

C3.5.4

PROCESS AND CONTROL DESCRIPTION

PROCESS AND CONTROL DESCRIPTION**TABLE OF CONTENTS**

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PROCESS CONTROL NARRATIVE

1 INLET WORKS

1.1 Process Description

The inlet works comprises 3 channels designed for a total hydraulic flow of 27 MI/d ADWF with a PWWF of 71.3 MI/d. In each channel, raw sewage is screened with a series of automatically raked, inclined bar screens – 25mm (coarse) and 6 mm (fine). Each screen is sized to handle 990 m³/h. Initially, only 2 of the 3 channels will be fit with automatic screens and the 3rd channel will house a manually raked 25 mm screen. The screen capacity is such that for the initial flows to the plant, the automatic screens will operate as duty/standby.

Screenings are automatically removed from the screens and conveyed to a set of duty/standby washer/compactors using hydraulic launder channels. 2nd class water is used as a conveyance medium for the launder channels at a maximum rate of 58m³/h. The washer/compactors compact screenings to a maximum moisture content of 65 wt.% at 1.6 m³/h. Compacted screenings are discharged to a set of duty/standby skips for collection and disposal to landfill. The filtrate from the compacted screenings is returned by gravity to upstream of the coarse screens.

After fine screening, grit is removed from the wastewater in each channel using an induced vortex degritter. Each grit trap will have a hydraulic capacity of 990 m³/h and remove 80% of grit particles larger than 0.2 mm. A grit slurry will be discharged from each grit trap using a self-priming pump at approximately 58 m³/h. Second class water is supplied to each grit trap chamber to loosen the compacted grit during discharging operations. The grit slurry is pumped to a set of duty/standby grit classifiers. The grit classifiers remove 90% of all grit particles greater than 0.2 mm and discharge grit at a rate of 0.21 m³/h at 85 wt.% grit content. The grit is washed in the grit classifier using 2nd class water to a volatile solid's concentration of less than 5%. The overflow from the grit classifier, together with organic material is returned by gravity to upstream of the grit traps. Grit is discharged to a set of duty/standby skips for collection and disposal to landfill.

After degritting, the wastewater flows through two ultrafine band screens (duty/standby) consisting of a 1mm perforated plate screening element. Each screen has a hydraulic capacity of 990 m³/h. Screenings are cleaned off the screening element automatically by using a low pressure and high pressure wastewater manifold connected to the 2nd class water system. Screenings are washed and conveyed at approximately 60 m³/h in a hydraulic launder channel to a set of duty/standby micro strainers and compacting units. The micro strainer units consist of a 2mm perforated plate basket and a compacting screw with a washwater manifold. Screenings are collected, washed and compacted to 30% dried solids (minimum) at a maximum rate of 2 m³/h. Filtrate from the micro strainers are returned back to the inlet works combined channel by gravity.

The wastewater leaving the ultrafine screens enters the Screened Wastewater Sump before being pumped up to the existing set of bioreactors.

1.2 Control Narrative

1.2.1 Coarse and Fine Screens

Refer to W1859-45003 and W1859-41005 when reading this section.

One set of screens shall be on duty and one set on standby with its inlet penstock closed. The difference in water levels across the duty set of each screen (measured by LT01 and LT02) shall be measured by ultrasonic level transmitters installed upstream and downstream of it. For the coarse screens, when, the level difference reaches a pre-set value on LT01 (LT03), the cleaning mechanism for screen MS01A (MS01B) shall start, by sending a run signal to MIC01A (MIC 01B), and run for a pre-set period. If there is no trigger from differential level on LT01 (LT03) for a pre-set period (typically 20 minutes), a cleaning cycle will be initiated to guard against possible level measurement problems. For the fine screens, when the level difference reaches a pre-set value on LT02 (LT04), the cleaning mechanism for screen MS02A (MS02B) shall start, by sending a run signal to MIC02A (MIC 02B), and run for a pre-set period. If there is no trigger from differential level on LT02 (LT04) for a pre-set period (typically 20 minutes), a cleaning cycle will be initiated to guard against possible level measurement problems.

For the coarse and fine screens, the cleaning cycle will involve engaging the rake mechanism to remove screenings (MIC01A/B and MIC02A/B). The rake mechanism drives (MIC01A/B and MIC02A/B) shall operate on separate VSDs with adjustable setpoints on the SCADA system. The rake mechanism drives (MIC01A/B and MIC02A/B) shall be reversible to allow the rakes to travel in reverse to assist with clearing blockages. Blockages shall be detected by hardwired torque sensors on the coarse and fine screens (XS01/ XS02/ XS03/ XS04) which will stop the drives if high torque is detected. The screen drives (MIC01A/B and MIC02A/B) shall operate on VSD to allow a controlled start-up time of the raking mechanism during screenings removal. This shall be adjustable and determined during commissioning. The current on drives MIC01A/B and MIC02A/B shall be monitored and trip on overcurrent should the torque switches (XS01/ XS02/ XS03/ XS04) fail.

