C3.5.2

PARTICULAR SPECIFICATION FOR MECHANICAL WORKS

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M1. GENERAL

Hammarsdale Wastewater Treatment, situated in KwaZulu Natal, treats a mixture of domestic and industrial wastewater. The treatment plant has a reported design ADWF hydraulic capacity of 27ML/d. But due to the high organic concentrations of the raw sewage, the treatment plant has been de-rated to treat approximately 8.5Ml/d.

The existing inlet works, located at the southern end of the site receives the raw sewage via a 900mm pipeline. Wastewater is also discharged manually from various tankers which combines with the main wastewater flow into the plant. The combined wastewater passes through a very course screen (approximately 30mm) before entering Pump Station 6's sump via the flow measurement flume. Pump Station 6 consists of 4 centrifugal pumps which pump wastewater through six, static, 0.8mm parabolic screens before going to the bioreactors.

There are 6 bioreactors operating as a 5 Stage Bardenpho configuration. The reactors are of an annular design. Aeration is supplied by surface aerators. Each reactor has a dedicated clarifier situated at the center of the annular reactor to settle out activated sludge. Effluent is discharged from the clarifiers to a series of maturation ponds. Disinfection is achieved by dosing chlorine before the wastewater is released to the environment.

Waste Activated Sludge (WAS) is pumped from the clarifier underflow to a collection sump. WAS is then either dewatered using an existing Pennwalt Sharples centrifuge and transferred to a storage silo for collection or is pumped to drying beds for further dewatering.

Most of the mechanical equipment described above has reached end of life and needs to be replaced. Further to this, it is the intention of eThekwini Municipality to upgrade the wastewater works in phases to achieve the original design ADWF of 27 Ml/d and improve overall process efficiency through equipment modernization.

M1.1 Purpose of Contract

The purpose of this contract is to facilitate the phased upgrade of Hammarsdale WWTW to achieve an ADWF of 27 Ml/d and improve overall process efficiency through equipment modernization. Under this contract, the following upgrades to the mechanical and electrical equipment will be achieved.

- A completely new inlet works (screening and degritting) together with a new pump station to supply the existing bioreactors.
- A completely new dewatering facility using high efficiency centrifuges together with new sludge handling and storage equipment.
- Replacement of the existing reactor surface aerators with modern, efficient units
- Replacement of existing reactor mixers with modern, efficient units
- Various upgrades to the electrical infrastructure and control and instrumentation (more detail in the electrical and electronic specification)

Under a separate contract, a new set of bioreactors will be constructed for the plant to achieve the design flow ADWF of 27 Ml/d.

M2. REFERENCES TO PRODUCT BRANDS

It is not the intention at any point in this document to recommend any particular product brand. Any accidental references to product brands shall automatically be assumed that an equivalent product is acceptable as long as the products are fundamentally the same and fit for purpose.

M3. SCOPE OF CONTRACT

This section provides a high-level summary of the total mechanical scope of this contract. More detail is provided in the individual sections of the document.

The scope of this Contract includes the design, supply, installation, testing, commissioning and upholding during the Trial Operation Period (TOP) and the Defects Notification Period (DNP) for the following: -

Inlet Works:

- Two mechanically raked, 25mm inclined bar screens
- Two mechanically raked, 6mm inclined bar screens
- A 25mm manually raked screen to be installed in the 3rd channel as a back-up
- Two (duty/standby) washer/compactor units
- Two induced vortex grit traps with self priming centrifugal pumps for grit removal
- Two (duty/standby) grit classifier units
- Duty/standby motorized dolly skip system for coarse and fine screen collection
- Duty/standby motorized dolly skip system for grit collection
- Hydraulic launder channels to convey screenings to the washer/compactors
- Two Automatically cleaned, perforated plate band screens
- Two microstrainer compacting units
- Two shaftless screw conveyors
- Four centrifugal pumps installed at the new pump station.
- One dry well sump pump at the new pump station
- 2nd class water supply system including automatically cleaned cartridge filers, three centrifugal pumps and accumulation vessel.
- All piping, fittings, supports, valves and fasteners required as indicated on the relevant Piping and Instrumentation Diagrams (P&ID's)

Dewatering Facility:

- Two (duty/standby) self-priming centrifugal pumps to transfer Waste Activated Sludge (WAS) from the existing WAS sump to the new dewatering facility.
- Two (duty/standby) macerator units
- Two submersible mixers to keep solids in suspension in the new Centrifuge Feed Tank.
- Two, progressive cavity, centrifuge feed pumps
- Two high efficiency, horizontal decanter centrifuge units complete with VSD and local control panel and PLC (package unit).
- Two (duty/standby) solid polyelectrolyte make-up systems complete with stainless steel hoppers, agitators, dual mixing chambers all controlled from a local PLC and HMI supplied as a package unit.
- Two progressive cavity polymer dosing pumps and two progressive cavity polymer lubrication pumps
- Two, centreless spiral screw conveyors to convey dewatered sludge from each centrifuge unit
- Stainless steel cake receiving hopper with motorized bridge breakers feeding two (duty/standby), screw fed progressive cavity cake pumps to transfer dewatered sludge to the storage silos
- Like-for-like replacement of the domestic sewage sump pump adjacent to the WAS sump
- All piping, fittings, supports, valves and fasteners required as indicated on the relevant Piping and Instrumentation Diagrams (P&ID's)

Reactors:

- Removal of 2 (two) existing 37 kW fixed surface aerators in the main aeration zones of reactors 1 and 3 to 6, complete with all cabling and switchgear (10 aerators in total).
- Removal of 2 (two) existing 30 kW fixed surface aerators in the main aeration zones of reactors 1 and 3 to 6, complete with all cabling and switchgear (10 aerators in total).
- Removal of 1 (one) existing 11 kW fixed surface aerators in the re-aeration zones of reactors 1 to 6, complete with all cabling and switchgear (6 aerators in total).
- 4 (four) new fixed 37 kW surface aerators in the main aeration zone of reactors 1 and 3 to 6, operating on VSD's, complete with motor, gearbox, supports and anchors into the concrete platform (20 aerators in total).

- 1 (one) new fixed 11 kW surface aerators in the re-aeration zone of reactors 1 to 6, operating on VSD's, complete with motor, gearbox, supports and anchors into the concrete platform (6 aerators in total).
- GRP draft tubes for all 37 kW surface aerators (20 in total)
- GRP draft tubes for all 11 kW surface aerators (6 in total)
- 2 (two) dissolved oxygen probes per reactor complete with controller, enclosure and stainless steel mounting arm and supports (12 probes and mounting arms in total)
- Prior to finalising the design of the surface aerators, conduct detailed dimensional survey of the existing civil infrastructure of each reactor, so much as it affects the design of each aerator and draft tubes.
- Access stairway, platform and handrailing for each of the new submersible mixers situated in the primary and secondary anoxic zones (12 in total)
- Removal of the existing submersible mixers, guiderails and supports in all reactors (12 in total) and disposal to a site approved by the Employer.
- One submersible mixer in each of the reactor's primary anoxic zone complete with guiderail, lifting davit arm and anchors (6 in total).
- One submersible mixer in each of the reactor's secondary anoxic zone complete with guiderail, lifting davit arm and anchors (6 in total)

M4. SYSTEM OPERATION AND DUTIES

M4.1 Inlet Works

Hammarsdale Inlet Works shall have 3 equally sized concrete channels situated on the southern boundary of the plant adjacent to the maturation ponds. Each channel will be designed to take an ADWF of 9 Ml/d. Two of the three channels will contain:

- An automated, front raked, coarse bar screen
- An automated, front raked, fine bar screen
- An induced vortex degritter
- An automated, perforated plate, band screen

In the 3rd channel, a manually raked screen shall act as a back-up.

All screenings from the automatic bar screens will be collected and conveyed automatically using hydraulic launders to a set of duty/standby washer compactors. Screenings will be washed, compacted, and sent to skips for collection. Grit will be removed from the induced vortex grit traps using a self-priming pumps and transferred to a set of duty/standby grit classifiers. The grit will be washed and conveyed to a skip for collection. Screenings from the ultrafine band screens will be conveyed using hydraulic launders to a set of duty/standby microstrainer units to be washed,compacted and discharged to skip. Screened and degritted wastewater will be pumped to the bioreactors from a new set of centrifugal pumps from a new wastewater collection sump.

The process is illustrated in Process Flow Diagram W1859-41002 (60325-M-LI-100)

Table 1 below describes the overall plant duties that Hammarsdale Inlet Works shall meet:

Table 1: Hammarsdale Inlet Works Plant Duties

Average Dry Weather Flow (ADWF)	27 Ml/d
Peak Wet Weather Flow (PWWF)	71.3 Ml/d

The following should be noted:

1. A PWWF factor of 2.64 was selected based on existing incoming flow data to the plant.
2. Hammarsdale WWTW receives a large portion of its wastewater from surrounding pump stations rather than gravity flow systems.
3. The current ADWF to the plant is between 4 and 5 Ml/d. The plant is licensed to treat 9.1 Ml/d. On this basis, only 2 of the 3 channels will be fitted with the full set of M&E equipment. Space will be made available for installation of the remainder of the equipment to achieve the full design ADWF of 27 Ml/d.

M4.2 Dewatering Facility

A new dewatering facility shall be built in the open area directly east of the existing drying beds. The facility will house 2 centrifuge units (with space for an additional 2 in to be installed in the future), a polymer make-up system, sludge conveying equipment and an MCC and control room.
WAS will be collected in the existing WAS sump onsite and transferred to a new centrifuge feed tank situated adjacent to the dewatering facility. The WAS will go through a macerator and heavy solids separator to remove any fibrous or heavy foreign material. WAS shall be dosed with polymer before being sent to the centrifuge units. Polyelectrolyte powder will be supplied in 25 kg bags and be made up to a specific concentration. Dewatered sludge will be discharged from the centrifuges and conveyed to two storage silos using a combination of screw conveyors and cake pumps. Sludge will be discharged from the storage silos to collection trucks by gravity.

The process is illustrated in Process Flow Diagram W1859-41001 (60325-M-SD-100)

Table 2 below describes the overall plant duties that Hammarsdale Dewatering Facility shall meet:

Table 2: Hammarsdale Dewatering Facility Plant Duties

Waste Activated Sludge Volumetric flow rate per centrifuge	65 m^3/h
Waste Activated Sludge percentage solids	1%

The following should be noted:

1. All equipment upstream and downstream of the centrifuge units must be sized to accommodate both centrifuge units running simultaneously should Operations want to perform wasting and dewatering during a day shift only.
2. The concentration of the WAS can vary between 0.8-1%.

M5. INLET WORKS SCREENING

M5.1 Scope

The scope associated with Inlet Works Screening shall include design, supply, delivery, installation, testing, commissioning and upholding during the Trial Operation Period and the Defects Notification Period (DNP) of the following:

i. Two automatic, front raked bar screens with a 25 mm bar spacing (coarse screening)
ii. Two automatic, front raked bar screens with 6 mm bar spacing (fine screening)
iii. Two automatic band screens complete with 1 mm perforated plant, low pressure and high pressure washwater cleaning system (ultrafine screening)
iv. Two high pressure, plunger pumps complete with motors and baseplates to be mounted onto concrete plinths for the supply of high pressure washwater to the band screens.
v. One manually raked screen with a 20 mm bar spacing
vi. All piping, fittings, isolation valves, supports and fasteners supplying low pressure and high pressure washwater from the tie-in to the 2nd class bulk supply manifold up to the supply point to each band screen.

The equipment shall be generally as shown on Piping and Instrumentation Drawing
W1859-45003 (60325-M-LI-101) and W1859-41005 (60325-M-LI-103) and on Equipment and Piping Layout Drawing W1859-85002 (60325-M-LI-106).

The existing static screens shall be left in place and will continue to operate with the new screens installed upstream. No modifications to the existing screens shall occur under this contract and no work under this contract shall interfere with the operation of the existing static screens.

M5.2 General Description of Technology

M5.2.1 **Front rake bar screens:**

Raw effluent shall flow through coarse and fine mechanically raked screens. The screen shall be constructed of bars with a spacing of 25 mm (coarse) and 6 mm (fine) and shall stop all debris which is larger than the respective screen size. The screenings collected against the screen shall be removed at regular intervals by means of a front rake mechanism, comprising a number of rakes mounted between two endless loops of chain. The teeth or tines of the rakes shall pass between the bars to remove entrapped material. These screenings shall be carried by the rakes up a debris plate and discharged by a scraper bar into a discharge chute for further processing.

Each screen shall be fitted with a single motor-gearbox drive for the rake mechanism. The drive shall normally be activated by a differential level system which compares the water levels upstream and downstream of each screen and initiates raking when the difference reaches a pre-set value. The screen controller shall in addition initiate raking after a pre-set period if no differential level trigger is received. It shall also be possible to initiate manual raking should the process require it.

M5.2.2 **Band screens**

After coarse screening, fine screening and degritting, wastewater will flow through an ultrafine band screen to remove fine particulates that are predominantly present from the industrial wastewater portion i.e. textile industry and chicken abattoir. The ultrafine band screen shall be capable of achieving the peak hydraulic capacity within an open, narrow channel as dictated by the available space for the new inlet works. To achieve this, it is envisaged that a centre-flow arrangement is required whereby the wastewater is introduced to the centre of the screen and flows through two screening elements situated parallel to the channel walls. This will be confirmed by the screening technology supplier at tender stage. Other configurations of band screens shall be accepted provided it achieves the same capacity and screening efficiency within the available channel size.

The screenings will be collected on an endless, folded perforated plate band, mounted parallel to the channel walls thus providing two screening elements and forming a band around the incoming wastewater. The perforated plate band shall be driven by a dedicated motor and gearbox arrangement. The drive shall normally be activated by a differential level system which compares the water levels upstream and downstream of each screen. When the drive is initiated, the folded band will rotate removing the blinded section of the band from the wastewater and replacing it with a clean section. The blinded band shall be cleaned with a low pressure sprayball manifold that will wash screenings into a hydraulic launder. In addition to this, a separate high pressure washwater manifold shall periodically (adjustable) clean the perforated band to remove all traces of material (stringy particulates, Fats Oils and Grease (FOG) etc.) and restore the screening elements back to a 100% clean state without the requirement for regular manual cleaning.

M5.2.3 **Manually raked screen**

An inclined, manually raked screen shall be installed in the 3rd channel as a standby for the mechanical screens. The screen will consist of bars with a 25 mm spacing. It shall be possible to easily lift the screen out of the channel and replace it again using a lifting device. The screen will be supplied with a manual rake.

M5.3 Duties

The duties required for this section of the process are indicated in Table 3 below:

Table 3: Inlet Works Screening Duties

Volumetric capacity of each 25 mm, front raked bar screen	990 m^3/h
Volumetric capacity of each 6 mm front raked bar screen	990 m^3/h
Volumetric capacity of each 1 mm band screen (future)	990 m^3/h

The requirements for the screens are outlined in Table 3 above and are specified at PWWF. ADWF is expected to be 2.64 times lower than PWWF.

Each of the screens shall be able to cope with the maximum flow and screenings loading on its own. The material to be screened shall include rags, stringy matter, food particles, plastic bags, earbuds, leaves, sticks, clothing, toys, tin cans, glass, plastic bottles, condoms, stones and masonry. For the purpose of this tender it is assumed that the total trash content in the wastewater is approximately 400-500 l/Ml of wastewater split over the coarse, fine and ultrafine screens. It should be noted that a large portion of the raw wastewater is supplied from pumped sources therefore large foreign material is not expected in the sewer network.

The coarse and fine screens shall be installed in a channel approximately 600 mm wide and 2 000 mm deep (bottom of channel to top of floor slab), with a nominal sewage depth of 1 000 mm. The Ultrafine screens (future) shall be installed in a channel approximately 1500 mm wide and 3 100 mm deep (bottom of channel to top of floor slab), with a nominal sewage depth of 900 mm

The following maximum head losses, at peak flow conditions, are allowed on the screen at a nominal 40% reduction of the screen's free open area (blinding):

- Coarse screen – 200 mm
- Fine screen – 300 mm
- Ultrafine screen – 600 mm

The maximum sewage velocity through the screen slots shall not exceed 1.2 m/s at peak wet weather flow to ensure that oversized material is not forced through the screen at peak flow conditions. Tenderers shall provide hydraulic calculations to illustrate that the selected screens are capable of processing the peak flow.

M5.4 Coarse and Fine Screen

M5.4.1 **Frame**

The frame shall be formed from stainless steel plate and shall support all parts of the screen. It shall be designed to accommodate the scraping mechanism, chain guides and idler sprockets in order to maintain the channel width through the plane of the screen.

The frame shall be accurately and securely set into position in the channel and sealed into it and shall be capable of supporting the entire screening assembly. The screen shall be set at the optimum angle to the horizontal, to be specified by tenderer. If the sections of the channels where screens are to be mounted are too wide to accommodate the selected screen, the channel width may be reduced as appropriate. In this case the contractor shall specify by what means and to what extent the channel width will be reduced as well as the means by which the screen frame will be mounted and sealed into the channel.

M5.4.2 **Screen Rack**

The screen shall comprise a series of parallel bars, accurately set and secured to provide 25 mm spacing's. The screen bars shall be of tapered cross section to minimise head loss across the screen and to discourage debris from becoming lodged between the bars. They shall be of sufficient strength to resist excessive deformation under conditions of maximum flow and heavy screenings loading. They shall also resist deformation in the event of the rake mechanism becoming jammed by debris wedged in the screen.

Provision shall be made for easy removal of the screen rack to permit repair or replacement in the event of wear or damage.

M5.4.3 **Sole plate**

The sole plate shall be profiled to prevent debris from accumulating at the foot of the screen and preventing engagement of rakes with the screen. The leading edge of the sole plate shall be level with the channel invert.

M5.4.4 **Rake mechanism**

The rake mechanism shall consist of rake bars installed between two endless loops of roller chain running in tracks attached to the screen frame. The chains shall be adequately specified for the loads involved. They

shall be driven by sprockets which are keyed to the drive shaft to ensure that the two chains remain synchronised. The chain return guides in the channel shall be of the stationary circular polymeric design, with provision for easy replacement if they become worn.

The rake drive shaft shall be supported in sealed, self-aligning bearings with an L_{10} life of not less than 100 000 hours. The bearings and seals shall be suitable for immersion in sewage and for operation in extremely abrasive conditions.

The design of the rake drive mechanism mounting shall enable the rake mechanism drive chains to be correctly tensioned and the raking bars to be accurately positioned across the screen face. Such adjustments shall be possible without dismantling any part of the screen frame and without the need for any special tools.

Rake bars and tines shall be formed from single continuous bars of sufficient dimensions to ensure complete stiffness. Tines shall have appropriate dimensions and profile to suit the screen bar shape and spacing. Provision shall be made for easy replacement of rakes in the event of damage.

M5.4.5 **Drive unit**

The screen rake drive unit shall be a gear motor rated for continuous duty and selected to match the requirements of the particular screen. The motor shall be a totally enclosed fan cooled (TEFC), constant speed unit, fed from 3-phase 380/400 VAC, 50 Hz power.

The gearbox shall have a minimum service factor of 1.75 and an IP55 protection rating. Nominal and minimum motor efficiencies shall comply with NEMA MG 1. The gearbox shall be designed for AGMA Class II, 24-hour duty.

The rake drive unit shall be mounted directly on the rake mechanism drive shaft and shall permit vertical adjustment for tensioning of the rake chains. It shall incorporate a switch to detect high torque for protection of the screen and the rake mechanism if a large object is encountered or debris becomes wedged in the screen. The drive shall be capable of reversal, under manual control, for the clearing rake jams.

M5.4.6 **Cleaning mechanism**

The rake cleaning mechanism shall comprise a scraper bar which engages with each raking bar as it rises above the upper edge of the screening retention plate. The scraper shall be designed and positioned so that it cleans the full width of each raking bar. The scraper bar shall be mounted on self-lubricating bushes.

M5.4.7 **Discharge chute**

The discharge chute shall guide the screening into the screenings handling system. It shall be angled to minimise hang-up of wet screenings on it. The chute shall form an integral part of the screen and shall be designed to interface with the hydraulic conveyor provided to handle the screenings.

M5.4.8 **Screen enclosure**

All parts of the screen above the channel shall be completely enclosed in a sheet metal cover to contain odours. The cover shall include hinged or removable panels to provide access for inspection, maintenance, cleaning and clearing blockages or rake mechanism jams. An extraction point shall be provided for connection to a future odour control extraction system if the Employer intends on installing a system under a separate contract. Under this contract, this connection shall simply be blanked. The cover shall prevent spillage of fluids out of the enclosure and shall be manufactured from stainless steel.

M5.5 Ultrafine Screen

M5.5.1 **Frame**

The frame shall be formed from stainless steel plate and shall support all parts of the screen. It shall be designed to accommodate the chain and cleaning elements, the low and high pressure cleaning equipment

and the screening collection launder while forming .an impenetrable seal with the concrete channel to prevent any bypassing of wastewater.

The frame shall accommodate a centre-flow arrangement with the screening elements arranged parallel to the channel walls. Other screen arrangements are acceptable as long as the same volumetric capacity and process performance is achievable within the available channel space. Any deviations from the proposed screen arrangement must be explicitly highlighted with the tender. If the sections of the channels where screens are to be mounted are too wide to accommodate the selected screen, the channel width may be reduced as appropriate. In this case the contractor shall specify by what means and to what extent the channel width will be reduced as well as the means by which the screen frame will be mounted and sealed into the channel.

M5.5.2 **Screening Elements**

The screen elements shall comprise a series of stainless steel, perforated plates with 1 mm apertures. The plates shall be linked together at both ends by chains driven by sprockets and an electric motor. The screening elements shall form a continuous band. Between the plates, the sealing shall ensure no bypassing of wastewater yet allowing adequate movement between plates to accommodate the motion of the plates as the band is rotated on the chain and sprocket system. The screening element shall be of sufficient strength to resist excessive deformation under conditions of maximum flow and heavy screenings loading.

Provision shall be made for easy removal of the screen band (all screening elements) to permit repair or replacement in the event of wear or damage. It shall be possible to replace a single screening element if damaged without the need to replace the entire band.

M5.5.3 **Sole plate**

The sole plate shall be profiled to prevent debris from accumulating at the foot of the screen and preventing engagement of rakes with the screen. The leading edge of the sole plate shall be level with the channel invert.

M5.5.4 **Low pressure spray bar**

Each screen will have a low-pressure spray manifold to mechanically remove screenings which have collected on the screening elements. The number of and type of sprayballs shall be specified by the Tenderer and shall be sufficient to ensure equal mechanical impingement of washwater across the surface area of the screening element being cleaned.

The spray manifold shall be able to be removed to clean/replace blocked/damaged sprayballs. Sprayballs will be fastened to the spray manifold with a threaded connection allowing the simple removal of individual sprayballs.

The spray manifold will receive filtered, 2nd class water (final effluent) at nominally 6 bar(g) pressure. The design of the spray bar will ensure the efficient use of washwater. The washwater flowrate shall not exceed 3 m^3/h per screen. Cleaning of the screening elements will only occur one screen at a time. This will be controlled using individual solenoid valves on each screen's spray bar.

The spray bar and sprayballs shall be made of stainless steel.

M5.5.5 **High pressure cleaning**

The wastewater at Hammarsdale WWTW contains fine particulates as well as a high degree of FOG. An automatic, high pressure cleaning system shall be supplied on each screen with a proven record of removing FOG and other problematic screenings to prevent continuous blinding of the screens.

The high pressure system will consist of a high pressure spray nozzle(s), driven by a electric motor, that traverses the width of the cleaning elements removing all traces of solid material that cannot be removed by the low pressure spray bar. Washwater will be supplied to the high pressure cleaning system at approximately 120 bar(g) from the 2nd class water system using a high pressure plunger booster pump. The high pressure washwater flow rate shall not exceed 1 m^3/h per screen. High pressure cleaning will only occur periodically

(one screen at a time) as dictated by the level of FOG or particulate material causing the screen to blind. The cleaning frequency shall be an adjustable parameter that can be changed on the plant PLC/SCADA system.

M5.5.6 **Cleaning Brush**

Each screen shall have a rotating cleaning brush to assist with the removal of screenings from the filter elements after low pressure water washing. The brush shall have its own drive and will automatically start when the screen band is started.

M5.5.7 **High pressure washwater pump**

High pressure wash water will be supplied from two high pressure booster pumps operating as duty/standby which will boost second class water pressure from 6 bar(g) to 120 bar(g). The pumps shall be a plunger type that that shall deliver 1.25 m^3/h at a discharge pressure of 120 bar(g). Each pump shall have dual plungers operated by a crankshaft. The pumps shall be able to pump solid sizes < 200µm. Y-strainers shall be installed on the pump suction to ensure that the maximum solid size is adhered to.

The speed of each pump shall be fixed. The pump shall be driven by a motor and pulley suitably sized to deliver the required pump duty.

The required discharge head of the pump is estimated for tender purposes only. It is the responsibility of the Contractor to confirm the required head during detail design

M5.5.8 **Main Drive unit**

The screen drive unit shall be a gear motor rated for continuous duty and selected to match the requirements of the particular screen. The motor shall be a totally enclosed fan cooled (TEFC), constant speed unit, fed from 3-phase 380/400 VAC, 50 Hz power.

The gearbox shall have a minimum service factor of 1.75 and an IP55 protection rating. Nominal and minimum motor efficiencies shall comply with NEMA MG 1. The gearbox shall be designed for AGMA Class II, 24-hour duty.

The rake drive unit shall be mounted directly on the rake mechanism drive shaft and shall permit vertical adjustment for tensioning of the rake chains. It shall incorporate a switch to detect high torque for protection of the screen and the rake mechanism if a large object is encountered or debris becomes wedged in the screen. The drive shall be capable of reversal, under manual control, for the clearing rake jams.

M5.5.9 **Screening discharge**

The discharge chute shall guide the screening into the screenings handling system. It shall be angled to minimise hang-up of wet screenings on it. The chute shall form an integral part of the screen and shall be designed to interface with the hydraulic conveyor provided to handle the screenings.

M5.5.10 **Screen enclosure**

All parts of the screen above the channel shall be completely enclosed in a sheet metal cover to contain odours. The cover shall include hinged or removable panels to provide access for inspection, maintenance, cleaning and clearing blockages or rake mechanism jams. An extraction point shall be provided for connection to the odour control extraction system which forms part of this contract. The cover shall prevent spillage of fluids out of the enclosure and shall be manufactured from stainless steel.

M5.6 Manually Raked Screen

A manually raked screen shall be supplied as a back-up screen to the mechanically raked screens. This screen will be mounted in the 3rd channel. The screen shall comprise a series of parallel bars installed at an angle of

60º to the horizontal in the effluent channel to permit easy manual raking. The screen bars shall be of rectangular cross section and provide 25 mm bar spaces. The lower attachment plate for the bars shall not protrude above the floor of the channel to avoid a dead space in which debris could collect. The upper ends of the bars should terminate in a level section where screenings can drain into the channel before being transferred to a bin or skip.

The screen shall be provided with an appropriate rake having the same spacing as the screen bars.

M5.7 Motors

Tenderers should take note of the 's requirements for electric motors, as per Section D35 of the Standard Specification for Mechanical Works. Where the Contractor is not able to conform to these requirements, they should explicitly highlight the deviations in his offer, for consideration by the Engineer.

It should also be noted that whilst preliminary motor selections have been made for the purposes of this tender, choice of final motor sizes shall rest with the Contractor. Furthermore, it shall be noted that the power rating shall be supplied as a 380 V low voltage unit. Whilst four pole motors are preferable for the anticipated rating, two pole motors will be acceptable.

M5.8 Penstocks

New rising spindle penstocks upstream and downstream of the screens shall be provided. All penstocks shall comply with Section D31 of the Standard Specification for Mechanical Works. The penstock door and frame shall be SS304. The penstocks upstream and downstream of the course and fine screens shall be designed to fit a channel 600mm wide with a total height (channel floor to top of channel) of 2188mm. The penstocks downstream of the ultrafine screens shall be designed to fit a channel 1500mm and 2970mm.

M5.9 Piping

All valves, fittings, piping material and sizes shall be as indicated on P&ID W1859-45003 (60325-M-LI-101). All piping, fittings and supports shall conform to section D20 of the Standard Specifications for Mechanical Works unless otherwise stated below. All piping shall be clearly identifiable as per SANS 10140-3. All valves shall conform to section D28, D29 and D30 of the Standard Mechanical Specification for Mechanical Works. Refer to control valve list W1859-61002, on/off valve list W1859-61003, pressure safety valve list W1859-61004, hand valve list W1859-61005 and check valve list W1859-61006 in Volume 3. The tenderer shall supply technical datasheets/brochures of the range for each valve type offered with the tender.

Washwater:
Washwater, both high and low pressure, shall be piped from the bulk 2nd class water supply to each ultrafine screen user. A manual ball valve shall provide isolation from the bulk 2nd class water supply manifold. A mechanical pressure reducing valve will regulate the pressure of the washwater supply. Each washwater point located on the screens shall have an automated solenoid on/off valve controlled by the SCADA/PLC system to control the flow of washwater to each screen.

M5.10 Motor Control Centre

All equipment and instrumentation indicated on P&ID W1859-45003 (60325-M-LI-101)) and W1859-45005 (60325-M-LI-103) will be operated from a local PLC situated in the new MCC room in the new pump station building.

All instrumentation and controls as shown on the P&ID W1859-45003 (60325-M-LI-101)) and W1859-45005 (60325-M-LI-103) and the instrumentation list (refer to volume 3) are to be supplied and installed to ensure safe, reliable and efficient operation under the conditions stated in this specification. This shall include all instrumentation required for start-up, shut-down, ongoing monitoring of essential system parameters and for safe operation in accordance with the applicable codes and standards.

The analogue instruments (e.g. T, P) shall be supplied complete with manufacturer calibration certificate and procedure and material certificates (SS 316). The certificates shall be available at FAT execution if applicable. All instrument loops and process control functionality shall be tested during FAT.

The MCC and PLC shall be supplied as per the Particular Electrical specification included in Volume 3.

M5.11 Corrosion Protection and Materials of Construction

M5.11.1 Materials of Construction

Mechanically raked screens:

Screen Framework	304 Stainless Steel.
Bar Rack	304 Stainless Steel.
Dead Plate	304 Stainless Steel.
Sole Plate	304 Stainless Steel.
Conveyor Chains	304 Stainless Steel.
Sprockets	304 Stainless Steel.
Shafts	304 Stainless Steel.
Tin Plate Assemblies	304 Stainless Steel.
Scraper Assembly	304 Stainless Steel.
Scraper Blade	UHMWPE.
Cladding Panels	304 Stainless Steel.
Fasteners and Concrete Anchors	304 Stainless Steel.

Band Screens:

Screen Framework	304 Stainless Steel.
Filter elements	304 Stainless Steel.
Dead Plate	304 Stainless Steel.
Sole Plate	304 Stainless Steel.
Sprockets	304 Stainless Steel.
Shafts	304 Stainless Steel.
Spray balls and manifolds	304 Stainless Steel.
Cladding Panels	304 Stainless Steel.
Fasteners and Concrete Anchors	304 Stainless Steel

Manually raked screen:

Screen	304 Stainless Steel
Screen Rake	304 Stainless Steel

High Pressure Booster Pump:

Crankcase	Cast aluminium
Crankshaft	Case-hardened steel
Plunger	Ceramic

Valve casings	Brass
Valves	Stainless Steel
Sleeves	Nitrile with fabric reinforcing
Support rings	Teflon with graphite

M5.11.2 **Corrosion Protection**

Corrosion protection shall be carried out in accordance with the requirements of Sections D1to D14 of the Standard Specification for Mechanical Works.Where stainless steel components are welded these shall be pickled and passivated. Pump housings and geared motor units shall be Alkyd overcoated.

Mechanically raked screens:

Screen Framework	Grit Blast and Pickle & Passivate.
Bar Rack	Grit Blast and Pickle & Passivate.
Dead Plate	Grit Blast and Pickle & Passivate.
Sole Plate	Grit Blast and Pickle & Passivate.
Tin Plate Assemblies	Pickle & Passivate.
Scraper Assembly	Grit Blast and Pickle & Passivate.
Cladding Panels	Grit Blast and Pickle & Passivate.
Geared Motor	Alkyd Over Coating System.

Manually raked screen:

Screen	Grit Blast and Pickle & Passivate
Screen Rake	Grit Blast and Pickle & Passivate

M5.12 Quality Management

A quality control plan shall be submitted for the design, manufacturer, installation and commissioning of each screen and its ancillaries, for approval and monitoring by the Engineer.

M5.13 Installation

The screens shall be installed by the Contractor in new concrete channels as indicated on the overall equipment layout W1859-85002 (60325-M-LI-108), in accordance with the instructions of the screen manufacturer and as shown on their drawings.

M5.14 Performance Testing

M5.14.1 **Works testing**

Works testing shall include the assembly of the complete screen. The following shall be checked:

i) Accuracy of alignment of all components.
ii) Correct meshing of the rake teeth with the screen.
iii) Operation of total assembly.

Inspection certificates detailing all works testing conducted shall be forwarded to the Engineer.

