering the site. The workers on site must retain some means of identification. The ESO and the contractor are responsible for ensuring that only authorised personnel are on site at all times. The site and crew are to be managed in strict accordance with the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993) and the National Building Regulations. Site-specific conditions and regulations as set forth by the health and safety agent should also be adhered to. The contractor shall ensure that all emergency procedures are in place prior to commencing work. Emergency procedures shall include (but not be limited to) fire, spills, contamination of the ground, accidents to employees, use of hazardous substances and materials, etc. The contractor shall ensure that lists of all emergency telephone numbers / contact persons are kept up to date and that all numbers and names are posted at relevant locations throughout the construction site. The nearest emergency service provider must be identified during all phases of the project as well as its				

capacity and the magnitude of accidents it will be able to handle. The contact details of this emergency centre, as well as the police and ambulance services must be available at prominent locations around the construction site and the construction crew camps.				
Visual impact Shade cloth must be utilised to conceal and minimise the visual impact of contractor camps (if required), lay down and storage areas as practically possible. Compacted areas will be ripped and windrowed topsoil be placed back on the disturbed areas. Topsoil needs to be placed back in such a way that it blends in with the natural contour and surrounding of the natural environment. Rubble and litter must be removed every two weeks or more often as the need arises and be disposed of at a registered landfill site. After construction all disturbed areas needs to be landscaped with indigenous species or the topsoil stripped prior to construction.	• Minimise visual impact.	• No complaints from I & AP's.	Contractor, landscape contractor, ESO.	Monitor daily.
Hydrology Increased run-off during construction must be managed using berm and other suitable structures as required to ensure flow velocities are reduced; this	• Minimise pollution of soil, surface and ground water resources in the immediate and	• No visible signs of pollution. • No signs of siltation of watercourses.	RE, Contractor, EO.	As and when required, monitor daily.

must be done in consultation with the Resident engineer as well as the ECO. The Contractor shall take reasonable measures to control the erosive effects of storm water runoff. Storm water, wherever possible, should be allowed to soak into the land in the area on which the water fell. The contractor shall ensure that excessive quantities of sand, silt and silt-laden water do not enter the storm water system. No wastewater may run freely into any of the surrounding streets.	surrounding environments. • Minimise impeding the natural flow of water. • Minimise the impact on natural water flow dynamics. • Minimise scarring of the soil surface and land features.	• No visible erosion scaring once construction is completed. • Minimum loss of topsoil.		

Soil and Ground water At the beginning of the construction phase, topsoil for vegetation clearance must be stripped and stockpiled/windrowed. All topsoil must be removed and stockpiled on the site. However, the use of topsoil for rehabilitation contaminated by the seed of alien vegetation (e.g. Port Jackson, etc.) must not be permitted unless a programme to germinate the seed and eradicate the seedlings is drawn up and approved, or some other mitigatory feature is found. This must be approved by the ECO. Single handling is recommended. Stockpiles must not be higher than 2m to avoid compaction. Dust suppression is necessary for stockpiles older than a month – with either water or a biodegradable chemical binding agent.	• Minimise scaring of the soil surface and land features. • Minimise disturbance and loss of soil. • Minimise construction footprint. • Minimise sedimentation of nearby drainage lines. • Maintain the integrity of topsoil's for future landscaping and rehabilitation. • Containment of invasive plant growth.	• No visible erosion scars once construction is completed. • The footprint has not exceeded the agreed site in terms of EA etc. • Minimal invasive weed growth. • No signs of sedimentation and erosion. • Method statement.	Contractor.	Daily.

TABLE 6: <u>OPERATIONAL</u> PHASE EMPR (GENERAL)

Phase of development	**OPERATIONAL**
Impact / issue	**General**

MITIGATION MEASURE	MANAGEMENT OBJECTIVES	MEASURABLE TARGETS	RESPONSIBLE PARTY	FREQUENCY OF ACTION
Waste management Please refer to the waste Minimization Plan Herewith attached.	• Sustainable management of waste by recycling • To keep the development neat and tidy • Minimise litigation and complaints by I&AP's • Reduce visual impact • Control potential influx of vermin and flies thereby minimising the potential of diseases at the site and the surrounding environment	• Disposal of refuse in an appropriate manner with no refuse polluting the development • Development is neat and tidy • No complaints from surrounding industries and businesses • Sufficient containers available on site • No visible or measurable signs of pollution of the environment (soils, ground and surface water)	Applicant	

TABLE 7: OPERATIONAL PHASE EMPR (EA CONDITIONS)

Phase of development	OPERATIONAL	GNEC-Guillaume Nel	
Impact / issue	EA Conditions	Developer	.....

MITIGATION MEASURE	MANAGEMENT OBJECTIVES	MEASURABLE TARGETS	RESPONSIBLE PARTY	FREQUENCY OF ACTION
	•	•		
	•	•		

EMPR NON-COMPLIANCE PENALTIES

Environmental management is concerned not only with the final results of the Contractor's operations, but also to the standard of the day-to-day operations required to complete the works.

Penalties may be instituted for non-compliance. The penalty is over and above the cost of rectifying the problem and/or damage. Penalties will vary on a sliding scale from **R 300 to R 5 000** for non-serious to serious issues as determined by the Engineer/RE/ECO. For each subsequent similar offence the fine shall be doubled in value to a maximum value of **R 20 000.**

The Engineer together with the ECO will decide how the penalties, if any, are to be spent on measures improving the environment. Such fines will be issued in addition to any remedial costs incurred as a result of non-compliance with the environmental specifications. The Engineer will inform the Contractor of the contravention and the amount of the fine, the amount will be deducted from the monies due in payment certificates issued under the Contract.

Maximum fines for the following contraventions by either the Contractor and/or his subcontractors may be imposed by the Engineer/ECO, as follows:

- Any persons, vehicles, plant, or materials related to the Contractors operations within the designated boundaries of a “no-go” area **R 5 000**
- Persistent failure to demarcate ‘’no-go’’ areas **R 2 000**
- Damage to trees not specified to be removed **R 3 000**
- Persistent and unrepaired oil leaks from machinery/ not using a drip tray to collect waste oil and other lubricants/not using specified absorbent material to encapsulate hydrocarbon spillage/using inappropriate methods of refuelling **R 3 000**
- Litter on site associated with construction activities **R 2 000**
- Deliberate lighting of illegal fires on site **R 1 000**
- Burning of waste without a permit **R 2 000**
- Insufficient amount of ablution facilities on site **R 500**
- Employees not making use of the site ablution facilities **R 300**
- Failure to implement specified noise controls **R 1 000**
- Failure to empty waste bins/ skips/ litter structures on a regular basis **R 2 000**
- Inadequate dust control or failure to apply dust suppression **R 2 000**
- Any water abstraction activities from a watercourse without approval **R 5 000**
- Inadequate handling of bitumen **R 3 000**
- Inadequate handling of concrete **R 2 000**
- The spoiling of materials outside the approved areas **R 5 000**

Any activity, that in the reasonable opinion of the Engineer, RE and ECO, constitutes a deliberate contravention of the requirements of the specifications relating to environmental matters **R 4 000**

THE CONSTRUCTION OF A BULK SEWER AND STROMWATER PIPES IN NDULI, CERES

(THE WASTE, WATER USE AND ELECTRICITY CONSUMPTION MINIMIZATION AND MANAGMENT PLAN)

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24 August 2023

REFERENCES

DEA&DP, 2003. A Waste Minimization Guideline Document for Environmental Impact Assessments (2003) by Common Ground in association with deVilliers Brownlie Associates.

National Environmental Management Act 107 of 1998 (NEMA)

National Environmental Management: Waste Act 59 of 2008 (NEM:WA)

National Environmental Management Laws Amendment Act 25 of 2014

National Environmental Management: Waste Amendment Act 26 of 2014

Stellendale Village DRAFT Green Building Guidelines by Steadfast Greening, 2008

1. INTRODUCTION

The Client, Drakenstein Municipality, will use this WASTE, WATER USE AND ELECTRICITY CONSUMPTION MINIMIZATION AND MANAGEMENT PLAN to minimize and manage waste and wastage, electricity consumption and water use in the design, construction and operational phase of the proposed activities as a tool in managing the impacts of the proposed development after environmental approval from the Department of Environmental Affairs and Development Planning (DEA&DP) in terms of the Environmental Impact Assessment Regulations GN No. R. 982, R. 983, R. 984, and R. 985 (as amended).

This document is based on the Waste Minimization Guideline Document on the DEA&DP website (by Common Ground in association with de Villiers Brownlie Associates) and the Stellendale Village DRAFT Green Building Guidelines by Steadfast Greening.

The regulation of activities that have a significant impact on the environment as well as the protection of the environment itself, have improved significantly in the last decade and a half with the promulgation of the Constitution, and general environmental legislation, such as the National Environmental Management Act (NEMA) and the National Water Act. One of the main impacts of human activities on the environment is that of waste disposal (Common Ground & deVilliers Brownlie Associates, 2003).

Waste may be in solid, liquid or gaseous form. It may be benign, toxic, or hazardous. The management of hazardous waste, with associated negative impacts on the environment, is generally covered by legislation. The longer term, cumulative impacts of relatively benign waste disposal is poorly addressed by our laws (DEA&DP Waste Minimization Guideline, 2003).

“Waste” in this document is primarily interpreted as solid waste. Waste minimization per se is not specifically legislated in South Africa at present. Similarly, there are no legal instruments that can be used to enforce reduction in wastage of electricity and water although the National Water Act No 36 of 1998 prohibits wastage of water without specifying what wastage means and how this section will be enforced. However, there are a number of laws and overarching policies that are aimed at

sustainable development and sound environmental management, and which are relevant to waste and wastage minimisation.

Wastage is defined in the Oxford Dictionary as…"expend or employ to no purpose or for inadequate result, use extravagantly or ineffectually, squander". Part of the obligation to protect the environment would be to limit wastage of resources. Thus limiting wastage of water would fall within this obligation. So too would be limiting the wastage of electricity that results in pollution at the site of electricity generation (Common Ground & deVilliers Brownlie Associates, 2003).

2. WASTE REDUCTION

2.1 BACKGROUND TO WASTE REDUCTION

A key element of environmentally friendly buildings is to promote awareness and change behaviour around all aspects of waste management.

Waste minimisation can therefore be assessed as a component of waste management that aims to reduce the amount of waste, which has to be disposed of. In this regard waste minimisation is aimed at tackling the causes and sources of waste rather than just trying to address and mitigate the symptoms (e.g. through treatment). Waste management can be depicted as a hierarchy, as shown in Figure 2 below. In the hierarchy, source reduction options are considered as a priority, followed by re-use and recycling options. Treatment options are considered only when acceptable waste minimisation techniques have been investigated. As a "last resort" disposal should be considered.

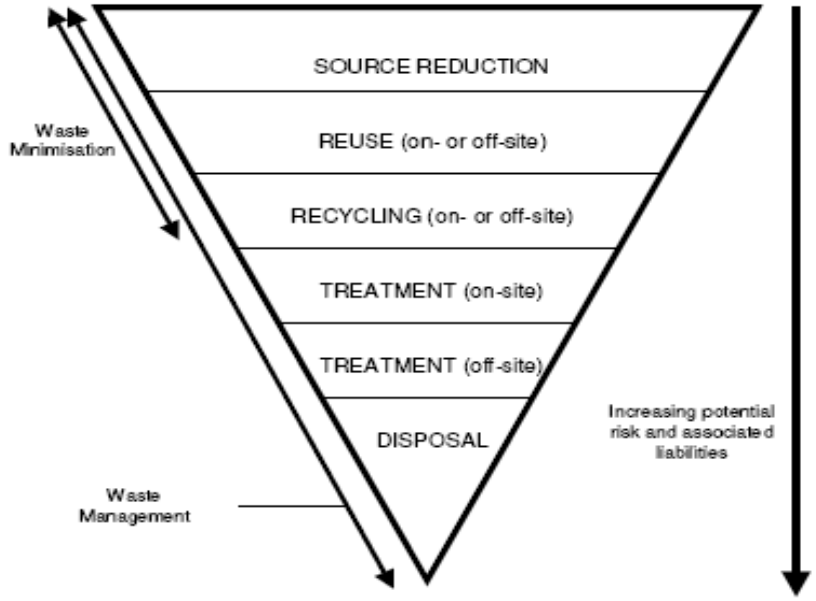


Figure 2 Waste Management Hierarchy (Common Ground & deVilliers Brownlie Associates, 2003).