An operator shall attempt to clear the problem by running the rake mechanism in reverse for ten seconds, then forward for ten seconds for a maximum of three cycles. Local forward and reverse controls shall be provided to permit this where the operator can observe the rake mechanism. If the blockage is not cleared, the screen shall be locked out until the cause of the problem has been rectified.

During periods of extreme high flow resulting in wastewater overflowing into the emergency bypass channel, the flowrate will be measured over a weir. The flowrate (FI02) and totalized flow (FQI02) shall be recorded on the SCADA system. Any flow detected will create a high flow alarm on the SCADA system.

After the fine screens, the inlet flow to the plant shall be measured with a Parshall flume (FE01). The flow will be indicated on the SCADA system (FI01) and totalized (FQI01) and generate a high (and high high) alarm during periods of high flow.

1.2.2 Washer/Compactors

The washer/compactors shall be controlled by the same PLCs which shall be installed under this contract for the control of all other equipment. Items relevant to their operation and control are shown on Piping and Instrumentation Drawing W1859-45003.

The duty washer/compactor WHC01 (WHC02) shall be selected by the operator on the SCADA by selecting a check box or similar method. The duty washer/compactor WHC01 (WHC02) shall start automatically after it has accumulated screenings from a pre-set number of screen cleaning cycles or if a predefined level is reached in the feed hopper as registered on LT07 (LT08). The drain valve XV 06 (XV07) shall close and the washwater inlet valve XV04 (XV05) shall open to admit washwater to the hopper. When the water level reaches the level setpoint, the water supply valve XV04 (XV05) shall close, and the pump impeller mixer MIC04 (MIC06) shall run for a pre-set time to wash organic matter from the screenings. The water shall then be drained from the unit via the drain valve XV 06 (XV07) and the screw MIC03 (MIC05) shall be started to compact and dewater the screenings and eject them via the discharge pipe.

Provision shall be made for the washer/compactor to operate without washwater in the event of low washwater pressure, as measured at the 2nd class water bulk supply system. An alarm shall be raised in this case. .

The washer/compactors WHC01 (WHC02) shall be operated in duty/standby mode. Under normal circumstances, the duty and standby units shall be changed over automatically on a weekly basis. If the duty washer/compactor fails to start or trips during a washing or compacting sequence, screenings shall be diverted by closing XV02 (XV03) and opening XV03 (XV02) to the standby washer/compactor and an alarm shall be raised. Provision shall be made for running both washer/compactors, by diverting screenings first to one then to the other using valves XV25 and XV26, during periods of high sewage flow.

1.2.3 Grit Traps

The grit traps and associated equipment shall be controlled by the PLCs which shall be installed at the Inlet Works for the control of all equipment in the area. Items relevant to their operation and control are shown on P&ID W1859-45004.

The grit traps GTR01 (GTR02) shall be operated in duty/standby mode. The duty grit trap GTR01 (GTR02) shall be selected by the operator on the SCADA by selecting a check box or similar. The duty grit trap paddle shall be operated continuously under normal operation. The duty and standby units shall be changed over automatically on a weekly basis. If the duty grit trap paddle drive MIC08 fails, an alarm shall be raised, and the duty channel shall be changed. If both grit traps fail MIC08/MIC09, an alarm shall be raised, and manual isolation shall be required.

The frequency at which the grit traps eliminate accumulated grit shall be adjustable but will nominally be at least 15-20 minutes per hour. Grit removal times for the two traps shall be staggered by an

adjustable pre-set time so as not to overload the classifiers during conditions of simultaneous operation. The procedure for grit removal shall be as follows all based on adjustable timers:

- 1) Open grit trap washwater supply valve VX19 (XV20).
- 2) After pre-set period (typically 5 – 10 minutes), open grit trap valve XV23 (XV24) and valve XV25 (XV26) to duty classifier. Start Grit Slurry Pump PMP05A (PMP05B). Close washwater supply valve XV19 (XV20).
- 3) After pre-set period (typically at least 5 – 10 minutes), stop Grit Slurry Pump PMP05A (PMP05B) and close grit trap valve XV23 (XV24) and valve to duty classifier XV25 (XV26).

Appropriate grit removal frequencies and times for washing and grit pumping shall be determined during commissioning.

Provision shall be made for the grit trap to operate without washwater in the event of low washwater pressure as detected at the 2nd class bulk water supply system. An alarm shall be raised in this case..

1.2.4 Grit Classifiers

The grit classifiers and associated equipment shall be controlled by the PLCs which shall be installed at the Inlet Works for the control of all equipment in the area. Items relevant to their operation and control are shown on P&ID W1859-45004.

The duty grit classifier GWR01 (GWR02) shall be selected by the operator on the SCADA by selecting a check box or similar method. The duty grit classifier mixer MIC12 (MIC14) shall run continuously but the grit removal screw MIC13 (MIC15) shall not run continuously as this will accelerate wear. The grit screw MIC13 (MIC15) shall run based on the amount of grit measured in the grit classifier by measuring the pressure at the bottom of the unit on PT01 (PT02) and performing a density calculation. Alternatively, the screw shall run on a timer. Appropriate on-off cycle times shall be determined during commissioning.