M5.14.2 **Before commissioning**

i) Contractors shall take note of Sections D77.1 to D77.4 of the Standard Specification for Mechanical Works, prior to starting commissioning
ii) Confirm accuracy of installation of screen in effluent channel.
iii) Confirm accuracy of alignment of rake mechanism and meshing with screen bars.
iv) Ensure all drive equipment is lubricated and gearboxes are filled to correct levels.
v) Test for correct rotation of all motors.
vi) Test for correct operation of all sensors.
vii) Test for correct operation of control gear, where provided under this Contract.
viii) Tests for correct operation of whole assembly.
ix) Submit all certification, motor test certificates, material certificates
x) Submit all operating and maintenance instructions

M5.14.3 **Commissioning tests**

Specifically, the screens shall undergo the following tests:

i) Operation of screen under maximum and minimum flow conditions.
ii) The mass fraction of > 25 mm solids in the screened effluent shall be determined. Objects having one or more dimensions below 25 mm (e.g. earbuds or sucker sticks) shall be excluded from this determination. Similar this will be repeated for each screen size i.e. 6 mm and 1mm
iii) Monitoring level differential of upstream and downstream sewage. This differential should not exceed maximum specified by the Supplier and should show no general upward trend.
iv) Check for hang-up of screenings.
v) Operation of screen automated start/stop sequence.
vi) Measure motor current.
vii) Test overload conditions and self-cleaning function.
viii) Check for operation of emergency stop.

Generally, the equipment will be considered acceptable at commissioning when all of the following conditions are satisfied:

i) The equipment meets the duty requirements as defined in this section of the Specification.
ii) Any other specific performance tests defined in this Section prove acceptable operation of the equipment
iii) Where a power test is required, the power absorbed by the motor at duty point does not exceed the values stated in the Technical Data Sheets by more than 5%.
iv) Where a vibration test is required, the vibration measured at each point does not exceed the level prescribed in BS 4675 Part 1-1976 for the appropriate class of machine.
v) Where a noise test is required, the noise generated by the equipment does not exceed the values stated in the Technical Data Sheets.

M5.14.4 **After Commissioning**

Check equipment for proper functioning and monitor process performance during the Test Period and the Trial Operational Period (TOP). Refer Section 9 in the Conditions of Contract.

For the purpose of this contract, the TOP shall be 28 days. The operating time of each duty screen shall be adjusted to ensure that the total operation hours (including the Test Period) is split equally between each screen. All laboratory testing required during the TOP and Test Period shall be done at a SANAS approved, independent laboratory. Tenderers shall allow for the cost of all sampling and testing in their offer.

The Overall Equipment Efficiency (OEE) of the screens shall be greater than 95% during the TOP. OEE is defined as the total running time of the equipment less the time lost for breakdowns and maintenance. Periods of downtime outside of the Contractor's control will not be included in the OEE calculation.

The oversized screening ability of the screens will be proven during the test period. The test period will be conducted over 5 days per set of coarse, fine and ultrafine screens. A daily composite sample, made up of 6 hourly samples, will be taken after each screen. For each daily composite sample, the mass fraction of solids in the sample will be characterized by performing a sieve analysis. From the sieve analysis, the mass fraction

of solids over 25mm will be determined. The average of the daily screening results (at the upper limit of the 95% confidence interval) shall be greater than what is guaranteed by the Contractor.

The performance of the equipment will be considered acceptable when the requirements as specified have been achieved consistently during the Test Period and TOP.

M5.14.5 **During Defects Notification Period**

Refer to Section M26 which further describes the Contractors responsibilities during DNP with respect to the operation and maintenance of the plant.

M5.15 Spares and maintenance

The Contractor shall be responsible for identifying and supplying the required spares for the selected mechanical equipment. The spares selection shall be subject to approval, in writing, by the Engineer.

M5.16 Operation and control

Refer to control narrative document W1859-48001 (in Volume 3) for details on the operation and control of the equipment in this section

M6. WASHER/COMPACTORS

M6.1 Scope

The scope associated with Inlet Works Washer/Compactors shall include design, supply, delivery, installation, testing, commissioning and upholding during the Trial Operation Period and the Defects Notification Period of the following:

i. Two washer/compactors complete with outlet chutes shall be provided to direct the compacted screenings into a skip. These units shall receive combined screenings from the coarse and fine screens via the hydraulic conveyor network
ii. All piping, fittings, isolation valves, supports and fasteners supplying washwater from the tie-in to the 2nd class bulk supply manifold up to the supply point to each washer/compactor.
iii. All piping, fittings, isolation valves, supports and fasteners returning dirty washwater from each of the washer/compactors back to the inlet works

The equipment shall be generally as shown on Piping and Instrumentation Drawing W1859-45003 (60325-M-LI-101) and equipment layout W1859-85002 (60325-M-LI-106) .

M6.2 General description

Wet screenings shall be fed to the washer/compactors by a hydraulic conveyor every time a screen is raked/cleaned. After the compactor has received material from a pre-set number of screen raking cycles, washwater shall be added to the receiving hopper and the agitator shall run for a period to release organics from the screenings. The water and organics shall then be drained and the screw operated for a pre-set period to compact and discharge the washed screenings.

The two washer/compactors shall be operated in duty/standby mode and discharge the compacted screenings directly into a skip. Used washwater shall be routed to the inlet of coarse screens.

M6.3 Duty

Each of the washer/compactors shall be able to cope with any material collected by the screens, including rags, stringy matter, food particles, plastic bags, earbuds, leaves, sticks, clothing, toys, tin cans, glass, plastic bottles, condoms, stones and masonry. The capacities of the units shall be as follows:

Because the washer/compactors are common to all the screens, the washer/compactor shall be designed to handle the future full ADWF of 27 Ml/d with 3 duty channels running. The washer/compactors shall therefore handle and average of 0.37 m^3/h of wet screenings with an estimated combined solids content of 19% coming off the screen. The system shall be designed with a peak factor of at least 4. The water content of the compacted screenings shall not exceed 65% therefore each washer/compactor shall be able to process 1.2 m^3/h of wet screenings to skip. The washed and compacted screenings shall be largely free from organic material.

The operation of the washer/compactors shall take into account that the screenings are conveyed hydraulically using a launder design supplied with 2nd class water at intermittently at approximately 58 m^3/h.

M6.4 Washer/compactor body

The washer/compactor body shall consist of a hopper section, where the screenings are collected and washed, and a tubular screw press body, where washed screenings are compacted.

The hopper section shall be suitably sized to hold the required volumes of screenings and washwater. It shall house a pump impeller mixer driven by an electric motor, a water level probe, a water supply connection and an overflow pipe connection. The region of the hopper where the impeller/motor is mounted shall be adequately reinforced to prevent any flexing during the washing cycle. The hopper shall be equipped with easily removable, watertight cover plates for inspection and cleaning. The top of the hopper shall be designed to mate with the outlet chute of the wet screenings hydraulic conveyor feeding it.

The screw press body shall be of circular cross section to house the shafted screw. It shall be fabricated from perforated plate with a cut out where it connects to the hopper to collect the screenings. Water that drains through the screw press body perforations shall be collected in a drain pan.

M6.5 Washer/compactor shafted screw

The shafted screw shall transport the screenings from the washing zone into the compaction zone and shall force the compacted screenings out of the discharge pipe. The shaft shall be fabricated from stainless steel. The screw flights shall be made of an appropriate wear resistant material and shall have adequate thickness to resist the forces involved.

The screw shall be cantilevered from the drive end and shall not deflect and touch the body walls even under maximum loading. There shall be no bearing at the discharge end of the screw.

M6.6 Washer/compactor drain pan

The drain pan shall collect the spent washwater and water squeezed from the screenings. It shall be welded to the washer body and equipped with easily removed, watertight inspection covers.

An adequately sized drain line with an electrically operated valve (controlled by the plant PLC) shall be provided to discharge drain water. One or more washwater inlets equipped with solenoid valves shall be provided for flushing the drain pan to prevent organic matter from accumulating.

M6.7 Washer/compactor discharge pipe

The discharge pipe shall be made of stainless steel and shall be flanged to the screening's washer body. The diameter of the straight section of the discharge pipe shall increase in size to ease the transport of the screenings.

The washer/compactors shall include an outlet chute to direct the compacted screenings from each unit into a skip.

M6.8 Washer/compactor drive

The screw drive unit shall be a geared motor rated for continuous duty and shall be selected to match the requirements of the equipment. It shall be direct coupled to the screw shaft.

The pump impeller mixer shall be direct driven by a motor.

Both motors shall be a totally enclosed fan cooled (TEFC), constant speed units, fed from 3-phase 380/400 VAC, 50 Hz power.

The screw drive gearbox shall have a minimum service factor of 1.75 and an IP55 protection rating. Nominal and minimum motor efficiencies shall comply with NEMA MG 1. The gearbox shall be designed for AGMA Class II, 24-hour duty.

Tenderers should take note of the ’s requirements for electric motors, as per Section D35 of the Standard Specification for Mechanical Works. Where the Contractor is not able to conform to these requirements, he should explicitly highlight the deviations in his offer, for consideration by the Engineer.

It should also be noted that whilst preliminary motor selections have been made for the purposes of this tender, choice of final motor sizes shall rest with the Contractor. Furthermore, whilst four pole motors are preferable for the anticipated rating, two pole motors will be acceptable.

M6.9 Piping

All valves, fittings, piping material and sizes shall be as indicated on P&ID W1859-45003 (60325-M-LI-101). All piping, fittings and supports shall conform to section D20 of the Standard Specifications for Mechanical Works unless otherwise stated below. All piping shall be clearly identifiable as per SANS 10140-3. All valves shall conform to section D28, D29 and D30 of the Standard Mechanical Specification for Mechanical Works. Refer to control valve list W1859-61002, on/off valve list W1859-61003, pressure safety valve list W1859-61004, hand valve list W1859-61005 and check valve list W1859-61006 in Volume 3.

Washwater Supply:
Washwater shall be piped from the bulk 2nd class water supply to each washer/compactor. A manual ball valve shall provide isolation from the bulk 2nd class water supply manifold. A mechanical pressure reducing valve will regulate the pressure of the washwater supply. Each washwater point located on the washer/compactors shall have an automated solenoid on/off valve controlled by the SCADA/PLC system to control the flow of washwater to each unit.

Overflow and drain piping:
Overflow and drain water from the washer/compactors shall be routed back upstream of the course screens. A pneumatically actuated, DN100, SS304 ball valve shall be fitted on the drain line to drain dirty washwater automatically based on the sequence set up on the PLC/SCADA system.

M6.10 Motor Control Centre

All equipment and instrumentation indicated on P&ID W1859-45003 (60325-M-LI-101) will be operated from a local PLC situated in the new MCC room at pump station.

All instrumentation and controls as shown on the P&ID W1859-45003 (60325-M-LI-101) and the instrumentation list (refer to volume 3) are to be supplied and installed to ensure safe, reliable and efficient operation under the conditions stated in this specification. This shall include all instrumentation required for start-up, shut-down, ongoing monitoring of essential system parameters and for safe operation in accordance with the applicable codes and standards.

The analogue instruments (e.g. T, P) shall be supplied complete with manufacturer calibration certificate and procedure and material certificates (SS 316). The certificates shall be available at FAT execution if applicable. All instrument loops and process control functionality shall be tested during FAT.

The MCC and PLC shall be supplied as per the Standard Electrical specification included in Volume 3.

M6.11 Corrosion Protection and Materials of Construction

M6.11.1 Materials of Construction

Press Chamber	304L Stainless Steel.
Inlet Hopper	304L Stainless Steel.
Screw Assembly	Carbon Steel.
Venturi (if applicable)	304L Stainless Steel.
Discharge Chute	304L Stainless Steel.
Lantern Housing	304L Stainless Steel.
Support Frame	304L Stainless Steel
Drainage Trough	304L Stainless Steel.
Fasteners and Concrete Anchors	316 Stainless Steel

M6.11.2 **Corrosion Protection**

Corrosion protection shall be carried out in accordance with the requirements of Sections D11 to D14 of the Standard Specification for Mechanical Works. Where stainless steel components are welded these shall be pickled and passivated. Pump housings and geared motor units shall be Alkyd overcoated.

Press Chamber	Grit Blast and Pickle & Passivate.
Inlet Hopper	Grit Blast and Pickle & Passivate.
Venturi (if applicable)	Pickle & Passivate.
Discharge Chute	Grit Blast and Pickle & Passivate.
Lantern Housing	Grit Blast and Pickle & Passivate.
Support Frame	Grit Blast and Pickle & Passivate.
Drainage Trough	Grit Blast and Pickle & Passivate.
Geared Motor	Alkyd Over Coat

M6.12 Quality Management

A quality control plan shall be submitted for each washer/compactor for approval and monitoring by the Engineer

M6.13 Installation

The washer/compactors and associated piping and ducts shall be installed by the Contractor in accordance with the instructions of the washer/compactor manufacturer and as shown on their drawings.

Aside from conformance to the general installation requirements as outlined in the Standard Specification for Mechanical Works. Contractors should ensure the least possible disruption to plant operation

M6.14 Performance testing

M6.14.1 **Works Testing**

Works testing of the washer/compactor shall include the following:

i) Alignment and fit of respective bearings and drives.
ii) Alignment of screw in screw press body.
iii) Operation of total assembly.

Inspection certificates detailing all works testing shall be forwarded to the Engineer.

M6.14.2 **Before Commissioning**

i) Contractors shall take note of Sections D77.1 to D77.4 of the Standard Specification for Mechanical Works, prior to starting commissioning.
ii) Check for alignment of bearings and drives.
iii) Check for alignment and fit of piping and valves.
iv) Ensure all drive equipment is lubricated and gearboxes are filled to correct levels.
v) Test for correct rotation of all motors.
vi) Test for correct operation of control gear, where provided under this Contract.
vii) Tests for correct operation of whole assembly.
viii) Submit all certification, motor test certificates, material certificates
ix) Submit all operating and maintenance instructions.

M6.14.3 **Commissioning tests**

Specifically, the washer/compactors shall undergo the following tests:

i) Correct operation under design flow conditions.
ii) Determination of appropriate timings for washer/compactor cycle.

iii) Check effectiveness of chutes.
iv) Check for freedom from hang-up of material.
v) Operation of automated start/stop sequence in conjunction with upstream equipment.
vi) Confirmation that the moisture content of the dewatered screenings is less than 65%.
vii) Measure motor current.
viii) Check for operation of emergency stop.

Generally, the equipment will be considered acceptable at commissioning when all of the following conditions are satisfied:

i) The equipment meets the duty requirements as defined in this section of the Specification.
ii) Any other specific performance tests defined in this Section prove acceptable operation of the equipment
iii) Where a power test is required, the power absorbed by the motor at duty point does not exceed the values stated in the Technical Data Sheets by more than 5%.
iv) Where a vibration test is required, the vibration measured at each point does not exceed the level prescribed in BS 4675 Part 1-1976 for the appropriate class of machine.
v) Where a noise test is required, the noise generated by the equipment does not exceed the values stated in the Technical Data Sheets.

M6.14.4 **After Commissioning**

Check equipment for proper functioning and monitor process performance during the Test Period and the Trial Operational Period (TOP). Refer to Section 9 in the Conditions of Contract.

For the purpose of this contract, the TOP shall be 28 days. The operating time of each duty washer/compactor shall be adjusted to ensure that the total operation hours (including the Test Period) is split equally between each unit. All laboratory testing required during the TOP and Test Period shall be done at a SANAS approved, independent laboratory. Tenderers shall allow for the cost of all sampling and testing in their offer.

The Overall Equipment Efficiency (OEE) of the washer/compactor shall be greater than 95% during the TOP. OEE is defined as the total running time of the equipment less the time lost for breakdowns and maintenance. Periods of downtime outside of the Contractor's control will not be included in the OEE calculation.

The screenings dryness will be proven during the Test Period. The Test Period will be conducted over 5 days per washer/compactor. A daily composite sample, made up of 6 hourly samples, will be taken of the compacted screenings as it falls out of the discharge chute (not in the skip). For each daily composite sample, the moisture content will be analysed. The average of the daily moisture contents (at the upper limit of the 95% confidence interval) shall be greater than what is guaranteed by the Contractor.

The performance of the equipment will be considered acceptable when the requirements as specified have been achieved consistently during the Test Period and TOP.

M6.14.5 **During Defects Notification Period**

Refer to Section M26 which further describes the Contractors responsibilities during DNP with respect to the operation and maintenance of the plant.

M6.15 Spares

The Contractor shall be responsible for identifying and supplying the required spares for the selected mechanical equipment. The spares selection shall be subject to approval, in writing, by the Engineer.

M6.16 Operation and Control

Refer to control narrative document W1859-48001 (in Volume 3) for details on the operation and control of the equipment in this section

M7. ULTRAFINE SCREENINGS HANDLING

M7.1 Scope

The scope associated with Inlet Works Grit Traps shall include design, supply, delivery, installation, testing, commissioning and upholding during the Trial Operation Period and the Defects Notification Period of the following:

i. Two (duty/standby) micro strainer and screenings compacting and washing units complete with steel inlet chamber, basket strainer, inclined screw compactor coupled to a gearbox and electrical motor, discharge chute, washwater manifold and spray nozzles, supports and fasteners.
ii. Two discharge hoppers with manual divert flap to discharge screenings into duty/standby screw conveyors.
iii. Two (duty/standby) enclosed, centreless spiral screw conveyors, designed to convey compacted screenings from the micro strainer units to the collection skip.
iv. All piping, fittings, isolation and pressure reducing valves, supports and fasteners to supply 2nd class water from the bulk supply manifold to each micro strainer unit.
v. All piping, fittings, isolation valves, supports and fasteners to supply screenings from the hydraulic launder discharge to each micro strainer unit, and then to convey the filtrate and discharge into the combined channel upstream of the grit traps.

The equipment shall be generally as shown on Piping and Instrumentation Drawings W1859-45005 (60325-M-LI-103) and on Equipment and Piping Layout Drawings W1859-85002 (60325-M-LI-106)

M7.2 General Description of Technology

Ultrafine screenings from the band screens, transported via a hydraulic launder system, shall be sent to two (duty/standby) micro strainer units. The micro strainer shall be identical in design and shall perform screening, compacting and washing within a single unit. Wet screenings shall be piped and flow from the hydraulic launder discharge into a steel inlet chamber by gravity. An inclined, 2mm perforated plate basket strainer shall be mounted in the inlet chamber. While diluted screenings flow through the basket strainer, screenings are trapped on the internal surface of the basket while the filtrate flows back to the inlet works combined channel. Screenings are continuously removed from the basket strainer using a screw containing wear resistant brushes on the screw flights. The screenings are transported through an inclined pipe. While the screenings are being transported, soluble/fine organic material is washed off the inorganic solids and returns back to the inlet works with the filtrate. Washing is achieved by spraying 2nd class water (at 5-6 bar) onto the screenings through a washwater manifold with spray nozzles mounted above the screw conveyor. After washing, the screenings are dewatered before being discharged. The inlet chamber on each micro strainer, shall come with a hinged lid to allow for the quick and easy inspection of the basket strainer, screw and washwater manifold.

Dewatered screenings shall be discharged to a set of duty/standby, shaftless screw conveyors. Each micro strainer unit shall be able to discharge to each screw conveyor. This shall be achieved using a discharge chute fitted with a manual divert flap to allow screenings to be diverted to the intel of the selected screw conveyor. The discharge chute and divert flap assembly shall be mounted directly onto the respective screw conveyor such that the transfer of screenings is fully contained.

M7.3 Duties

Each of the micro strainer units shall be able to cope with any material collected by the screens, including rags, stringy matter, food particles, plastic bags, earbuds, leaves, sticks, clothing, toys, tin cans, glass, plastic bottles, condoms, small stones and masonry. The capacities of the units shall be as follows:

Because the micro strainer units are common to all the ultrafine screens, they shall be designed to handle the future full ADWF of 27 Ml/d with 3 duty channels running. The washer/compactors shall therefore handle an average of 0.9 m^3/h of wet screenings with an estimated solids content of 10% coming off the screen. The system shall be designed with a peak factor of at least 4. The water content of the compacted screenings shall not exceed 70%. Each washer/compactor shall be able to process a maximum of 2 m^3/h of wet screenings to skip. The washed and compacted screenings shall be largely free from organic material.

The operation of the micro strainers shall consider that the screenings are conveyed hydraulically using a launder design supplied with 2nd class water intermittently at approximately 58 m^3/h. The screen basket diameter shall be sized to accommodate the full hydraulic load considering the available considering the head loss available at site.

M7.4 Inlet Chamber

The basket strainer shall be inclined and mounted within a stainless steel chamber. The chamber shall have a inlet flange (minimum DN300, PN10) supplying diluted screenings, piped from the hydraulic launder. The chamber shall have an outlet flange (minimum DN300, PN10) to connect the filtrate discharge pipe returning filtrate back to the combined wastewater channel at the inlet works. The inlet chamber on each micro strainer, shall come with a hinged lid to allow for the quick and easy inspection of the basket strainer, screw and washwater manifold.

M7.5 Basket Strainer

The basket strainer shall be a perforated plate with 2 mm apertures. The small aperture size and blinding effect shall ensure a high capture rate of ultrafine screenings is achieved. The diameter of the basket shall be sized for the maximum hydraulic load specified in the Duties section of this specification.

M7.6 Micro strainer shafted screw

The shafted screw shall transport the screenings from the washing zone into the compaction zone and shall force the compacted screenings out of the discharge pipe. The shaft shall be fabricated from stainless steel. The screw flights shall be fitted with a wear resistant cleaning brush to aid the cleaning of the strainer.

M7.7 Screenings divert flap

Dewatered screenings shall be discharged to a set of duty/standby, shaftless screw conveyors. Each micro strainer unit shall be able to discharge to each screw conveyor. This shall be achieved using a stainless steel discharge chute fitted with a stainless steel manual divert flap to allow screenings to be diverted to the inlet of the selected screw conveyor. The discharge chute and divert flap assembly shall be mounted directly onto the respective screw conveyor such that the transfer of screenings is fully contained. The flap shall be fitted with a handle to allow the operator to slide the flap into the desired position by hand thereby selecting the duty screenings conveyor. Proximity switches shall be mounted to indicate the position of the flap which shall be used for equipment interlocking purposes.

M7.8 Ultrafine screenings screw conveyor trough

M7.8.1 **Conveyor trough**

The conveyor trough shall be manufactured in a “U” shape to accommodate the centreless spiral screw. It shall have a lip on each side for rigidity and shall be flanged at both ends for mounting the screw drive and outlet chute. It shall be adequately supported to avoid deformation. The conveyors shall have a chute designed to attach directly to the discharge chute of the centrifuges. The chute design will ensure there are no sloped walls. In instances where this is unavoidable, the angle of the slope must be approved by the Engineer.

The trough covers shall be made of stainless steel and shall be screwed or bolted to the trough to minimise the risk of personal injury and the release of odours. A hinged cover shall be provided at each end to provide relief in the event of a blockage.

The trough shall be equipped with replaceable wear liners to prevent metal-to-metal contact with the screw. The liners shall have a thickness of not less than 10 mm and shall be manufactured from a material that has two colours laminated together to provide clear indication when the inner layer of the liner has worn away.

M7.8.2 **Centreless spiral**
The centreless spiral shall be manufactured from high tensile steel flat bar, at least 20mm thick. It shall have a flange at one end for connection to the drive unit.

M7.9 Screw conveyor and micro strainer drives

The screws' drive unit shall be a geared motor rated for continuous duty and shall be selected to match the requirements of the equipment. It shall be direct coupled to the screw shaft.

Both motors shall be a totally enclosed fan cooled (TEFC), constant speed units, fed from 3-phase 380/400 VAC, 50 Hz power.

The screw drive gearbox shall have a minimum service factor of 1.75 and an IP55 protection rating. Nominal and minimum motor efficiencies shall comply with NEMA MG 1. The gearbox shall be designed for AGMA Class II, 24-hour duty.

Tenderers should take note of the 's requirements for electric motors, as per Section D35 of the Standard Specification for Mechanical Works. Where the Contractor is not able to conform to these requirements, he should explicitly highlight the deviations in his offer, for consideration by the Engineer.

It should also be noted that whilst preliminary motor selections have been made for the purposes of this tender, choice of final motor sizes shall rest with the Contractor. Furthermore, whilst four pole motors are preferable for the anticipated rating, two pole motors will be acceptable.

M7.10 Piping

All valves, fittings, piping material and sizes shall be as indicated on P&ID W1859-45005 (60325-M-LI-103). All piping, fittings and supports shall conform to section D20 of the Standard Specifications for Mechanical Works unless otherwise stated below. All piping shall be clearly identifiable as per SANS 10140-3. All valves shall conform to section D28, D29 and D30 of the Standard Mechanical Specification for Mechanical Works. Refer to control valve list W1859-61002, on/off valve list W1859-61003, pressure safety valve list W1859-61004, hand valve list W1859-61005 and check valve list W1859-61006 in Volume 3. The tenderer shall supply technical datasheets/brochures of the range for each valve type offered with the tender.

Washwater Supply:
Washwater shall be piped from the bulk 2nd class water supply to each Micro strainer. A manual ball valve shall provide isolation from the bulk 2nd class water supply manifold. A mechanical pressure reducing valve will regulate the pressure of the washwater supply. Each washwater point located on the micro strainer unit shall have an automated solenoid on/off valve controlled by the SCADA/PLC system to control the flow of washwater to each unit.

Screenings supply and filtrate piping:
Diluted screenings shall be piped with a stainless steel DN300, PN10 pipe from the hydraulic launder to the inlet chamber of each micro strainer. Each inlet pipe shall have a DN300, PN6 knifegate valve (SS304) with motorised actuator to isolate the respective micro strainer. Filtrate shall be piped back to the combined wastewater channel at the inlet works with DN300, PN10 pipe. The flow of screenings and filtrate shall be by gravity only.

M7.11 Motor Control Centre

All equipment and instrumentation indicated on P&ID W1859-45005 (60325-M-LI-103) will be operated from a local PLC situated in the new MCC room at the pump station.

All instrumentation and controls as shown on the W1859-45005 (60325-M-LI-103) and the instrumentation list (refer to volume 3) are to be supplied and installed to ensure safe, reliable and efficient operation under the

conditions stated in this specification. This shall include all instrumentation required for start-up, shut-down, ongoing monitoring of essential system parameters and for safe operation in accordance with the applicable codes and standards.

The analogue instruments (e.g. T, P) shall be supplied complete with manufacturer calibration certificate and procedure and material certificates (SS 316). The certificates shall be available at FAT execution if applicable. All instrument loops and process control functionality shall be tested during FAT.

The MCC and PLC shall be supplied as per the electrical specification..

M7.12 Corrosion Protection and Materials of Construction

A5.10.1. Materials of Construction

Micro Strainer:

Inlet Chamber	304L Stainless Steel.
Screw compactor body	304L Stainless Steel.
Screw	Stainless steel.
Support Frame	304L Stainless Steel
Strainer basket	304L Stainless Steel.
Discharge chute/divert flap	304L Stainless Steel
Fasteners and Concrete Anchors	316 Stainless Steel

Screenings Conveyor:

Support Framework	304 Stainless steel
Trough	304 Stainless steel
Outlet chutes	304 Stainless steel
Centreless Screw Spiral	High tensile steel flat bar at least 20 mm thick
Shafted screws	High tensile steel flat bar at least 6 mm thick
Trough covers	304 Stainless steel
Trough liners	UHMWPE

A5.10.2. Corrosion Protection

Corrosion protection shall be carried out in accordance with the requirements of Sections D11 to D14 of the Standard Specification for Mechanical Works. Where stainless steel components are welded these shall be pickled and passivated. Pump housings and geared motor units shall be Alkyd overcoated.

M7.13 Quality Management

A quality control plan shall be submitted for each washer/compactor.

M7.14 Installation

The micro strainer, screw conveyors and associated piping and ducts shall be installed by the Contractor in accordance with the instructions of the washer/compactor manufacturer and as shown on their drawings.

Aside from conformance to the general installation requirements as outlined in the Standard Specification for Mechanical Works.

M7.15 Performance testing

M7.15.1 Works Testing

Works testing of the micro strainer shall include the following:

i) Alignment and fit of respective bearings and drives.
ii) Alignment of screw in screw press body.
iii) Operation of total assembly.

Inspection certificates detailing all works testing shall be forwarded to the Engineer.

M7.15.2 Before Commissioning

i) Contractors shall take note of Sections D77.1 to D77.4 of the Standard Specification for Mechanical Works, prior to starting commissioning.
ii) Check for alignment of bearings and drives.
iii) Check for alignment and fit of piping and valves.
iv) Ensure all drive equipment is lubricated and gearboxes are filled to correct levels.
v) Test for correct rotation of all motors.
vi) Test for correct operation of control gear, where provided under this Contract.
vii) Tests for correct operation of whole assembly.
viii) Submit all certification, motor test certificates, material certificates
ix) Submit all operating and maintenance instructions.

M7.15.3 Commissioning tests

Specifically, the microstrainer shall undergo the following tests:

i) Correct operation under design flow conditions.
ii) Determination of appropriate timings for washer/compactor cycle.
iii) Check effectiveness of chutes.
iv) Check for freedom from hang-up of material.
v) Operation of automated start/stop sequence in conjunction with upstream equipment.
vi) Confirmation that the moisture content of the dewatered screenings is less than 65%.
vii) Measure motor current.
viii) Check for operation of emergency stop.

Generally, the equipment will be considered acceptable at commissioning when all of the following conditions are satisfied:

i) The equipment meets the duty requirements as defined in this section of the Specification.
ii) Any other specific performance tests defined in this Section prove acceptable operation of the equipment
iii) Where a power test is required, the power absorbed by the motor at duty point does not exceed the values stated in the Technical Data Sheets by more than 5%.
iv) Where a vibration test is required, the vibration measured at each point does not exceed the level prescribed in BS 4675 Part 1-1976 for the appropriate class of machine.
v) Where a noise test is required, the noise generated by the equipment does not exceed the values stated in the Technical Data Sheets.

M7.15.4 After Commissioning

Check equipment for proper functioning and monitor process performance during the Test Period and the Trial Operational Period (TOP). Refer to Section 9 in the Conditions of Contract.

For the purpose of this contract, the TOP shall be 28 days. The operating time of each duty micro strainer shall be adjusted to ensure that the total operation hours (including the Test Period) is split equally between each unit. All laboratory testing required during the TOP and Test Period shall be done at a SANAS approved, independent laboratory. Tenderers shall allow for the cost of all sampling and testing in their offer.

The Overall Equipment Efficiency (OEE) of the micro strainer shall be greater than 95% during the TOP. OEE is defined as the total running time of the equipment less the time lost for breakdowns and maintenance. Periods of downtime outside of the Contractor's control will not be included in the OEE calculation.

The screenings dryness will be proven during the Test Period. The Test Period will be conducted over 5 days per micro strainer. A daily composite sample, made up of 6 hourly samples, will be taken of the compacted screenings as it falls out of the discharge chute (not in the skip). For each daily composite sample, the moisture content will be analysed. The average of the daily moisture contents (at the upper limit of the 95% confidence interval) shall be greater than what is guaranteed by the Contractor.

The performance of the equipment will be considered acceptable when the requirements as specified have been achieved consistently during the Test Period and TOP.

M7.15.5 **During Defects Notification Period**

Refer to Section M26 which further describes the Contractors responsibilities during DNP with respect to the operation and maintenance of the plant.

M7.16 Spares

The Contractor shall be responsible for identifying and supplying the required spares for the selected mechanical equipment. The spares selection shall be subject to approval, in writing, by the Engineer.

M7.17 Operation and Control

Refer to control narrative document W1859-48001 (in Volume 3) for details on the operation and control of the equipment in this section

M8. GRIT TRAPS

M8.1 Scope

The scope associated with Inlet Works Grit Traps shall include design, supply, delivery, installation, testing, commissioning and upholding during the Trial Operation Period and the Defects Notification Period of the following:

i. Two induced vortex grit traps shall be installed complete with motors, gearboxes, shafts and paddles with all associated support structures (only the civil works of a third grit trap shall be completed under this contract).
ii. Two self-priming centrifugal pumps complete with motor, baseplate and air release valves to transfer grit slurry from the grit traps to the grit classifiers.
iii. All piping, fittings, isolation and pressure reducing valves, supports and fasteners to supply 2nd class water from the bulk supply manifold to each grit trap.
iv. All piping, fittings, isolation valves, supports and fasteners for the grit slurry piping transporting grit slurry from the grit traps to the grit classifiers.

The grit traps shall be installed in new channels and civil works (refer to civil specification). The Contractor shall confirm any modifications to the current civil design to accommodate the mechanical equipment offered

The equipment shall be generally as shown on Piping and Instrumentation Drawings W1859-45004 (60325-M-LI-102) (60325-M-LI-102) and on Equipment and Piping Layout Drawings W1859-85002 (60325-M-LI-106).

M8.2 General Description of Technology

Screened sewage from the mechanically raked screens flows into two induced vortex grit traps. Each trap is circular in design and is a conical bottomed concrete tank positioned adjacent to the channel. The inlet and outlet channels shall be separated by 270º. Sewage flows tangentially into the trap and the grit accumulates at the bottom of the tank. A continuously rotating paddle (with non-clogging blades) ensures a constant velocity in the trap (independent of the sewage flow) that ensures organic matter remains in suspension while grit is allowed to settle out. The de-gritted sewage containing organic matter flows through the trap to the screened wastewater sump.