Waste Management, therefore, involves interventions to minimize waste generation in the planning, operation, management and maintenance of the built environment, and includes waste prevention, waste reduction, waste re-use, and recycling.

A further aspect is minimizing the environmental and health impacts by reducing toxicity, and ensuring environmentally sound treatment and disposal of remaining waste. The ultimate is however to promote a zero waste concept where all the related materials can be used again over the longer term with life-cycle assessments, cradle to cradle.

Zero Waste is a goal, a process, a way of thinking that is different to the way we think about products and processes. Not only is Zero Waste about recycling and avoiding waste going to landfill, it also changes production and distribution systems to prevent waste from being manufactured in the first place. It is a way of changing how materials flow through society in such a way that, as in nature, they flow in a closed loop – resulting in efficient use of material and other resources, such as energy and water (Steadfast Greening, 2008).

Zero Waste therefore aims to:

- Prevent rather than manage waste.

- Turn resource that would normally be thrown away into economic value instead of loss.
- Support sustainable development.
- Follows natural processes where everything is recycled.
- Promote the efficient flow of energy and materials.

It is thus essential to ensure that waste avoidance is built into the process at a design phase, referring to the construction and maintenance of the building. This will be done through selection of the appropriate building materials and managing the construction process in a responsible manner.

Opportunities for the separation of waste at source must also be built into the design of the building to encourage people to recycle their waste.

2.2 BENEFITS OF WASTE REDUCTION

The benefits of waste reduction as described in the DEA&DP Waste Minimization Guideline (Common Ground & deVilliers Brownlie Associates, 2003) include the following benefits.

2.2.1 FINANCIAL BENEFITS

- Reduced transportation costs for waste materials (less transportation because of less material wasted).This includes transportation to and from the site and disposal.
- Reduced disposal costs of waste materials (disposal costs are likely to rise significantly in the near future)
- Reduced purchase quantity and price of raw materials by waste minimisation.
- Reduced purchase price of new materials when considering reuse and recycling (depending on materials).
- Increased returns can be achieved by selling waste materials to be reused.

2.2.2 ENVIRONMENTAL BENEFITS

Some of the environmental benefits are:

- Reduced quantity of waste generated.

- Efficient use of waste generated.
- Minimised amounts of waste disposed of at landfills, which therefore extend the lifespan of landfills.
- Reduced environmental effects as a result of disposal, e.g. noise, pollution.
- Reduced transportation of waste to be disposed of (hence less noise, vehicle emission pollution, and energy used).

2.2.3 SOCIAL BENEFITS

- Increased site safety.
- Increased work efficiency.
- Enhanced company image.
- Job creation through recycling initiatives.

2.3 GENERATED WASTE

2.3.1 EXAMPLES OF WASTE GENERATED DURING CONSTRUCTION:

- Waste wood from cutting structural elements, broken structural elements and damaged elements from incorrect storage
- Damaged or off-cut steel components
- Off-cut electrical wiring and cabling
- Broken or off-cut tiles
- Packaging
- Off-cut and broken bricks
- Surplus material from cut and fill activities
- Spoil from cut and fill activities
- Off-cut, or broken conduit and plumbing
- Off-cut or damaged insulation elements
- Surplus paint and paint containers
- Broken or redundant plant and equipment
- Surplus concrete, cement and grouting
- General waste

3. WASTE MINIMIZATION PLAN

3.1 WASTE MINIMIZATION DURING CONSTRUCTION

Issue	Minimization Plan
General Considerations	
Material Selection	The Client will, for as far as it is economically feasible select: • materials for least waste generation during preparation and use during construction, • materials used in the construction which are durable in order to minimise maintenance or replacement, • standard materials to increase re-use/ recycling potential, • materials which are sourced locally.
Pre-Fabrication	The Client will, for as far as it is economically feasible make use of pre-fabricated components in order to minimise waste on site and permit re-use by the manufacturers of any waste generated during construction of the units.
Hazardous Substances	The Client will, for as far as it is economically feasible make use of non hazardous substances to replace hazardous substances such as replacing asbestos with fibre glass etc.
Ordering	The Client will strive to order materials "just-in-time" to avoid deterioration/ breakage during storage The Client will strive to (as far as reasonably possible) order materials only from suppliers which will take back any unused/ off-spec or broken materials favoured. The Client will strive to (as far as reasonably and economically possible) order materials in bulk to reduce packaging but without over-ordering resulting in waste generation. Suppliers which take back the packaging will be favoured by the Client.

Load and unloading of materials	The construction site staff will be trained to load and unload materials correctly to avoid breakage and wastage.
Storing of materials	Care will be taken to ensure that materials are stored appropriately according to supplier specifications to reduce the risk of damage or deterioration.
The use of temporary structures	The Client will attempt to keep temporary structures on site to a minimum. Where unavoidable the temporary structures used on this site, will be re-used on other sites.
General	The **contractors must provide and maintain a method statement** for "solid waste management". The method statement must provide information on the proposed licensed facility to be utilised and details of proposed record keeping for auditing purposes. For the disposal of clean building rubble, a General & Hazardous Waste Landfill sites can be utilized. • Waste shall be separated into recyclable and non-recyclable waste, and shall be separated as follows: Hazardous waste: including (but not limited to) old oil, paint,etc, • General waste: including (but not limited to) construction rubble, • Reusable construction material. Recyclable waste shall preferably be deposited in separate bins. The contractor is advised that "Collect-a-Can" collect tins, including paint tins, chemical tins, etc. and "Consol" collect glass for recycling. Any illegal dumping of waste will not be tolerated. Proof of legal dumping must be able to be produced on request.

	Bins must be clearly marked for ease of management. All refuse bins must have a lid secured so that animals cannot gain access. Under no circumstances may any waste be burnt. All waste must be managed in accordance with the Norms and Standards in terms of NEM:WA.
	The use of building materials which result in least amount of waste generated (e.g. pre-fabrication as opposed to on-site construction/ fabrication) will be favoured by the Client as far as economically feasible. Materials will be re-used on site wherever possible. Off-cuts and equipment will be re-used on other jobs wherever possible.

4. WATER USE AND MANAGEMENT PLAN

4.1- WATER USE MINIMIZATION AND MANAGEMENT DURING CONSTRUCTION AND OPERATION

CONSTRUCTION PHASE	
Issue	Management Plan
General Considerations	
Ablutions	The Client will re-use as much of the water from wash basins on site as possible.
Concrete and cement preparation	The Client /contractor will order concrete and cement from supplier for as far as possible. The mixing area should not contain any liquids, to prevent contamination of soil and storm water
General cleansing operations	All hoses will be fitted with trigger gun spray nozzles to limit wastage. Dry sweeping will be used (for as far as possible) in preference to washing of areas and equipment. Wherever possible biodegradable and non-toxic detergents, soaps and degreasers will be used. Regular Maintenance of equipment will be conducted in order to prevent wastage.

ANNEXURE 1 DECLARATION OF UNDERSTANDING BY THE ENGINEER

I, _____

Representing _____

Declare that I have read and understood the contents of the Environmental Management Programme for:

Contract _____

I also declare that I understand my responsibilities in terms of enforcing and implementing the Environmental Specifications for the aforementioned Contract.

Signed: _____

Place: _____

Date: _____

Witness 1: _____

Witness 2: _____

ANNEXURE 2 DECLARATION OF UNDERSTANDING BY THE CONTRACTOR

I, _____

Representing _____

Declare that I have read and understood the contents of the Environmental Management Programme for:

Contract _____

I also declare that I understand my responsibilities in terms of enforcing and implementing the Environmental Specifications for the aforementioned Contract.

Signed: _____

Place: _____

Date: _____

Witness 1: _____

Witness 2: _____

ANNEXURE 3 INCIDENT AND ENVIRONMENTAL LOG

ENVIRONMENTAL INCIDENT LOG				
Date	**Env. Condition**	**Comments** *(Include any possible explanations for current condition and possible responsible parties. Include photographs, records etc. if available)*	**Corrective Action Taken** (*Give details and attach documentation as far as possible)*	*Signature*

DEPARTMENT OF LAND REFORM AND RURAL DEVELOPMENT

CONTRACT NO.: SSC WC 01 (2026/2027) DLRRD

THE APPOINTMENT OF A CONTRACTOR FOR THE CONSTRUCTION OF A SEWER AND STORMWATER PIPE IN NDULI, CERES, UNDER WITZENBERG MUNICIPALITY, IN THE WESTERN CAPE PROVINCE

C7: DRAWINGS

Civil Drawings	
DRAWING NUMBER	**DRAWING TITLE**
P1174-L01	Sewer Layout
P1174-L02	Sewer Long Section
P1174-L03	Stormwater Long Section
P1174-L04	Stormwater Long Section
P1174-L05	Detail of Flushing Syphon Chamber
P1174-L06	Detail of Steel Mesh Fencing
P1174-L07	Stormwater Details
P1174-L08	Sewer Details
P1174-L09	Traffic Accommodation
P1174-L10	Project Nameboard

Mechanical and Electrical Drawings	
DRAWING NUMBER	**DRAWING TITLE**
P1174/M01	Nduli Screening Facility: Mechanical & Electrical Equipment Layout
P1174/M02	Nduli Screening Facility: General Civil Layout
P1174/M03	Nduli Screening Facility: Process Flow Diagram



PROPOSED SEWER LAYOUT

SCALE 1:1000

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LEGEND
EXISTING SERVICES

- 200mmØ PVC-U CLASS 34 PIPELINE
- FOUL SEWER MANHOLE
- FOUL SEWER FLOW DIRECTION
- 196.00 / 194.00 / 2.00 — COVER LEVEL / IL (OUT) / DEPTH

LEGEND
PROPOSED SERVICES

- NEW FOUL SEWER
- FOUL SEWER MANHOLE
- FOUL SEWER FLOW DIRECTION
- 196.00 / 194.00 / 2.00 — COVER LEVEL / IL (OUT) / DEPTH

REVISIONS

REV	DESCRIPTION	DATE	BY
A	ISSUED FOR TENDER	2026/04/20	AvN

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PROJECT

NDULI MAIN SEWER LINE UPGRADE

DRAWING No.