Periodically, washwater is injected down into the base of the tank to fluidise and wash the accumulated grit. A self priming centrifugal pump then transfers the grit slurry to a separate grit classifier. The washwater shall be provided by the upstream 2nd class water pumps.

The two grit traps shall operate in duty/standby mode; however, allowance shall be made for both units to operate in parallel during periods of peak flow.

M8.3 Duties

Each grit trap shall have a hydraulic capacity of 990 m^3/h. The estimated average rate of grit removal per grit trap shall be approximately 0.63 m^3/d at an average dry weather flow of 9 Ml/d per channel and approximately 1.67 m^3/d at the peak wet weather flow of 23.8 Ml/d per grit trap assuming an average grit content of 70 l/Ml.

The estimated washwater requirement per grit trap is approximately 15 m^3/h, for 10 minutes every hour. Each self-priming pump shall deliver 58 m^3/h at 7 m differential head. .

The separation efficiency of the grip trap shall be >85 % of grit particles larger than 0.21 mm.

The Contractor shall liaise with the agents for the grit traps to confirm the quantities of water that shall be discharged into each of the classifiers by the grit traps when the grit pumps are operating.

M8.4 Grit Slurry Pumps

The Grit Slurry Pumps shall be self-priming centrifugal type pumps conforming to section D43 of the Standard Mechanical Specifications. Each pump shall operate on a duty basis for their respective grit trap and shall be capable of delivering a maximum volumetric flowrate of 58 m^3/h at 7 m. The pumps shall be designed for continuous operation in an abrasive environment (grit, stones etc.) which is typical of municipal wastewater degritting application. The pump and impeller shall be designed to pump solids at a concentration of 3 wt.% and be able to handle solid particle sizes up to 60 mm together with stringy material without the risk of clogging. A cover plate situated on the pump housing shall allow easy access to clear blockages without having to remove piping. A replaceable wear plate shall be supplied on the cover plate to allow for easy inspections during servicing.

The speed of each pump shall be fixed. The pump shall have a mechanical seal, oil lubricated, double floating type. The seal shall have silicon carbide rotating and stationary faces with a SS316 stationary seat. Elastomers shall be fluorocarbon.

The required discharge head of the pump is estimated for tender purposes only. It is the responsibility of the Contractor to confirm the required head during detail design.

M8.5 Penstocks

New rising spindle penstocks upstream of the degritters shall be provided. All penstocks shall comply with Section D31 of the Standard Specification for Mechanical Works. The penstock door and frame shall be SS304. The penstocks upstream of the degritters shall be designed to fit a channel 700mm wide with a total height (channel floor to top of channel) of 2326mm.

M8.6 Motors

Tenderers should take note of the ’s requirements for electric motors, as per Section D35 of the Standard Specification for Mechanical Works. Where the Contractor is not able to conform to these requirements, he should explicitly highlight the deviations in his offer, for consideration by the Engineer.

It should also be noted that whilst preliminary motor selections have been made for the purposes of this tender, choice of final motor sizes shall rest with the Contractor. Furthermore, it shall be noted that the power rating shall be supplied as a 380 V low voltage unit. Whilst four pole motors are preferable for the anticipated rating, two pole motors will be acceptable.

M8.7 Piping

All valves, fittings, piping material and sizes shall be as indicated on P&ID W1859-45004 (60325-M-LI-102) (60325-M-102). All piping, fittings and supports shall conform to Section D20 of the Standard Specification for Mechanical Works unless otherwise stated below. All piping shall be clearly identifiable as per SANS 10140-3. All valves shall conform to section D28, D29 and D30 of the Standard Mechanical Specification for Mechanical Works. Refer to control valve list W1859-61002, on/off valve list W1859-61003, pressure safety valve list W1859-61004, hand valve list W1859-61005 and check valve list W1859-61006 in Volume 3. The tenderer shall supply technical datasheets/brochures of the range for each valve type offered with the tender.

Washwater:
Washwater shall be piped from the bulk 2nd class water supply to each grit trap. A mechanical pressure reducing valve shall regulate the pressure of the washwater supply. A manual ball valve shall provide isolation from the bulk 2nd class water supply manifold. A diaphragm hand valve shall be locked in position to set the flow rate during commissioning. The washwater supply piping to each trap shall have an automated solenoid on/off valve controlled by the SCADA/PLC system to control the flow of washwater to each trap.

Grit slurry:

The grit slurry piping shall extend from the lower chamber of each grit trap up until the supply to each grit classifier. The piping shall be PN10 and SS304. Automated on/off knife gate valves shall be placed on the discharge of each grit slurry pump and similarly, automated on/off knifegate valves shall be placed at the inlet of each grit classifier. The pipe route shall ensure that any grit trap can supply any grit classifier which shall be controlled by the automated valves and the PLC. A site glass shall be installed on the discharge of each grit slurry pump. In addition to this, 2nd class water flushing points and a rodding point shall be supplied to assist with preventing and/or unblocking the pipeline.

M8.8 Motor Control Centre

All equipment and instrumentation indicated on P&ID W1859-45004 (60325-M-LI-102) (60325-M-102) will be operated from a local PLC situated in the new Motor Control Centre (MCC) room.

All instrumentation and controls as shown on the P&ID W1859-45004 (60325-M-LI-102) (60325-M-102) and the instrumentation list (refer to volume 3) are to be supplied and installed to ensure safe, reliable and efficient operation under the conditions stated in this specification. This shall include all instrumentation required for start-up, shut-down, ongoing monitoring of essential system parameters and for safe operation in accordance with the applicable codes and standards.

The analogue instruments (e.g. T, P) shall be supplied complete with manufacturer calibration certificates and procedure and material certificates (SS 316). The certificates shall be available at FAT execution if applicable. All instrument loops and process control functionality shall be tested during FAT.

The MCC and PLC shall be supplied as per the Standard Electrical specification included in Volume 3.

M8.9 Corrosion Protection and Materials of Construction

M8.9.1 Materials of Construction

Materials of construction, where new parts are required shall be as follows:

Paddle drive gearbox	Cast iron
Paddle Drive Housing	Mild Steel.
Paddle Drive Tube	304 Stainless Steel.
Paddle Arms and Paddles	304 Stainless Steel.
Any Submerged Steelwork & Brackets	304Stainless Steel.
All piping	304 Stainless Steel.
Fasteners and Concrete Anchors	304 Stainless Steel
Grit removal pump	
Pump Casing	Grey Cast Iron
Impeller	Hardened Iron
Impeller Shaft	Alloy Steel 4150
Shaft Sleeve	Alloy Steel 4130
Wear Plate	Hardened Alloy Steel
Flap valve	Neoprene/nylon and steel reinforcing
Bearing housing	Grey Cast Iron
Baseplate	Mild Steel, Hot dip galvanized
Mechanical Seal	Silicone Carbide

M8.9.2 **Corrosion Protection**

Corrosion protection shall be carried out in accordance with the requirements of Sections D11 to D14 of the Standard Specification for Mechanical Works. Where stainless steel components are welded these shall be pickled and passivated. Pump housings and geared motor units shall be Alkyd overcoated.

Paddle Drive Housing	Hot Dip Galvanised.
Paddle Drive Tube	Grit Blast and Pickle & Passivate.
Paddle Arms and Paddles	Grit Blast and Pickle & Passivate.
Grit slurry piping	Grit Blast and Pickle & Passivate.
Other Pipework (submerged)	Grit Blast and Pickle & Passivate.
Any Submerged Steelwork & Brackets	Grit Blast and Pickle & Passivate.

M8.10 Quality Management

A quality control plan shall be submitted for the design, manufacturer, installation and commissioning of each grit trap and its ancillaries, for approval and monitoring by the Engineer.

M8.11 Installation

The grit traps and associated equipment shall be installed by the Contractor adjacent to new concrete channels as indicated on the overall equipment layout drawing W1859-85002 (60325-M-LI-106), in accordance with the instructions of the grit trap manufacturer and as shown on their drawings.

Aside from conformance to the general installation requirements as outlined in the Standard Specification for Mechanical Works, Contractors should ensure the least possible disruption to plant operation.

M8.12 Performance Testing

M8.12.1 Works Testing

Works testing of the grit trap equipment shall include the following:

i) Alignment and fit of respective bearings and drives.
ii) Operation of total assembly.

Inspection certificates detailing all works testing shall be forwarded to the Engineer.

M8.12.2 Before Commissioning

i) Contractors shall take note of Sections D77.1 to D77.4 of the Standard Specification for Mechanical Works, prior to starting commissioning.
ii) Ensure all drive equipment is lubricated and gearboxes are filled to correct levels.
iii) Test for correct rotation of all motors.
xi) Test for correct operation of control gear, where provided under this Contract.
iv) Check for alignment of bearings and drives.
v) Check for alignment of piping and valves.
vi) Test operation of total assembly, i.e. grit trap paddles and actuated valves, including all interlocks.
vii) Test paddle speeds against design.
viii) Check all equipment and piping for leaks.
ix) Measure motor current.
x) Submit all certification including motor test certificates and material certificates.
xi) Submit all operating and maintenance instructions.

M8.12.3 Commissioning Testing

Specifically, the grit traps shall undergo the following tests:

i) Operation of grit traps under maximum and minimum flow conditions.
ii) Determine appropriate intervals and durations for washing and grit removal operations and check to confirm these occur correctly.
iii) Measurement of the flow rate of water entering the grit traps during a washing operation and comparison to the grit traps' design parameters.
iv) Confirmation that the separation efficiency of the grip trap is 85% of grit particles larger than 0.21 mm by sampling before (inlet channel) and after (outlet channel) the grit trap and having the samples analysed for percentage grit and grit particle size distribution
v) After one week of continuous operation, each grit trap shall be isolated and drained to establish whether any appreciable grit build-up has occurred (which would indicate a problem with one of the grit trap components or possibly non-optimised operation).
vi) Measure motor current.
vii) Check for operation of emergency stop.

Generally, the equipment will be considered acceptable at commissioning when all of the following conditions are satisfied:

i) The equipment meets the duty requirements as defined in this Section of the Specification.
ii) Any other specific performance tests defined in this Section prove acceptable operation of the equipment.
iii) Where a power test is required, the power absorbed by each motor at duty point does not exceed the values stated in the Technical Data Sheet by more than 5%.
iv) Where a vibration test is required, the vibration measured at each point does not exceed the level prescribed in BS 4675 Part 1-1976 for the appropriate class of machine.
v) Where a noise test is required, the noise generated by the equipment does not exceed the values stated in the Technical Data Sheet.
vi) The grit removal efficiency is acceptable of a 95% confidence level.

M8.12.4 **After Commissioning**

Check equipment for proper functioning and monitor process performance during the Test Period and the Trial Operational Period (TOP). Refer to Section 9 in the Conditions of Contract.

For the purpose of this contract, the TOP shall be 28 days in which the Test Period shall be executed.

The operating time of each duty grit trap shall be adjusted to ensure that the total operation hours (including the Test Period) is split equally between each trap. All laboratory testing required during the TOP and Test Period shall be done at a SANAS approved, independent laboratory. Tenderers shall allow for the cost of all sampling and testing in their offer.

The Overall Equipment Efficiency (OEE) of the grip traps shall be greater than 95% during the TOP. OEE is defined as the total running time of the equipment less the time lost for breakdowns and maintenance. Periods of downtime outside of the Contractor's control will not be included in the OEE calculation.

The separation efficiency of the grip trap shall be proven during the Test Period. The Test Period will be conducted over 5 days per grit trap. A daily composite sample made up of 6 hourly samples will be taken before and after each grit trap. Each composite sample will be analyzed to determine the total grit content and using sieve analysis, the percentage particles > 0.21 mm shall be determined. The removal percentage will be calculated as follows:

% removal = 1 – (Mass particles > 0.21mm, outlet/ Mass particles > 0.21mm, inlet) x 100

For each set of daily composite samples, the grit removal efficiency shall be calculated. The average of the grit removal efficiency (at the lower limit of the 95% confidence interval) shall be greater than what is guaranteed by the Contractor.

The performance of the equipment will be considered acceptable when the requirements as specified have been achieved consistently during the Test Period and TOP.

M8.12.5 **During Defects Notification Period**

The Contractor shall submit reports to the Engineer after each inspection.

Refer to Section M26 which further describes the Contractors responsibilities during DNP with respect to the operation and maintenance of the plant.

M8.13 Spares

The Contractor shall be responsible for identifying and supplying the required spares for the selected mechanical equipment. The spares selection shall be subject to approval, in writing, by the Engineer.

M8.14 Operation and Control

Refer to control narrative document W1859-48001 (in Volume 3) for details on the operation and control of the equipment in this section

M9. GRIT CLASSIFIERS

M9.1 Scope

The scope associated with Inlet Works Grit Classifiers shall include design, supply, delivery, installation, testing, commissioning and upholding during the Trial Operation Period and the Defects Notification Period of the following:

i. Two new grit classifiers complete with grit removal screws and stirrers shall be installed together with all associated support structures,.
ii. Each grit classifier shall require an outlet chute to direct the dewatered grit into a skip.
iii. All piping, fittings, isolation and pressure reducing valves, supports and fasteners to supply 2nd class water from the bulk supply manifold to each grit classifier
All piping, fittings, isolation valves, supports and fasteners to return the grit classifier overflow and organic drain points back to the combined channel ahead of the grit traps

The equipment shall be generally as shown on Piping and Instrumentation Drawings W1859-45004 (60325-M-LI-102) and on Equipment and Piping Layout Drawings W1859-85002 (60325-M-LI-106).

M9.2 General description

The grit slurry (which may also contain material such as corn, cigarette ends and other organic matter) shall be pumped to the reservoir of the classifier by the grit trap self-priming grit pumps. A rotating central stirrer shall ensure organic matter remains in suspension while the grit shall settle to the bottom of the reservoir. Washwater shall be supplied into the bottom chamber of the reservoir, that is separated from the grit washer chamber, to wash the grit and remove organic matter. The washed and dewatered grit shall be conveyed out of the reservoir by an inclined screw conveyor and shall be deposited in a grit skip.

The clarified water shall leave the reservoir via an overflow pipe. The organic matter shall leave the reservoir via a separate discharge pipe. The overflow pipe and organic matter discharge pipe shall gravity flow to the combined channel ahead of the grit traps.

The two grit classifiers shall be operated in duty/standby mode.

M9.3 Duty

The maximum grit slurry volumetric flow to both classifiers shall be 58 m³/h. The estimated maximum instantaneous washwater requirement for the classifiers shall be 10 m³/h.

The grit classifiers shall be sized to receive grit from 3 duty grit traps in the future. Each grit classifier shall be sized to be able to remove 0.21 m³/h of grit at 85 wt.% solids.

The classifiers shall retain more than 90% of grit particles larger than 0.2 mm. The water content of the grit discharged from the classifiers shall be less than 15% and the volatile solids concentration shall be less than 5%.

M9.4 Classifier body

The main body of the grit classifier shall consist of a reservoir and a screw conveyor trough. The reservoir shall be equipped with an inlet for the grit slurry, an overflow pipe for the clarified water, and a separate discharge pipe for the organic matter. The reservoir shall include a bottom chamber wherein the washwater shall be fed into and a top chamber wherein the settled grit shall be washed. The bottom and top chambers shall be separated by a perforated plate and rubber diaphragm. Internal baffles may be fitted to achieve a good separation between the water and grit.

The screw conveyor trough shall be constructed in a “U” shape to accommodate the screw. It shall be equipped with easily replaceable non-metallic wearing strips to prevent contact between the screw and the trough. It shall be flanged at the drive end for attachment of the drive unit and discharge chute. The discharge chute shall mount directly onto the end of the conveyor trough. A drain connection shall be provided at the lower end to facilitate draining of the equipment for maintenance.

The classifier shall be covered for odour control purposes. Easily removable, watertight cover plates shall be provided for inspection and cleaning.

M9.5 Classifier Screw

The screw shall be a centreless spiral, manufactured from high tensile steel flat bar, at least 20 mm thick. It shall have a flange at one end for connection to the drive unit.

M9.6 Classifier Stirrer Drive and Screw Drive

The stirrer and screw drive units shall be a geared motor rated for continuous duty and shall be selected to match the requirements of the equipment. The motor shall be a totally enclosed fan cooled (TEFC), constant speed unit, fed from 3-phase 380/400 VAC, 50 Hz power. The drive unit shall be direct coupled to the stirrer and screw shafts.

The gearbox shall have a minimum service factor of 1.75 and an IP55 protection rating. Nominal and minimum motor efficiencies shall comply with NEMA MG 1. The gearbox shall be designed for AGMA Class II, 24-hour duty.

M9.7 Motors

Tenderers should take note of the ’s requirements for electric motors, as per Section D35 of the Standard Specification for Mechanical Works. Where the Contractor is not able to conform to these requirements, he should explicitly highlight the deviations in his offer, for consideration by the Engineer.

It should also be noted that whilst preliminary motor selections have been made for the purposes of this tender, choice of final motor sizes shall rest with the Contractor. Furthermore, it shall be noted that the power rating shall be supplied as a 380 V low voltage unit. Whilst four pole motors are preferable for the anticipated rating, two pole motors will be acceptable.

M9.8 Piping

All valves, fittings, piping material and sizes shall be as indicated on P&ID W1859-45004 (60325-M-LI-102). All piping, fittings and supports shall conform to section D20 of the Standard Specifications for Mechanical Works unless otherwise stated below. All piping shall be clearly identifiable as per SANS 10140-3. All valves shall conform to section D28, D29 and D30 of the Standard Mechanical Specification for Mechanical Works. Refer to control valve list W1859-61002, on/off valve list W1859-61003, pressure safety valve list W1859-61004, hand valve list W1859-61005 and check valve list W1859-61006 in Volume 3. The tenderer shall supply technical datasheets/brochures of the range for each valve type offered with the tender.

Grit slurry:
The grit slurry piping shall have a pneumatic actuated knife gate on/off valve controlled by the SCADA/PLC system to control the flow of the grit slurry from each grit trap into either of the grit classifiers.

Washwater:
Washwater shall be piped from the bulk 2nd class water supply to each grit classifier. A manual ball valve shall provide isolation from the bulk 2nd class water supply manifold. A diaphragm hand valve shall be locked in position to set the flow rate during commissioning. The washwater supply piping to each trap shall have an automated solenoid on/off valve controlled by the SCADA/PLC system to control the flow of washwater to each trap.

Clarified water and organic matter:
The clarified water and organic matter shall leave the grit classifier reservoir via an overflow pipe and organic matter discharge pipe, respectively, to the combined channel ahead of the grit traps. The organic matter discharge pipe shall have a pneumatic actuated knife gate on/off valve controlled by the SCADA/PLC system to control the flow from the grit classifier.

M9.9 Motor Control Centre

All equipment and instrumentation indicated on P&ID W1859-45004 (60325-M-LI-102)) will be operated from a local PLC situated in the new Motor Control Centre (MCC) room.

All instrumentation and controls as shown on the P&ID W1859-45004 (60325-M-LI-102) and the instrumentation list (refer to volume 3) are to be supplied and installed to ensure safe, reliable and efficient operation under the conditions stated in this specification. This shall include all instrumentation required for start-up, shut-down, ongoing monitoring of essential system parameters and for safe operation in accordance with the applicable codes and standards.

The analogue instruments (e.g. T, P) shall be supplied complete with manufacturer calibration certificates and procedure and material certificates (SS 316). The certificates shall be available at FAT execution if applicable. All instrument loops and process control functionality shall be tested during FAT.

The MCC and PLC shall be supplied as per the Standard Electrical specification included in Volume 3.

M9.10 Corrosion Protection and Materials of Construction

M9.10.1 Materials of Construction

Materials of construction, where new parts are required shall be as follows:

Trough and Body	304L Stainless Steel.
Hopper Cover	304L Stainless Steel.
Screw and Centre Shaft	304L Stainless Steel.
Stirrer and Shaft	304L Stainless Steel.
Outlet Weir	304L Stainless Steel.
Baffle	304L Stainless Steel.
Piping Nozzles	304L Stainless Steel.
Fasteners and Concrete Anchors	316L Stainless Steel.
Stirrer and shaft	304L Stainless Steel.

M9.10.2 Corrosion Protection

Corrosion protection shall be carried out in accordance with the requirements of Sections D11 to D14 of the Standard Specification for Mechanical Works.
Where stainless steel components are welded these shall be pickled and passivated.
Pump housings and geared motor units shall be Alkyd overcoated

Trough and Body	Grit Blast and Pickle & Passivate.
Hopper Cover	Grit Blast and Pickle & Passivate.
Outlet Weir	Grit Blast and Pickle & Passivate.
Baffle	Grit Blast and Pickle & Passivate.
Piping Nozzles	Grit Blast and Pickle & Passivate.
Geared Motor	Alkyd Over Coat.

M9.11 Quality Management

A quality control plan shall be submitted for the design, manufacturer, installation and commissioning of each grit classifier and its ancillaries, for approval and monitoring by the Engineer.

M9.12 Installation

The grit classifiers and associated piping shall be installed by the Contractor as indicated on the overall equipment layout drawing W1859-85002 (60325-M-LI-108), in accordance with the instructions of the classifier manufacturer and as shown on their drawings.

Aside from conformance to the general installation requirements as outlined in the Standard Specification for Mechanical Works Section D5, Contractors should ensure the least possible disruption to plant operation.

M9.13 Performance Testing

M9.13.1 Works Testing

Works testing of the grit classifiers shall include the following:

i) Alignment and fit of respective bearings and drives.
ii) Straightness and alignment of spiral screw in trough.
iii) Operation of total assembly.

Inspection certificates detailing all works testing shall be forwarded to the Engineer.

M9.13.2 Before Commissioning

i) Contractors shall take note of Sections D77.1 to D77.4 of the Standard Specification for Mechanical Works, prior to starting commissioning.
ii) Ensure all drive equipment is lubricated and gearboxes are filled to correct levels.
iii) Check for alignment of bearings and drives.
iv) Check for alignment and fit of piping and valves.
v) Check all equipment and piping for freedom from leaks.
vi) Test for correct rotation of all motors.
vii) Test for correct operation of control gear, where provided under this Contract.
viii) Test for correct operation of total assembly, i.e. grit classifier stirrer, screw and actuated valves, including all interlocks.
ix) Test stirrer and screw speeds against design.
x) Submit all certification, motor test certificates, material certificates
xi) Submit all operating and maintenance instructions

M9.13.3 Commissioning tests

Specifically, the grit classifiers shall undergo the following tests:

i) Operation under maximum and minimum flow conditions.
ii) Check for freedom from hang-up of material.
iii) Operation of automated start/stop sequence in conjunction with upstream equipment.
iv) Confirmation that the separation efficiency of the grip classifier is 90% of grit particles larger than 0.2 mm by sampling the inlet grit slurry and grit removed (exiting from the chute) and conducting a mesh test to confirm particle size distribution.
v) Confirmation that the moisture content of the dewatered grit is less than 15%.
vi) Confirmation that the volatile solids concentration of the dewatered grit is less than 5%.
vii) After one week of continuous operation, the average weekly volume of grit removed from the system shall be recorded.
viii) Measure motor current.
ix) Check for operation of emergency stop.

Generally, the equipment will be considered acceptable at commissioning when all of the following conditions are satisfied:

i) The equipment meets the duty requirements as defined in this Section of the Specification.
ii) Any other specific performance tests defined in this Section prove acceptable operation of the equipment.
iii) Where a power test is required, the power absorbed by the motor at duty point does not exceed the values stated in the Technical Data Sheets by more than 5%.

iv) Where a vibration test is required, the vibration measured at each point does not exceed the level prescribed in BS 4675 Part 1-1976 for the appropriate class of machine.
v) Where a noise test is required, the noise generated by the equipment does not exceed the values stated in the Technical Data Sheets.
vi) The grit removal efficiency, grit dryness and organic content of the grit are within specification.
vii) The grit removal efficiency is acceptable of a 95% confidence level.

M9.13.4 **After Commissioning**

Check equipment for proper functioning and monitor process performance during the Test Period and the Trial Operational Period (TOP). Refer to Section 9 in the Conditions of Contract.

For the purpose of this contract, the TOP shall be 28 days in which the Test Period shall be executed.

The operating time of each duty grit classifier shall be adjusted to ensure that the total operation hours (including the Test Period) is split equally between each unit. All laboratory testing required during the TOP and Test Period shall be done at a SANAS approved, independent laboratory. Tenderers shall allow for the cost of all sampling and testing in their offer.

The Overall Equipment Efficiency (OEE) of the grit classifier shall be greater than 95% during the TOP. OEE is defined as the total running time of the equipment less the time lost for breakdowns and maintenance. Periods of downtime outside of the Contractor's control will not be included in the OEE calculation.

The separation efficiency of the grit classifier shall be proven during the Test Period. The Test Period will be conducted over 5 days per grit classifier. A daily composite sample, made up of 6 hourly samples, will be taken of the grit exiting the classifiers as it falls out of the discharge chute (not in the skip) as well as the grit slurry entering the grit classifier – the respective grit contents shall be measured and by conducting a sieve analysis, the grit removal percentage above 0.2mm shall be calculated as follows:

% grit removal = 1 – (Mass particles > 0.2mm, grit out)/ Mass particles > 0.2mm, grit slurry) x 100

For each daily composite sample, the moisture content (% dryness) and volatile solids concentration (% organics) will also be analyzed. The average % dryness, % organics and % grit removal (at the upper/lower limit of the respective 95% confidence interval) shall be greater than what is guaranteed by the Contractor.

The performance of the equipment will be considered acceptable when the requirements as specified have been achieved consistently during the Test Period and TOP.

M9.13.5 **During Defects Notification Period**

The Contractor shall submit reports to the Engineer after each inspection.

Refer to Section M26 which further describes the Contractors responsibilities during DNP with respect to the operation and maintenance of the plant.

M9.14 Spares

The Contractor shall be responsible for identifying and supplying the required spares for the selected mechanical equipment. The spares selection shall be subject to approval, in writing, by the Engineer.

M9.15 Operation and Control

Refer to control narrative document W1859-48001 (in Volume 3) for details on the operation and control of the equipment in this section

M10. SKIP TRANSFER SYSTEM

M10.1 Scope

The scope shall include the design, supply, delivery, installation, testing, commissioning and upholding during the Trial and Operation Period (TOP) and the Defects Notification Period (DNP) of the following:

i. A motorised skip dolly for two skips, (duty/standby), controls and rail system to receive screenings from the coarse and fine screens.
ii. A motorised skip dolly for two skips, controls and rail system to receive grit from the grit classifiers and screenings from the ultrafine screens

Refer to P&ID and layout drawing W1859-45003 (60325-M-LI-101) and W1859-45004 (60325-M-LI-102) and layout drawing W1859-85002 (60325-M-LI-106).

M10.2 General description

A transfer system is required to move two skips in and out of place to facilitate the removal of solid waste (grit and screenings) from the sewage treatment facility. There shall be a separate duty/standby skip arrangement to collect coarse/fine screenings and grit/ultrafine screenings respectively (4 skips in total).. Each set of duty/standby skips shall be moved in and out of place by motorized wheeled carriages to allow the skips to be removed and replaced by a skip truck. The system is electrically powered via a mechanical drive and handheld control unit.

M10.3 Skip and Skip Dolly

M10.3.1 Skip Type

The skip/s to be used are Enviroserv type 6m^3, fabricated from steel with level upper side wall tops, or equivalent and approved.

M10.3.2 Skip Dolly

A conceptual skip dolly design is set out in drawing W1859-54001 (60325-M-LI-104), Skip Dolly Plan & Elevation.

Each set of skip dollies shall consist of two connected carriages. Only one of the carriages shall be motorized and shall be designed to push or pull the entire load of both duty/standby skips.

The motorised skip dolly shall be constructed from 3Cr12 or hot dip galvanized steel, welded and bolted together to facilitate access to the geared motor drive. The drive train shall be installed low down in the carriage to facilitate a low skip loading height. The dolly shall have 4 steel rail type wheels which run on rails. The flanged circumference of the wheels shall prevent derailing of the dolly under no load or full load. The driven wheels shall be fixed to an axle constructed from EN8, or higher, rotating in Plummer box self-aligning rolling element bearings, bolted to the frame. A hollow shaft geared drive unit, located outboard of the dolly frame, shall be mounted on the drive shaft (axle) and suitable fixed by a torque arm anchored to the frame. The dolly shall move at 30mm/s under full load. The electrical cable to the geared drive unit shall be tensioned at one end by means of a self-winding cable reel and controlled via a handheld unit.

The dolly frame shall be fitted with angled guides to facilitate easy loading and unloading of the skip. The guides shall be protected with polymeric wear strips and allow a lateral movement of 20-30mm in any direction.

M10.4 Skip Rails, end stops and chutes

The rails shall form part of the mechanical scope of supply; however, the following items shall be considered in that design and be done in conjunction with the rail supplier:

a) Rails for the mechanised skip dolly must have sufficient length to roll the dolly to the filling and pickup locations indicated on the layout drawing W1859-85002 (60325-M-LI-108).
b) A proximity switch at either end of the rail system shall detect the limit of dolly's travel on the rails and be interlocked with its stop sequence.

c) Mechanical stops at both ends of the rail shall be welded or bolted to the rails and shall be the physical restraint of the dolly's travel and position on the rails.
d) The rails shall be installed by the Civil Works contractor. Mechanical contractor shall liaise closely with Civil contractor to provide rails in keeping with civil works construction programme.

M10.5 Motors

Motors and power transmission mechanisms shall comply with the requirements of Section D35 and D36 of the Standard Specification for Mechanical Works. Motors and power transmission systems shall be manufactured in South Africa or shall have spares locally available.

M10.6 Corrosion protection and materials of construction

The following corrosion protection and materials of construction shall be considered in conjunction with the requirements of Section D11 to D14 of the Standard Specification for Mechanical Works:

a) The dolly frame shall be made from 3Cr12 or hot dip galvanized Gr350WA steel.
b) Wheels shall be machined cast iron or alloy steel.
c) The local control panel should be constructed of 3CR12 and have a powder coated finish.
d) Carbon steel shall be hot dip galvanized and painted.
e) Cast Iron shall be painted with a powder coat finish.

M10.7 Installation

All items shall adhere to the installation guidelines of the manufacturer, in conjunction with Section D5 of the Standard Specification for Mechanical Works.

M10.8 Performance testing

M10.8.1 **Works testing**
The contractor shall carry out sufficient factory tests of all items prior to dispatch to site to ensure that all equipment supplied under this Contract meets the required specifications as set out herein.

M10.8.2 **Before commissioning**
In conjunction Section D77 of the Standard Specification for Mechanical Works, the following pre-commissioning checks shall be conducted:

a) Check alignment of rails are within tolerance.
b) Check all supports are correctly aligned and cladding is secured.
c) Check that no rain shall be able to fall into the skip while it is in an enclosure.
d) Ensure inlet chute is correctly aligned so that screenings/grit shall fall into the skip.
e) Check that mechanical stops on rails are correctly positioned and secured.
f) Ensure strip curtains extend to the correct height and can move easily for skip transfer.
g) Check motor rotation, skip dolly speed, stop interlocks
h) Tests for correct operation of the whole assembly.
i) Submit all certification and material certificates.
j) Submit all operating and maintenance instructions.

M10.8.3 **Commissioning tests**
The following checks shall be carried out at commissioning and records shall be given to the Engineer:

a) Test that inlet chute can convey solids to a skip.
b) Test motorised dolly system for movement of skips under no load and full load.
c) Test loading and unloading of skips off and onto the dolly by the appropriate truck and associated equipment.

Generally, the equipment will be considered acceptable at commissioning when all of the following conditions are satisfied:

a) The system meets the duty requirements as defined in this Section of the Specification.

b) Any other specific performance tests defined in this Section prove acceptable operation of the equipment.
c) The power absorbed by each motor at duty point does not exceed the values stated in the Technical Data Sheets by more than 5%.
d) The noise generated by the equipment does not exceed the values stated in the Technical Data Sheets.

M10.8.4 **After commissioning**

Check equipment for proper functioning and monitor process performance during the Test Period and the Trial Operational Period (TOP). Refer to Section 9 in the Conditions of Contract.

For the purpose of this contract, the TOP shall be 28 days. All laboratory testing required during the TOP and Test Period shall be done at a SANAS approved, independent laboratory. Tenderers shall allow for the cost of all sampling and testing in their offer.

The Overall Equipment Efficiency (OEE) of the skip dolly system shall be greater than 95% during the TOP. OEE is defined as the total running time of the equipment less the time lost for breakdowns and maintenance. Periods of downtime outside of the Contractor's control will not be included in the OEE calculation.

The performance of the equipment will be considered acceptable when the requirements as specified have been achieved consistently during TOP.

M10.8.5 **During Defect Notification Period**

Check all items for correct operation and functioning at 3 months, 6 months, 9 months and 12 months after plant take-over. The Contractor shall submit reports to the Engineer after each inspection.

Refer to Section M26 which further describes the Contractors responsibilities during DNP with respect to the operation and maintenance of the plant.

M10.9 Spares

The Contractor shall be responsible for identifying and supplying the required spares for the selected mechanical equipment. The spares selection shall be subject to approval, in writing, by the Engineer.

M10.10 Operation and control

Refer to control narrative document W1859-48001 (in Volume 3) for details on the operation and control of the equipment in this section

M11. HYDRAULIC LAUNDER CONVEYOR

M11.1 Scope

The scope shall include the design, supply, delivery, installation, testing, commissioning and upholding during the Trial and Operation Period (TOP) and the Defects Notification Period (DNP) of the following:

i. A hydraulic launder conveyor (also referred to as a flume) to collect screenings from the coarse and fine screens and deliver the screenings to one of two washer/compactor units. The scope of work includes the flume support structure.
ii. A hydraulic launder conveyor to collect screenings from the ultrafine screens and deliver the screenings to one of two micro strainer/compactor units. The scope of work includes the flume support structure.
iii. All piping, fittings, isolation and pressure reducing valves, supports and fasteners to supply 2nd class water from the bulk supply manifold to each point of the hydraulic launders.

The equipment shall be generally as shown on Piping and Instrumentation Drawing W1859-45003 (60325-M-LI-101) and on Equipment and Piping Layout Drawing W1859-85002 (60325-M-LI-106).

M11.2 General description

Screenings shall be collected by the raked screens in duty/standby operation; however, during periods of peak flow both raked screens could operate simultaneously. The screenings shall be deposited into the flume from the screens' discharge chutes, Screenings will not be discharged continuously as the rakes operate only as required.

Screenings shall be collected from the ultrafine band screens using a rotating brush together with high and low pressure washwater. The screenings shall be deposited into the flume from the band screens' discharge chutes without spillage.

Motive force for the hydraulic conveyor shall be via final effluent received from the 2nd Class Water bulk supply system. The flume shall be designed to slope continuously towards the washer/compactor units and shall be fitted with a pneumatically operated slide valve to allow discharge into either unit.

M11.3 Duty

Each flume shall be designed to convey course, fine and ultrafine screenings with a variable percentage solids coming off the screen which can vairy between 10-80%. The coarse and fine screenings flume shall be able to convey 2.2 m^3/h of uncompacted wet screenings to the washer compactor units using intermittent 2nd class water with an approximate flow of 58 m^3/h. The ultrafine screenings flume shall be able to convey 3.6 m3/h of uncompacted wet screenings to the micro strainer compacting units using intermittent 2nd class water with an approximate flow of 58 m^3/h. The bulk density of the screenings are low and sufficient freeboard shall be provided to account for bulking of the screening during transfer

These duties are specified at tender stage, the Contractor shall determine the optimum ratio of washwater to screenings to provide effective transfer but shall not offer equipment that requires washwater in excess of 60 m^3/h.

M11.4 Piping

All valves, fittings, piping material and sizes shall be as indicated on P&ID W1859-45003 (60325-M-LI-101) and . P&ID W1859-45005 (60325-M-LI-103). All piping, fittings and supports shall conform to section D20 of the Standard Specifications for Mechanical Works unless otherwise stated below. All piping shall be clearly identifiable as per SANS 10140-3. All valves shall conform to section D28, D29 and D30 of the Standard Mechanical Specification for Mechanical Works. Refer to control valve list W1859-61002, on/off valve list W1859-61003, pressure safety valve list W1859-61004, hand valve list W1859-61005 and check valve list W1859-61006 in Volume 3. The tenderer shall supply technical datasheets/brochures of the range for each valve type offered with the tender.

Washwater

Washwater shall be piped from the bulk 2nd class water supply to each point of the hydraulic launder and each hose connection point. A mechanical pressure reducing valve will regulate the pressure of the washwater supply. A manual ball valve shall provide isolation from the bulk 2nd class water supply manifold. Each washwater point located on the hydraulic launder shall have an automated motorized on/off valve controlled by the SCADA/PLC system to control the flow of washwater to each point. A diaphragm hand valve shall be locked in position to set the flow rate during commissioning.

M11.5 Conveyor Structure

The flume shall be fabricated to form a trough of sufficient width and depth to accommodate peak flow conditions of low bulk density screenings. Where it is required that the flume changes direction such bends shall be slow radius to prevent snagging of any screenings.

The internal surface of the flume shall be smooth to and free of burrs. The flume shall have a slope of at least 1° continuously in the direction of flow to ensure complete drainage. The flume shall be supported at regular intervals to ensure rigidity.

The flume shall be fitted with easily removable hinged covers designed to prevent any source of odour.

The discharge slide valve shall be designed to present a large opening to prevent clogging of screenings into the first washer/compactor unit.

M11.6 Corrosion protection and materials of construction

M11.6.1 Materials of Construction

Flume trough	304L Stainless Steel
Trough covers	304L Stainless Steel
Flume supports	Mild Steel

M11.6.2 Corrosion Protection

Corrosion protection shall be carried out in accordance with the requirements of Sections D11 to D14 of the Standard Specification for Mechanical Works. Where stainless steel components are welded these shall be pickled and passivated. Pump housings and geared motor units shall be Alkyd overcoated

Flume trough	Grit Blast and Pickle and Passivate
Trough covers	Grit Blast and Pickle and Passivate
Flume supports	Galvanised

M11.7 Quality management

A quality control plan shall be submitted for the flume for approval and monitoring by the Engineer.

M11.8 Installation

The flume shall be installed by the Contractor in accordance with the manufacturer’s instructions. Contractor shall ensure that the slope is maintained and the slide valve operates freely after installation.

M11.9 Performance testing

M11.9.1 Works testing

The contractor shall pre-assemble to flume onto its supports to ensure correct fit-up. The flume shall be inspected to ensure a smooth internal finish. Trough covers shall be checked for easy operation.

M11.9.2 **Before commissioning**

In conjunction Section D77 of the Standard Specification for Mechanical Works, the following pre-commissioning checks shall be conducted:

a) Check that trough slopes continuously.
b) Check all supports are correctly aligned and secured.
c) Check that covers are tight fitting.
d) Check that slide valve operates smoothly.
e) Check operation of washwater supply valve.
f) Submit all certification and material certificates.
g) Submit all operating and maintenance instructions.

M11.9.3 **Commissioning tests**

The following checks shall be carried out at commissioning and records shall be given to the Engineer:

a) Test that washwater to screenings ratio is sufficient to provide the required screenings removal rate.
b) Check that screenings are able to pass through slide valves without clogging.
c) Test operation of washwater supply valve operation against required timings to ensure all screenings are effectively transferred.
d) Check that rate of screenings transfer meets that of design capacity.

Generally, the equipment will be considered acceptable at commissioning when all of the following conditions are satisfied:

a) The system meets the duty requirements as defined in this Section of the Specification.
b) The system operates without screening clogging.

M11.9.4 **After commissioning**

Check equipment for proper functioning and monitor process performance during the Test Period and the Trial Operational Period (TOP). Refer to Section 9 in the Conditions of Contract.

For the purpose of this contract, the TOP shall be 28 days. All laboratory testing required during the TOP and Test Period shall be done at a SANAS approved, independent laboratory. Tenderers shall allow for the cost of all sampling and testing in their offer.

The Overall Equipment Efficiency (OEE) of the hydraulic launder system shall be greater than 95% during the TOP. OEE is defined as the total running time of the equipment less the time lost for breakdowns and maintenance. Periods of downtime outside of the Contractor's control will not be included in the OEE calculation.

The performance of the equipment will be considered acceptable when the requirements as specified have been achieved consistently during TOP.

M11.9.5 **During Defects Notificaton Period**

Check all items for correct operation and functioning at 3 months, 6 months, 9 months and 12 months after plant take-over. The Contractor shall submit reports to the Engineer after each inspection.

Refer to Section M26 which further describes the Contractors responsibilities during DNP with respect to the operation and maintenance of the plant.

M11.10 Spares

The Contractor shall be responsible for identifying and supplying the required spares for the selected mechanical equipment. The spares selection shall be subject to approval, in writing, by the Engineer

M11.11 Operation and Control

Refer to control narrative document W1859-48001 (in Volume 3) for details on the operation and control of the equipment in this section

M12. SCREENED WASTEWATER SUMP

M12.1 Scope

The scope associated with Screened Wastewater Sump shall include design, supply, delivery, installation, testing, commissioning and upholding during the Trial Operation Period and the Defects Notification Period of the following:

i. Four (3 duty, 1 standby) centrifugal, single stage, end suction type pumps complete with directly coupled motor operating on VSD, baseplate and fasteners.
ii. All piping, fittings, isolation valves, supports and fasteners taking suction from inside the Screened Wastewater Sump up to the interface with the new HDPE rising main as indicated on equipment layout drawing W1859-85002 (60325-M-LI-108).
iii. All piping, fittings, isolation valves, supports and fasteners taking suction from inside the Screened Wastewater Sump up to blank flanges within the dry well for the future installation of an additional three centrifugal pumps (under a separate contract) as indicated on equipment layout drawing W1859-85002 (60325-M-LI-108).
iv. One fixed speed, vertical immersible sump pump complete with motor, baseplate and fasteners.
v. All piping, fittings, isolation valves, supports and fasteners from the discharge of the sump pump up to the discharge point into the top of the Screened Wastewater Sump.
vi. A new 2 tonne monorail crane including the hooks, power supply system, controls, load testing and certification.

The equipment shall be generally as shown on Piping and Instrumentation Drawings W1859-45005 (60325-M-LI-103) and on Equipment and Piping Layout Drawing W1859-85002 (60325-M-LI-106).

M12.2 General Description

Screened and degritted raw wastewater shall be pumped from the Screened Wastewater Sump up to the bioreactors using a set of centrifugal, single stage, end suction type pumps with directly coupled motors. The pumps shall operate on VSD. The pumps shall be suited for dry well installations, bottom entry, vertical shaft orientation as depicted on W1859-85002 (60325-M-LI-108). The pumps shall be designed as "back pull-out" such that the entire rotating assembly can be removed from the casing without disturbing the suction and discharge connections. The pumps shall be non-clogging and allow free passage of solids up 90 mm. The head-capacity curve shall have a single flow rate for each pumping head value and have a continuously rising head characteristic from the specified design point to shut-off so as to ensure stability and control in both individual and/or parallel operation.

The head-capacity curve shall have a single flow rate for each pumping head value and have a continuously rising head characteristic from the specified design point to shut-off so as to ensure stability and control in both individual and/or parallel operation.

The operating range of the pump, as specified, is defined by the maximum and minimum operating heads against which the pump will be required to operate. At no point on the pump's power demand curve between shut-off and the minimum operating head shall the pump's power demand exceed the rated power of the motor.

M12.3 Duties

The duties for this section shall be as follows:

	Volumetric Flow (m^3/h)	Differential Head (m)
Bioreactor Feed Pump	563	30
Dry well sump pump	50	7.5

The following should be noted:

1. The Bioreactor Feed Pumps shall operate as 3 duty/1 standby.
2. The pumps shall pump screened wastewater (25mm and 6 mm screens) and degritted raw wastewater. The pumps should be able to handle an element of ragging and some materials that could make it through the screens i.e. earbuds, hair etc. which is typically found in raw sewage.
3. The sewage will go through grit traps that will remove approximately 85% of grit larger than 0.21 mm however, the pumps need to be suitable to handle periods when the degritters are down or grit makes it through the system. Suitable wear protection must be allowed for.
4. The pH of the wastewater is between 6 and 9.
5. The average solids concentration is approximately 610 mg/l but should be able to handle periods of high concentration or some settling in the sump that the pumps take suction from i.e. max (10-30 g/l).
6. The differential head indicated here is for tender purposes only. The differential head shall be confirmed by the Contractor against the piping isometric and layout drawings issued for construction during the design stage of the contract.

M12.4 Bioreactor Feed Pumps

The bioreactor feed pumps shall be centrifugal, single stage, end suction type pumps and conform to Section D43 of the Standard Mechanical Specifications. In addition to that, the following detailed specifications shall apply.

M12.4.1 Casing

The pump shall have a volute casing with centerline discharge. The single piece pump casing shall be made of suitable thickness to allow for long pump life and to safely withstand the pressure at shut off head. The discharge nozzle shall be provided with integrally cast flange.
Critical mating surfaces where watertight sealing is required shall be machined and fitted with O- rings. Fittings will be the result of controlled compression of rubber O-rings in two planes and O-ring contact of four sides without the requirement of a specific torque limit.
Rectangular cross-sectioned gaskets requiring specific torque limits to achieve compression shall not be considered as adequate or equal. No secondary sealing compounds, elliptical O-rings, grease or other devices shall be used.

M12.4.2 Wear Rings

The pump shall be provided with replaceable impeller and casing wear rings to insure efficient sealing between the volute and suction inlet of the impeller. It shall be firmly secured to prevent rotation or displacement.

M12.4.3 Clean Out Port

The Pumps shall have, at minimum, a 140 mm diameter clean out port cast into the pump casing. The clean out port cover shall be cast of the same material as the pump casing. The port cover shall extend completely through the pump casing matching its interior contour. The cover shall fasten to a flange cast onto the pump casing and shall be sealed with an o-ring. Fabricated (non-cast) cover plates, covers not contoured to match the casing interior, or covers with flat gasket seals shall not be considered as acceptable.

M12.4.4 Impeller

The impeller shall be of a centrifugal, closed, non-clogging design for high efficiency pumping of industrial and municipal wastewater. The impeller shall have vanes and allow free passage of solids of 90 mm in size, long fibres, sludge and other materials as may normally be found in wastewater. Back vanes shall be provided to minimize axial loads and to propel solids away from the seal area. The impellers lateral cavities shall be of ample size to protect against wear and clogging. The impeller shall be a one-piece casting of the material as specified. It shall be smooth, well finished, free from blowholes and imperfections, and be dynamically balanced. The impeller shall be securely fitted to the pump shaft in such a manner that it does not loosen or become detached if the pump is operated in the wrong direction as may happen by reversed flow or reversed motor connections.

M12.4.5 Pump Shaft

The pump shaft shall be of sufficient size to transmit full driver output with a maximum deflection of 0,05 mm measured at the lower mechanical seal. The pump shaft shall be of stainless steel.

M12.4.6 **Bearings**

The bearing frame shall be of heavy, cast iron construction accurately machined to ensure permanent bearing alignment. The shaft shall rotate on antifriction bearings. The bearing system shall be adequately designed so as to be capable of handling all axial thrust loads plus any and all radial loads.

Each pump shall come with an integral hardwired temperature sensor to monitor bearing temperature. This shall stop the pump if a high temperature is detected.

M12.4.7 **Mechanical Seal**

Each pump shall be provided with two totally independent, mechanical seals, installed in tandem, each with its own independent single spring system acting in a common direction. The sealing shall not depend on the direction of rotation. The primary, impeller-side seal shall operate in a large, flooded chamber formed by cast recesses in the impeller and backplate. The impeller-side seal shall be of bellows type mechanical seal. The primary and the secondary seal faces shall operate in a generously proportioned lubricant chamber that hydrodynamically lubricates the seal faces to allow for extended periods of dry-running operation without the need for external seal lubrication or cooling systems. The lubricant chamber liquid shall be an environmentally friendly and nontoxic.

The seal face material of the primary seal shall be of at minimum Silicon Carbide versus Silicon Carbide (SiC/SiC) for excellent hardness and chemical resistance across the entire "pH" range. The secondary seal shall be of Carbon versus Silicon Carbide (Carbon/SiC). The seal faces must be of a solid material capable of being re-lapped. The seals shall require neither routine maintenance nor adjustment, but capable of being easily inspected and replaced. Mechanical seal metal parts shall be of stainless steel.
Seals shall be non-proprietary in design and shall be available from another vendor in addition to the pump manufacturer.

Conventional double mechanical seals with a single or multiple spring acting in opposed direction, cartridge-type mechanical seals; seals with materials other than those specified; shall not be considered as adequate for this critical sealing area

Each pump shall come with an integral switch fitted in the seal chamber to monitor the integrity of the mechanical seal. This shall hardwire to stop the pump should the seal fail.

M12.4.8 **Proven Technology**

The pump offered by the tenderer shall be proven technology required for this application. Proven technology will be demonstrated by a successful reference sites. To be considered a reference site, the pump model must be used in the pumping of raw sewage. In order to be considered responsive, the pump model must have a minimum of 10 reference sites within South Africa. A list of reference sites, together with equipment capacities and reference contact details must be supplied with the tender.

In addition to the above, the equipment technology supplier must have a proven track record of at least 10 years.

M12.5 Dry Well Sump Pumps

The dry well sump pumps shall be the immersible type and shall confirm to Section D44 of the Standard Mechanical Specifications. The pump capacity shall be 50 m^3/h at 7.5m head.

M12.6 Motors

The bioreactor feed pumps shall be driven by a IE3 TEFC motor. At no point on the pump's power demand curve between shut-off and the minimum operating head shall the pump's power demand exceed the rated power of the motor. Each pump motor shall have integral hardwired instrumentation to provide thermal winding and housing leak protection.

Tenderers should take note of the 's requirements for electric motors, as per Section D35 of the Standard Specification for Mechanical Works. Where the Contractor is not able to conform to these requirements, they should explicitly highlight the deviations in his offer, for consideration by the Engineer.

It should also be noted that whilst preliminary motor selections have been made for the purposes of this tender, choice of final motor sizes shall rest with the Contractor. Furthermore, it shall be noted that the power rating shall be supplied as a 380 V low voltage unit. Whilst four pole motors are preferable for the anticipated rating, two pole motors will be acceptable.

M12.7 Piping

All valves, fittings, piping material and sizes shall be as indicated on P&ID W1859-45005 (60325-M—LI-103). All piping, fittings and supports shall conform to section D20 of the Standard Specifications for Mechanical Works unless otherwise stated below. All piping shall be clearly identifiable as per SANS 10140-3. All valves shall conform to section D28, D29 and D30 of the Standard Mechanical Specification for Mechanical Works. Refer to control valve list W1859-61002, on/off valve list W1859-61003, pressure safety valve list W1859-61004, hand valve list W1859-61005 and check valve list W1859-61006 in Volume 3. The tenderer shall supply technical datasheets/brochures of the range for each valve type offered with the tender.

Wastewater Piping:
The suction piping on each pump shall extend into the concrete sump and terminate with a vertically orientated bellmouth. The suction piping running through the sump walls shall be cast (by the civil contractor) into the walls complete with puddle flanges. The mechanical contractor shall connect up to the flange points of either side of the wall. The suction piping for each pump in dry well shall extend up to the suction of the inlet flange of the respective pump. The suction piping shall be installed within trenches covered by galvanised steel grating to allow access. Each pump suction piping shall have 350NB, resilient seal gate valves in compliance with Section D28.3 of the Standard Mechanical Specifications.

The discharge piping of each pump shall have a swing check valve in accordance with Section D29.7 of the Standard Mechanical Specifications. Each pump shall be isolated on the discharge end by a 350NB, resilient seal gate valves in compliance with Section D28.3 of the Standard Mechanical Specifications. The discharge piping of each pump will combine into a common stainless steel 304 discharge manifold which will tie into the new HDPE rising main. The new HDPE rising main, and the tie in to the existing concrete rising main extending to the existing reactors shall be handled by the Civil Contractor.

The suction and discharge piping of each pump shall have a rubber bellows pipe coupling in accordance with Section D24.5 of the Standard Mechanical Specifications.

The piping shall allow for the installation of three additional centrifugal pumps at a future date under a separate contract. The piping for the future pumps installed under this contract includes the suction piping (for each of the three future pumps) and the tie in point on the common standby pump (PMP01D) discharge. Each point shall terminate with resilient seal gate valves (in compliance with Section D28.3 of the Standard Mechanical Specifications blanked off on the downstream flanges.

A drain line shall be installed to allow for the rising main piping to be drained back to the Screened Wastewater Sump. The drain line shall be isolated with a 50NB resilient seal gate valve in compliance with Section D28.3 of the Standard Mechanical Specifications.

Fluidization Piping:
Second class water shall be introduced at the floor of the screened wastewater sump intermittently to prevent the settling of solids and to flush solids towards the inlet of the bioreactor feed pumps' suction piping. Each fluidization line shall branch off from the second class supply manifold and contain a diaphragm isolation/throttling valve (compliant with D29 of the standard mechanical specifications), a non return valve (compliant with D29 of the standard mechanical specifications) and a diaphragm solenoid valve. Each fluidization line shall terminate with a suitably sized nozzle to create turbulence pushing sediment towards the pump suctions.

M12.8 Gantry Crane

The Tenderer shall confirm the gantry crane sizing for the new equipment and shall submit dynamic and static loading calculations to this effect for approval. Tenderers are referred to section D37 of the Standard Specification for Mechanical Works for general design requirements with respect to materials of construction, paint specifications and required design parameters that should be considered.

The Contractor shall allow in his tender price for all equipment necessary to perform the work and the load testing and certification.

M12.9 Motor Control Centre

All equipment and instrumentation indicated on P&ID drawing W1859-45005 (60325-M-LI-103) will be operated from a local PLC situated in the new Motor Control Centre (MCC) room.

All instrumentation and controls as shown on the P&ID drawing W1859-45005 (60325-M-LI-103) and the instrumentation list (refer to volume 3) are to be supplied and installed to ensure safe, reliable and efficient operation under the conditions stated in this specification. This shall include all instrumentation required for start-up, shut-down, ongoing monitoring of essential system parameters and for safe operation in accordance with the applicable codes and standards.

The analogue instruments (e.g. T, P) shall be supplied complete with manufacturer calibration certificates and procedure and material certificates (SS 316). The certificates shall be available at FAT execution if applicable. All instrument loops and process control functionality shall be tested during FAT.

The MCC and PLC shall be supplied as per the Electrical specification.

M12.10 Corrosion Protection and Materials of Construction

M12.10.1 Materials of Construction

<u>Bioreactor Feed Pumps:</u>	
Pump casing:	Cast iron
Casing wear ring:	Semi austenitic CrNi stainless steel VG 434 (A 890 Grade 5A)
Discharge cover:	Cast iron
Shaft:	Stainless steel EN-1.4021+QT800 (A 276 Type 420)
Impeller:	Duplex stainless steel EN-1.4517 (A 890 CD4MCu)
Impeller wear ring:	Semi austenitic CrNi stainless steel VG 434 (A 890 Grade 5A)
Bearing bracket:	Cast iron
Elastomer components:	Nitrile rubber (NBR)
Fasteners:	Stainless steel A4 (EN-1.4571) (A 276 Type 316)
Baseplate	Mild steel, hot dip galvanised
<u>Dry well Sump pumps:</u>	
Pump Casing	Cast iron
Shaft	Stainless Steel 316
Impeller	Stainless Steel 316
Baseplate	Mild steel, hot dip galvanised
Wastewater piping and fittings	Stainless Steel 304

M12.10.2 Corrosion Protection

Corrosion protection shall be carried out in accordance with the requirements of Sections D11 to D14 of the Standard Specification for Mechanical Works. Where stainless steel components are welded these shall be pickled and passivated.
Pump housings and geared motor units shall be Alkyd overcoated

M12.11 Quality Management

A quality control plan shall be submitted for the design, manufacturer, installation and commissioning of each piece of equipment and its ancillaries, for approval and monitoring by the Engineer.

M12.12 Installation

The installation of the new equipment into the new Screened Wastewater Sump shall not impede on the functioning of the existing inlet works. The Contractors attention is specifically drawn to the tie in of the bioreactor feed rising main with the existing rising main. Under no circumstances can the flow to the existing bioreactors be interrupted.

M12.13 Performance Testing

M12.13.1 Factory Testing

For the bioreactor feed pumps:
Balancing of the complete impeller and shaft shall be undertaken at the manufacturer's works. Flow-head curves shall be generated at the manufacturer's or agent's premises and checked against the manufacturer's listed pump curves for any major discrepancies.

M12.13.2 Before Commissioning

i. Tenderers shall take note of Sections D78.1 to D78.4 of the Standard Specification for Mechanical Works, prior to starting commissioning
ii. Contractor will confirm construction of the plant as per design drawings. This shall be approved by the Engineer.
iii. Ensure all drive equipment is lubricated, with correct oil
iv. Test for correct rotation of all motors
v. Test for correct operation of control system functionality and instrumentation as per the functional design specification.
vi. Leak test all process vessels and pipelines
vii. Submit all certification, motor test certificates, material certificates
viii. Submit all operating and maintenance instructions

M12.13.3 Commissioning

Specifically, the bioreactor feed pumps shall undergo the following tests:

i) Verify operation under maximum and minimum flow conditions.
ii) Verify duty points for each pump in single operation and in multiple pump operation
iii) Verify system operates as per functional design.
iv) Measure motor current and test power consumption.
v) Test overload conditions.
vi) Check vibration of equipment with 1, 2 and 3 duty pumps running.
vii) Check for operation of emergency stop.

Generally, the equipment will be considered acceptable at commissioning when all of the following conditions are satisfied:

vi) The equipment meets the duty requirements as defined in this section of the Specification.
vii) Any other specific performance tests defined in this Section prove acceptable operation of the equipment
viii) Where a power test is required, the power absorbed by the motor at duty point does not exceed the values stated in the Technical Data Sheets by more than 5%.
ix) Where a vibration test is required, the vibration measured at each point does not exceed the level prescribed in BS 4675 Part 1-1976 for the appropriate class of machine.

M12.13.4 After Commissioning

Check equipment for proper functioning and monitor process performance during the Test Period and the Trial Operational Period (TOP). Refer Section 9 in the Conditions of Contract.

For the purpose of this contract, the TOP shall be 28 days. The operating time of each duty unit shall be adjusted to ensure that the total operation hours (including the Test Period) is split equally between each unit.

All laboratory testing required during the TOP and Test Period shall be done at a SANAS approved, independent laboratory. Tenderers shall allow for the cost of all sampling and testing in their offer.

The Overall Equipment Efficiency (OEE) of the bioreactor feed pumps and dry well sump pump shall be greater than 95% during the TOP. OEE is defined as the total running time of the equipment less the time lost for breakdowns and maintenance. Periods of downtime outside of the Contractor's control will not be included in the OEE calculation. -

M12.13.5 During Defects Notification Period

Check all items for correct operation and functioning at 3 months, 6 months, 9 months and 12 months after plant take-over.

Refer to Section M26 which further describes the Contractors responsibilities during DNP with respect to the operation and maintenance of the plant.

M12.14 Spares

The Contractor shall be responsible for identifying and supplying the required spares for the selected mechanical equipment. The spares selection shall be subject to approval, in writing, by the Engineer

M12.15 Control and Automation

Refer to control narrative document W1859-48001 (in Volume 3) for details on the operation and control of the equipment in this section.

The gantry crane shall be provided with a separate stop/start cubicle in the field, equipped with stop/start buttons and an isolator. These cubicles shall also contain soft starters. The gantry crane shall have on/off control, activated manually via the stop/start.

M13. WASTE ACTIVATED SLUDGE TRANSFER

M13.1 Scope

The scope shall include the design, supply, delivery, installation, testing, commissioning and upholding during the Trial Operational Period (Operational Acceptance Period) and the Maintenance Period (Defects Notification Period) of the following:

i. Two self-priming centrifugal pumps, operating on VSD's complete with motor, and baseplate to transfer Waste Activated Sludge (WAS) from the existing WAS sump up to the new Centrifuge Feed Tank.

ii. Two macerator and heavy solid separator units complete with motor, gearbox, cutting screen, blades and baseplate

iii. Like-for-like replacement of the domestic sewage sump pump adjacent to the WAS sump

iv. All piping, fittings, isolation valves, supports and fasteners transferring WAS from the existing WAS sump up to the inlet to the Centrifuge Feed Tank.

M13.2 General Description

WAS is collected in the existing WAS sump adjacent to pump station 5. The WAS shall be transferred from the sump to the Centrifuge Feed Tank using self-priming centrifugal pumps operating in a duty/standby arrangement.

Before entering the Centrifuge Feed Tank, the WAS is pumped through duty/standby macerators and heavy solids separator units. The macerator and solids separator units shall cut stringy and fibrous material (such as hair, textile fibers) that are entangled in the WAS. Cutting of the material is performed by a set of self-sharpening blades rotating on a cutting screen. The units shall also settle out larger, heavier foreign objects which shall collect in the bottom compartment of the of each unit and channeled to a collection container. It shall be possible to remove foreign objects easily and safely from the collection chambers.

M13.3 Duties

The duties for this section shall be as follows:

WAS Transfer Pumps volumetric flow rate	150 m^3/h
Macerator and solids separator volumetric flow rate	150 m^3/h
Domestic sewage sump pump	20 m^3/h

The following should be noted:

1. The WAS Transfer Pumps, and Macerator units shall operate as duty/standby. The capacities specified above are for each item of equipment.
2. The equipment will be used to pump waste activated sludge biological activated sludge reactors treating a mixture of industrial (textiles and chicken abattoir) and domestic wastewater. The sludge is wasted from the secondary settling tanks at a solids content of 0.8 - 1 wt.%.
3. The WAS Transfer Pumps, and Macerator units shall be able to handle foreign objects that would be typically found at a municipal sewage works operating with open-top biological reactors. Some possible material shall include rags, stringy matter, food particles, plastic, earbuds, leaves, sticks, cloth, bits of tin cans, broken glass, stones and masonry.
4. The domestic sewage sump pump is a submersible centrifugal pump. A like-for-like replacement of this unit is required. The flowrate is estimated for tender purposes. During the contract, the flowrate will be confirmed by the Contractor.

M13.4 WAS Transfer Pumps

The WAS Transfer Pumps shall be self-priming centrifugal type pumps conforming to section D43 of the Standard Mechanical Specifications. Each pump shall operate on a duty/standby basis and shall be capable of delivering a maximum volumetric flowrate of 150 m^3/h at 15 m. The pumps shall be designed for continuous

operation in an abrasive environment (grit, stones etc.) which is typical of municipal sludge. The pump and impeller shall be designed to pump solids at a concentration of 1 wt.% and be able to handle solid particle sizes up to 50 mm together with stringy material without the risk of clogging. A cover plate situated on the pump housing shall allow easy access to clear blockages without having to remove piping. A replaceable wear plate shall be supplied on the cover plate to allow for easy inspections during servicing.

The speed of each pump shall be controlled on a VSD. The speed of the pump shall be adjusted based on the level registered by an ultrasonic level probe (supplied under this contract) situated in the WAS sump.

The pump shall have a mechanical seal, oil lubricated, double floating type. The seal shall have tungsten titanium carbide rotating and stationary faces with a SS316 stationary seat. Elastomers shall be fluorocarbon.

The required discharge head of the pump is estimated for tender purposes only. It is the responsibility of the Contractor to confirm the required head during detail design.

M13.5 Macerator and Heavy Solids Separator

The macerator and heavy solids separator units shall be an inline design mounted, with flanges, into the WAS transfer piping making use of the discharge pressure from the duty WAS transfer pump to transfer the WAS through the unit. Each unit shall be supplied complete with inlet and outlet flange connections, housing, cutting screen and blades, gearbox, motor and baseplate. The motor shall run off a VSD to vary the speed to supply constant torque on the cutting blades.

The unit shall perform a maceration function by rotating blades against a cutting screen. The knives shall be driven by a geared motor designed to deliver the adequate rotational speed and torque optimized for the maceration of domestic and industrial sludge. The drive will allow the knives to be automatically reversed to limit blockages. The screen size shall be 8 mm (To be confirmed during detail design based on technology supplier's recommendation) to protect the downstream centrifuge units from oversized material. There shall be an automatic warning system indicating when there is wear on the blades and that they need to be replaced. The pressure between the blades and the screen shall be automatically controlled to ensure that the optimal pressure is maintained at all times during operation to extend the lifetime of the blades.

Heavy solids that cannot be macerated shall collect in the bottom chamber of each unit and be channelled to a collection chamber. This shall occur simultaneously while maceration takes place. It shall be possible to remove foreign objects easily and safely from the collection chamber of the standby unit.

The design of the housing shall be split and allow for easy disassembling to gain access to the blades and screen for maintenance purposes.

M13.6 Motors

Tenderers should take note of the 's requirements for electric motors, as per Section D35 of the Standard Specification for Mechanical Works. Where the Contractor is not able to conform to these requirements, he should explicitly highlight the deviations in his offer, for consideration by the Engineer.

It should also be noted that whilst preliminary motor selections have been made for the purposes of this tender, choice of final motor sizes shall rest with the Contractor. Furthermore, it shall be noted that the power rating shall be supplied as a 380 V low voltage unit. Whilst four pole motors are preferable for the anticipated rating, two pole motors will be acceptable.

M13.7 Piping

All valves, fittings, piping material and sizes shall be as indicated on P&ID W1859-45001 (60325-M-SD-101) All piping, fittings and supports shall conform to section D20 of the Standard Specifications for Mechanical Works unless otherwise stated below. All piping shall be clearly identifiable as per SANS 10140-3. All valves shall conform to section D28, D29 and D30 of the Standard Mechanical Specification for Mechanical Works. Refer to control valve list W1859-61002, on/off valve list W1859-61003, pressure safety valve list W1859-

61004, hand valve list W1859-61005 and check valve list W1859-61006 in Volume 3. The tenderer shall supply technical datasheets/brochures of the range for each valve type offered with the tender.