P1174-L01

REV A

PROJECT No.
P1174

CONTRACT No.
SSC WC 01 (2026/2027)
DLRRD

SHEET
1 OF 1

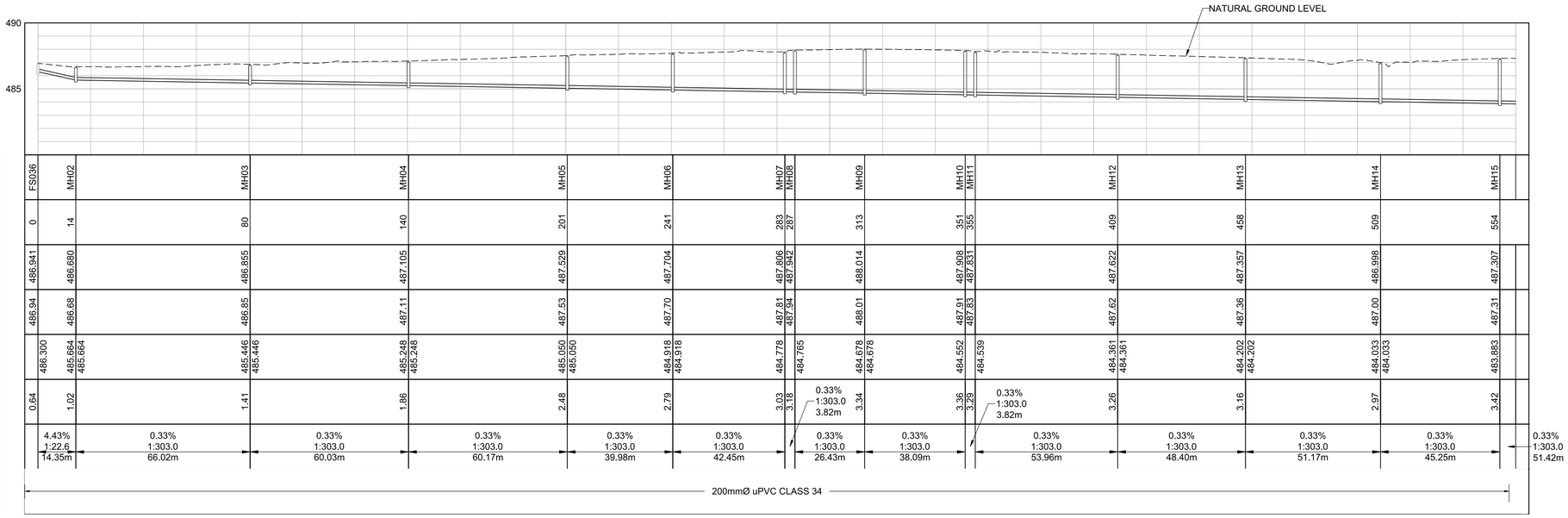
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PAPER SIZE
A1

DATE
2026/04/20

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Vertical 1:200

DATUM 480.000



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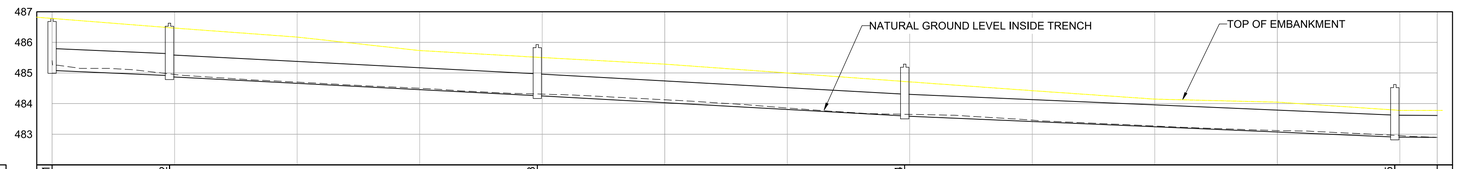
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STORMWATER LAYOUT
SCALE 1:500

SCALES:
Horizontal 1:250
Vertical 1:50

DATUM 482.000



MANHOLE NUMBER		SWMH1.1	SWMH1.2	SWMH1.3	SWMH1.4	SWMH1.5	HW1.1
DISTANCE (m)		0	19	79	139	219	226
GROUND LEVEL		485.409	484.972	484.315	483.652	482.965	482.897
COVER LEVEL		486.78	486.63	485.93	485.29	484.62	483.84
PIPE INVERT LEVEL	IL (IN)	485.140	484.972	484.316	483.652	482.965	482.955
	IL (OUT)		484.936	484.315	483.652	482.965	
SLOPE / LENGTH			0.88% 1:114.1 19.17m	1.03% 1:96.8 60.03m	1.11% 1:90.4 59.97m	0.86% 1:116.5 80.00m	0.15% 1:680.3 6.91m
DEPTH TO INVERT		1.64	1.69	1.61	1.64	1.66	0.89
PIPE TYPE AND SIZE		600mmØ CLASS 100D REINFORCED CONCRETE PIPE					
CROSSINGS							

STORMWATER LONGITUDINAL SECTION
SCALE AS SHOWN

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LEGEND
EXISTING SERVICES

- 200mmØ PVC-U CLASS 34 PIPELINE
- FOUL SEWER MANHOLE
- FOUL SEWER FLOW DIRECTION
- 196.00 / 194.00 / 2.00 — COVER LEVEL / IL (OUT) / DEPTH

LEGEND
PROPOSED SERVICES

- NEW 600mm STORMWATER
- STORMWATER MANHOLE
- STORMWATER FLOW DIRECTION
- 196.00 / 194.00 / 2.00 — COVER LEVEL / IL (OUT) / DEPTH

REVISIONS

REV	DESCRIPTION	DATE	BY
A	ISSUED FOR TENDER	2026/04/20	AvN

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NDULI MAIN SEWER LINE UPGRADE

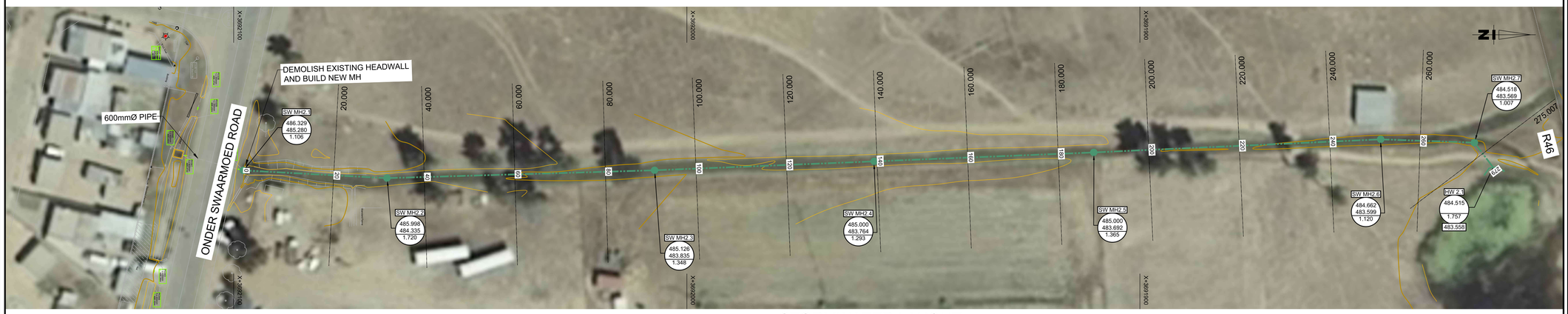
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PROJECT No. P1174
CONTRACT No. SSC WC 01 (2026/2027) DLRRD
SHEET 1 OF 1
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DATE 2026/04/20

Date: 2023-05-30
Checked: Shaun Roestorff
Auditing:

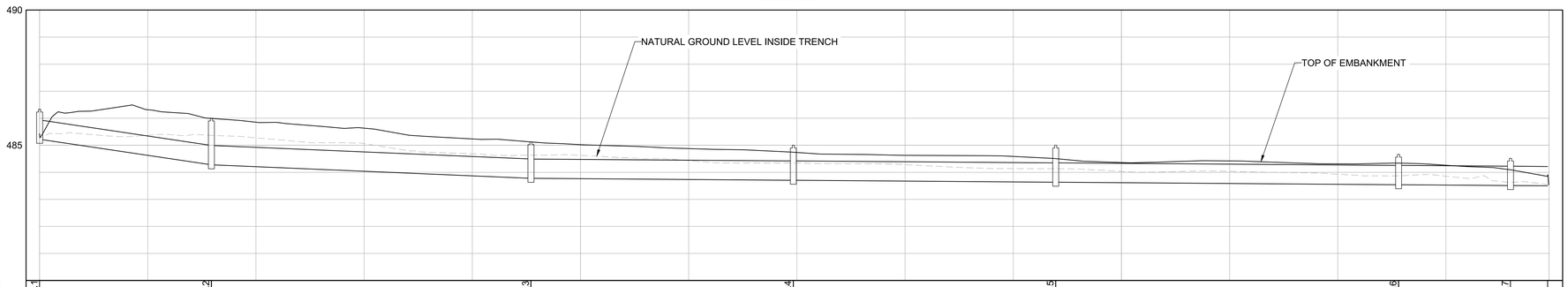


KEY PLAN
SCALE 1:4500



STORMWATER LAYOUT

SCALE 1:500



SCALES:
Horizontal 1:250
Vertical 1:50

DATUM 480.000

MANHOLE NUMBER	SW MH2.1	SW MH2.2	SW MH2.3	SW MH2.4	SW MH2.5	SW MH2.6	SW MH2.7	HW 2.1	
DISTANCE (m)	0	32	91	139	188	251	???	279	
GROUND LEVEL	485.432	485.365	484.633	484.341	484.134	483.870	483.629	483.545	
COVER LEVEL	486.33	486.00	485.13	485.00	485.00	484.66	484.52	484.52	
PIPE INVERT LEVEL IL (IN)	485.280	484.335	483.835	483.764	483.692	483.599	483.569	483.569	
PIPE INVERT LEVEL IL (OUT)		484.335	483.835	483.764	483.692	483.599	483.569	483.558	
DEPTH OF MANHOLE	1.11	1.72	1.35	1.29	1.36	1.12	1.01	1.76	
SLOPE / LENGTH		2.97% 1:33.6 31.76m	0.85% 1:118.0 59.08m	0.15% 1:680.3 48.51m	0.15% 1:680.3 48.51m	0.15% 1:680.3 63.39m	0.15% 1:680.3 20.71m	0.15% 1:680.3 6.87m	
PIPE TYPE AND SIZE	600mmØ CLASS 100D REINFORCED CONCRETE PIPE								
CROSSINGS									

STORMWATER LONGITUDINAL SECTION

SCALE AS SHOWN

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LEGEND
EXISTING SERVICES

- 200mmØ PVC-U CLASS 34 PIPELINE
- FOUL SEWER MANHOLE
- FOUL SEWER FLOW DIRECTION
- 196.00 / 194.00 / 2.00 — COVER LEVEL / IL (OUT) / DEPTH

LEGEND
PROPOSED SERVICES

- NEW 600mm STORMWATER
- STORMWATER MANHOLE
- STORMWATER FLOW DIRECTION
- 196.00 / 194.00 / 2.00 — COVER LEVEL / IL (OUT) / DEPTH

REVISIONS

REV	DESCRIPTION	DATE	BY
A	ISSUED FOR TENDER	2026/04/20	AvN

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NDULI MAIN SEWER LINE UPGRADE

P1174-L04

REV A

PROJECT No. P1174	SCALE AS SHOWN
CONTRACT No. SSC WC 01 (2026/2027) DLRRD	PAPER SIZE A1
SHEET 1 OF 1	DATE 2026/04/20

Date: 2023-05-30
Checked: Shaun Roestorff
Auditing:

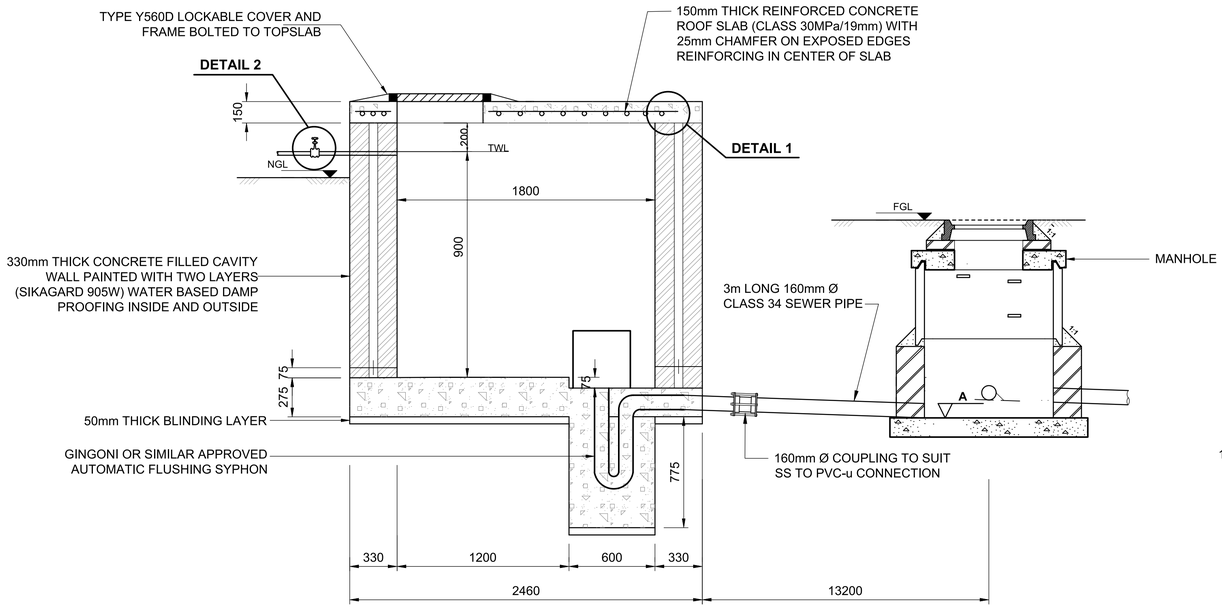
NOTES:

1. MATERIALS :

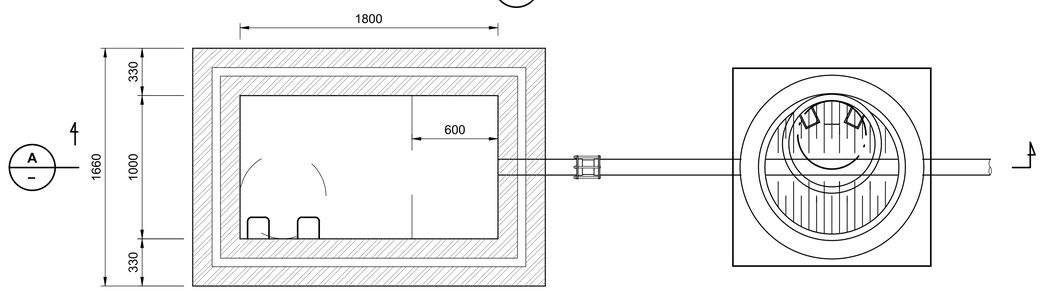
1. ALL STEEL PIPES TO BE STAINLESS STEEL GRADE 316 AND 4.5mm THICK
2. DIMENSIONS OF ALL PIPES, FITTINGS, VALVES, ETC. MUST BE SUBMITTED FOR APPROVAL ON A SHOPDRAWING BEFORE ANY MATERIAL IS ORDERED.
3. STEP IRONS TO BE CALCAMITE-TYPE OR APPROVED EQUIVALENT.
4. ALL STRUCTURAL CONCRETE SHALL BE 30MPa/19mm CONCRETE.

2. GENERAL :

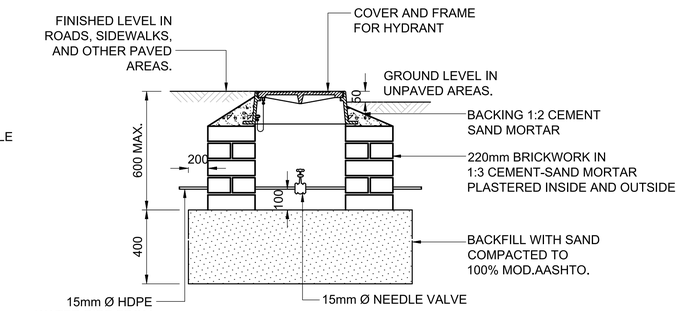
1. ALL DIMENSIONS SHOWN ON THIS DRAWING SHALL BE VERIFIED BY THE CONTRACTOR IN ORDER TO ENSURE THAT ON-SITE REQUIREMENTS ARE MET. DIMENSIONS MAY VARY DEPENDING ON THE TYPE AND MAKE OF ITEMS SUCH AS VALVES. ANY DISCREPANCIES MUST BE REPORTED TO THE ENGINEER PRIOR TO THE ORDERING OF ANY MATERIALS.
2. FINAL POSITION OF VALVES AND DISMANTLING JOINTS TO BE DETERMINED ONCE PUDDLE PIPES HAVE BEEN FIXED INTO PLACE



SECTION A — 1:20



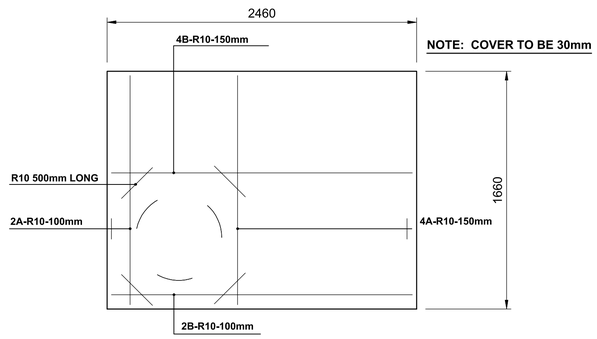
PLAN 1:20



DETAIL 2 NEEDLE VALVE CHAMBER
NTS



DETAIL 1 — NTS



REINFORCING : TOP SLAB : SYPHON CHAMBER
NTS

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PROJECT
NDULI MAIN SEWER LINE UPGRADE

DRAWING No.
P1174-L05
REV A

PROJECT No.
P1174

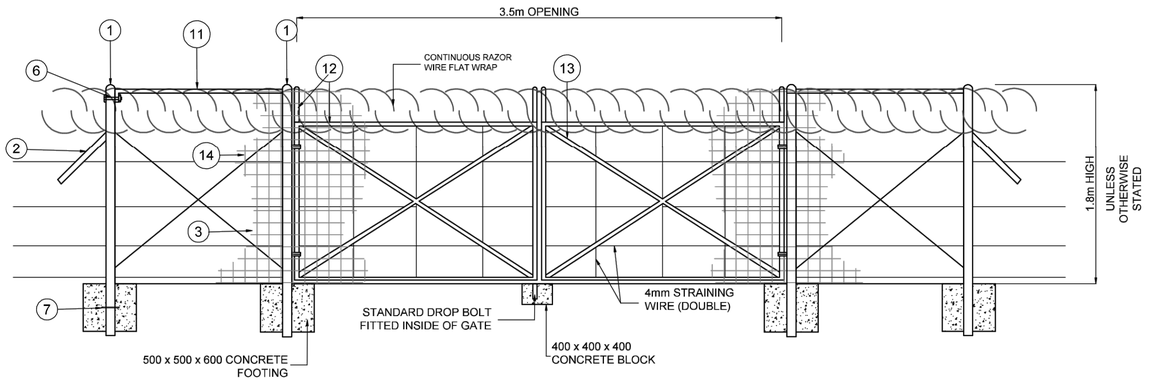
CONTRACT No.
SSC WC 01 (2026/2027) DLRRD

SHEET
1 OF 1

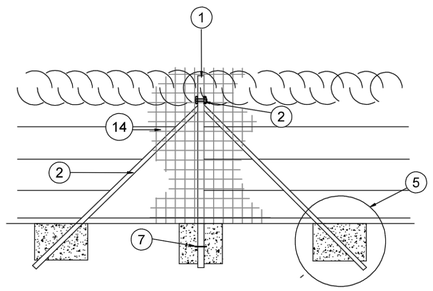
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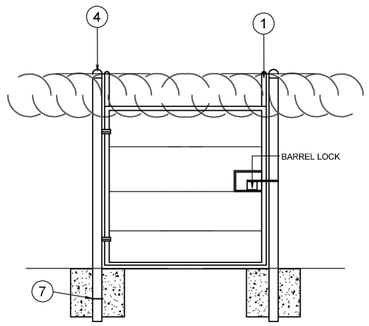
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2026/04/20



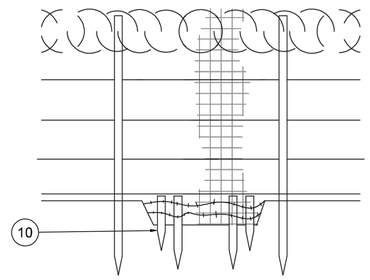
GATE



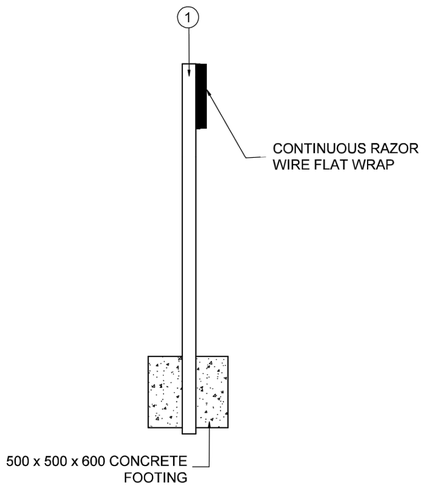
STRAINING POST



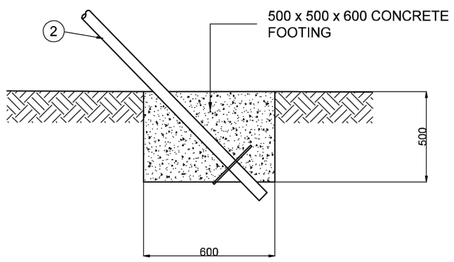
PEDESTRIAN GATE



ACCROSS CHANNELS AND TRENCHES



STRAINING POST



DETAIL 1

LEGEND:

1. **101.6mm OUTSIDE DIA STEEL PIPE, WALL THICKNESS = 2.95mm**
2. **60,33mm OUTSIDE DIA STEEL PIPE, WALL THICKNESS = 2.95mm**
3. **6-CORD STRAINING WIRE**
4. **SEE GENERAL NOTES**
5. **SEE DETAIL 1**
6. **10mm DIA x 300mm ANCHOR PIN**
7. **10mm DIA x 300 mm ANCHOR PIN**
8. **CLASS CONCRETE 25MPa/19mm**
9. **NATURAL GROUND LEVEL**
10. **STEEL POSTS**
11. **42, 86mm OUTSIDE DIA STEEL PIPE, WALL THICKNESS = 2.64mm**
12. **48,42mm OUTSIDE DIA STEEL PIPE, WALL THICKNESS 2.95mm**
13. **34,13mm OUTSIDE DIA STEEL PIPE, WALL THICKNESS = 2.64mm**
14. **STEEL MESH, 2.5mm THICK WITH 50mm X 50mm OPENINGS**

STEEL MESH FENCING

NTS

NOTES:

1. ALL WORK MUST BE DONE IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS SANS1200 AND THE GENERAL CONDITIONS OF CONTRACT FOR THE CONSTRUCTION OF CIVIL ENGINEERING WORKS
2. ALL THE MODIFICATION TO EXISTING SERVICE AND DEVIATIONS FROM TO THE DESIGN TO BE AS PER INSTRUCTION OF THE ENGINEER ONLY.
3. ALL DISCREPENCIES ON DRAWINGS TO BE CLARIFIED WITH THE ENGINEER PRIOR TO CONSTRUCTION
4. CONTRACTOR TO ENSURE THAT ALL SPECIALS ARE COMPATABLE ,PRIOR TO ORDERING OF THE MATERIALS
5. ALL MATERIALS TO BE APPROVED BY THE ENGINEER : WATER SERVICE PRIOR TO CONSTRUCTION
6. ALL STEEL MEMBERS (EXCLUDING WIRING) TO BE HOT DIPPED GALVANISED IN COMPLIANCE WITH SANS 32 CLASS A1.
7. UNLESS STATED OTHERWISE, THE FOLLOWING SHALL APPLY:
   i) ALL CONCRETE TO BE 25MPa/19mm
   ii) CEMENT : SAND RATIO OF MORTAR TO BE 1:3
8. ALL OPENINGS ON POST MUST BE SEALED
8. ALL WIRING, INCLUDING BARBED WIRE, BUT EXCLUDING RAZOR WIRE, TO BE HEAVY DUTY HOT DIPPED GALVANISED TO SANS (675:2009) CLASS A,COATING DESIGNATION Z600
9. 2m WIDE STRIP ALONG FENCING ROUTE TO BE CLEANED FOR FENCE INSTALLATION
10. VERTICAL ALIGNMENT OF FENCE SECTIONS TO BE CONFIRMED WITH RESIDENT ENGINEER PRIOR TO PERMANENT FIXING OF WALL SECTIONS
11. RAZOR AND BARBED WIRE TO BE CONNECTED TO EACH OTHER AT 500mm INTERVALS WITH BINDING WIRE.
12. UPON COMPLETION OF FENCE, 1.0m STRIP OF GROUND ON BOTH SIDES OF FENCE TO BE TREATED WITH WEED KILLER FOR FULL LENGTH OF FENCE.
13. RAZOR WIRE FLATWRAP TO BE CONNECTED TO EACHOTHER AT 500mm INTERVALS
14. STRAINING POSTS TO BE INSTALLED EVERY 50m
15. STRAIN WIRE 4mm Ø MILD STEEL OR 2mm ØHIGH TENSILE STEEL
16. 150mm THICK GRAVEL DRAINAGE LAYER TO BE PLACED AS PER THE ENGINEERS INSTRUCTIONS
17. ALL STAINLESS STEEL BOLT THREADS TO BE TREATED WITH NICKEL ANTI SEEZE COMPOUND

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PROJECT

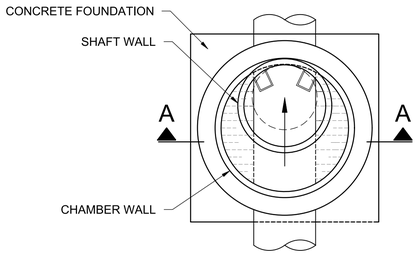
NDULI MAIN SEWER LINE UPGRADE

DRAWING No.

P1174-L06

REV A

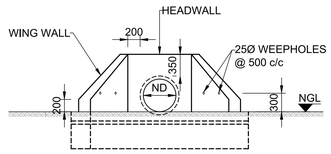
PROJECT No.	SCALE
P1174	AS SHOWN
CONTRACT No.	PAPER SIZE
SSC WC 01 (2026/2027) DLRRD	A1
SHEET	DATE
1 OF 1	2026/04/20



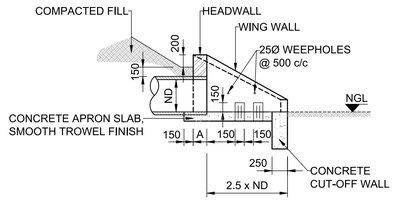
PLAN VIEW

NOTES:

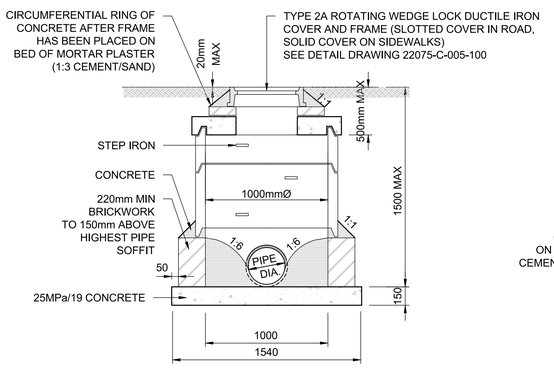
1. FINAL COVER LEVELS:
   IN ROADS, SIDEWALKS & WALKWAYS: FLUSH WITH FINAL LEVELS.
   WITHIN THE ERVEN: 250mm ABOVE THE SURROUNDING FINAL GROUND LEVEL
   OPEN VELD: 500mm ABOVE THE SURROUNDING NATURAL GROUND LEVEL.
2. BENCHING TO BE RENDERED IN 20mm CEMENT MORTAR.
3. COPOLYMER POLYPROPYLENE COVERED STEP IRONS TO BE PLACED AT 250mm CENTRES AND STAGGERED LEFT AND RIGHT 250mm c/c.
4. THE COVER SLAB TO BE POSITIONED SUCH THAT THE MANHOLE COVER IS CENTERED OVER THE DOWNSTREAM END OF THE MAJOR THROUGH PIPE.
5. PIPE SOFFIT LEVELS IN MANHOLE TO BE EQUAL EXCEPT WHERE OTHERWISE SHOWN.
6. ALL CONCRETE TO BE CLASS 25MPa/19mm.
7. ALL PIPE CONNECTIONS TO MANHOLES TO HAVE FLEXIBLE JOINTS.
8. BRICKWORK ON THE MANHOLES MUST BE PLASTERED ON THE OUTSIDE AND BAGGED ON THE INSIDE.



FRONT ELEVATION



SECTION A-A



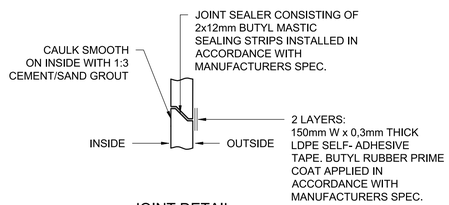
SECTION A-A

SHALLOW MANHOLE (DEPTH < 2,5m)

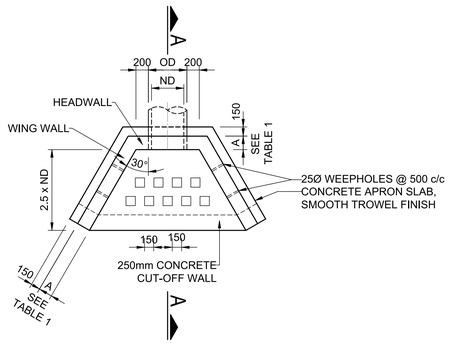
DETAIL OF STORMWATER MANHOLE

SCALE 1:25

PIPE DIAMETER	CHAMBER DIAMETER
375	1000
450	1000
525	1250
UP TO 675	1250



JOINT DETAIL



TYPICAL INLET/OUTLET STRUCTURE

SCALE 1:50

TABLE 1
HEADWALL & WING WALL THICKNESS

NOMINAL PIPE DIAMETER (ND)	WALL THICKNESS "A"	
	BRICKWORK	CONCRETE
300 - 600	230	150
675 - 1350	350	200

NOTES:

1. DISSIPATING BLOCKS 150x150x300 WITH 2xY12x200mm
2. ALL CONCRETE TO BE CLASS 20/19 MPa
3. PIPE OUTLETS WITHOUT ANY WALLS ARE NOT PERMISSIBLE
4. HEADWALL AND WING WALLS TO BE CONSTRUCTED FROM EITHER BRICKWORK OR CONCRETE.
5. BRICKWORK: SEE SECTION 10.4.10 "SPECIFICATION FOR MASONRY UNITS".
6. ALL EXPOSED BRICKWORK TO BE RENDERED IN 12mm PLASTER (CEMENT:SAND RATIO 1:3)
7. ALL EXPOSED CORNERS TO HAVE 25mm CHAMFER
8. WEEP HOLES TO BE PROVIDED WHERE REQUIRED.
9. REINFORECEMENT IN WINGWALL AND HEADWALL FOR PIPES AND CULVERTS 900mm AND BIGGER
   IN FRONT: Y6,3 - 200x200 - 245 MESH
   BEHIND: Y8 - 200x200 - 395 MESH WITH 600mm LENGTH IN FLOOR SLAB

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PROJECT

NDULI MAIN SEWER LINE UPGRADE

DRAWING No.
P1174-L07
REV A

PROJECT No.
P1174

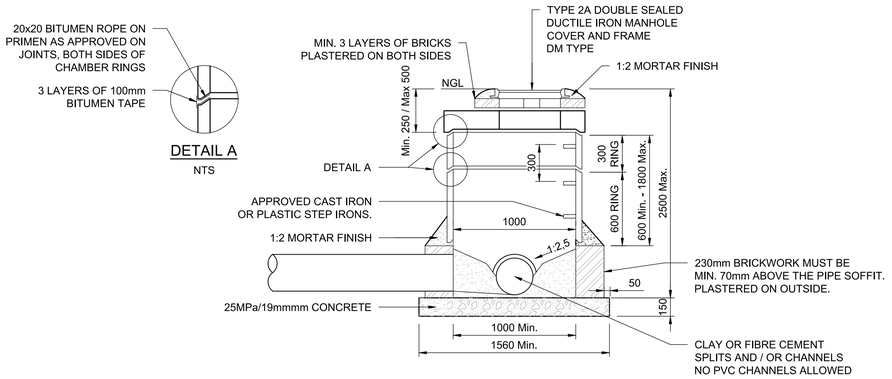
CONTRACT No.
SSC WC 01 (2026/2027)
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SHEET
1 OF 1

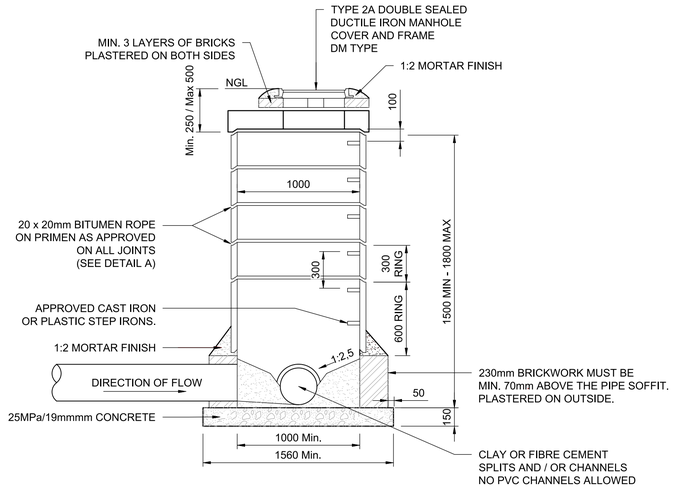
SCALE
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PAPER SIZE
A1

DATE
2026/04/20



SHALLOW SEWER MANHOLE
(PRECAST CONCRETE RINGS)
SCALE 1:25



DEEP SEWER MANHOLE
(PRECAST CONCRETE RINGS)
SCALE 1:25

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PROJECT
NDULI MAIN SEWER LINE UPGRADE