Sludge Piping:
New sludge piping shall extend from inside the existing WAS sump up to the inlet of the Centrifuge Feed Tank. There shall be spillback lines on the discharge of each of the WAS transfer pumps to allow recirculation of sludge in the sump if required. All valves in the piping shall be a knife-gate type. Manual valves shall allow the safe isolation of the standby WAS transfer pump and macerator. It shall be possible to transfer WAS from either transfer pump through either of the macerator and solid separator units. The piping shall be manufactured from stainless steel 304 and shall have limited bends. Swing type check valves shall be installed on the discharge of each WAS transfer pump in accordance with Section D29.7 of the Standard Mechanical Specifications.

The existing manually actuated valve on the inlet feed line to the WAS sump shall be replaced with a new motorized knife gate valve. This valve will be interlocked to close when a high high level is reached in the WAS sump.

M13.8 Motor Control Centre

All equipment and instrumentation indicated on P&ID W1859-45001 (60325-M-SD-101) will be operated from a PLC situated in the new MCC room in the new dewatering building.

All instrumentation and controls as shown on the P&ID W1859-45001 (60325-M-SD-101) and the instrumentation list (refer to volume 3) are to be supplied and installed to ensure safe, reliable and efficient operation under the conditions stated in this specification. This shall include all instrumentation required for start-up, shut-down, ongoing monitoring of essential system parameters and for safe operation in accordance with the applicable codes and standards.

The analogue instruments (e.g. T, P) shall be supplied complete with manufacturer calibration certificate and procedure and material certificates (SS 316). The certificates shall be available at FAT execution if applicable. All instrument loops and process control functionality shall be tested during FAT.

M13.9 Corrosion Protection and Materials of Construction

M13.9.1 Materials of Construction

WAS Transfer Pumps:

Pump Casing	Grey Cast Iron
Impeller	Ductile Iron
Impeller Shaft	Alloy Steel 4150
Shaft Sleeve	Alloy Steel 4130
Wear Plate	Carbon Steel 1015
Flap valve	Neoprene/nylon and steel reinforcing
Bearing housing	Grey Cast Iron
Baseplate	Mild Steel, Hot dip galvanized.
Mechanical Seal	Tungsten Titanium Carbide

Macerator and Solids Separator:

Housing	Mild Steel, Hot dip galvanized.
Cutter head	Mild Steel, Hot dip galvanized
Knife Blades:	Hardened Steel 90MnCrV8
Cutting Screen	Hardened Steel
Baseplate	Mild Steel, Hot dip galvanized
Shaft	Hardened Alloy Steel
Mechanical Seal	Cartridge seal, Duronite or Silicon Carbide

Sludge piping:

Piping	Stainless Steel 304
Fittings	Stainless Steel 304
Fasteners	Stainless Steel 304
Supports	Mild Steel, Hot dip galvanized.

M13.9.2 **Corrosion Protection**

Corrosion protection shall be carried out in accordance with the requirements of Sections D11 to D14 of the Standard Specification for Mechanical Works. Where stainless steel components are welded these shall be pickled and passivated.
Pump housings and geared motor units shall be Alkyd overcoated

M13.10 Quality Management

A quality control plan shall be submitted for the design, manufacturer, installation and commissioning of each piece of equipment and its ancillaries, for approval and monitoring by the Engineer.

M13.11 Installation

The installation of the new equipment into the existing WAS sump shall not impede on the functioning of the existing sludge pumps or the existing sludge transfer piping up to the drying beds and existing centrifuge unit.

M13.12 Performance Testing

M13.12.1 **Factory Testing**

For all pumps:
Balancing of the complete impeller and shaft shall be undertaken at the manufacturer's works. Flow-head curves shall be generated at the manufacturer's or agent's premises and checked against the manufacturer's listed pump curves for any major discrepancies.

M13.12.2 **Before Commissioning**

i. Tenderers shall take note of Sections D78.1 to D78.4 of the Standard Specification for Mechanical Works, prior to starting commissioning
ii. Contractor will confirm construction of the plant as per design drawings. This shall be approved by the Engineer.
iii. Ensure all drive equipment is lubricated, with correct oil
iv. Test for correct rotation of all motors
v. Test for correct operation of control system functionality and instrumentation as per the functional design specification.
vi. Leak test all process vessels and pipelines
vii. Submit all certification, motor test certificates, material certificates
viii. Submit all operating and maintenance instructions

M13.12.3 **Commissioning**

Specifically, the WAS transfer pumps and macerator units shall undergo the following tests:

i) Verify Operation under maximum and minimum flow conditions.
ii) Check operation of macerator and heavy solid separators Ensure no blockages and that large foreign objects are collected in the collection chamber. Verify control of blades is as per design.
iii) Verify system operates as per functional design.
iv) Measure motor current.
v) Test overload conditions and self-cleaning function.
vi) Check for operation of emergency stop.

Generally, the equipment will be considered acceptable at commissioning when all of the following conditions are satisfied:

i) The equipment meets the duty requirements as defined in this section of the Specification.
ii) Any other specific performance tests defined in this Section prove acceptable operation of the equipment
iii) Where a power test is required, the power absorbed by the motor at duty point does not exceed the values stated in the Technical Data Sheets by more than 5%.
iv) Where a vibration test is required, the vibration measured at each point does not exceed the level prescribed in BS 4675 Part 1-1976 for the appropriate class of machine.

M13.12.4 **After Commissioning**

Check equipment for proper functioning and monitor process performance during the Test Period and the Trial Operational Period (TOP). Refer Section 9 in the Conditions of Contract.

For the purpose of this contract, the TOP shall be 28 days. The operating time of each duty unit shall be adjusted to ensure that the total operation hours (including the Test Period) is split equally between each unit. All laboratory testing required during the TOP and Test Period shall be done at a SANAS approved, independent laboratory. Tenderers shall allow for the cost of all sampling and testing in their offer.

The Overall Equipment Efficiency (OEE) of the WAS transfer pumps and macerator units shall be greater than 95% during the TOP. OEE is defined as the total running time of the equipment less the time lost for breakdowns and maintenance. Periods of downtime outside of the Contractor's control will not be included in the OEE calculation.

M13.12.5 **During Defects Notification Period**

Check all items for correct operation and functioning at 3 months, 6 months, 9 months and 12 months after plant take-over. The Contractor shall submit reports to the Engineer after each inspection.

Refer to Section M26 which further describes the Contractors responsibilities during DNP with respect to the operation and maintenance of the plant.

M13.13 Spares

For tenders to be considered responsive, contractors must be able to offer comprehensive routine maintenance comprising the required activities and at the recommended intervals as stated in their offer. Similarly, critical spares and special tools must be easily available from the contractor, preferably being kept in stock in South Africa.

Macerator and solids separators:
1 x full set of knife blades for each unit
1 x screen

M13.14 Control and Automation

Refer to control narrative document W1859-48001 (in Volume 3) for details on the operation and control of the equipment in this section

M14. CENTRIFUGE FEED TANK

M14.1 Scope

The scope shall include the design, supply, delivery, installation, testing, commissioning and upholding during the Trial Operational Period (Operational Acceptance Period) and the Maintenance Period (Defects Notification Period) of the following:

i. Two fixed speed, submersible mixers complete with motor, gearbox, shaft, impeller, lifting davit arms and all steel supports
ii. All piping, fittings, isolation valves, supports and fasteners for the overflow and drain piping and all instrumentation connections up to puddle flanges.
iii. Steel access ladders, platforms, handrailing, supports and fasteners around the centrifuge tank

Under this contract the Contractor shall supply all flanges and fittings required to install the instrumentation and auxiliary piping. The tank shall be manufactured from concrete and is handled under the Civil Specification. Any alterations to the civil design of the tank in order to accommodate the mechanical equipment offered will be communicated at tender stage and be included in the tendered price in the space provided in the relevant Schedule of Quantity.

M14.2 General Description

Waste Activated Sludge (WAS) shall be transferred through new piping from the existing WAS sump into the Centrifuge Feed Tank. The Centrifuge Feed Tank will act as a common collection point for WAS coming from the existing biological reactors as well as the new biological reactors to be installed at a future date under a separate contract. The tank will have a working volume of 30 m^3 and act as a header tank for the pumps supplying the centrifuge units. The tank shall be flat bottom, fully enclosed with a concrete roof, and made of concrete with a suitable admix to protect against concrete corrosion (refer to Civil Specification). Activated sludge shall be kept in suspension using two, horizontal submersible mixers mounted diagonally opposite each other.

M14.3 Duties

The tank will have a working volume of 30 m^3 and act as a header tank for the pumps supplying the centrifuge units. The tank shall have the following dimensions:

Length = 4 m
Width = 2.5m
Height = 3.5 m

The tank will contain waste activated sludge at 0.8-1% dry solids from domestic and industrial wastewater.

The submersible mixers shall be designed with sufficient thrust/mixing capacity to keep activated sludge in suspension. The mixers shall be sized to maintain an effectively constant suspended solids concentration throughout with not more than 200mg/l variation from the average at any point in the respective volume. Tenderers shall ensure that the equipment suppliers, experienced in the mixing of activated sludge, size the mixers based on the required duties and confirmatory calculations are submitted to the Engineer

M14.4 Tank Nozzles

The tank shall be flat bottom, fully enclosed, and made of concrete lined with HDPE or similar approved material or admix. The tank and plinth shall be supplied under a separate civil contract. The Contractor shall take note of the required nozzles onto which the Contractor shall install piping.
The tank shall have the following nozzles as a minimum:

Waste activated sludge supply (Existing Bioreactors)
Waste activated sludge supply (Future Bioreactors)
2nd class water supply
Drain

Discharge
Overflow
High level switch
Low level switch
Level probe
Top access hatch (suitable sized for maintenance purposes)
Side access hatch (suitable sized for maintenance purposes)

Refer to P&ID W1859-45001 (60316-M-SD-101) for line sizes.

M14.5 Mixer

Submersible mixers shall be in accordance with Section D50 of the Standard Specification for Mechanical Works. The mixers shall be horizontal submersible type equipped with a gearbox and energy efficient, non-clogging (swept blade) impellers.

To prevent ingress of surrounding liquid, the mixers shall have two radial lip, FKM rubber seals (or similar approved). The units shall come with ceramic wear plates with a mechanical seal made of silicon carbide/silicon carbide or tungsten carbide/tungsten carbide.

The oil filled gearbox shall be monitored for leak detection by an integral leak sensor within the gearbox which shall be used to trigger an alarm signal to trip the motors.

The motor shall be a high efficiency (IE3) type and be fed from 3-phase 400 VAC, 50 Hz power. The mixers shall come standard with integral thermal protection to protect motor windings. Vendors shall confirm motor sizes based on the required duties.

M14.6 Motors

Tenderers should take note of the ’s requirements for electric motors, as per Section D35 of the Standard Specification for Mechanical Works. Where the Contractor is not able to conform to these requirements, he should explicitly highlight the deviations in his offer, for consideration by the Engineer.

It should also be noted that whilst preliminary motor selections have been made for the purposes of this tender, choice of final motor sizes shall rest with the Contractor. Furthermore, it shall be noted that the power rating shall be supplied as a 380 V low voltage unit. Whilst four pole motors are preferable for the anticipated rating, two pole motors will be acceptable.

M14.7 Piping

All valves, fittings, piping material and sizes shall be as indicated on P&ID W1859-45001 (60316-M-SD-101). All piping, fittings and supports shall conform to section D20 of the Standard Specifications for Mechanical Works unless otherwise stated below. All piping shall be clearly identifiable as per SANS 10140-3. All valves shall conform to section D28, D29 and D30 of the Standard Mechanical Specification for Mechanical Works. Refer to control valve list W1859-61002, on/off valve list W1859-61003, pressure safety valve list W1859-61004, hand valve list W1859-61005 and check valve list W1859-61006 in Volume 3. The tenderer shall supply technical datasheets/brochures of the range for each valve type offered with the tender.

<u>Overflow and drain piping:</u>
The drain and overflow piping on the Centrifuge Feed Tank will extend from the respective puddle flanges and direct flow to an underground drain pipe (by civil contractor) back to the existing Detritus Tank splitting the flow to the existing bioreactors. All valves in the piping shall be a knifegate type. The piping shall be manufactured from stainless steel 304 and shall have limited bends.

<u>2nd Class Water piping:</u>
2nd class water piping will extend from the bulk supply manifold up to the supply puddle flange on the tank. The line will be used for flushing purposes for tank maintenance and commissioning. The piping shall have a manual butterfly valve at the tank to isolate the line from the bulk supply.

M14.8 Access Platforms and Handrailing

The Centrifuge Feed Tank shall have two cat ladders, platforms and handrailing to access the submersible mixers. All ladders and handrails shall comply with D18 and D19 of the Standard Specification for Mechanical Works

M14.9 Corrosion Protection and Materials of Construction

M14.9.1 Materials of Construction

The following materials of construction are required. Where Tenderers cannot conform to these requirements, they are to explicitly highlight this in their tender, for consideration by the Engineer.

Mixers	
Centrifuge Feed Tank mixers impellers	Stainless Steel 304
Centrifuge Feed Tank mixer shaft	Stainless Steel 304
Davit arm, guide, supports and fasteners	Stainless Steel 304
Lifting wire	Stainless Steel 316
Motor	Grey Cast Iron
Sludge and 2nd class water piping:	
Piping	Stainless Steel 304
Fittings	Stainless Steel 304
Fasteners	Stainless Steel 304
Supports	Mild Steel, Hot dip galvanized.

M14.9.2 Corrosion Protection

Corrosion protection shall be carried out in accordance with the requirements of Sections D11 to D14 of the Standard Specification for Mechanical Works.
Where stainless steel components are welded these shall be pickled and passivated.
Pump housings and geared motor units shall be Alkyd overcoated

M14.10 Motor Control Centre

All equipment and instrumentation indicated on P&ID W1859-45001 (60316-M-SD-101) will be operated from a PLC situated in the new MCC room in the new dewatering building.

All instrumentation and controls as shown on the P&ID W1859-45001 (60316-M-SD-101) and the instrumentation list (refer to volume 3) are to be supplied and installed to ensure safe, reliable and efficient operation under the conditions stated in this specification. This shall include all instrumentation required for start-up, shut-down, ongoing monitoring of essential system parameters and for safe operation in accordance with the applicable codes and standards.

The analogue instruments (e.g. T, P) shall be supplied complete with manufacturer calibration certificate and procedure and material certificates (SS 316). The certificates shall be available at FAT execution if applicable. All instrument loops and process control functionality shall be tested during FAT.

M14.11 Quality Management

A quality control plan shall be submitted for the design, manufacturer, installation and commissioning of each centrifuge feed tank mixer and its ancillaries, for approval and monitoring by the Engineer.

M14.12 Installation

The mechanical equipment and associated piping shall be installed by the Contractor in accordance with the instructions of the manufacturers and as shown on their drawings.

M14.13 Performance Testing

M14.13.1 Works Testing

For all Mixers:

Performance testing shall be carried out in accordance with the requirements of Sections D50.3 of the Standard Specification for Mechanical Works. The mixer units shall be tested at the manufacturers works in the presence of the Engineer or his representative. The cost of carrying the work performance tests shall be deemed to be included in the overall cost of the contract. The following shall be completed:

i. Balancing of the complete impeller and shaft at the manufacturers place.
ii. Gearboxes shall be checked for oil tightness, lubrication, oil temperature and unusual noises.
iii. Inspection certificates detailing all works testing shall be forwarded to the Engineer.

M14.13.2 Before Commissioning

i. Tenderers shall take note of Sections D78.1 to D78.4 of the Standard Specification for Mechanical Works, prior to starting commissioning
ii. Contractor will confirm construction of the plant as per design drawings. This shall be approved by the Engineer.
iii. Check for levelling of the mixer assembly and test for correct alignment of shafts and couplings.
iv. Ensure all drive equipment is lubricated, with correct oil
v. Test for correct rotation of all motors
vi. Test for correct operation of control system functionality and instrumentation as per the functional design specification.
vii. Leak test all process vessels and pipelines
viii. Submit all certification, motor test certificates, material certificates
ix. Submit all operating and maintenance instructions

M14.13.3 Commissioning Tests

Commissioning tests on the mixers will take place in the presence of wastewater as per D50.2 of the Standard Mechanical Specifications.

i) Verify Operation under maximum and minimum level conditions.
ii) Check operation of the lifting davit arms. Load tests to be conducted on all lifting devices.
iii) Verify system operates as per functional design.
iv) Measure motor current.
v) Check for operation of emergency stop.

Generally, the equipment will be considered acceptable at commissioning when all of the following conditions are satisfied:

i) The equipment meets the duty requirements as defined in this section of the Specification.
ii) Any other specific performance tests defined in this Section prove acceptable operation of the equipment
iii) Where a power test is required, the power absorbed by the motor at duty point does not exceed the values stated in the Technical Data Sheets by more than 5%.
iv) Where a vibration test is required, the vibration measured at each point does not exceed the level prescribed in BS 4675 Part 1-1976 for the appropriate class of machine.

v) The mixer performance test passes as per D50.2 of the Standard Mechanical Specifications.
vi) All functionality of the system control and automation is as per specification

M14.14 After Commissioning

Check equipment for proper functioning and monitor process performance during the Test Period and the Trial Operational Period (TOP). Refer Section 9 in the Conditions of Contract.

For the purpose of this contract, the TOP shall be 28 days. The operating time of each duty unit shall be adjusted to ensure that the total operation hours (including the Test Period) is split equally between each unit. All laboratory testing required during the TOP and Test Period shall be done at a SANAS approved, independent laboratory. Tenderers shall allow for the cost of all sampling and testing in their offer.

The Overall Equipment Efficiency (OEE) of the mixers shall be greater than 95% during the TOP. OEE is defined as the total running time of the equipment less the time lost for breakdowns and maintenance. Periods of downtime outside of the Contractor's control will not be included in the OEE calculation.

M14.15 During Defects Notification Period

Check all equipment for correct operation and functioning at 3 months, 6 months, 9 months and 12 months after plant take-over. The Contractor shall record all findings in a report for approval by the Engineer.

Refer to Section M26 which further describes the Contractors responsibilities during DNP with respect to the operation and maintenance of the plant.

M14.16 Spares

For tenders to be considered responsive, Tenderers must be able to offer comprehensive routine maintenance comprising the required activities and at the recommended intervals as stated in their offer. Similarly, critical spares must be easily available from the contractor, preferably being kept in stock in South Africa.

The Contractor shall be responsible for identifying and supplying the required spares for the selected mechanical equipment. The spares selection shall be subject to approval, in writing, by the Engineer.

M14.17 Control and Automation

Refer to control narrative document W1859-48001 (in Volume 3) for details on the operation and control of the equipment in this section.

M15. CENTRIFUGES

M15.1 Scope

The scope shall include the design, supply, delivery, installation, testing, commissioning and upholding during the Trial Operational Period (Operational Acceptance Period) and the Maintenance Period (Defects Notification Period) of the following:

i. Two off, high efficiency, horizontal decanter centrifuges complete with feed pipe, cylindrical bowl and scroll, base frame, enclosure, scroll and bowl drive systems.
ii. Two off, progressive cavity sludge feed pumps complete with motor, gearbox and baseplate
iii. Two off, progressive cavity poly electrolyte dosing pumps complete with motor, gearbox and baseplate
iv. Two off, solids discharge chutes, including compensators, to direct dewater sludge to the sludge conveyors
v. All piping, fittings, isolation valves, safety relief devices, supports and fasteners transferring WAS from the outlet of the Centrifuge Feed Tank up to the inlet of each centrifuge unit.
vi. All piping, fittings, isolation valves, safety relief devices, supports and fasteners transferring polymer from the Polymer Make-Up system up to the dosing points in the feed piping to the centrifuge units.
vii. All piping, fittings, isolation valves, pressure regulating devices, supports and fasteners supply 2nd class washwater from the bulk supply manifold up to the flushing points and poly dilution points at each centrifuge unit.
viii. Instrumentation and control hardware to achieve the required process performance.
ix. New 10 tonne double girder electric overhead travelling crane in the Centrifuge Hall including the rails, hooks, power supply system, load testing and certification and access ladder and walkway.

Under this contract, only two centrifuge units and auxiliary equipment shall be installed. Space shall be allowed for a further two centrifuges of the same capacity in the future. The Contractor shall take this into account in the M&E design.

M15.2 General description

Waste Activated Sludge shall be dewatered using high efficiency, horizontal decanter centrifuges. Each centrifuge shall consist of a feed pipe that introduces pumped sludge into a rotating cylindrical bowl section. Within the bowl, centrifugal force pushes the solids to the outside of the bowl. The solids are moved by a rotating scroll through a conical section of the bowl before being discharged into a dedicated solids discharge chute which directs the sludge to the sludge handling conveyors. The liquid portion (centrate) is then discharged at the feed end of the centrifuge over adjustable weir plates. Centrate is returned by gravity back to the existing bioreactors.

Second class washwater will be connected to the feed pipe of the centrifuge to allow the unit to be flushed after use during process upsets. Flushing sequences shall be automated and controlled by the PLC/SCADA system. An automated knifegate valve in the solids discharge chute will divert washwater away from the sludge handling conveyors during a flushing sequence.

Polyelectrolyte shall be dosed directly in the sludge feed line to the centrifuge to assist with the dewatering process. Refer to section M16 describing the polyelectrolyte make-up system and dosing.

M15.3 Duties

The duty of the centrifuge units shall be as follows:

	WAS Dewatering
No. of machines	2
Sludge feed	Waste Activated Sludge (Domestic Sludge)
Maximum WAS volumetric flowrate per machine	65 m^3/h
Maximum volumetric flowrate per machine (incl. poly dose)	70 m^3/h
Minimum feed % dry solids (before poly dosing)	0.8% DS
Maximum feed % dry solids (before poly dosing)	1.0% DS
Maximum solids loading per machine (kgDS/h)	650 kgDS/h
Capture rate of solids into cake	99% minimum
Cake dryness	>16% dry solids
Polyelectrolyte consumption	<15 kg powder / ton of feed DS
Polyelectrolyte concentration	0.2% by mass

- *Capture rate definition:*
- *Feed flux = Feed (m^3/h) * feed TSS (mg/l)*
- *Centrate flux = Centrate flow (m^3/h) *Centrate TSS (mg/l)*
- *Capture rate = (Feed flux – Centrate flux) / Feed flux *100*

The following should be noted:

1. At the current sludge flowrate, only a single duty centrifuge is required to meet the daily solids load however the process shall be designed to run both centrifuge units as duty units to conduct daily sludge wasting activities over a shorter period of time as required by the operational staff.
2. A polyelectrolyte consumption of 15 kg powder / ton DS is an absolute worst-case scenario upon which the equipment capacities are based. Preference will be given to technology that consumes the least amount of polyelectrolyte solution while still achieving the required solids capture rate.
3. The sludge comes from conventional activated sludge biological reactors. The organic fraction in the sludge (Volatile Suspended Solids VSS/Total Suspended Solids TSS) can vary depending on the sludge age in the system. For the purpose of this tender, it is assumed that the organic fraction in the sludge is 0.85.
4. The inlet works will be upgraded to include new screening and degritting equipment. In addition to this, a macerator and heavy solids separator will be installed upstream to protect the centrifuge units however adequate wear protection must be included in the design
5. The pH of the sludge is expected to be between 6 and 8. The sludge will be at ambient temperature.

M15.4 Centrifuge installation design

As a minimum, each centrifuge shall include the following features:

1. Dedicated control panel
2. VFDs with differential speed controller for scrolls and bowls
3. Electrically or pneumatically actuated isolation valves
4. Feed flow meter and flow control
5. Polyelectrolyte injection and mixing systems
6. Automated service water flushing system
7. Feed, centrate and cake sampling points

8. Chutes for thickened/dewatered sludge
9. Centrate chutes
10. Diversion valve to divert cake outlet to centrate sump during machine washing/flushing to ensure dewatered cake route will not be wetted by wash-water

M15.5 Bowl

The bowl shall be manufactured from Duplex Stainless Steel SAF 2205 and designed with adequate safety factors at the maximum design speed. The minimum gravitational force produced shall be at normal operating speed. Maximum design speed shall not be used for calculation of gravitational force.

The centrifuge bowl wall thickness of the cylindrical and conical sections shall be sufficient for an operational lifetime of 20 years. During operation, the solids from the sludge will form a stable passive wear protection layer between the strips.

The centrifuge bowl shall be well supported and fitted for convenient external lubrication. Pool depth shall be readily adjustable via weir plates located at the large diameter end of the bowl. Solids shall be discharged at the small diameter end of the bowl.

The angle of the conical section (beach angle) shall insure proper and stable cake discharge at maximum operating speed.

M15.6 Scroll Conveyor

The centrifuge shall include a Stainless Steel 316 scroll conveyor equipped with helical flights, continuously welded to the scroll tube. The scroll conveyor shall be designed such that the feed is evenly discharged into the bowl via feed distribution ports. The scroll shall utilize a variable differential speed to convey solids from the cylindrical section to the conical section and out of the bowl.

The scroll conveyor shall be supported on grease lubricated anti-friction roller bearings sealed from process contamination. The edge and the face of the conveyor flights and feed ports shall be protected by a system described in the abrasion protection section.

M15.7 Frame and Casing

The rotating assembly and bearings of the centrifuge shall rest on a fabricated steel frame to provide maximum stiffness and durability. The casing assembly shall be specifically designed for rigidity, noise reduction and to provide a complete enclosure for odour containment. The case top shall be bolted in place with lift off design for inspection and maintenance. The top shall be fabricated from stainless steel 304 and shall be designed to act as a protective guard. Fiberglass or Plastic upper casings shall not be allowed for safety reasons. The upper and lower casing shall have a gasket between them to contain vapours and minimize noise.

The entire end frame under the main bowl bearings shall be solid steel to provide a rigid base for alignment and support of the bearings. Frame designs using hollow construction under the main bearings shall not be allowed.

The solids and centrate discharge from the casing shall be flanged to allow for a simplified and sealed installation.

An inspection port shall be provided at the centrate end to allow for adjustment of the pond settings without removal of the upper casing.

The rotating assembly, frame and casing shall be designed such that another rotating assembly is interchangeable with it and can be installed in the existing frame without realigning or shimming the bearing assemblies.

M15.8 Feed Tube

The feed tube assembly shall be designed such that polyelectrolyte can be fed directly into the feed chamber for efficient sludge conditioning.

M15.9 Bearings

The centrifuge shall be designed so that the entire rotating assembly is supported by two main «T» type bearings. Main bearings shall be housed in «U». The bearings shall be conservatively designed to withstand all stresses of the service specified. The main bearings shall have a minimum L-10 life rating of 100,000 hours at standard operating speeds without correction factors.

M15.10 Lubrication

The main bearings on the centrifuge shall be grease lubricated.
The scroll bearing shall be grease lubricated.

M15.11 Vibration Isolators

The centrifuge shall be mounted on rubber-type vibration isolators. The number and vibration constant of the isolator shall be as recommended by the manufacturer for the load and impact resulting from the operation of the centrifuge provided. No excessive vibration must be experienced during factory and site acceptance conditions. Vibration monitoring shall be provided and shall use an accelerometer type sensor/switch with analogue and discrete signals for monitoring and alarm purposes. Vibration of a predetermined displacement shall automatically shut down the machine.

There shall be no rigid connections to the feed tube, solids discharge, liquid discharge or electrical connections from the machine. Flexible connections shall be supplied at these points.

M15.12 Noise and Vibration

The centrifuge units will be installed in the centrifuge hall which will be a dedicated noise zone. The centrifuge hall will form an acoustic enclose for all the centrifuges and noise breakthrough to outside must be limited.

On the outside of the centrifuge hall the sound must not exceed 70db at 7m away. In office/control room and similar areas the sound must not exceed 65db.

M15.13 Flexible Connectors

To ensure a quiet installation, flexible connectors shall be provided by the centrifuge manufacturer to isolate the centrifuge from the building structure. Supplied connectors shall include the solids discharge, centrate and sludge feed.

Flexible electrical connectors for the drive motor shall be supplied by the installing Contractor per local codes.

M15.14 Piping

All valves, fittings, piping material and sizes shall be as indicated on P&ID W1859-45002 (60325-M-SD-102) All piping, fittings and supports shall conform to section D20 of the Standard Specifications for Mechanical Works unless otherwise stated below. All piping shall be clearly identifiable as per SANS 10140-3. All valves shall conform to section D28, D29 and D30 of the Standard Mechanical Specification for Mechanical Works. Refer to control valve list W1859-61002, on/off valve list W1859-61003, pressure safety valve list W1859-61004, hand valve list W1859-61005 and check valve list W1859-61006 in Volume 3. The tenderer shall supply technical datasheets/brochures of the range for each valve type offered with the tender.

<u>Sludge Piping:</u>
Sludge supply piping shall extend from the Centrifuge Feed Tank outlet flange up to the inlet flange at each centrifuge unit. Blank flanges and isolation valves will be provided for installation of future centrifuge units.

<u>Centrate Piping:</u>
The centrate piping from each centrifuge shall be returned to a common sump by gravity. The pipe routing design shall ensure that no splashing occurs as the centrate enters the sump.

<u>Washwater Supply:</u>

Washwater shall be piped from the bulk 2nd class water supply to the feed pipe and solids discharge chute of each centrifuge for flushing purposes. A manual ball valve shall provide isolation from the bulk 2nd class water supply manifold. A mechanical pressure reducing valve will regulate the pressure of the washwater supply. Each washwater point shall have an automated solenoid on/off valve controlled by the SCADA/PLC system to control the flow of washwater to each unit.

Polyelectrolyte dosing:
Polyelectrolyte dosing piping shall extend from the outlets of the Poly Make-Up systems directly into the feed line of each centrifuge to provide the required level of mixing to sufficiently condition the sludge before entering the centrifuge unit. The Contractor shall consult the centrifuge supplier to determine the correct distance of the dosing point from the centrifuge. Any additional dosing point requirements, to ensure optimal centrifuge operation, shall be communicated by centrifuge supplier to the Contractor and the Contractor shall install it as such. An inline dilution point (with 2nd class water) shall be provided to allow the polymer solution to be further diluted if required by Operations. Mixing of the dilution water with the polymer solution shall be provided using a static mixer made up of internal helical elements to promote radial flow resulting in a completed mixed solution before injection into the sludge piping.

M15.15 Drive System

The main bowl drive shall consist of a VFD controlled electric motor and a belt drive system. The belt drive system shall consist of multiple belts as required to provide full load capacity.

M15.16 Bowl Drive Motor

The bowl drive motor is to be rated for continuous duty and to have a kilowatt output sufficient for operating conditions of maximum bowl speed and sludge feed rate. The motor torque shall be adequate for all operating conditions

The motor shall conform to the norms and standard as required by the Standard Mechanical Specification Section D35. The contractor must make allowance for adhering to these.

M15.17 Scroll Conveyor Drive System

The scroll conveyor drive shall be independently driven and shall allow the scroll conveyor to operate with the bowl stopped. Systems that cannot operate independently shall not be allowed.

The centrifuge shall be furnished with a hydraulic drive system that provides a variable speed differential between the scroll conveyor and the bowl. The scroll conveyor drive system shall be furnished with all the required instrumentation and electrical controls to meet the operating requirements of this specification.

The scroll drive system shall consist of a hydraulic motor mounted on the centrifuge to drive the scroll conveyor. The hydraulic motor shall be mounted directly to the bowl and between the main bearings to minimize noise and vibration. The drive shaft of the hydraulic motor shall be directly connected to the scroll conveyor.

The hydraulic motor shall be powered by a hydraulic pump unit. The hydraulic pumping system shall utilize an adjustable pump with combined pressure-flow regulation that adapts to performance requirements. A pressure filter with electronic contamination indication shall also be provided. The hydraulic pumping unit shall be located adjacent to the centrifuge.

The hydraulic drive system shall be capable of operating in either a manual or automatic mode. In the manual mode it shall provide for operation at a specific, adjustable scroll differential speed with internal torque allowed to vary up to the maximum allowable scroll shaft torque.

In the automatic mode it shall continuously monitor changes in internal torque created by variations in influent feed solids and automatically maintain a preset torque input to the scroll by allowing the differential speed to vary. The hydraulic drive shall operate in a manner such that, as the reactive torque of the scroll shaft increases due to an increase in solids inventory in the bowl, the scroll differential speed shall gradually increase. Conversely, as the inventory of solids in the bowl and resultant reactive torque decreases, the scroll differential speed shall decrease. The net effect of this system shall be to maximize the time that cake solids are under

the influence of increased gravitational force to ensure that the driest possible dewatered cake product is produced without plugging the centrifuge.

Torque-based adjustment shall be a function of input to the driven unit. The maximum torque input and rate of change of scroll differential speed shall be adjustable.

In the event that torque exceeds the normal operating range, the sludge feed pump shall be automatically stopped to allow the centrifuge to clear itself. The sludge feed pump shall be restarted when the torque drops to the normal operating range.

In the event that the torque approaches the limit of the drive, automatic shutdown of the sludge feed pump and centrifuge bowl drive shall be initiated. In this instance, manual restart of the main bowl drive and feed pump shall be required.

Mechanical scroll conveyor drives shall not be allowed.

M15.18 Anchor Bolts

Anchor bolts shall be sized by the design engineer and shall be furnished by the installing Contractor.

M15.19 Accessories

The following shall be provided:

- Initial fill of scroll conveyor drive and bearings lubricant.
- Two (2) cans of spray touch up paint.

M15.20 Abrasion Protection

- In order to minimize wear due to abrasive materials in the feed, replaceable hard surfacing or wear resistant materials shall be provided at critical points on the centrifuge. The following shall be considered the minimum degree of protection required:
- Bowl Wall: The bowl wall and conical section shall be protected with a series of welded wear strips designed to form a protective layer of solids between the bowl wall and the conveyor.
- Feed Compartment: The feed compartment shall be of special design where the design helps build-up a passive wear protection layer inside the feed chamber.
- Feed Bushings: Feed bushings shall be made from sintered tungsten carbide
- Solids Discharge Ports: Solids discharge ports shall be made from sintered tungsten carbide bushing inserts.
- Scroll Conveyor Flights: Flame sprayed hardsurfacing containing a minimum of 50% tungsten carbide particles.
- Solids Discharge Casing: The solids discharge casing shall be protected by a replaceable stainless-steel wear liner.

M15.21 Scroll Wear Monitoring System

A method shall be provided to easily measure the amount of wear that occurs on the outer diameter of the scroll flights. This system shall not require the disassembly of the rotating assembly and shall be easily accomplished during routine centrifuge inspections. It shall consist of a series of plugged holes at critical locations along the length of the bowl. During the inspection process, the plugs are removed, allowing a depth gauge to be inserted through the outer bowl wall. This will allow the diameter of the scroll to be measured and the amount of wear to be determined.

M15.22 Proven Technology

The technology offered by the tenderer to meet this specification should be well developed and proven in installations of similar capacity to that required for this application. Trial technology or technology still under development will not be accepted. A history of successfully completed projects using the same technology offered to meet this specification must accompany the tender. To be considered a reference installation the

installation must apply the technology in the dewatering of sewage sludges. Reference installations must be at a commercial scale.

For tenders to be considered responsive the technology offered must have a proven track record of at least 10 years of working installations. Furthermore, the technology must have at least 10 commissioned working installations worldwide. Within South Africa, where centrifuge technology is not widely used on domestic sludge, the technology supplier shall demonstrate reference sites dewatering solids from industrial processes. At least 5 reference sites should be supplied in this regard. Tenderers must submit details of the reference site (including contact details) as supporting documentation to the tender.

The technology must have national representation within South Africa at the time of tender. A copy of the contractual agreement between the national representation and the technology supplier must be provided with the tender. If the technology does not have national representation in South Africa at the time of tender, a letter of intent indicating the intent to set up national representation with the technology supplier will also be accepted and must be submitted with the tender. The letter of intent must confirm the details of the national representative and that the length of the agreement will extend past the end of this contractual end date.

M15.23 Pumps

In addition to the detailed specifications below, the Contractor shall pay particular attention to the requirements of section D46 of the Standard Specification for Mechanical Works

The required discharge head of the pumps are estimated for tender purposes only. It is the responsibility of the Contractor to confirm the required head during detail design.

M15.23.1 Sludge Feed Pumps

There shall be one sludge feed pump per centrifuge. The pumps shall be progressive cavity pumps with variable speed drives. They shall be capable of supplying waste activated sludge to the centrifuges at 65 m^3/h at 20 m head. The pumps will convey the sludge from the Centrifuge Feed Tank to the centrifuges. Knife gate manual Isolation valves shall be provided at all pumps. Each pump shall have overpressure protection in the discharge piping in the form of a pressure transmitter/switch connected to the PLC/SCADA system to stop the pump if a high pressure is generated. Additional high pressure protection shall be provided by a mechanical pressure relieving valve on the discharge of each pump. The pumps shall also be stopped if low flow conditions are registered by the flow meters on the discharge of the pumps. Each pump shall have a temperature switch to prevent the pump rotor damaging the stator when run dry.

The sludge feed pumps' motors shall have forced cooling to allow the pump speed to operate at minimum conditions without risk of overheating the motor.

M15.23.2 Polyelectrolyte Dosing Pumps

There shall be one polyelectrolyte feed pump per centrifuge. The pumps shall be progressive cavity pumps with variable speed drives. They shall be capable of supplying polyelectrolyte solution at the polymer concentration range (refer to Polymer Make-Up section M15) to the centrifuges at 5 m^3/h at 20 m head. The pumps will convey polyelectrolyte solution from the Polymer Make-Up system to the centrifuges. Ball valve manual Isolation valves shall be provided at all pumps. Each pump shall have overpressure protection in the discharge piping in the form of a pressure transmitter/switch connected to the PLC/SCADA system to stop the pump if a high pressure is generated. Additional high pressure protection shall be provided by a mechanical pressure relieving valve on the discharge of each pump. The pumps shall also be stopped if low flow conditions are registered by the flow meters on the discharge of the pumps. Each pump shall have a temperature switch to prevent the pump rotor damaging the stator when run dry.

The polyelectrolyte dosing pumps' motors shall have forced cooling to allow the pump speed to operate at minimum conditions without risk of overheating the motor.

M15.24 Centrifuge Package Instrumentation

The following safety instrumentation shall be provided as a minimum for the centrifuge package:

1. A vibration switch on the base frame to monitor vibrations to use for interlocking and safely shutting the machine down when excessive vibrations are reached.
2. Speed sensors and frequency measuring converter on the bowl and scroll for the safe limitation of speed.
3. Resistance thermometer mounted on the main bearings for the rotating bowl.

M15.25 Gantry Crane

The Tenderer shall confirm the gantry crane sizing for the new equipment and shall submit dynamic and static loading calculations to this effect for approval. Tenderers are referred to section D37 of the Standard Specification for Mechanical Works for general design requirements with respect to materials of construction, paint specifications and required design parameters that should be considered.

The Contractor shall allow in his tender price for all equipment necessary to perform the work and the load testing and certification.

M15.26 Motors

Tenderers should take note of the ’s requirements for electric motors, as per Section D35 of the Standard Specification for Mechanical Works. Where the Contractor is not able to conform to these requirements, he should explicitly highlight the deviations in his offer, for consideration by the Engineer.

It should also be noted that whilst preliminary motor selections have been made for the purposes of this tender, choice of final motor sizes shall rest with the Contractor. Furthermore, it shall be noted that the power rating shall be supplied as a 380 V low voltage unit. Whilst four pole motors are preferable for the anticipated rating, two pole motors will be acceptable.

M15.27 Motor Control Centre

All equipment and instrumentation indicated on P&ID 1859-45001 (60325-M-SD-101) will be operated from a PLC situated in the new MCC room in the new dewatering building. The centrifuge shall be supplied with a Local Control Panel (LCP) monitoring and controlling all aspects within the centrifuge package unit. Each centrifuge LCP will communicate with the PLC (Master Control Panel) with a standard protocol (Profibus/Modbus) which will integrate the centrifuge with the rest of the plant operation. A Graphical User Interface (GUI) shall be located on the centrifuge control cabinet door. This GUI shall display all information needed to operate the centrifuge and shall allow the switch from remote to manual control and vice versa. All instrumentation indicated on the HMI supplied as part of the centrifuge package shall be displayed on the plantwide SCADA system for indication and alarming purposes.

All instrumentation and controls as shown on the P&ID 1859-45001 (60325-M-SD-101) and the instrumentation list (refer to volume 3) are to be supplied and installed to ensure safe, reliable and efficient operation under the conditions stated in this specification. This shall include all instrumentation required for start-up, shut-down, ongoing monitoring of essential system parameters and for safe operation in accordance with the applicable codes and standards.

The analogue instruments (e.g. T, P) shall be supplied complete with manufacturer calibration certificate and procedure and material certificates (SS 316). The certificates shall be available at FAT execution if applicable. All instrument loops and process control functionality shall be tested during FAT.

The MCC and PLC shall be supplied as per the Standard Electrical specification included in Volume 3.

The following instrumentation shall be provided at a minimum as shown on the P&ID's:

- Flow meter with isolation valves for each pump
- Pump over-pressurisation protection
- Stator temperature protection
- Sludge feed and polyelectrolyte flow meters at each centrifuge
- Pressure indication on the pump-outlet line
- Solids meters on sludge feed

The following instrumentation shall be provided at a minimum as part of the centrifuge package:

- Vibration senors
- Main bearing temperature
- Speed sensors on scroll and bowl
- Hydraulic oil level, temperature and pressure

M15.28 Corrosion Protection and Materials of Construction

M15.28.1 Materials of Construction

The centrifuges must be equipped with sufficient wear protection for any abrasive substances e.g. grit. The contractor is expected to consult their technology specialist in identifying suitable materials. As a minimum all high wearing surfaces must be tungsten carbide applied via flame spraying with overhead wear protection.

All wetted parts of the centrifuge rotating assembly shall be stainless steel, except for the "O" rings, seals, and abrasion-resistant material. Minimum material quality of construction shall be as follows:

Centrifuge:

• Bowl:	Duplex Stainless Steel 2205
• Scroll conveyor body:	Stainless Steel 316
• Feed tube:	Stainless Steel 316
• Casing cover:	Stainless Steel 304
• Lower casing:	Stainless Steel 304
• "O" rings:	Nitrile rubber
• Lip type seals:	Nitrile rubber
• Base and frame:	Hot dip galvanised steel plus organic coating
• Guards:	Stainless Steel 316
• Fasteners:	Stainless Steel 316
• Sludge discharge bushings:	Sintered tungsten carbide
• Chutes:	Stainless Steel 316

Sludge feed pumps:

• Pump Housing	Cast iron/cast steel
• Rotor	Chrome Steel Hardened.
• Stator	Rubber
• Connecting rods	304 Stainless steel
• Rotating Parts	1.4021 Steel

Polyelectrolyte pumps:

• Pump Housing	Cast iron/cast steel
• Rotor	CrNiMo17-12-2
• Stator	Rubber
• Connecting rods	304 Stainless steel
• Rotating Parts	CrNiMo17-12-2

M15.28.2 Corrosion Protection

Corrosion protection shall be carried out in accordance with the requirements of Sections D11 to D14 of the Standard Specification for Mechanical Works.

Where stainless steel components are welded these shall be pickled and passivated.

Pump housings and geared motor units shall be Alkyd overcoated.

The materials of construction of the polymer pump rotors and stators shall be selected for the polyelectrolyte at maximum solution strength

M15.29 Quality Management

A quality control plan shall be submitted for the design, manufacturer, installation and commissioning of each centrifuge and its ancillaries, for approval and monitoring by the Engineer.

M15.30 Installation

The centrifuges, piping, all instrumentation, and appurtenances shall be installed by the Contractor in accordance with the instructions of the equipment manufacturer and as shown on the drawings. All piping shall be supported so as to preclude the possibility of exerting undue forces and movements on the connecting flanges. Equipment and each part weighing over 25 kilograms which can be disassembled shall be provided with lifting lugs or other provisions for easy handling.

Each centrifuge shall be mounted on a flat and level concrete plinth. Support legs and columns shall be equipped with baseplates. After the equipment has been set in position and levelled at the proper elevation, the space between the bottom of the base and the concrete floor or equipment pad is to be filled with grout.

The centrifuges will be installed inside the new dewatering building. This space will have surfaces prepared for the new equipment. The building shall have sufficient ventilation and sound attenuation considering the heat loads and sounds emitted from the equipment. An overhead gantry crane system will be installed as required for the new equipment.

Aside from conformance to the general installation requirements as outlined in the Standard Specification for Mechanical Works, Contractors should ensure the least possible disruption to plant operation.

M15.31 Performance Testing

M15.31.1 Factory Acceptance Testing

Prior to shipment to site, each centrifuge shall undergo a set of factory acceptance tests as a minimum:

1. Alignment and fit of respective bearings and drives.
2. Performance testing using water at minimum and maximum loads, as well as various loads in between.
3. Noise measurement
4. Vibration measurement
5. The oil lubrication system shall be run and tested for leaks
6. Verification of emergency shut-down procedure
7. Verification of alarm operation
8. Simulation of safety device operation
9. Simulation of charge for modulating of control valves and control loops
10. Visual and final inspection of equipment before shipment

M15.31.2 Before commissioning

The following shall be conducted before commissioning:

1. Contractors shall take note of Sections D78.1 to D78.4 of the Standard Specification for Mechanical Works, prior to starting commissioning

2. Check for correct rotor alignment and clearances.
3. Check for alignment and fit of piping and valves.
4. Check for freedom from leaks.
5. Ensure all drive equipment is lubricated and gearboxes are filled to correct levels.
6. Tests for correct rotation of all motors
7. Test functionality of all safety interlocks relating to vibration, speed control and bearing temperatures.
8. Tests for correct operation of control gear, where provided under this Contract
9. Submit all certification, motor test certificates, material certificates
10. Submit all operating and maintenance instructions

M15.31.3 **Commissioning tests**

Specifically, the centrifuges shall undergo the following tests. This is applicable to each of the centrifuges:

1. Operation of centrifuge under maximum and minimum duties as specified in the duty section of this section.
2. Optimise the type of polyelectrolyte solution and correct dosing concentration by verifying the effect on sludge cake dryness.
3. Measurement of polyelectrolyte consumption against specification.
4. Measure motor current.
5. Checking of correct start-up and shut-down sequence, both under normal and emergency conditions
6. The contractor shall take grab samples of the sludge feed and cake and test the percentage solids and verify it matches the reading from the solids meter

Specifically, the pumps shall undergo the following tests:

1. Operation under maximum and minimum conditions.
2. Check the control of ramp up and ramp down according to flow required and polyelectrolyte dosing required.
3. Check for freedom from hang-up of material.
4. Setting of variable frequency drive to provide required flow rates. Measured flowrates to be within 2% of setpoint flowrates for both the sludge and the polymer dosing pumps.
5. Test polyelectrolyte dosing rates are controlled by solids metering of feed to centrifuges.
6. Check operation of thermal cut out switches
7. Operation of automated start/stop sequence under control of pressure sensors in sump.
8. Measure pump motor currents.
9. Check for operation of emergency stop.

Generally, the equipment will be considered acceptable at commissioning when all of the following conditions are satisfied:

1. The equipment meets the duty requirements at a 95% confidence level as defined in this Section of the Specification.
2. Any other specific performance tests defined in this Section prove acceptable operation of the equipment.
3. Where a vibration test is required, the vibration measured at each point does not exceed the level prescribed in BS 4675 Part I – 1976 for the appropriate class of machine.
4. Where a noise test is required, the noise generated by the equipment does not exceed the values stated in the Technical Data Sheets.

M15.31.4 **After commissioning**

Check equipment for proper functioning and monitor process performance during the Test Period and the Trial Operational Period (TOP). Refer Section 9 in the Conditions of Contract.

For the purpose of this contract, the TOP shall be 28 days. The operating time of each duty centrifuge shall be adjusted to ensure that the total operation hours (including the Test Period) is split equally between each centrifuge. All laboratory testing required during the TOP and Test Period shall be done at a SANAS approved, independent laboratory. Tenderers shall allow for the cost of all sampling and testing in their offer.

The Overall Equipment Efficiency (OEE) of the centrifuges shall be greater than 95% during the TOP. OEE is defined as the total running time of the equipment less the time lost for breakdowns and maintenance. Periods of downtime outside of the Contractor's control will not be included in the OEE calculation.

The cake dryness shall be proven during the Test Period. The Test Period will be conducted over 72 hours per centrifuge. The centrifuge shall be run at maximum duty for as long as waste activated sludge is available for that day. Grab samples will be taken every 6 hours and analyzed for percentage dry solids and compared against the online solids meter to verify the meter accuracy. The time-weighted solids concentration over the test period for each centrifuge shall be greater than what is guaranteed by the Contractor.

The polymer consumption shall be continually monitored during the Test Period and will be verified against the polymer consumption guaranteed at tender stage.

The performance of the equipment will be considered acceptable when the requirements as specified have been achieved consistently during the Test Period and TOP.

M15.31.5 **During Maintenance Period (Defects Notification Period)**

Check all equipment for correct operation and functioning at 3 months, 6 months, 9 months and 12 months after plant take-over. The Contractor shall submit reports to the Engineer after each inspection.

Refer to Section M26 which further describes the Contractors responsibilities during DNP with respect to the operation and maintenance of the plant.

M15.32 Spares and maintenance

For tenders to be considered responsive, contractors must be able to offer comprehensive routine maintenance comprising the required activities and at the recommended intervals as stated in their offer. Similarly, critical spares and special tools must be easily available from the contractor, preferably being kept in stock in South Africa. The Contractor shall be responsible for identifying and supplying the required spares for the selected mechanical equipment. The spares selection shall be subject to approval, in writing, by the Engineer.

Costs for the above activities and spares shall be included in the Returnable Schedules.

M15.33 Operation and control

Refer to control narrative document W1859-48001 (in Volume 3) for details on the operation and control of the equipment in this section.

The gantry crane shall be provided with a separate stop/start cubicle in the field, equipped with stop/start buttons and an isolator. These cubicles shall also contain soft starters. The gantry crane shall have on/off control, activated manually via the stop/start.

M16. POLYMER MAKE-UP SYSTEM

M16.1 Scope

The scope shall include the design, supply, delivery, installation, testing, commissioning and upholding during the Trial Operational Period (Operational Acceptance Period) and the Maintenance Period (Defects Notification Period) of the following:

i. Two (duty/standby) polymer make-up package systems each complete with polymer powder hoppers, heated metering screws, 2 chamber mixing system with agitators and motors.

ii. All piping, fittings, isolation valves, pressure regulators, supports and fasteners supplying potable water from the tie-in to the potable water bulk supply, up to the potable water connection points on each of the polymer make-up systems.

iii. Access staircase and platforms to load polymer powder into the powder hoppers.

M16.2 General Description

The polyelectrolyte used must be an organic polyelectrolyte suitable for use in the overall process. The make-up systems will produce polyelectrolyte solution at an adjustable concentration range (0.1 – 0.5 wt.%) by dissolving polyelectrolyte powder into potable water. Polyelectrolyte power shall be manually added to the polymer feed hopper by pouring 25 kg polyelectrolyte bags into the hopper. Based on the required concentration (adjustable) polyelectrolyte powder shall be metered into the make-up system using a dosing screw. The polyelectrolyte solution shall be made up in a batchwise fashion to ensure that the entire batch is matured before use. The make-up system shall alternate between batch tanks. While a solution is being made up in one tank, another tank is acting as a dosing tank and vice versa. Each tank will mix in the polymer using vertical shaft mixers at the optimally designed mixing rates.

Two separate make-up trains shall serve the centrifuges operating on a duty/standby basis. The size of the system shall ensure that at full capacity, all of the polyelectrolyte solution within a specific batch has had a maturation time of at least 60 minutes before being dosed to the centrifuge unit.

M16.3 Duties

Each polyelectrolyte make-up system shall be able to produce an uninterrupted flow of 6 m^3/h of polyeletrolyte solution at a concentration of 0.2 wt.%. The concentration of the polyelectrolyte solution shall be adjustable within a range of 0.1 - 0.5 wt.%

M16.4 Polyelectrolyte supply, handling and storage

Polyelectrolyte powder shall be received in 25 kg bags and be stored in a laydown area within the dewatering building. The bags shall be opened and poured into the polymer hoppers by operational staff. Access staircases, platforms and handrailing shall be supplied for the operators to easily and safely access the hopper opening to discharge polymer powder into the hopper.

M16.5 Polyelectrolyte make-up

Polyelectrolyte powder will be stored in an enclosed stainless-steel hopper before being used in the make-up system. Each make-up system will have a dedicated hopper. The lid of the hopper shall be securely fastened to the main body of the hopper. The fastening mechanism shall allow the easy opening of the lid (no hand tools required) by the operational staff to discharge polymer powder into the hopper. Each hopper shall have an ultrasonic level probe to monitor the level in the hopper. When a low level is reached (adjustable), an alarm will be sent to the SCADA system to alert the operators to refill the hopper. At full capacity, each hopper shall have at least an 8 hour storage capacity.

Each hopper shall supply two dosing screws that will discharge polymer powder into the make-up tanks. The screws shall operate on a VSD or timer basis such that the setpoint concentration of the polymer solution can be adjusted and carefully controlled. Each make-up system shall have 2 tanks that will automatically alternate between being a make-up tank and a dosing tank. Each tank will have a dedicated dosing screw. Within a make-up system, only one dosing screw will be activated at a time to charge powder to the designated make-up tank. Each dosing screw will be heated using heat tracing to prevent blockages. The heating system will have feedback to the SCADA system to alarm when there is a fault or if the system is turned off when that make-up system is called to run.

In each make-up tank, sufficient potable water shall be added and mixed with the poly to produce a solution at the setpoint concentration. Water shall be fed into the make-up tank through the powder wetting device (active whilst powder is being fed) and a rapid-fill line. Control of water addition shall be tightly controlled to provide no batch-to-batch variations in polymer concentration.

The size of each tank shall be identical to allow for the control philosophy of alternating tanks between make-up and dosing operation. The size of the make-up system shall ensure that at full capacity, all of the polyelectrolyte solution within a specific batch has had a maturation time of at least 60 minutes before being dosed to the centrifuge unit. Each tank shall be suitably baffled to facilitate mixing. The Tank shall be designed to support the static and dynamic loads imposed by the mixer and platforms.

Each tank shall have a dedicated vertical shaft mixer

M16.6 Polyelectrolyte dosing

The discharge of polyelectrolyte solution shall be controlled with automated solenoid valves situated on the tank discharge lines. When a tank is used as a dosing tank, the solenoid valve will open and allow polyelectrolyte solution to flow to the common manifold where each dosing pump shall draw suction. The details of the dosing pumps are listed in M15.23.2 Polyelectrolyte Dosing Pumps.

M16.7 Motors

Contractors should take note of the ’s requirements for electric motors, as per Section D35 of the Standard Specification for Mechanical Works. Where the Contractor is not able to conform to these requirements, he should explicitly highlight the deviations in his offer, for consideration by the Engineer.

M16.8 Piping

All valves, fittings, piping material and sizes shall be as indicated on P&ID W1859-45002 (60325-M--SD-102). All piping, fittings and supports shall conform to section D20 of the Standard Specifications for Mechanical Works unless otherwise stated below. All piping shall be clearly identifiable as per SANS 10140-3. All valves shall conform to section D28, D29 and D30 of the Standard Mechanical Specification for Mechanical Works. Refer to control valve list W1859-61002, on/off valve list W1859-61003, pressure safety valve list W1859-61004, hand valve list W1859-61005 and check valve list W1859-61006 in Volume 3. The tenderer shall supply technical datasheets/brochures of the range for each valve type offered with the tender.

Potable Water Supply:
Potable water will be piped from the potable water tie-in point on the main supply header up to the connection points to each of the polymer make-up systems (wetting device and rapid fill line). The piping shall include manual isolating ball valves to isolate each make-up unit and to isolate the complete supply manifold from the potable water bulk supply header. A pressure reducing valve will be installed to control the pressure to the polymer make-up systems. Solenoid valves on each of the supply lines, shall automatically control the supply of potable water to the polymer make-up system.

Polymer dosing:
The discharge piping from each make-up/dosing tank shall run to a common manifold from which each polymer dosing and lubrication pump shall draw suction from. Automated solenoid valves shall be installed in the discharge lines from each tank to isolate the respective tank from the common discharge manifold.

Overflow and drains:
Each tank shall have a dedicated overflow and drain line suitably sized for the maximum charging and discharging rates of the tanks. All drainpipes shall be routed to contained areas.

M16.9 Access Platforms and Handrailing

A staircase, access platform and handrailing shall be provided to allow manual emptying of 25kg bags of polyelectrolyte into the storage hopper on each poly make-up unit. The access staircases and platforms shall be constructed of hot dipped galvanized mild steel. Painting of the galvanized surfaces is not required. The staircase and access platform shall comply with Sections D18 and D19 of the Standard Specification for Mechanical Works.

M16.10 Motor Control Centre

All equipment and instrumentation indicated on P&ID W1859-45002 (60325-M-SD-102). will be operated from a PLC situated in the new MCC room in the new dewatering building. The poly make-up systems shall be supplied with a Local Control Panel (LCP) monitoring and controlling all aspects within the poly make-up system package unit. Each poly make-up system package LCP will communicate with the PLC (Master Control Panel) with a standard protocol (Profibus/Modbus) which will integrate the make-up system package with the rest of the plant operation. .

All instrumentation and controls as shown on the W1859-45002 (60325-M-SD-102) and the instrumentation list (refer to volume 3) are to be supplied and installed to ensure safe, reliable and efficient operation under the conditions stated in this specification. This shall include all instrumentation required for start-up, shut-down, ongoing monitoring of essential system parameters and for safe operation in accordance with the applicable codes and standards.

The analogue instruments (e.g. T, P) shall be supplied complete with manufacturer calibration certificate and procedure and material certificates (SS 316). The certificates shall be available at FAT execution if applicable. All instrument loops and process control functionality shall be tested during FAT.

The MCC and PLC shall be supplied as per the Electrical Specification.

The following outputs will be made available from the polymer make-up system PLC to the master PLC (at a minimum) to be used for indication and control purposes on the SCADA system:

1. Status of the polymer make-up system (fault, running, off etc.)
2. The status off each tank (make-up, dosing, offline etc.)
3. The level in the polymer hoppers
4. The level in each tank
5. The status of the heat tracing of the polymer dosing screws

M16.11 Corrosion Protection and Materials of Construction

M16.11.1 Materials of Construction

The following materials of construction shall apply:

- Tanks — Glass reinforced plastic (GRP)/Polypropylene (PP)
- Hopper — 304 Stainless steel
- Screw feeder screw — 304 Stainless steel
- Support Framework — Galvanised mild steel
- Polyelectrolyte solution piping — 304 Stainless steel

Corrosion protection shall be carried out in accordance with the requirements of Sections D11 to D14 of the Standard Specification for Mechanical Works.

Where stainless steel components are welded these shall be pickled and passivated.

Pump housings and geared motor units shall be Alkyd overcoated.

M16.11.2 **Corrosion Protection**

Corrosion protection shall be carried out in accordance with the requirements of Sections D11 to D14 of the Standard Specification for Mechanical Works. Where stainless steel components are welded these shall be pickled and passivated. Pump housings and geared motor units shall be Alkyd overcoated

M16.12 Quality Management

A quality control plan shall be submitted for each item of equipment, for approval and monitoring by the Engineer.

M16.13 Installation

The tanks, pumps, piping, all instrumentation, and appurtenances shall be installed by the Contractor in accordance with the instructions of the equipment manufacturer and as shown on their drawings. Installation shall conform to the general installation requirements as outlined in the Standard Specification for Mechanical Works.

M16.14 Performance Testing

M16.14.1.1 **Works testing**

1. The tanks shall be tested for leaks at the manufacturer's works
2. Balancing of the complete impeller and shaft shall be undertaken at the manufacturer's works.
3. Alignment and fit of respective bearings and drives.
4. Inspection certificates detailing all works testing shall be forwarded to the Engineer.

M16.14.1.2 **Before commissioning**

1. Contractors shall take note of Sections D78.1 to D78.4 of the Standard Specification for Mechanical Works, prior to starting commissioning
2. Test for correct alignment of shafts.
3. Check for alignment and fit of piping and valves.
4. Check for freedom from leaks.
5. Ensure all drive equipment is lubricated and gearboxes are filled to correct levels.
6. Tests for correct rotation of all motors.
7. Tests for correct operation of control gear, where provided under this Contract.
8. Tests for correct operation of whole assembly.
9. Submit all certification, motor test certificates, material certificates
10. Submit all operating and maintenance instructions

M16.14.1.3 **Commissioning tests**

Specifically, the equipment shall undergo the following tests:

1. Accuracy and repeatability of the polyelectrolyte powder screw feeder at high, intermediate and low levels in powder hopper - the delivered charge shall be accurate to within 1% of set the feed rate and subsequent delivered charges shall be consistent to within 1%.
2. Efficiency of powder wetting device – a uniform distribution and wetting of the polyelectrolyte powder shall be attained.
3. Efficiency of mixer in dissolving wetted powder – the powder shall be promptly and completely dissolved. The combined charging and dissolution time shall take no more than 1 hour.
4. Check for freedom from hang-up of material.
5. Verifying the functionality of the control system.
6. Measure motor currents.
7. Check for operation of emergency stop and trip wire (if fitted).
8. Checking of correct start-up and shut-down sequence, both under normal and emergency conditions.
9. Verify the polymer concentration is as per the set point and that the batch to batch variation in concentration does not differ by more than 1%.

Generally, the equipment will be considered acceptable at commissioning when all of the following conditions are satisfied:

1. The equipment meets the duty requirements as defined in this Section of the Specification.
2. Any other specific performance tests defined in this Section prove acceptable operation of the equipment.
3. Where a power test is required, the power absorbed by the motor at duty point does not exceed the values stated in the Technical Data Sheets by more than 5%.
4. Where a vibration test is required, the vibration measured at each point does not exceed the level prescribed in BS 4675 Part I – 1976 for the appropriate class of machine.
5. Where a noise test is required, the noise generated by the equipment does not exceed the values stated in the Technical Data Sheets.

M16.14.1.4 **After commissioning**

Check equipment for proper functioning and monitor process performance during the Test Period and the Trial Operational Period (TOP). Refer Section 9 in the Conditions of Contract.

For the purpose of this contract, the TOP shall be 28 days. The operating time of each duty polymer make-up system shall be adjusted to ensure that the total operation hours (including the Test Period) is split equally over the period. All laboratory testing required during the TOP and Test Period shall be done at a SANAS approved, independent laboratory. Tenderers shall allow for the cost of all sampling and testing in their offer.

The Overall Equipment Efficiency (OEE) of the polymer make-up system shall be greater than 95% during the TOP. OEE is defined as the total running time of the equipment less the time lost for breakdowns and maintenance. Periods of downtime outside of the Contractor’s control will not be included in the OEE calculation.

The accuracy of the polymer solution make-up shall be proven during the Test Period. The Test Period will be conducted over 72 hours per centrifuge.

M16.14.1.5 **During Maintenance Period (Defects Notification Period)**

Check all equipment for correct operation and functioning at 3 months, 6 months, 9 months and 12 months after plant take-over. The Contractor shall submit reports to the Engineer after each inspection.

Refer to Section M26 which further describes the Contractors responsibilities during DNP with respect to the operation and maintenance of the plant.

M16.15 Spares and Maintenance

The Contractor shall be responsible for identifying and supplying the required spares for the selected mechanical equipment. The spares selection shall be subject to approval, in writing, by the Engineer.

Costs for the above activities and spares shall be included in the Returnable Schedules.

M16.16 Operation and Control

Refer to control narrative document W1859-48001 (in Volume 3) for details on the operation and control of the equipment in this section

M17. SLUDGE CONVEYING EQUIPMENT

M17.1 Scope

The scope shall include the design, supply, delivery, installation, testing, commissioning and upholding during the Trial Operational Period (Operational Acceptance Period) and the Maintenance Period (Defects Notification Period) of the following:

i. Two enclosed, centreless, spiral screw conveyors designed to convey dewatered sludge cake from the dewatering centrifuges to the common sludge hopper
ii. One common sludge hopper complete with diverting flap and motorized bridge breakers, mounted onto the cake pumps
iii. Two (duty/standby) screw fed, progressive cavity cake pumps complete with variable frequency drive, motor, gearbox and baseplate.
iv. Two (duty/standby) poly lubrication pumps complete with complete with variable frequency drive, motor, gearbox and baseplate
v. All piping, fittings, manual and automated isolation valves, pressure safety devices, supports and fasteners from the discharge of each cake pump up to the inlet of each sludge storage silo.
vi. All piping, fittings, manual and automated isolation valves, pressure safety devices, supports and fasteners from where the poly lubrication pumps take suction up to the polymer injection point on the discharge of each of the cake pumps.
vii. All piping, fittings, manual and automated isolation valves, pressure regulating devices, supports and fasteners supplying treated effluent flushing water from the 2nd class water bulk supply manifold up to each supply point on the sludge hopper.

Space shall be made available to include a 3rd and 4th centrifuge at a later date (separate contract) which will operate with identical equipment as installed under this contract.

M17.2 General description

Sludge shall be automatically conveyed in the horizontal direction from the centrifuge units to a common sludge hopper using enclosed, centreless, spiral screw conveyors. Each centrifuge will have a dedicated screw conveyor.

The sludge from all the centrifuge units shall be combined into a common sludge hopper mounted on top of two sludge cake pumps operating as duty/standby. A manual diverting flap shall divert sludge to into the receiving hopper of the duty cake pump. At the bottom of the hopper, above the feed chamber to each cake pump, a motor driven mechanical bridge breaker shall be installed to ensure the uninterrupted flow of sludge into the sludge cake pumps. The cake pumps shall be screw fed, progressive cavity pumps that are specifically designed to pump dewatered waste activated sludge. The sludge shall be continuously pumped to the sludge silos and the rate of pumping shall be controlled by the level in the common sludge hopper.

To lower the pressure drop when pumping sludge to the storage silos, lubrication in the form of polyelectrolyte solution shall be supplied to the discharge end of the cake pumps using two progressive cavity pumps operating as duty/standby. The rate of lubrication shall be controlled by a VSD on each pump. Polymer solution shall be injected through specially designed injection point which shall introduce polymer solution around the complete circumference of the pipe. There shall be a dedicated sludge transfer line per cake pump and each cake pump shall be able to pump sludge to each of the silos by using automated knifegate diverting valves.