DRAWING No.
P1174-L08
REV A

PROJECT No.
P1174

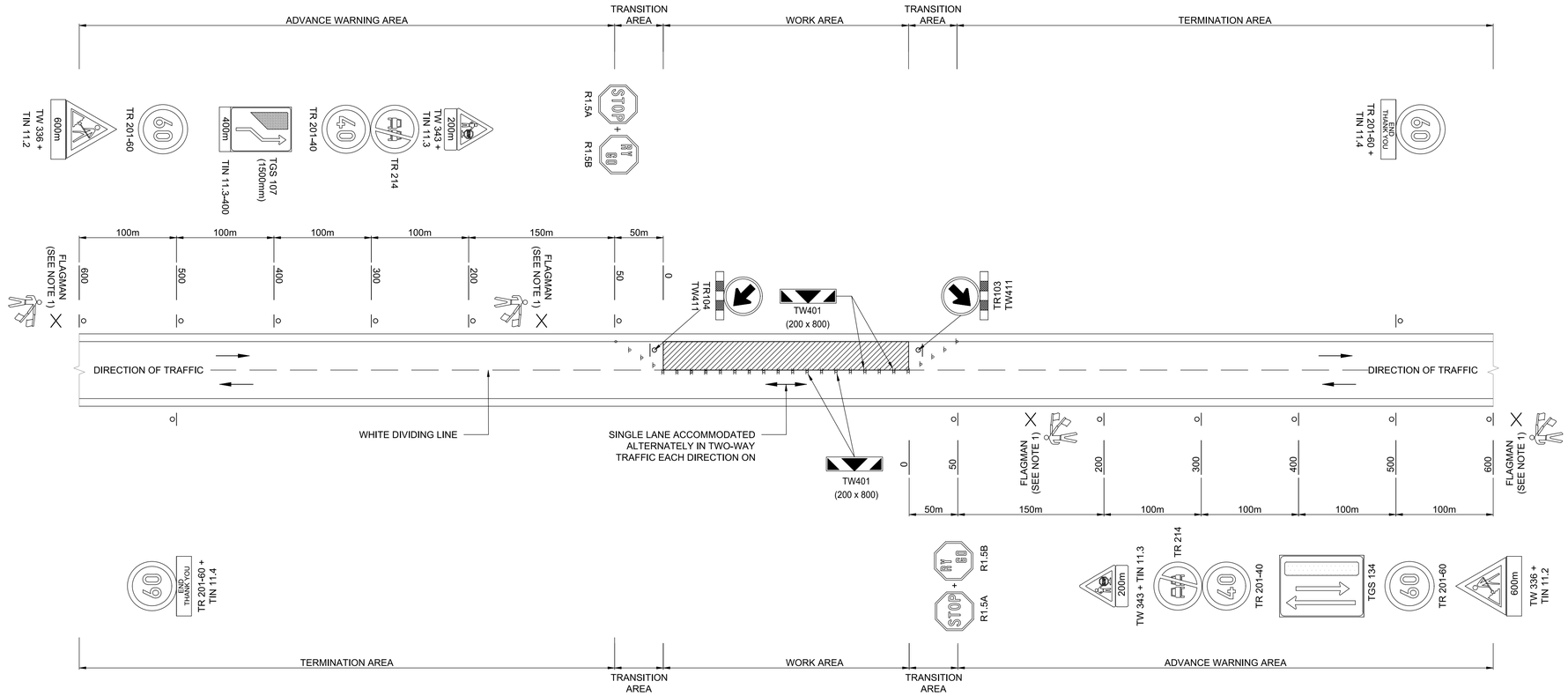
CONTRACT No.
SSC WC 01 (2026/2027) DLRRD

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1 OF 1

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ACCOMMODATION OF TRAFFIC - HALF WIDTH CONSTRUCTION

SCALE 1:1

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NOTES:

1. FLAGMEN MUST BE ON DUTY AT ALL TIMES.
2. THE CONTRACTOR MUST INFORM THE FIRE AND TRAFFIC DEPARTMENT ON THE DATES AND TIMES OF ROAD CLOSURE WELL IN ADVANCE.

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PROJECT

NDULI MAIN SEWER LINE UPGRADE

DRAWING No.

P1174-L09

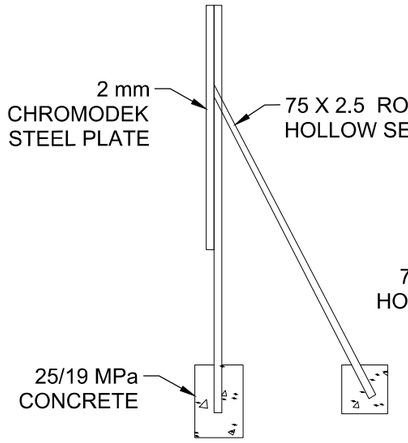
REV A

PROJECT No. P1174	SCALE AS SHOWN
CONTRACT No. SSC WC 01 (2026/2027) DLRRD	PAPER SIZE A1
SHEET 1 OF 1	DATE 2026/04/20

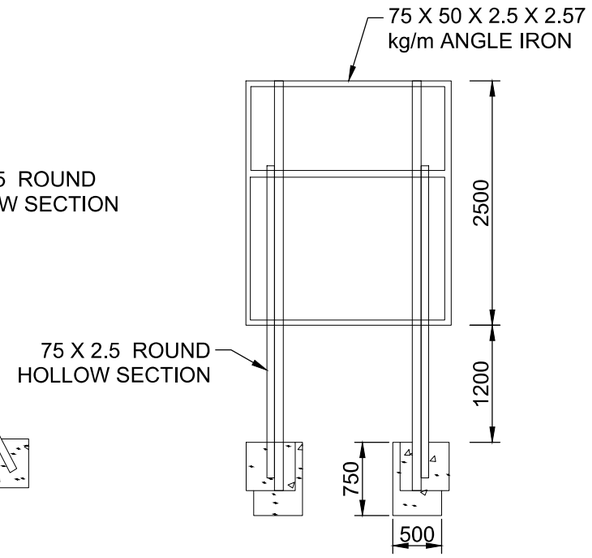
Date: 2023-09-14
Checked:
Auditing: Adelina van Niekerk

NOTES:

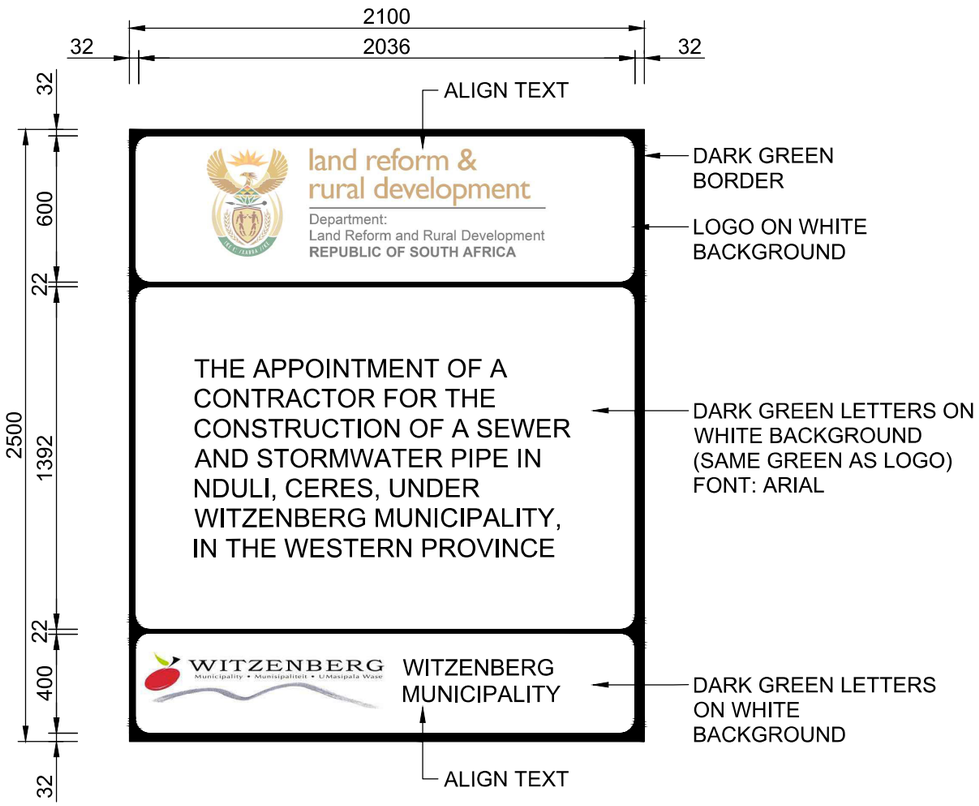
1. Material of the nameboard to be reflective (e.g. stop sign quality)
2. The vinyl quality to be 5-7 year durability also reflective
3. All steel sections to be hot dipped galvanised



SIDE ELEVATION
N.T.S.



BACK ELEVATION
N.T.S.



BOARD INFORMATION LAYOUT
N.T.S.

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PROJECT
NDULI MAIN SEWER LINE UPGRADE

DRAWING NAME
PROJECT PERMANENT NAMEBOARD

REV A

DRAWING No.
P1174-L10

CONTRACT No.
SSC WC 02 (2025 / 2026)
DLRRD

SHEET
1 OF 2

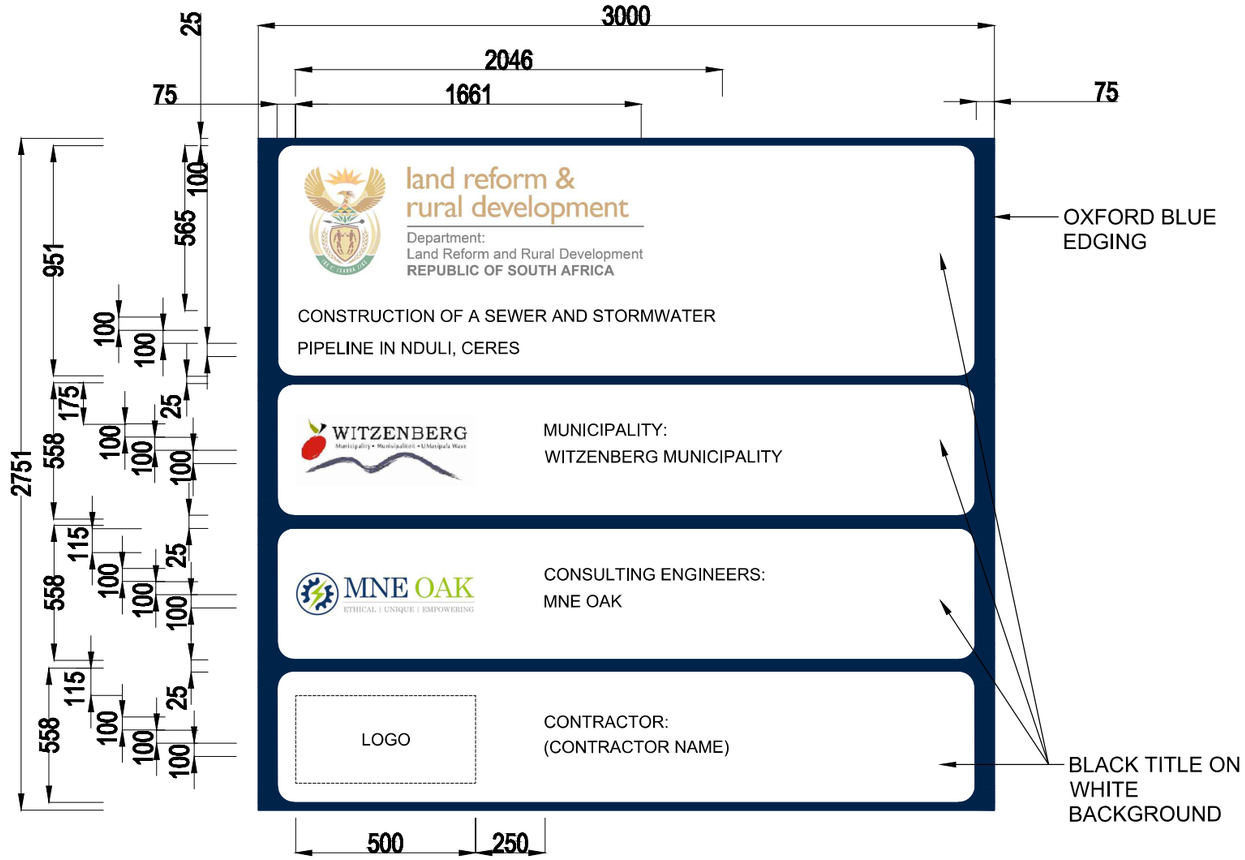
SCALE
N.T.S

PAPER SIZE
A3

DATE
2026/04/20

NOTES:

1. Material of the nameboard to be reflective (e.g. stop sign quality)
2. The vinyl quality to be 5-7 year durability also reflective
3. All steel sections to be hot dipped galvanised



BOARD INFORMATION LAYOUT
N.T.S.