Multiple flushing points shall be provided on the cake hopper to allow automated line flushing. Once the transfer of sludge is complete, the flushing valves shall automatically open and introduce 2nd class water into the hopper. The duty cake pump will continue to run and pump through the flushing water. Diverting valves situated on the sludge lines will automatically divert the flush water away from the sludge silo to drain. When commencing with sludge transfer again, the diverting valves will allow the residual water in the sludge line to be diverted away from the sludge silos (on an adjustable timer basis) before allowing sludge to enter the silos.

The screw conveyors shall comply with the requirements of Section D52 of the Standard Specification for Mechanical Works.

M17.3 Duties

The capacities of the various units shall be as follows:

Centrfuge Cake conveyors	5 m^3/h of sludge cake with a minimum solids content of minimum 16%
Cake pumps	10 m^3/h of sludge cake with a minimum solids content of 16%.
Poly lubrication pumps	0.3 m^3/h

The following should be noted:

1. The conveyors should be designed to operate continuously for 24 hours per day, 365 days a year with average capacities as stated above.
2. The sludge comes from conventional activated sludge biological reactors. The organic fraction in the sludge (Volatile Suspended Solids VSS/Total Suspended Solids TSS) can vary depending on the sludge age in the system. For the purpose of this tender, it is assumed that the organic fraction in the sludge is 0.85.
3. The inlet works will be upgraded to include new screening and degritting equipment. In addition to this, a macerator and heavy solids separator will be installed upstream to protect the centrifuge units however adequate wear protection must be included in the design
4. The pH of the sludge is expected to be between 6 and 8. The sludge will be at ambient temperature.

M17.4 Conveyor trough

The conveyor trough shall be manufactured in a “U” shape to accommodate the centreless spiral screw. It shall have a lip on each side for rigidity and shall be flanged at both ends for mounting the screw drive and outlet chute. It shall be adequately supported to avoid deformation. The conveyors shall have a chute designed to attach directly to the discharge chute of the centrifuges. The chute design will ensure there are no sloped walls. In instances where this is unavoidable, the angle of the slope must be approved by the Engineer. The trough covers shall be made of stainless steel and shall be screwed or bolted to the trough to minimise the risk of personal injury and the release of odours. A hinged cover shall be provided at each end to provide relief in the event of a blockage.
The trough shall be equipped with replaceable wear liners to prevent metal-to-metal contact with the screw. The liners shall have a thickness of not less than 10 mm and shall be manufactured from a material that has two colours laminated together to provide clear indication when the inner layer of the liner has worn away.

M17.5 Centreless spiral

The centreless spiral shall be manufactured from high tensile steel flat bar, at least 20mm thick. It shall have a flange at one end for connection to the drive unit.

M17.6 Drive units

Each drive unit shall be a shaft mounted geared motor rated for continuous duty and shall be selected to match the requirements of the particular conveyor. The motor shall be a totally enclosed fan cooled (TEFC), constant speed unit, fed from 3-phase 380/400 VAC, 50 Hz power.

The gearboxs shall have a minimum service factor of 1.75 and an IP55 protection rating. Nominal and minimum motor efficiencies shall comply with NEMA MG 1. The gearbox shall be designed for AGMA Class II, 24-hour duty.

As per clause D52 of the General Specification for Mechanical Works, contractors should take note of the requirements for isolating the radial and axial thrusts from the gearbox and motor, by means of adequately designed bearings. Contractors should also note that the preferred location for the drive is on the high end of the conveyor (where applicable). If the drive is flange mounted, a lantern housing incorporating a shaft seal shall be positioned between the geared motor and the conveyor trough to prevent liquid from passing along the screw drive shaft to the gearbox.

M17.7 Outlet chute

The outlet chutes shall mount directly onto the end of the conveyor troughs.

M17.8 Pumps

The required discharge head of the pumps are estimated for tender purposes only. It is the responsibility of the Contractor to confirm the required head during detail design.

M17.8.1 Cake Pumps

Each progressive cavity cake pump shall be installed to transfer dewatered sludge from the common sludge hopper to each of the storage silos at 10 m3/h at 200 m head. The pump shall have an enlarged receiving hopper with an integrated bridge breaker and feed screw to ensure efficient transfer of the product into the rotor and stator. The pump shall include a variable frequency drive (VFD) linked to the level in the sludge cake hopper which shall be used to control the speed of the pump. Knifegate manual isolation valves shall be provided at each of the pumps. Each pump shall have overpressure protection in the discharge piping in the form of a pressure transmitter/switch connected to the PLC/SCADA system to stop the pump if a high pressure is generated. Additional high pressure protection shall be provided by a mechanical pressure relieving device (bursting disc) on the discharge of each pump. The pumps shall also have dry-run protection which includes a thermal sensor to monitor the temperature between the rotor and stator during normal operation.

The cake pump motors shall have forced cooling to allow the pump speed to operate at minimum conditions without risk of overheating the motor.

M17.8.2 Poly lubrication pumps

There shall be two poly lubrication pumps operating as duty/standby. The duty poly lubrication pump shall provide polymer solution to the discharge line of the duty cake pump. Either of the poly lubrication pumps shall be capable of supplying either of the cake pumps. The correct duty pump will be selected on the SCADA system. The pumps shall be progressive cavity pumps with variable speed drives. They shall be capable of supplying polyelectrolyte solution at the polymer concentration range (refer to Polymer Make-Up section M16) at 0.3 m^3/h at 200 m head. Ball valve manual isolation valves shall be provided at each of the pumps. Each pump shall have overpressure protection in the discharge piping in the form of a pressure transmitter/switch connected to the PLC/SCADA system to stop the pump if a high pressure is generated. Additional high pressure protection shall be provided by a mechanical pressure relieving device on the discharge of each pump. The pumps shall also have dry-run protection which includes a thermal sensor to monitor the temperature between the rotor and stator during normal operation.

M17.9 Piping

All valves, fittings, piping material and sizes shall be as indicated on W1859-45002 (60325-M-SD-102). All piping, fittings and supports shall conform to section D20 of the Standard Specifications for Mechanical Works unless otherwise stated below. All piping shall be clearly identifiable as per SANS 10140-3. All valves shall conform to section D28, D29 and D30 of the Standard Mechanical Specification for Mechanical Works. Refer to control valve list W1859-61002, on/off valve list W1859-61003, pressure safety valve list W1859-61004, hand valve list W1859-61005 and check valve list W1859-61006 in Volume 3. The tenderer shall supply technical datasheets/brochures of the range for each valve type offered with the tender.

<u>Sludge cake piping:</u>

Sludge cake piping will extend from the discharge of each cake pump up to the inlet of each of the sludge silos. There will be a dedicated sludge pipe for each cake pump. The piping shall be manufactured from stainless steel 304 and shall have limited bends. Where bends are required it should be swept bends with a bend to pipe diameter ratio of at least 3:1. The piping shall have blank flanges be able to be opened a certain locations in the case of blockages to allow for rodding. The piping shall be designed to withstand a continuous operating pressure of 2000 kPa(g). Bursting discs shall relieve high pressures on the discharge of the cake pumps. Samples points, with sample valves specifically designed for cake sampling, shall be conveniently located on the discharge of the discharge of the of each sludge line. All manual and automated valves shall be knifegate. All automated valves in the sludge cake piping shall be motor driven. Cake pump's must be designed with a suitable rubbing velocity to prevent excessive wear.

Polymer lubrication piping:
Polymer lubrication piping shall extend from the common polymer supply manifold up to the poly injection points at the discharge of each sludge cake pump. The design of the polymer injection point will introduce polymer solution around the circumference of the sludge pipe wall to aid with lubrication.

Washwater Supply:
Washwater shall be piped from the bulk 2nd class water supply to each compartment of the sludge hopper for flushing purposes. A manual ball valve shall provide isolation from the bulk 2nd class water supply manifold. A mechanical pressure reducing valve will regulate the pressure of the washwater supply. Each washwater point shall have an automated on/off valve controlled by the SCADA/PLC system to control the flow of washwater to each unit. Manual diaphragm valves at each flushing point can be manually set to control the rate that flushing water is introduced into the hopper.

M17.10 Motor Control Centre

All equipment and instrumentation indicated on W1859-45002 (60325-M-SD-102) will be operated from a PLC situated in the new MCC room in the new dewatering building.

All instrumentation and controls as shown on the W1859-45002 (60325-M-SD-102) and the instrumentation list (refer to volume 3) are to be supplied and installed to ensure safe, reliable and efficient operation under the conditions stated in this specification. This shall include all instrumentation required for start-up, shut-down, ongoing monitoring of essential system parameters and for safe operation in accordance with the applicable codes and standards.

The analogue instruments (e.g. T, P) shall be supplied complete with manufacturer calibration certificate and procedure and material certificates (SS 316). The certificates shall be available at FAT execution if applicable. All instrument loops and process control functionality shall be tested during FAT.

The MCC and PLC shall be supplied as per the Standard Electrical specification included in Volume 3.

M17.11 Corrosion Protection and Materials of Construction

M17.11.1 Materials of Construction

The following materials of construction shall apply:

Sludge Conveyors:

- Support Framework 304 Stainless steel
- Trough 304 Stainless steel
- Outlet chutes 304 Stainless steel
- Centreless Screw Spiral High tensile steel flat bar at least 20 mm thick
- Shafted screws High tensile steel flat bar at least 6 mm thick
- Trough covers 304 Stainless steel

Cake pumps:

- Pump Housing Cast iron/cast steel
- Rotor 1.2436 Hardened Tool Steel.
- Stator Rubber
- Connecting rods 304 Stainless steel
- Rotating Parts CrNiMo17-12-2

Polyelectrolyte lubrication pumps:

- Pump Housing Cast iron/cast steel
- Rotor CrNiMo17-12-2
- Stator Rubber

- Connecting rods 304 Stainless steel
- Rotating Parts CrNiMo17-12-2

M17.11.1.1 **Corrosion Protection**

Corrosion protection shall be carried out in accordance with the requirements of Section D11 to D14 of the Standard Specification for Mechanical Works.

- Support Framework Grit Blast and Pickle & Passivate.
- Trough Grit Blast and Pickle & Passivate.
- Screw Spiral Prime Painted Only
- Trough Covers Grit Blast and Pickle & Passivate
- Motor & Gearbox Acrylic Over Coat

M17.12 Quality Management

A quality control plan shall be submitted for each conveyor.

M17.13 Installation

The conveyors and associated inlet and outlet chutes and pumps shall be installed by the Contractor in accordance with the instructions of the conveyor manufacturer and as shown on their drawings.

Aside from conformance to the general installation requirements as outlined in the Standard Specification for Mechanical Works, Contractors should ensure the least possible disruption to plant operation.

M17.14 Performance testing

M17.14.1 **Works Testing**

Works testing shall include the following:

Screw conveyors:

1. Straightness of trough and fit of covers.
2. Alignment and fit of respective bearings and drives.
3. Straightness and alignment of spiral in trough.
4. Operation of total assembly for a sustained period

Cake Pumps:

Balancing of the complete rotor, screw and shaft shall be undertaken at the manufacturer's works.
Flow-head curves shall be generated at the manufacturer's or agent's premises and checked against the manufacturer's listed pump curves for any major discrepancies.

Inspection certificates detailing all works testing shall be forwarded to the Engineer.

M17.14.2 **Before Commissioning**

1. Contractors shall take note of Sections D78.1 to D78.5 of the Standard Specification for Mechanical Works, prior to starting commissioning.
2. Confirm accuracy of installation of conveyor.
3. Ensure all drive equipment is lubricated and gearboxes are filled to correct levels.
4. Test for correct rotation of all motors.
5. Test for correct operation of control gear, where provided under this Contract.
6. Check for smooth concentric running of screw in trough.

7. Tests for correct operation of whole assembly.
8. Sludge piping shall be pressure tested to 1.5 times the maximum allowable pressure.
9. Submit all certification, motor test certificates, material certificates.
10. Submit all operating and maintenance instructions.

M17.14.3 **Commissioning tests**

Specifically, the conveyors shall undergo the following tests:

1. Operation of conveyor under maximum and minimum conditions.
2. Check effectiveness of chutes and freedom from hang-up of material.
3. Operation of automated start/stop sequence in conjunction with upstream equipment.
4. Verify the duty points of the sludge cake pumps at design and minimum operating conditions.
5. Measure motor current.
6. Check for operation of emergency stop and trip wire (if fitted).
7. Check for mass flowrate and volumetric flowrate conveyed by taking sludge samples and testing for TSS while collecting a known volume and timing the duration to collect this volume.

Generally, the equipment will be considered acceptable at commissioning when all of the following conditions are satisfied:

1. The equipment meets the duty requirements as defined in this section of the Specification.
2. Any other specific performance tests defined in this Section to prove acceptable operation of the equipment.
3. Where a power test is required, the power absorbed by the motor at duty point does not exceed the values stated in the Technical Data Sheets by more than 5%.
4. Where a vibration test is required, the vibration measured at each point does not exceed the level prescribed in BS 4675 Part 1-1976 for the appropriate class of machine.
5. Where a noise test is required, the noise generated by the equipment does not exceed the values stated in the Technical Data Sheets.

M17.14.4 **After Commissioning**

Check equipment for proper functioning and monitor process performance during the Test Period and the Trial Operational Period (TOP). Refer Section 9 in the Conditions of Contract.

For the purpose of this contract, the TOP shall be 28 days. The operating time of each duty cake pump and sludge conveyor shall be adjusted to ensure that the total operation hours (including the Test Period) is split equally over the period. All laboratory testing required during the TOP and Test Period shall be done at a SANAS approved, independent laboratory. Tenderers shall allow for the cost of all sampling and testing in their offer.

The Overall Equipment Efficiency (OEE) of the sludge conveying equipment shall be greater than 95% during the TOP. OEE is defined as the total running time of the equipment less the time lost for breakdowns and maintenance. Periods of downtime outside of the Contractor’s control will not be included in the OEE calculation.

The equipment will be considered acceptable when the requirements as specified have been achieved consistently during the Test Period and TOP.

M17.14.5 **During Maintenance Period (Defects Notification Period)**

Refer to Section M26 which further describes the Contractors responsibilities during DNP with respect to the operation and maintenance of the plant.

M17.15 Spares and Maintenance

The Contractor shall be responsible for identifying and supplying the required spares for the selected mechanical equipment. The spares selection shall be subject to approval, in writing, by the Engineer.
The following spares shall be supplied at a minimum:

- Trough liner
- Complete set of screw bearings

The installation of the screw conveyors will ensure that there is sufficient space to remove the entire screw for maintenance purposes.

M17.16 Operation and Control

Refer to control narrative document W1859-48001 (in Volume 3) for details on the operation and control of the equipment in this section

M18. SLUDGE CAKE SILOS

M18.1 Scope

The scope shall include the design, supply, delivery, installation, testing, commissioning and upholding during the Trial Operational Period (Operational Acceptance Period) and the Maintenance Period (Defects Notification Period) of the following:

i. Two modulating knifegate valves with electric actuators for controlling the sludge discharge from the sludge silos.
ii. All piping, fittings, manual isolation valves, pressure regulating devices, supports and fasteners supplying treated effluent flushing water from the 2nd class water bulk supply manifold up to each supply point on the sludge cake silos.
iii. All piping and fittings to install instrumentation and provide access to the silos as indicated on P&ID W1859-45002 (60325-M-SD-102)

Note that the construction of the sludge cake silos forms part of the civil scope of work. Refer to the detailed civil specification for more details. Any alterations to the civil design of the tank in order to accommodate the mechanical equipment offered will be communicated at tender stage and be included in the tendered price in the space provided in the relevant Schedule of Quantity.

M18.2 General Description

Dewatered sludge will be stored in two concrete storage silos with a working volume of 120 m^3 each. The silos shall be elevated on four concrete support legs to allow sludge to be discharged into the collection trucks by gravity. The collection trucks shall position themselves directly under the silos at the outlet. .

Discharging of the sludge will occur by adjusting the modulating gate valve at the bottom of each silo. The sludge shall flow by gravity into the collection truck. .

M18.3 Duties

The design of the silos shall ensure that there is a working volume of 120m^3 in each silo. The design must consider the angle of repose of the sludge. At tender stage the angle of repose was assumed to be 45° which yields a total volume of 150 m^3 assuming a cone angle of 60° at the bottom of the silo.

M18.4 Piping

All valves, fittings, piping material and sizes shall be as indicated on P&ID W1859-45002 (60325-M-SD-102). All piping, fittings and supports shall conform to section D20 of the Standard Specifications for Mechanical Works unless otherwise stated below. All piping shall be clearly identifiable as per SANS 10140-3. All valves shall conform to section D28, D29 and D30 of the Standard Mechanical Specification for Mechanical Works. Refer to control valve list W1859-61002, on/off valve list W1859-61003, pressure safety valve list W1859-61004, hand valve list W1859-61005 and check valve list W1859-61006 in Volume 3. The tenderer shall supply technical datasheets/brochures of the range for each valve type offered with the tender.

Wash water piping:
Washwater shall be piped from the bulk 2nd class water supply to each wash down stations situated below each of the storage silos. A manual ball valve shall provide isolation from the bulk 2nd class water supply manifold. A mechanical pressure reducing valve will regulate the pressure of the washwater supply. Each wash down point will have a ball valve and quick connector to allow for the connection of a flexible hose. Two hose pipes with quick connectors and suitable spray nozzles shall be provided.

M18.5 Motor Control Centre

All equipment and instrumentation indicated on P&ID W1859-45002 (60325-M-SD-102) will be operated from a PLC situated in the new MCC room in the new dewatering building.

All instrumentation and controls as shown on the P&ID W1859-45002 (60325-M-SD-102) and the instrumentation list (refer to volume 3) are to be supplied and installed to ensure safe, reliable and efficient

operation under the conditions stated in this specification. This shall include all instrumentation required for start-up, shut-down, ongoing monitoring of essential system parameters and for safe operation in accordance with the applicable codes and standards.

The analogue instruments (e.g. T, P) shall be supplied complete with manufacturer calibration certificate and procedure and material certificates (SS 316). The certificates shall be available at FAT execution if applicable. All instrument loops and process control functionality shall be tested during FAT.

The MCC and PLC shall be supplied as per the Standard Electrical specification included in Volume 3.

M18.6 Corrosion Protection and Materials of Construction

M18.6.1.1 Materials of Construction

Sludge Conveyors:

- Support Framework — 304 Stainless steel
- Trough — 304 Stainless steel
- Outlet chutes — 304 Stainless steel
- Centreless Screw Spiral — High tensile steel flat bar at least 20 mm thick
- Trough covers — 304 Stainless steel
- Trough liners — Ultra High Molecular Weight Polyethylene - UHMWPE

Sludge cake and polyelectrolyte pumps:

- Pump Housing — Cast iron/cast steel
- Rotor — Hardened Tool Steel.
- Stator — Rubber
- Connecting rods — 316 Stainless steel
- Baseplate — 304 Stainless steel

Knife gate valves:

- Valve body — Cast iron/cast steel, FBE coated
- Valve blades — 316 Stainless steel.

M18.6.2 Corrosion Protection

Corrosion protection shall be carried out in accordance with the requirements of Sections D11 to D14 of the Standard Specification for Mechanical Works. Where stainless steel components are welded these shall be pickled and passivated. Pump housings and geared motor units shall be Alkyd overcoated

M18.7 Supports and Accessways.

Adequate access shall be provided to the silo manways, silo inlet valves, and silo discharge valves. The structures shall be manufactured and erected in accordance with the provisions of SANS 1200 H: Structural Steelwork.

The layout of the access walkways shall be as indicated on drawing W1859-85002 (60325-M-LI-108). Access walkway details are contained within the civil specification and drawings.

M18.8 Quality Management

A quality control plan shall be submitted for each conveyor.

M18.9 Installation

Aside from conformance to the general installation requirements as outlined in the Standard Specification for Mechanical Works, Contractors should ensure the least possible disruption to plant operation.

M18.10 Performance Testing

M18.10.1 Works Testing

N/A

M18.10.2 Before Commissioning

1. Contractors shall take note of Sections D78.1 to D78.5 of the Standard Specification for Mechanical Works, prior to starting commissioning.
2. Confirm accuracy of installation
3. Tests for correct operation of whole system.
4. Submit all certification, motor test certificates, material certificates.
5. Submit all operating and maintenance instructions.

M18.10.3 Commissioning tests

Specifically, the conveyors shall undergo the following tests:

1. Check effectiveness of discharge chutes and freedom from hang-up of material.

2. Verify if there are no spillages or hang-ups of sludge during operation.

Generally, the equipment will be considered acceptable at commissioning when all of the following conditions are satisfied:

1. The equipment meets the duty requirements as defined in this section of the Specification.
2. Any other specific performance tests defined in this Section to prove acceptable operation of the equipment.
3. Where a power test is required, the power absorbed by the motor at duty point does not exceed the values stated in the Technical Data Sheets by more than 5%.
4. Where a vibration test is required, the vibration measured at each point does not exceed the level prescribed in BS 4675 Part 1-1976 for the appropriate class of machine.
5. Where a noise test is required, the noise generated by the equipment does not exceed the values stated in the Technical Data Sheets.

M18.10.4 After Commissioning

Check equipment for proper functioning and monitor process performance during the Test Period and the Trial Operational Period (TOP). Refer Section 9 in the Conditions of Contract.

For the purpose of this contract, the TOP shall be 28 days. All laboratory testing required during the TOP and Test Period shall be done at a SANAS approved, independent laboratory. Tenderers shall allow for the cost of all sampling and testing in their offer.

The Overall Equipment Efficiency (OEE) of the silo equipment shall be greater than 95% during the TOP. OEE is defined as the total running time of the equipment less the time lost for breakdowns and maintenance. Periods of downtime outside of the Contractor’s control will not be included in the OEE calculation.

The equipment will be considered acceptable when the requirements as specified have been achieved consistently during the Test Period and TOP.

M18.10.5 During Maintenance Period (Defects Notification Period)

Refer to Section M26 which further describes the Contractors responsibilities during DNP with respect to the operation and maintenance of the plant.

M18.11 Spares

The Contractor shall be responsible for identifying and supplying the required spares for the selected mechanical equipment. The spares selection shall be subject to approval, in writing, by the Engineer.

M18.12 Control and Automation

Refer to control narrative document W1859-48001 (in Volume 3) for details on the operation and control of the equipment in this section

M19. HVAC

M19.1 Scope

This section of the specification covers the design, preparation of drawings, fabrication, supply, delivery to site, offloading, handling, erection and installation, commissioning, adjustment, operation, testing and handing over in complete working order and upholding of the installations during the Trial Operational Period (Operational Acceptance Period) of mechanical plant and equipment as follows:-

i. Air conditioning wall mounted unit for the office in the Dewatering Building.
ii. Air conditioning wall mounted unit for the office at the Inlet Works.

M19.2 General description and technology

M19.2.1 Office air conditioning systems

A wall-mounted air-conditioning split unit shall be installed in the office to ensure a comfortable environment for the occupants. The condensers shall be mounted to the external wall of the building away from any intake louvres and shall be corrosion protected and protected from the elements. A remote control shall be supplied with each unit.

M19.3 Quality management

A quality control plan shall be submitted for each item.

M19.4 Installation

Installation of the air conditioning systems shall comply with the manufacturer's requirements. When erected and installed, the plant and equipment shall be of neat and workmanlike appearance, solidly and evenly supported, true to line, level, plumb and in proper working order. The Contractor shall provide all foundation bolts, supports, hangers, brackets, etc. required for the support and fixing of equipment.

Special care shall be taken to ensure that all external exits are fitted with suitable insect screens to prevent insects and vermin entering and nesting.

M19.5 Performance testing

M19.5.1 Works testing

Inspection certificates detailing all works testing conducted shall be forwarded to the Engineer.

M19.5.2 Before commissioning

1. Before starting up any section of the Works, the Contractor shall make all necessary checks to ensure that the installation has been correctly carried out, that all parts are clean, that all equipment is correctly aligned, lubricated and connected up, and is in all respects ready to start with safety.
2. Tests for correct rotation of all motors.
3. Test fans fall within the maximum allowed noise levels specified in this Contract.
4. Check that all brackets are correctly aligned and supporting the equipment.
5. Tests for correct operation of control gear, where provided under this Contract.
6. Tests for the correct operation of whole assembly.
7. Submit all certification.
8. Submit all operating and maintenance instructions.

M19.5.3 **Commissioning tests**

Generally, the equipment will be considered acceptable at commissioning when all of the following conditions are satisfied:

1. The equipment meets the duty requirements as defined in this Section of the Specification.
2. Any other specific performance tests defined in this Section prove acceptable operation of the equipment.
3. Where a vibration test is required, the vibration measured at each point does not exceed the level prescribed in BS 4675 Part I – 1976 for the appropriate class of machine.
4. Where a noise test is required, the noise generated by the equipment does not exceed the values stated in the Technical Data Sheets.
5. Successful commissioning shall be dependent on completion of the Trial Operational Period, described in M19.5.4 below.

M19.5.4 **After commissioning**

Check equipment for proper functioning and monitor process performance during the Test Period and the Trial Operational Period (TOP).

For the purpose of this contract, the TOP shall be 28 days. All laboratory testing required during the TOP and Test Period shall be done at a SANAS approved, independent laboratory. Tenderers shall allow for the cost of all sampling and testing in their offer.

The Overall Equipment Efficiency (OEE) of the air conditioning systems shall be greater than 95% during the TOP. OEE is defined as the total running time of the equipment less the time lost for breakdowns and maintenance. Periods of downtime outside of the Contractor's control will not be included in the OEE calculation.

The performance of the equipment will be considered acceptable when the requirements as specified have been achieved consistently during TOP.

M19.5.5 **During Defects Notification Period**

Check all equipment for correct operation and functioning at 3 months, 6 months, 9 months and 12 months after plant take-over. The Contractor shall submit reports to the Engineer after each inspection.

Refer to Section M26 which further describes the Contractors responsibilities during DNP with respect to the operation and maintenance of the plant.

M19.6 Spares and maintenance

The Contractor shall be responsible for identifying and supplying the required spares for the selected mechanical equipment. The spares selection shall be subject to approval, in writing, by the Engineer.

Costs for the above activities and spares shall be included in the Returnable Schedules.

M19.7 Operation and control

The air conditioning equipment shall be manually controlled via remote control.

M20. SURFACE AERATORS

M20.1 Scope

Design, supply, delivery, installation, testing, commissioning and upholding during the Trial and Operation Period (TOP) and the Defects Notification Period (DNP) of the following:

i. Removal of 2 (two) existing 37 kW fixed surface aerators in the main aeration zones of reactors 1 and 3 to 6, complete with all cabling and switchgear (10 aerators in total).

ii. Removal of 2 (two) existing 30 kW fixed surface aerators in the main aeration zones of reactors 1 and 3 to 6, complete with all cabling and switchgear (10 aerators in total).

iii. Removal of 1 (one) existing 11 kW fixed surface aerators in the re-aeration zones of reactors 1 to 6, complete with all cabling and switchgear (6 aerators in total).

iv. 4 (four) new fixed 37 kW surface aerators in the main aeration zone of reactors 1 and 3 to 6, operating on VSD's, complete with motor, gearbox, supports and anchors into the concrete platform (20 aerators in total).

v. 1 (one) new fixed 11 kW surface aerators in the re-aeration zone of reactors 1 to 6, operating on VSD's, complete with motor, gearbox, supports and anchors into the concrete platform (6 aerators in total).

vi. GRP draft tubes for all 37 kW surface aerators (20 in total)

vii. GRP draft tubes for all 11 kW surface aerators (6 in total)

viii. 2 (two) dissolved oxygen probes per reactor complete with controller, enclosure and stainless steel mounting arm and supports (12 probes and mounting arms in total)

ix. Prior to finalising the design of the surface aerators, conduct detailed dimensional survey of the existing civil infrastructure of each reactor, so much as it affects the design of each aerators and draft tubes.

The aerators shall be generally positioned in the aeration basins as indicated on drawing W1859-85003 (60325-M-LS-304).

All civil repair work or modifications required to the reactor concrete structure to accommodate the equipment offered must be included at tender stage.

M20.2 General Description

The biological reactors at Hammarsdale WWTP operate as a 5-Stage Bardenpho process and aeration is supplied with fixed mounted, low speed turbine surface aerators. There are 4 surface aerators in the main aeration basin and a single surface aerator in the re-aeration basin of each reactor. There are 6 reactors in total numbered from 1 to 6.

All the aerators in reactors 1 and 3-6 will be replaced with fixed mounted, low speed, turbine type surface aerators. In reactor the surface aerators shall dissolve oxygen into the wastewater by creating a high degree of agitation at the surface of the water thereby contacting the wastewater with ambient air. Each unit will operate on a VSD to allow the rate of agitation to be varied based on the dissolved oxygen levels in the reactor.

Dissolved Oxygen (DO) will be measured in each of the main aeration zones using luminescent dissolved oxygen probes. Each probe will be mounted adjacent to the reactor walkway on a retractable steel pole to allow for easy access for regular cleaning and maintenance purposes. Each probe will be connected to a controller located within a stainless-steel protective enclosure situated at the reactor walkways. The enclosure shall protect the controller from weather and UV damage. More details of the DO probes and controller can be found in the detailed electrical specification.

M20.3 Duties

Each aerator in the main aeration zone shall be capable of supplying a minimum Standard Oxygen Requirement (SOR) of nominally 56 kg O_2/h. The minimum standard oxygen transfer efficiency of each surface aerator shall be 2 kgO_2/ kWh. To allow a degree of safety factor in the design and an element of redundancy, each aerator in the main aeration zone shall have a motor size of 37 kW.

Each surface aerator in the re-aeration zone shall have a motor size of 11 kW. The minimum standard oxygen transfer efficiency of each surface aerator in the re-aeration zone shall be 2 kgO_2/ kWh.

The following operating conditions have been assumed:

1. Operating DO level of 2 mg/l
2. Site altitude of 600 m
3. Maximum water temperature of 30ºC
4. α factor of 0.80
5. β factor of 0.95
6. Peak/average oxygen requirement factor of 1.30
7. Line to shaft efficiency of 0.9.

The reactors at Hammarsdale are an annular design with a total volume of 5 582 m3. The following parameters must be considered when undertaking the sizing of equipment:

Details of Hammarsdale aeration basins

Basin	**Operating depth (m)**	**Maximum mixed liquor concentration (mg TSS/l)**	**Volume (m^3)**	**Basin width (OD-ID of annular basins, m)**
Anaerobic	4.7	5500	419	12
Primary Anoxic	4.7	5500	837	12
Main Aeration	4.7	5500	3070	12
Secondary Anoxic	4.7	5500	837	12
Re-aeration	4.7	5500	419	12

Refer to drawing W1859-85003 (60325-M-LS-304) which gives further details on the reactor layout and dimensions. The dimensions listed here are for tender purposes only. The Contractor is responsible for confirming the reactor dimensions prior to finalizing the design of the equipment.

M20.4 Aerator design

Aerators are to be of the low-speed turbine type, mounted to the existing concrete walkways. Contractors are referred to Section D48 of the Standard Specification for Mechanical Works, for general design requirements with respect to motor/gearbox ratings, mixing requirements, preferred rotational speeds and required design parameters that should be considered.

It is essential that the aerators be capable of mixing the contents of the aeration basin at all times 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 having a low rotational velocity. For aerators having driving motors of over 30 kW the maximum rotational speed shall not exceed 40 rpm while for smaller aerators the velocity shall not exceed 50 rpm.

Preference will be given to aerators having a tip speed below 5 meters per second and which are essentially non-clogging in nature, as it is impossible to guarantee that this aeration basin will be free of rags and material of a fibrous nature.

The blades of each aerator shall be fully welded to the central supporting cone/structure. Welding shall be in accordance with SABS 044 and shall include for all testing of welds. Special care shall be taken for all testing to avoid crevice corrosion and mating flanges shall be sealed to prevent the ingress of moisture.

The gearbox output half coupling and the mating flange on the turbine shaft shall be of the machined spigot and groove design, while the mating flange on the turbine shaft to the turbine blades shall incorporate a minimum of two machine fitted bolts to ensure accuracy when bolting up the two flanges. In addition, all mating flanges shall be clearly marked after balancing to ensure the same flanges will mate with their respective partners when assembling on site. It shall be a requirement that each aerator turbine be operated in air after installation and before operating in liquid to ensure there is no imbalance or out of round motion due to misalignment during erection.

After assembly of the finished aerator cone, shaft and mounting flange (but before dispatch to site), the assembled unit shall be statically balanced in a jig fitted with anti-friction type bearings to support each turbine and shaft. In addition, the unit shall be tested for centricity and correct angular attachment of cone and flange to shaft, all in the presence of the Engineer or his representative. It is imperative therefore that each aerator cone, its attached shaft and the gearbox coupling are furnished with spigots with fine tolerances to avoid any misalignment during installation. Should any undue vibration occur during operation, the whole assembly shall be taken out of service and dynamically balanced at twice the operating speed of the turbine impeller. The Tenderer shall allow in his tender price for all equipment necessary to perform the work and this test.

Due to the mixing challenges associated with an annular aeration basin, all aerators will be supplied with draft tubes. The dimensions of the draft tubes will be specified by the surface aerator equipment supplier considering the dimensions of the reactor and the operating water height. The draft tube shall be manufactured in GRP with stainless steel holding down bolts. Wave action shall be minimized by judicious selection of rotation and by means of draught tubes.

Tenderers must submit a detailed description and a clearly detailed cross-sectional drawing of the aerators, together with submergence details with their tenders. Failure to submit this drawing and description will render the tender incomplete and as such liable to rejection.

M20.5 Dissolved Oxygen Measurement

Dissolved Oxygen (DO) will be measured in each of the main aeration zones using luminescent dissolved oxygen probes. Each probe will be mounted adjacent to the reactor walkway on a retractable steel pole to allow for easy access for regular cleaning and maintenance purposes. Each probe will be connected to a controller located within a stainless-steel protective enclosure situated at the reactor walkways. The enclosure shall protect the controller from weather and UV damage. More details of the DO probes and controller can be found in the detailed electrical specification.

M20.6 Corrosion Protection and Materials of Construction

M20.6.1 Materials of Construction

Impeller and shaft	:	Low carbon steel to system as described in D14.5.2
Motor and gearbox	:	System as described in D14.5.11
Fasteners	:	Stainless steel 304
Draft Tubes		GRP

M20.6.2 Corrosion Protection

Corrosion protection shall be carried out in accordance with the requirements of Sections D11 to D14 of the Standard Specification for Mechanical Works. Where stainless steel components are welded these shall be pickled and passivated. Pump housings and geared motor units shall be Alkyd overcoated

M20.7 Quality Management

A quality control plan shall be submitted for the design, manufacturer, installation and commissioning of each aerator and its ancillaries, for approval and monitoring by the Engineer.

M20.8 Installation

The Contractor will be responsible for draining the reactors to a destination specified by the Employer. The installation of the surface aerators will happen in a phased manner with only one reactor being made available at a time to limit the impact on the wastewater works.

The Contractor shall be responsible for rigging and securing each surface aerator into position, along with connection to the relevant motor control switchgear.

M20.9 Performance Testing

M20.9.1 Works testing

Prior to shipment to site, each aerator shall be run at the manufacturer's works to check for the following:

i) Impeller vibration
ii) Shaft alignment with gearbox and motor
iii) Functioning of gearbox: meshing of gears, oil tightness and noise
iv) Motor cooling
v) Oxygenation efficiency in clean tap water, expressed as kg O_2/h/kW at 20ºC, 101.325 kPa and an operating DO level of 2 mg/l.
vi) Standard oxygen transfer rate in clean tap water expressed as kg O_2/h.

All oxygen transfer testing shall be conducted by an independent testing facility and testing shall be conducted as per the ASCE Clean Water Test Procedure (2006 or latest edition).

M20.9.2 Before commissioning

i) Contractors shall take note of Sections D77.1 to D77.4 of the Standard Specification for Mechanical Works, prior to starting commissioning.
ii) Tests for correct rotation of all motors
iii) Tests for correct operation of control gear, where provided under this Contract.
iv) Tests for correct alignment of shafts and belts
v) Submit all certification, motor test certificates, material certificates.
vi) Submit all operating and maintenance instructions.

M20.9.3 Commissioning

Specifically, the aerators shall undergo the following tests:

i) Checking of oxygenation capacity (kg O/h) under steady state field conditions – the Contractor shall provide the necessary calibrated dissolved oxygen meters and shall submit the test procedure to the Engineer for approval, prior to commencing the tests.
ii) Checking of oxygenation efficiency (kg O/h/kW) under steady state field conditions – the Contractor shall provide the necessary equipment to measure the power consumed and shall submit the test procedure to the Engineer for approval, prior to commencing the tests.

Generally, the equipment will be considered acceptable at commissioning when all of the following conditions are satisfied:

i) The equipment meets the duty requirements as defined in this Section of the Specification.
ii) Any other specific performance tests defined in this Section prove acceptable operation of the equipment.
iii) Where a power test is required, the power absorbed by each motor at duty point does not exceed the values stated in the Technical Data Sheets by more than 5%.
iv) Where a vibration test is required, the vibration measured at each point does not exceed the level prescribed in BS 4675 Part I – 1976 for the appropriate class of machine.
v) Where a noise test is required, the noise generated by the equipment does not exceed the values stated in the Technical Data Sheets.

M20.9.4 After commissioning

Check equipment for proper functioning and monitor process performance during the Test Period and the Trial Operational Period (TOP). Refer Section 9 in the Conditions of Contract.

For the purpose of this contract, the TOP shall be 28 days. All laboratory testing required during the TOP and Test Period shall be done at a SANAS approved, independent laboratory. Tenderers shall allow for the cost of all sampling and testing in their offer.

The Overall Equipment Efficiency (OEE) of the surface aerator equipment shall be greater than 95% during the TOP. OEE is defined as the total running time of the equipment less the time lost for breakdowns and maintenance. Periods of downtime outside of the Contractor's control will not be included in the OEE calculation.

The equipment will be considered acceptable when the requirements as specified have been achieved consistently during the Test Period and TOP.

M20.9.5 During Defects Notification period

Check all equipment for correct operation and functioning at 3 months, 6 months, 9 months and 12 months after plant take-over. The Contractor shall submit reports to the Engineer after each inspection.

Refer to Section M26 which further describes the Contractors responsibilities during DNP with respect to the operation and maintenance of the plant.

M20.10 Spares

The Contractor shall be responsible for identifying and supplying the required spares for the selected mechanical equipment. The spares selection shall be subject to approval, in writing, by the Engineer.
Costs for the above activities and spares shall be included in the Returnable Schedules.

In addition to this the following spares shall be provided:

- The complete set of mechanical seals for 11 kW unit (1 set)
- The complete set of bearing seals for 11 kW unit (1 set)
- The complete set of mechanical seals for 37 kW unit (3 set)
- The complete set of bearing seals for 37 kW unit (3 sets)
- Complete DO probe mounting arm and supports (1 set)

M20.11 Operation and control

Refer to control narrative document W1859-48001 (in Volume 3) for details on the operation and control of the equipment in this section

M21. REACTOR MIXERS

M21.1 Scope

Design, supply, delivery, installation, testing, commissioning and upholding during the Trial and Operation Period (TOP) and the Defects Notification Period (DNP) of the following:

i. Access stairway, platform and handrailing for each of the new submersible mixers situated in the primary and secondary anoxic zones (12 in total)

i. Removal of the existing submersible mixers, guiderails and supports in all reactors (10 in total) and disposal to a site approved by the Employer.

ii. One submersible mixer in each of the reactor's primary anoxic zone complete with guiderail, lifting davit arm and anchors (6 in total).

iii. One submersible mixer in each of the reactor's secondary anoxic zone complete with guiderail, lifting davit arm and anchors (6 in total)

All civil repair work or modifications required to the reactor concrete structures to accommodate the equipment offered must be included at tender stage.

Note that under this contract, the Employer is responsible to the design and supply of the submersible mixers however the Contractor is responsible for the installation and carrying out all performance tests to verify that the equipment meets the required performance specifications. The Contractor is also responsible for the upholding of the equipment during the DNP period. Details of the equipment is provided with this tender in Volume 3. It is the responsibility of the Tenderer to familiarize themselves with the procured equipment and the respective supplier and ensure that all technical and commercial aspects are understood in so far as it will affect the ability of the Contractor to meet their obligations with regards to the scope.

M21.2 General Description

Submersible mixers shall be installed in the primary and secondary anoxic zones to keep the activated sludge in suspension. Each mixer shall be designed with sufficient thrust/mixing capacity to keep activated sludge in suspension but not create excessive turbulence such that oxygen is introduced into either the anoxic or anaerobic zone thereby negatively effecting the zones' performance. The mixers shall be sized to maintain an effectively constant suspended solids concentration throughout with not more than 200mg/l variation from the average at any point in the respective volume.

The mixers shall be designed with efficient impellers to reduce energy usage. Impeller designs shall have a proven track record within the wastewater treatement application and shall be of an anti clogging nature such that it cannot accumulate rags, plastic or other stringy material.

Motor and gearbox ratings for continuous operation shall provide a 20% margin higher than the maximum mixer shaft input requirement. Vendors shall confirm motor sizes based on the required duties.

M21.3 Duties

Refer to section M20.3 which lists the reactor details and the size of the primary and secondary anoxic zone.

M21.4 Mixers

The mixers will be supplied by the Employer complete with guide rails and lifting davit arms. The mixers are a submersible type - Grundfos SMG.56.86.264.5.1B. Refer to technical details attached in Volume 3. The Contractor shall remove the existing mixers (10 in total) and dispose of them to a location approved by the Employer.

The mixers are submersible with a propeller integrally mounted on a submersible motor.

The contractor is responsible for integrating all integral safety signals (water ingress, temperature, overload etc) into the SCADA system.

The mixers shall be mounted with a sliding bracket on a guide column fixed to the floor of the reactor. This allows rotation of the mixer through an angle of 180º while the mixer is operating and to fix the direction and height in the position selected.

M21.5 Access Platforms

An access platform shall be supplied and installed by the Contractor at each submersible mixer lifting davit arm to allow operational staff to safely access each mixer. Details of the mixer platform design can be found in the following drawings 60325-C-LS-108, 60325-C-LS-109, and 60325-C-LS-110 in Volume 3

M21.6 Motor Control Centre

The mixers shall be controlled by the MCC's located adjacent to the reactors in pump stations 1-4. More details are included in the Particular Electrical Specification.

M21.7 Quality Management

A quality control plan shall be submitted for the design, manufacturer, installation and commissioning of each aerator and its ancillaries, for approval and monitoring by the Engineer.

M21.8 Installation

The Employer will be responsible for draining the reactors. The installation of the mixers will happen in a phased manner with only one reactor being made available at a time to limit the impact on the wastewater works.

M21.9 Performance Testing

Performance testing shall be carried out in accordance with the requirements of Section D50.3 of the Standard Specification for Mechanical Works.

M21.9.1 Factory Testing

Mixers are supplied by the Employer and are located at the site. Factory testing is not applicable to this tender.

M21.9.2 Before Commissioning

i) Contractors shall take note of Sections D77 and D78 of the Standard Specification for Mechanical Works, prior to starting commissioning.
ii) Check for correct installation of the mixer and davit arm assembly
iii) Ensure all drive equipment is lubricated, with correct oil.
iv) Submit all certification, motor test certificates, material certificates.
v) Submit all operating and maintenance instructions.

M21.9.3 Commissioning Tests

i) Check for correct direction of rotation of motors and impellers.
ii) Check for correct current drawn.
iii) Check for any vortex formation at the water surface which could draw air into the mixed liquor.
iv) Check operation of start/stop controls.
v) Check operation of emergency stop.
vi) Check the functioning of the lifting davit arm and winch on each unit in the presence of wastewater.

vii) Performance test – consists of taking six samples at random points close to the surface and from the bottom of the reactor within five minutes. Duplicate analysis of these samples for suspended solids concentration will then be carried out in a suitable laboratory and the average concentration calculated. The suspended solids concentration of any one sample shall not differ from this average by more than 200mg/l.

Generally, the equipment will be considered acceptable at commissioning when all of the following conditions are satisfied:

i) The equipment meets the duty requirements as defined in this Section of the Specification.
ii) Any other specific performance tests defined in this Section prove acceptable operation of the equipment.
iii) Where a power test is required, the power absorbed by each motor at duty point does not exceed the values stated in the Technical Data Sheets by more than 5%.
iv) Where a vibration test is required, the vibration measured at each point does not exceed the level prescribed in BS 4675 Part I – 1976 for the appropriate class of machine.
v) Where a noise test is required, the noise generated by the equipment does not exceed the values stated in the Technical Data Sheets.

M21.9.4 **After Commissioning**

Check equipment for proper functioning and monitor process performance during the Test Period and the Trial Operational Period (TOP). Refer Section 9 in the Conditions of Contract.

For the purpose of this contract, the TOP shall be 28 days. All laboratory testing required during the TOP and Test Period shall be done at a SANAS approved, independent laboratory. Tenderers shall allow for the cost of all sampling and testing in their offer.

The Overall Equipment Efficiency (OEE) of the mixer equipment shall be greater than 95% during the TOP. OEE is defined as the total running time of the equipment less the time lost for breakdowns and maintenance. Periods of downtime outside of the Contractor's control will not be included in the OEE calculation.

The equipment will be considered acceptable when the requirements as specified have been achieved consistently during the Test Period and TOP.

M21.9.5 **During Defects Notification Period**

Refer to Section M26 which further describes the Contractors responsibilities during DNP with respect to the operation and maintenance of the plant.

M21.10 Spares

For Tenders to be considered responsive, Contractors must be able to offer comprehensive routine maintenance comprising the required activities and at the recommended intervals as stated in their offer. Similarly, critical spares must be easily available from the contractor, preferably being kept in stock in South Africa. Costs for the above activities and spares shall be included in the Returnable Schedules.

M21.11 Control and Automation

Refer to control narrative document W1859-48001 (in Volume 3) for details on the operation and control of the equipment in this section

M22. SECOND CLASS WATER SYSTEM

Hammarsdale WWTW has a current second-class water system which supplies a small area of the wastewater treatment works. The draw off point for the current supply is from the fourth leg of the maturation pond. The second-class water is able to supply areas like the fine screens, centrifuge building and the six reactor tanks.

Note: The civil work shall allow for the inclusion of all underground services like piping, valves and manhole which the second-class water shall supply varies areas of the site.

The process is illustrated in Second Class Water Piping and Instruments Diagram shown on drawing no. 5331-C-MISC-412

Table 1 below describes the overall second-class water demand that the design shall meet:

Table 1: Hammarsdale second-class water demand

	Flow rate m3/hr	**Pressure kPa**
Head of works:		
Coarse and Fine Screenings launder	18	100
Ultra fine screenings launder	18	100
Ultra fine screen washwater (normal)	2.5	600
Ultra fine screen washwater (HP)	1.25	12000
Grit trap	15	400
Grit classifier	10	400
Wash down points	5	300
Micro strainer washwater	2.5	600
Total instantaneous	**72.25**	
Dewatering:		
Centrifuge flushing	25	300
Poly dilution line	15	2500
Wash points	5	300
Cake pump wash water	12	100
Poly make-up	15	100
Total instantaneous	**72**	
Kleerflo filters head loss		50
Other:		
Chlorine Building		
For dosing	24	400
Aeration tanks		
Wash points	5	300
Division and Detritus tank		
Wash points	5	300
Existing Sludge drying beds	5	300
Total instantaneous	**39**	
Total Instantaneous flow (m3/hr)	**183.25**	***229.1***
(l/s)	**50.90**	***63.63***

The following should be noted:

1. The total instantaneous flow of 50.90l/s is based on the individual areas that requires second-class water.
2. For design of the new system, the instantaneous flow is increased by 25% which is highlighted in red.
3. All piping and equipment are sized using the 25% increased total instantaneous flow.

M22.1 Scope

The scope associated with Second-class water system shall include design, supply, delivery, installation, testing, commissioning, and upholding during the Trial Operation Period and the Defects Notification Period of the following:

i. Four self-priming centrifugal pumps, (three duty/ one standby)
ii. Two Kleerflo filters (One duty/one standby) with 250micron size wire screen aperture.
iii. All piping, fittings, isolation valves, supports and fasteners supplying low pressure and high-pressure second-class water from the source (maturation pond) to the different areas that will supply second-class water to.

The equipment shall be generally as shown on Piping and Instrumentation Drawing 5331-C-MISC-412.

The new second-class water supply shall be reticulated to the different areas of the plant which the general layout of the pipework. The new pump station structure location and details shall illustrated on drawings 5331-C-MISC-410 and 5331-ST-MISC-413.

M22.2 General Description of Technology

M22.2.1 Pumps

Final effluent shall flow from the last leg of the maturation pond to the rest of the plant. The suction head of the pumps is maximum of 1.4m with a maximum delivery head of 33.4m. There are three duty and one standby, each pump shall be set to deliver 18l/s at 33.4m. The effluent shall be pumped from the maturation pond via pumps to the filters.

M22.2.2 Filters

The clean, filtered water then gets pumped to the rest of the plant for varies functions such as process and day-to-day cleaning. The equipment shall initiate a backwash cycle in which dirty liquid with solids trapped by the apertures.
The backwashing of each screen is operated by an integral actuator. The type of actuator being used in this configuration is an "Airstroke Actuator" - which is suitable for operation from line pressure: or from an external source of pressure — such as pneumatic or mains pressure.

Line Pressure Operation:
Due to inefficiencies and friction, there is a shortfall in the force required to positively shut off the backwash operation of the screens at line pressures under Bar — thus it is recommended that a minimum line pressure of 2 Bar is required to ensure satisfactory operation.

Air or Mains Water Operation:
Satisfactory operation of the filter can be achieved by making use of Air or Water Mains pressure that is at least line pressure but a minimum of 4 Bar.

Air Consumption:
Each backwash operation will require ±2 litres of air; litres per screen.

Considering this volume of air will only be required at a frequency of about every one hour on each filter, and also that each screen operation has a dwell period in between, i.e. the required volume of air is not required continuously. Thus, only a nominal supply of air is required at a minimum pressure equal to the line pressure -
i.e., a flow of air is not required constantly, only the pressure is required to hold the integral backwash actuators in an extended position.

The backwash flow shall gravitate by pipe via a manhole to the Overflow Chamber that flows to the inlet works.

M22.3 Duties

The duties required for this section of the process are indicated in Table 3 below:

Table 3: Pumps and Filters duties

Volumetric capacity of each self-priming centrifugal pump (four pumps)	18l/s @ 33.4
Volumetric capacity of each filters (two pumps)	230 m^3/h

M22.4 Pumps and Filters

M22.4.1 **Frame**

Pump and motor shall be mounted on fabricated mild steel galvanized base plate complete with wedge belts, pulleys and guard.

The frame shall be accurately and securely set into position in the plinth on the floor of the second class water pump station.

M22.5 Motors

Tenderers should take note of the ’s requirements for electric motors, as per of the Standard Specification for Mechanical Works. Where the Contractor is not able to conform to these requirements, he should explicitly highlight the deviations in his offer, for consideration by the Engineer.

It should also be noted that whilst preliminary motor selections have been made for the purposes of this tender, choice of final motor sizes shall rest with the Contractor. Furthermore, it shall be noted that the power rating shall be supplied as a 380 V low voltage unit. Whilst four pole motors are preferable for the anticipated rating, two pole motors will be acceptable.

M22.6 Piping

All valves, fittings, piping material and sizes shall be as indicated on 5331-C-MISC-412. All piping, fittings and supports shall conform to section D20 of the Standard Specifications for Mechanical Works unless otherwise stated below. All piping shall be clearly identifiable as per SANS 10140-3.

M22.7 Motor Control Centre

All equipment and instrumentation indicated on P&ID 5331-C-MISC-412 will be operated from a local PLC situated in the new MCC room in the new pump station building.

All instrumentation and controls as shown on the P&ID are to be supplied and installed to ensure safe, reliable and efficient operation under the conditions stated in this specification. This shall include all instrumentation required for start-up, shut-down, ongoing monitoring of essential system parameters and for safe operation in accordance with the applicable codes and standards.

The MCC and PLC shall be supplied as per the Standard Electrical specification included in Volume 3.

M22.8 Corrosion Protection and Materials of Constructution

M22.8.1 Materials of Construction

Shafts	304 Stainless Steel.
Fasteners and Concrete Anchors	304 Stainless Steel.
Valve body	Cast iron/cast steel, FBE coated
Valve blades	316 Stainless steel.

M22.8.2 Corrosion Protection

Corrosion protection shall be carried out in accordance with the requirements of Section D11 to D14 of the Standard Specification for Mechanical Works.

Geared Motor	Alkyd Over Coating System.

M22.9 Vibration Testing

Rotating elements shall be balanced and the vibration severity of each unit during operation shall not exceed Vrms = 1 mm/s at the pump and motor bearings. The vibration testing shall be done by an approved agency when requested by the Engineer.

M22.10 Performance Testing

In addition to ensuring that the complete new installation performs successfully, the Contractor shall carry out the following performance acceptance tests (see Sub-Clause 9.1 of the Conditions of Contract for Plant and Design-Build FIDIC 2017) in the presence of the Engineer: Performance acceptance tests shall not be considered to be satisfactory and acceptable until all of the conditions have been confirmed by the tests and all test results have been provided in report form to the Engineer.

Whilst it is understood that breakdowns may occur, the second-class water system is an important element in the running of the dewatering facility. The limiting criterion for performance will be that the process can operate but, in addition to this, all reasonable attempts shall be made to ensure that the standby equipment is available.

M22.10.1 General

The following workshop or site tests shall be carried out at the Contractors expense if and as called for in the ‘Project Specification – Detail’.

The contractor shall include for the cost of all the test equipment, calibration of the equipment, testing and re-testing if required.

All testing shall be carried out under the supervision of competent and experienced staff, fully conversant with the testing to BS 5316 Part 1.

The Contractor shall be liable for any costs incurred by the Employer in the event of an abortive test requiring a re-test.

Except as provided for in (a) and (b) below for site tests, all labour, materials, fuel, stores, apparatus and instruments for the tests shall be supplied at no extra cost by the Contractor.

(a) The cost of additional tests and/or analyses as are required by the Engineer to be effected by independent authorities will be refunded to the Contractor by the Employer if the results of such tests and/or analyses prove satisfactory.

(b) The Employer will provide free of charge, as and when available, the required electrical power and the necessary water required to run the plant for the Contractor's Preliminary tests and for the final acceptance tests.

The Contractor shall carry out the tests on site so as not to interfere with the operation of the Works and the execution of other contracts.

M22.10.2 Testing Equipment and Personnel

In carrying out all tests the quantity of water pumped shall be measured volumetrically if facilities are available, but if not, by a Venturi or orifice plate made in strict accordance with BS 5316 Part 1 Class B or C.

Apparatus shall be provided to calibrate the gauges before and after the tests and to measure accurately the electrical power consumed.

All measuring instruments used in the tests shall have previously been certified by an independent testing authority not more than one month prior to the test, and to the Engineer's satisfaction.

A test manual, fully describing the test procedure, etc., as well as details of the calibration procedures and calibration interval of all instruments, shall be available at all times while the pumps are under test. The test manual shall include simplified explanations of all key points necessary on measurements, datum corrections, calculations and all points to be considered in assessing the test procedure. The manual shall be sufficiently comprehensive to make it the only document required by test personnel.

Three copies of the Contractor's records of all tests shall be furnished to the Engineer.

(a) Works test

The equipment provided by the Contractor to verify the guaranteed pump performance as specified, shall consist of the complete pump test rig including all instrumentation to test the pumps in accordance with BS 5316 Part 2 Class B.

Should the Contractor lack the necessary works facilities, the pumps shall be tested on the SABS pump test rig in Pretoria at no additional cost

(b) Site test

The equipment provided by the Contactor on Site to test the performance of the equipment shall include all the instrumentation not included in the permanent installation (e.g. Watt meter, suitable pressure gauges and water meter all of sufficient accuracy to ensure testing to BS 5316 Part 1 Class C and all tools and the suitably trained staff necessary to carry out the tests.

M22.10.3 Performance Guarantees

(a) Where required by the 'Project Specification – Detail', the Contractor shall guarantee the output and efficiency of all pumps, which guarantees shall be binding under the Contract.

The fulfilment of these guarantees shall be demonstrated at the Contractor's Works In accordance with BS 5316 Part 2 Class B or shall be verified on Site in accordance with BS 5316 Part 1 Class C.

(b) Where guaranteed performance is specified, certified test curves shall be drawn from the test data obtained from the purchased pumps and shall include; head (m), quantity pumped (m³/h or ℓ/s), efficiency (%), power consumption (kW), and speed in R.P.M. The probable performance with maximum and minimum impeller sizes shall also be indicated, as well as tested NPSH required by the pump.

All tests to verify the pump characteristic curves shall be done using water.

M22.10.4 Pump testing - Manufacturer's Works

Where specified in the 'Project Specification – Detail', witnessed shop performance tests shall be carried out on the pumps to be installed under this Contract at the manufacturer's works before despatch, or alternatively, where not specified, shall have been carried out on identical pumps, or such pumps that have been in service for extended periods and be giving satisfactory results, all under conditions identical with or closely approaching those under which they will operate under this Contract.

Test measurements shall be carried out in accordance with BS 5316 Part 1 Class B.

Certified test results, whether from the manufacturer's works or elsewhere, shall be provided when so ordered by the Engineer.

M22.10.5 Pump Testing at Site of Works

Two separate series of tests called the Preliminary Test and Final Acceptance Test shall be carried out by the Contractor on all pumping units with motors over 30 kW rating after installation. Test measurements shall be carried out in accordance with BS 5316 Part 1 Class C.

One series of tests only called the Preliminary Test shall be carried out on all pumps up to and including 30 kW. A final acceptance test is not required in these cases.

M22.10.6 Preliminary tests

The Preliminary Test shall be carried out by the Contractor after he has run the plant for a period of at least 24 hours and is satisfied that the pumping units are ready to be taken over by the Employer.

M22.10.7 Final tests

The Final Acceptance Test shall be carried out not less than three months after an acceptable Preliminary Test.

A representative of the Engineer will be present at all tests and shall be provided with full details and the measured and calculated results.

M22.10.8 NPSH Test

An NPSH Test shall be conducted when the NPSH available does not exceed the NPSH required by the pump by at least 1,0 m.

M22.10.9 Failure to Achieve Performance Guarantees

If, in the Preliminary Test, the characteristics in regard to discharge and efficiency at "duty point" head, after allowing a tolerance of ± 4,5% in the overall efficiency of pump and motor, fall short of those specified or stated in the 'Project Specification – Detail', the Contractor shall immediately remedy the defects to ensure that the installation complies with the requirements, at his own expense and within such time as may be laid down by the Engineer. When the Contractor has made good the defects, and is satisfied that the pumping unit is ready to be taken over by the Employer, a second Preliminary Test shall be carried out, by the Contractor.

If in the second Preliminary Test, the performance of any of the pump units falls short of requirements, using the criteria in the preceding paragraph, the equipment or part thereof may be rejected, in which case the Contractor shall take immediate steps to replace the rejected equipment with equipment complying with the

specifications. Further, any payments made by the Employer to the Contractor in respect of such rejected equipment shall be repaid by the Contractor within 30 days of such rejection or may be recovered from the Contractor by the Employer.

Such replaced equipment shall be subjected to a Preliminary Test and the provisions of the two preceding paragraphs shall apply thereto.

M22.10.10 Final test (for Site Testing only)

The Contractor shall provide all necessary instruments, staff and labour for the tests and a representative of the Engineer will be present at all tests and shall be provided with full details and the calculated results as specified.

If in the Final Acceptance Test the discharge and efficiency characteristics at "duty point" head fall short of those specified or stated by the Contractor in his tender, the remedial measures and second Final Acceptance Test procedure as specified for the Preliminary Tests shall be carried out and replacement equipment supplied if required.

Permissible variations from the required performance are as for Class B test in BS 5316 : Part 1.

Such replaced equipment shall be subjected to a Preliminary Test with the provisions for rejection and replacement stipulated for the Preliminary Test and also to the Final Acceptance Test specified above.

M22.11 Quality Management

A quality control plan shall be submitted for the design, manufacturer, installation and commissioning of each screen and its ancillaries, for approval and monitoring by the Engineer.

M23. WITNESSING OF FACTORY ACCEPTANCE TESTING

The Employer's team and engineering team reserve the right to witness and sign off Factory Acceptance Testing (FAT) of all equipment. Witnessing of testing and the relevant representatives from the Employer and engineering team shall be confirmed during the contract. In the absence of witnessing, inspection certificates detailing all works testing conducted shall be forwarded to the Engineer for approval.

The Tenderer should make provision for all allowances, disbursements, accommodation and associated costs for travelling to areas outside the Ethekwini Metropolitan Area, to inspect and conduct factory acceptance testing or any other Inspections, tests, etc. of equipment in the BoQ.

The following provisions shall be made for travel inside South Africa per relevant equipment item FAT:

- Total number of representatives: 2 – Employer, 2- Engineering team
- Hotel/Guest house accommodation in a 3 or 4 start hotel for 2 nights
- Return flights economy class
- Car hire with a class B car
- Subsistence allowance as per the SARS guideline "Guide for Employers in Respect of Allowances" for travel within the Republic of South Africa.

The following provisions shall be made for travel outside South Africa per relevant equipment item FAT:

- Total number of representatives: 2 – Employer, 2- Engineering team
- Hotel/Guest house accommodation in a 3 or 4 start hotel for 5 nights
- Return flights economy class
- Car hire with a class B car
- Subsistence allowance as per the SARS guideline "Guide for Employers in Respect of Allowances" for travel outside the Republic of South Africa.
- VISA costs and travel insurance.

The Tenderer shall make provision for the Employer's representatives and engineering team representatives to witness FAT testing on the following equipment:

- Screens/Washer compactors
- Grit traps/classifier
- Biological reactor feed pumps
- Decanter centrifuges
- Polymer make-up units
- Submersible mixers
- Sludge cake conveyors
- Cake pumps
- Surface aerators
- All associated electrical and control panels

M24. TRAINING

The contractor will conduct training during the commissioning and TOP stage. This section describes the training requirements:

M24.1 General Training Needs

- The Contractor shall conduct comprehensive training for EWS maintenance and operational staff on the plant during the commissioning period.
- The training program will cover operation and maintenance of following areas:
    - Process and mechanical equipment
    - Electrical (Medium Voltage and Low Voltage)
    - Instrumentation, Control and the SCADA system
    - All equipment shall be operational order before training commences.
- The training shall be designed specifically for the works paying close attention to specialized equipment
- The training shall allow for at least 5 of each operational/maintenance staff members and 5 engineering staff members. The employer shall provide a list of trainees and the contractor shall draw up a training schedule based on the trainee availability.
- The contractor must allow for sufficient time when specialists are engaged for specialized training to allow expert training to be given to operational/maintenance and engineering staff which shall be highlighted in the training schedule.
- During the installation phase, the Employer may nominate a team of operational/maintenance/engineering employees who will be closely involved with the installation and commissioning process. These employees will only observer to get the maximum information regarding the installation, to enable efficient maintenance to be undertaken by the Employer.
- The training shall be a combination of classroom training sessions and “on-the job” training.

M24.2 Training Manual

- Training and training manuals shall be based on the O&M Manuals. Note: The contractor is responsible to prepare training manuals summarizing the critical aspects in the O&M manual and not simply copy the O&M manual in its entirety.
- Each trainee shall have his/her own manual with three additional copies which shall form part of the Operation and Maintenance Manuals. An electronic copy of the training manual in Ebook format will also be supplied by the contractor to the employer.

M24.3 Training Schedule

- The Engineer shall approve the training schedule. A CV of the training facilitator(s) shall be submitted to the Engineer for approval.
- The training shall include operator training, technical and maintenance training.
- The program for the training shall include instruction for a minimum of 2 days on-site extending across multiple shifts.
- The schedule shall cover the following:
    - General process/system overview
    - Functional operation of the system. A complete operational narrative in conjunction with PID, electro mechanical schematic detailing the start up ,shut down process, interlock checking , specific operations of process equipment across all driplines , what alarms are critical, where to reset, fault finding, standby supply operations etc
    - Maintenance Schedule and how to complete them
    - Standard Maintenance Procedures
    - Spare Part Lists
- EWS maintenance staff and other supporting staff should be fully proficient in the system operation and maintenance thereof once the training programme is complete

M24.4 Maintenance and Operations Training

The training shall be designed to teach operators how to operate the Process, Electrical, Mechanical, Instrumentation and Control systems and shall include but not be limited to the following:

- Start-up, shut-down and operating instruction for all operational modes for the works shall be provided. This shall be comprehensive and shall include actions to be taken in the case of all alarm conditions and basic to in depth fault finding.
- A layout drawing of the installation, a process flow diagram, and a P&ID shall be provided for each Operator. The instructions described in (1.3.1a) above shall also be provided in printed form for each operator.
- If a SCADA and Telemetry system is part of the control system, the SCADA operations training as described in the SCADA and Telemetry standard specification shall be incorporated in the training.
- This training shall be designed to teach operations and maintenance personnel how to operate, repair and maintain the electrical, mechanical ,instrumentation and control systems .

M25. PROCUREMENT OF EQUIPMENT FROM LOCAL AGENTS

The Contractor will be required under this contract to ensure as far as possible that all items of mechanical and electrical equipment and instrumentation are sourced from suppliers or agents of original equipment manufacturers located within the Ethekwini Municipality.

Should the Contractor be found to be non-compliant in this regard, he shall have valid reason to be so, failing which he shall be obliged to comply with the above requirement and bear responsibility for any delays and costs that may arise.

M26. CONTRACTORS OBLIGATION DURING TRIAL OPERATION PERIOD AND DEFECTS NOTIFICATION PERIOD

Upon successful completion of all the work under the trial operating period, the Contractor may thereafter be required to take full responsibility for the operation and maintenance of all new items of equipment installed under the contract, either for the full duration of the defects notification period or part thereof.

In this regard, the Contractor will be expected to maintain on site a team that will be responsible on a full time or part time (min. 3 days a week) basis to attend to the following:

- Operation of the new sludge dewatering facility complete and all associated equipment, including the provision of all chemicals and consumables as well at attendance to all maintenance requirements.

- Operation of the new inlet works equipment and attendance to all maintenance.

A provisional sum item has been set aside in the Bill of Quantities for this and the planning, programming and costing of this work shall be discussed and agreed between the Employer, Engineer and Contractor within the last 6 months of the time for completion.