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PROJECT
NDULI MAIN SEWER LINE UPGRADE

DRAWING NAME
PROJECT NAMEBOARD

REV A

DRAWING No.
P1174-L10

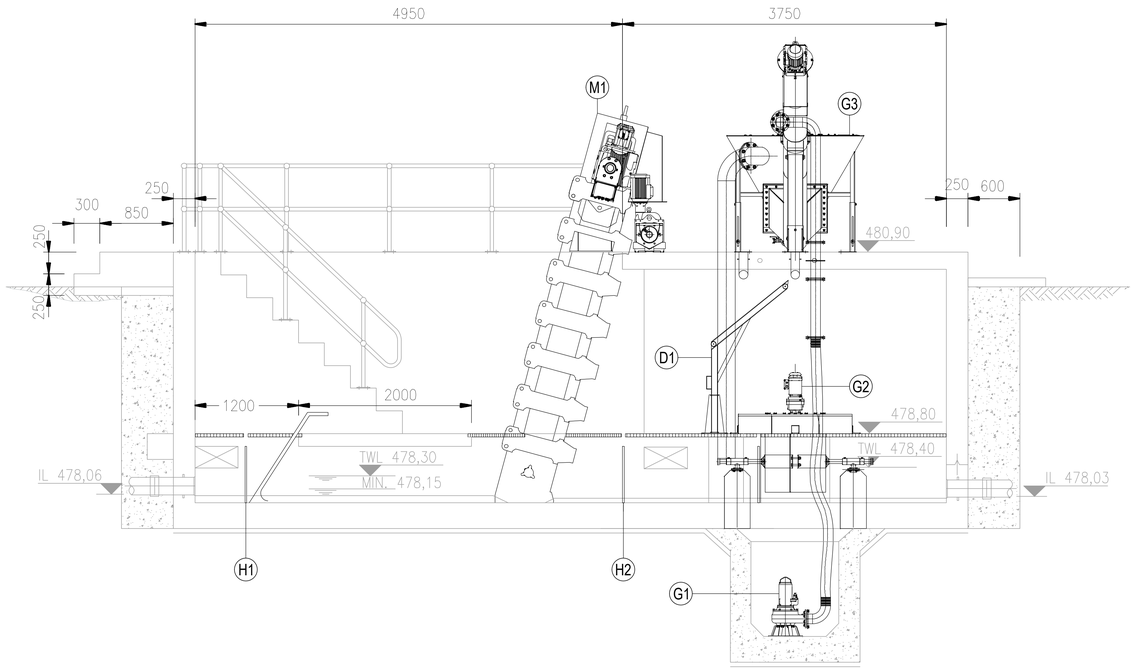
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SSC WC 02 (2025 / 2026)
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SHEET
2 OF 2

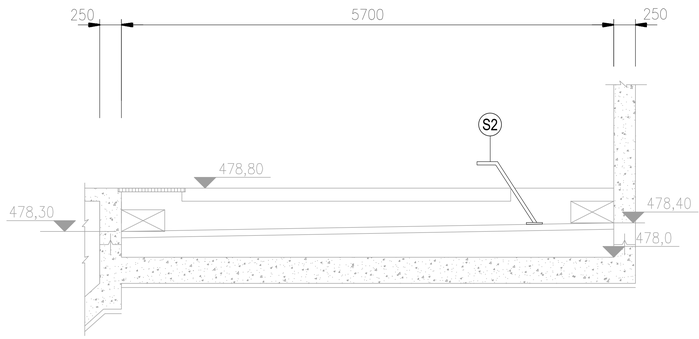
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PAPER SIZE
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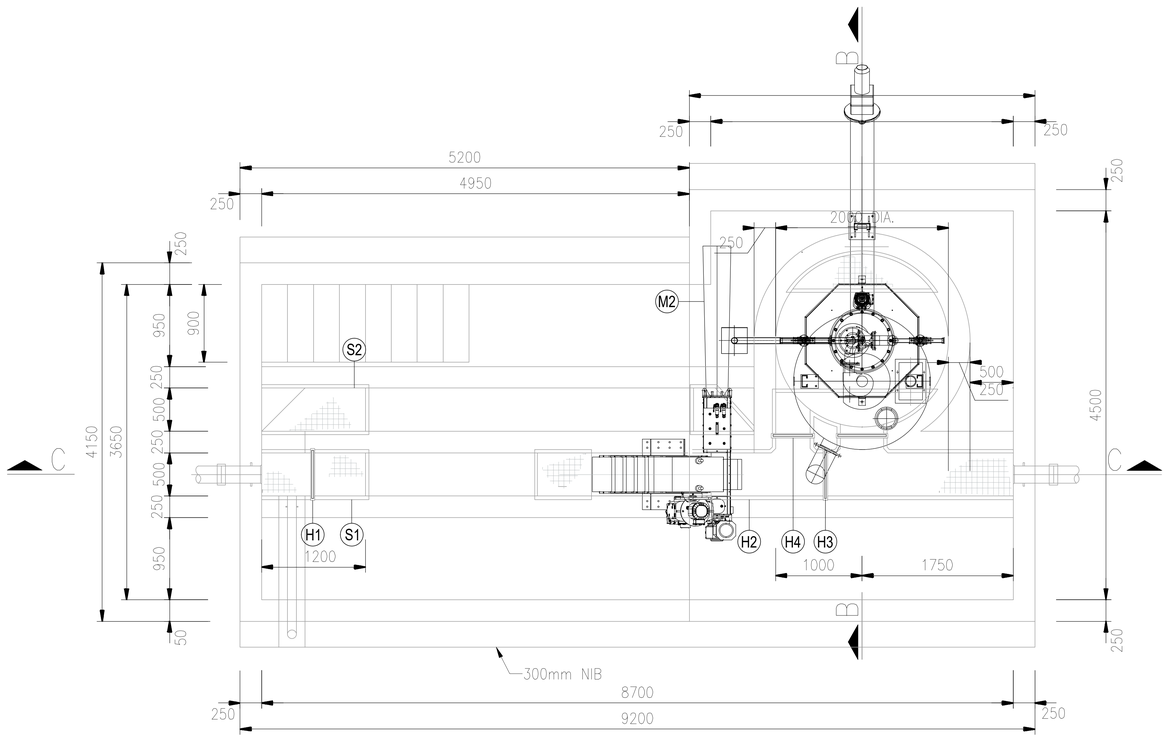
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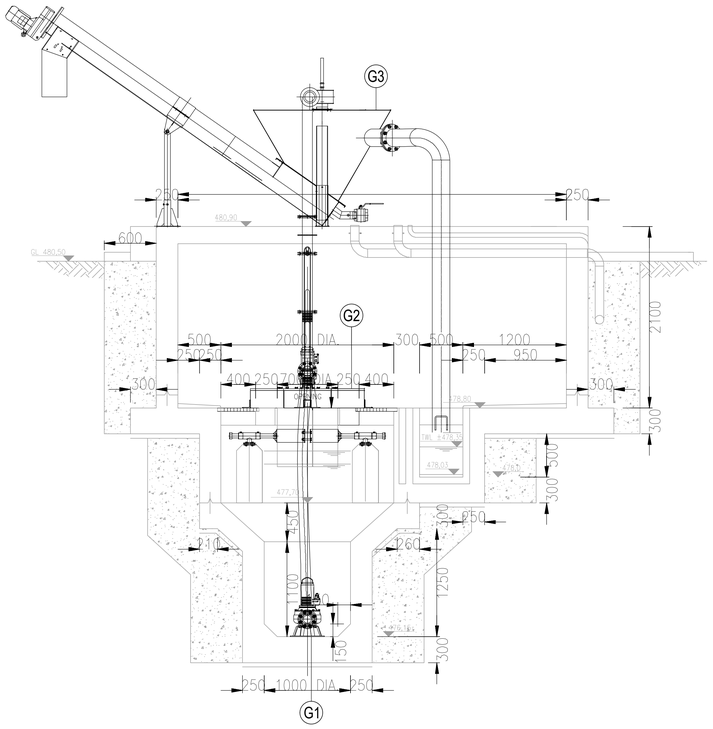
SECTION C - C
SCALE 1:25



SECTION E - E (CHANNEL BYPASS)
SCALE 1:25



PLAN VIEW
SCALE 1:25



SECTION B - B
SCALE 1:25

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MECHANICAL AND ELECTRICAL EQUIPMENT	
ITEM	DESCRIPTION
D1	ROTATING DAVIT
G1	GRIT PUMP
G2	PADDLE DRIVE
G3	GRIT CLASSIFIER
H1	HAND STOP
H2	HAND STOP
H3	HAND STOP
H4	HAND STOP
H5	HAND STOP
M1	MECHANICAL FRONT RAKE SCREEN
M2	SCREENING WASHER COMPACTOR
S1	COARSE HAND RAKE SCREEN
S2	FINE HAND RAKE SCREEN

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REV	DESCRIPTION	DATE	BY
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DRAWN DA	DATE:
CHECKED TA	APPROVED CLIENT:
	DATE:

CLIENT
WITZENBERG Municipality • Munisipaliteit • UMasipala Wase

PROJECT
NDULI MAIN SEWER LINE UPGRADE

DRAWING NAME
NDULI SCREENING FACILITY :
MECHANICAL AND ELECTRICAL EQUIPMENT LAYOUT

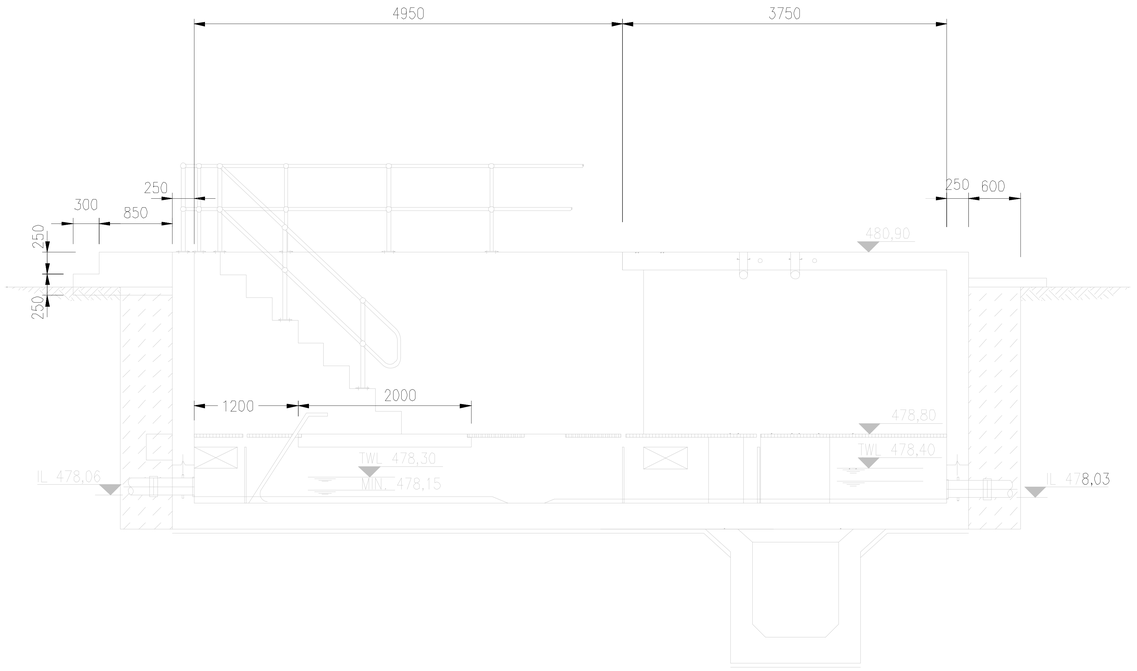
DRAWING No.
P1174 - M01

REV
A

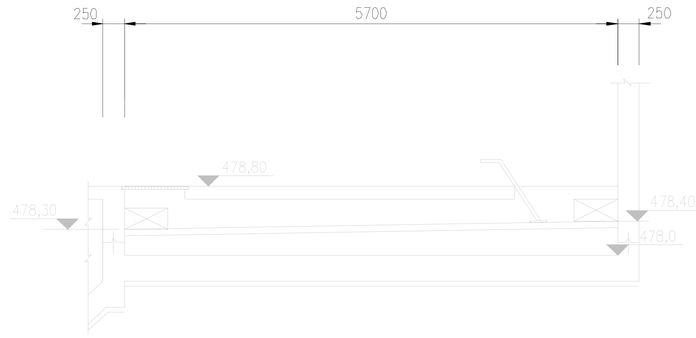
PROJECT No. P1174	SCALE 1 : 25
CONTRACT No. SSC WC 01 (2026 / 2027) DLRRD	PAPER SIZE A0
SHEET 1 OF 1	DATE 2026/04/20

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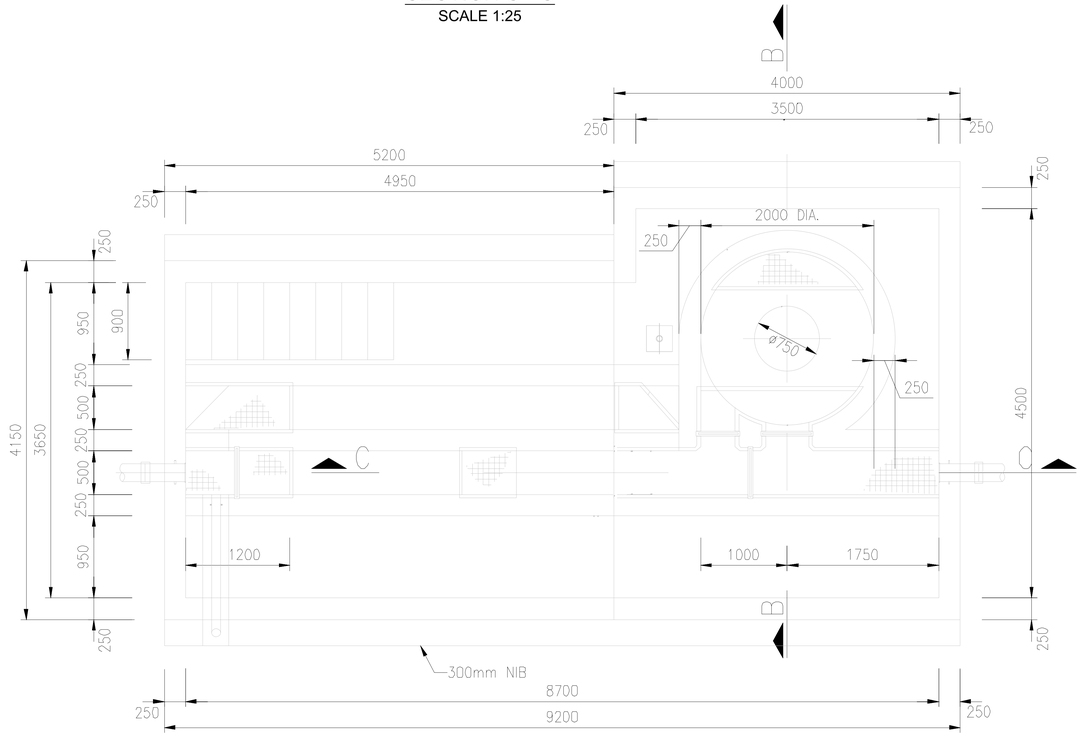
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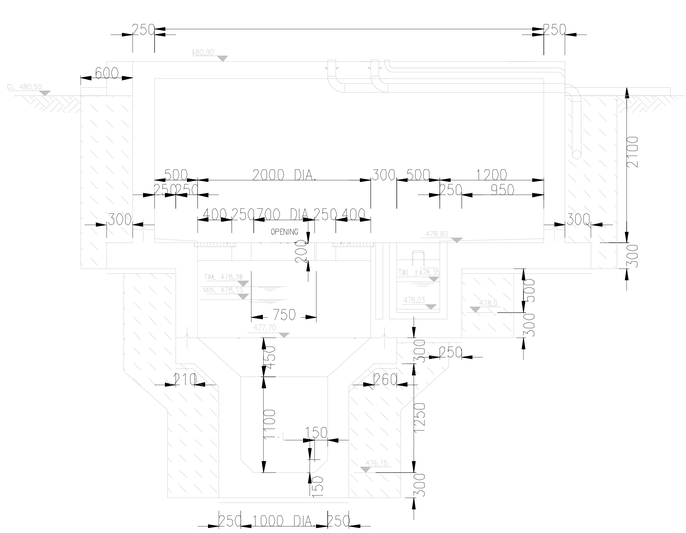
SECTION C - C
SCALE 1:25



SECTION E - E (CHANNEL BYPASS)
SCALE 1:25



PLAN VIEW
SCALE 1:25



SECTION B - B
SCALE 1:25

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	DATE:

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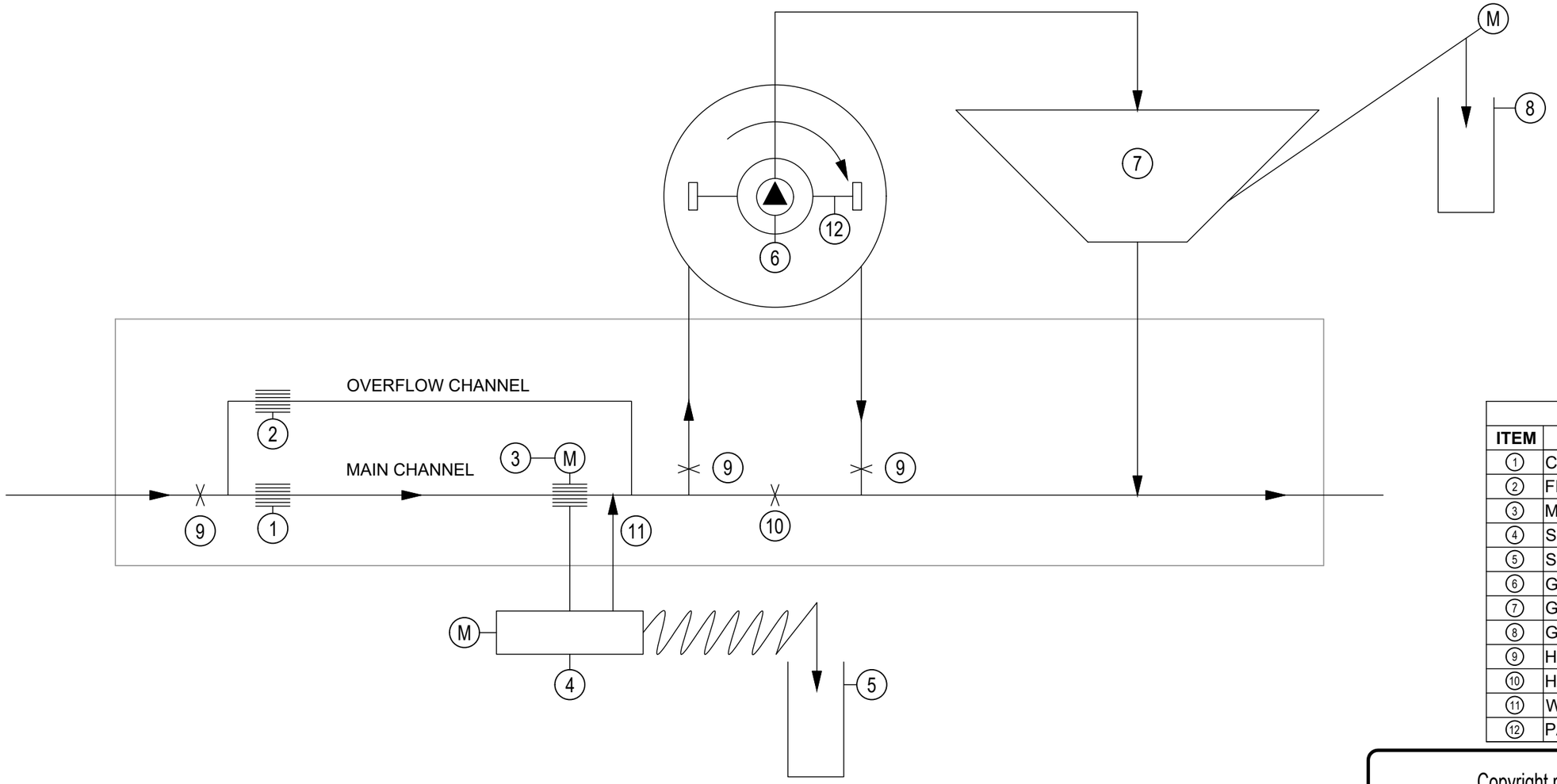
PROJECT
NDULI MAIN SEWER LINE UPGRADE

DRAWING NAME
NDULI SCREENING FACILITY : GENERAL CIVIL LAYOUT

DRAWING No.
P1174 - M02

REV A

PROJECT No. P1174	SCALE 1 : 25
CONTRACT No. SCC WC 01 (2026 / 2027) DLRRD	PAPER SIZE A0
SHEET 1 OF 1	DATE 2026/04/20



MECHANICAL EQUIPMENT	
ITEM	DESCRIPTION
1	COARSE HAND RAKE SCREEN
2	FINE HAND RAKE SCREEN
3	MECHANICAL FRONT RAKE SCREEN
4	SCREENING WASHER COMPACTOR
5	SCREENINGS BIN
6	GRIT PUMP
7	GRIT CLASSIFIER
8	GRIT BIN
9	HAND STOP (NORMALLY OPEN)
10	HAND STOP (NORMALLY CLOSED)
11	WASH WATER RETURN
12	PADDLE DRIVE

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REVISIONS			
REV	DESCRIPTION	DATE	BY
REV	FOR TENDER PURPOSES	2026/04/20	TB

DESIGNED TB

DRAWN DA

CHECKED TA

DESIGNED

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ETHICAL | UNIQUE | EMPOWERING

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PROJECT
NDULI MAIN SEWER LINE UPGRADE

DRAWING NAME
NDULI SCREENING FACILITY :
PROCESS FLOW DIAGRAM

REV
A

DRAWING No.
P1174 - M03

CONTRACT No.
SSC WC 01 (2026 / 2027)
DLRRD

SHEET
1 OF 1

SCALE
N.T.S

PAPER SIZE
A3

DATE
2026/04/20