Each grit classifier GWR01 (GWR02) shall have a washing function to remove residual organics from the grit. Washing shall be automatically started based on a timer system. When washing is initiated, a solenoid valve XV21 (XV22) is automatically opened to introduce 2nd class water into the grit classifier in an up flow direction. This fluidizes the grit bed and removes organics. The organics discharge valve XV29 (XV30), automatically opens during a washing cycle to allow the organics to drain back to the inlet works.

The grit classifiers GWR01 (GWR02) shall be operated in duty/standby mode. Under normal operation, the duty and standby units shall be changed over automatically on a weekly basis. If the duty classifier fails to start or trips during operation, grit shall be diverted to the standby classifier and an alarm shall be raised.

1.2.5 Ultrafine Screens

Ultrafine screens MSR03A (MSR03B) shall operate as duty (standby). The difference in water levels across the duty set of each screen (measured by LT09 and LT10) shall be measured by ultrasonic level transmitters installed upstream and downstream of it. When the level difference reaches a pre-set value on LT09 (LT10), the cleaning mechanism for screen MS03A (MS03B) shall start, by sending a run signal to MIC18 (MIC20), to run the screening element run for a pre-set period. During cleaning, the cleaning brush MIC34 (MIC35) is started while low pressure wash water is sent to the screen by opening valve XV09. If there is no trigger from differential level on LT09 (LT10) for a pre-set period (typically 20 minutes), a cleaning cycle will be initiated to guard against possible level measurement problems. High pressure cleaning is initiated on the screens on a timer basis This typically once per day but is adjustable based on wastewater. During high pressure cleaning the screening element is run by sending a run signal to MIC18 (MIC20), the high pressure booster pump PU03A (PU03B) is started, valve XV10 (XV11) is opened and MIC19 (MIC21) is started. High pressure cleaning runs for a pre-set time which is adjustable depending on wastewater characteristics.

1.2.6 Micro Strainer/Compacting Units

The duty micro strainer WHC03 (WHC04) shall be selected by the operator on the SCADA by selecting a check box or similar method. Inlet valve XV13 (XV16) will open when WHC03 (WHC04) is called to run. The duty micro strainer WHC03 (WHC04) shall start automatically after it has accumulated screenings from a pre-set number of screen cleaning cycles of the Ultrafine screens MSR03A/B. When WHC03 (WHC04) starts, the screw MIC24 (MIC25) runs for a pre-set time. While MIC24 (MIC25) runs, washwater is supplied by opening valves XV14 (XV17) and XV15 (XV18) to wash the screenings.

Provision shall be made for the micro strainer units to operate without washwater in the event of low washwater pressure, as measured at the 2nd class water bulk supply system. An alarm shall be raised in this case.

The micro strainer units WHC03 (WHC04) shall be operated in duty/standby mode. Under normal circumstances, the duty and standby units shall be changed over automatically on a weekly basis. If the duty micro strainer unit fails to start or trips during compacting, screenings shall be diverted by closing XV13 (XV16) and opening XV16 (XV13) to the standby micro strainer unit and an alarm shall be raised. Provision shall be made for running both micro strainer units, by diverting screenings first to one then to the other using valves XV13 and XV16, during periods of high sewage flow.

Ultrafine screenings from MSR03A/B shall be conveyed to skip with the Ultrafine Screenings Conveyor SCC01A/B which operates as duty standby. During normal operation, the duty and standby units shall be changed over manually on a weekly basis. The discharge chute from micro strainer WHC03 (WHC04) will have a manual diverter plate to divert screenings into the duty screw conveyor SCC01A (SCC0B). The position of the plate shall be detected by proximity switches ZS05 and ZS06 (ZS05 and ZS06). The position of the diverter plate will select the duty conveyor. The duty conveyor MIC36 (MIC37) will start and stop when the duty micro strainer screw MIC24 (MIC25) starts. If MIC36

(MIC37) fails to start, the micro strainer screw MIC24 (MIC25) will stop, and an alarm will be raised. If the cover of the ultrafine screenings conveyor is removed, ZS09 (ZS10) is activated and stops MIC36 (MIC37).

1.2.7 Skip Transfer System

The skip transfer system shall be controlled by the PLCs which shall be installed at the Inlet Works for the control of all equipment in the area. Items relevant to their operation and control are shown on W1859-45003 (60325-M-01 Sheet 002) and W1859-45004 (60325-M-01 Sheet 003)

The Contractor shall comply with D76 of the Standard Specification for Mechanical Works. The design of the system, including drawings and functional specification, shall be submitted to the Engineer for acceptance. In general, the operating philosophy as described below shall apply:

The coarse and fine screen duty skip DO01A (DO01B) shall be located under the common discharge point for the washer/compactors WHC01 and WHC02 and be operated on a common motorized dolly system MIC07. Once the duty skip DO01A (DO01B) is full, the operator shall direct the dolly system MIC07 left or right depending on the position of the standby empty skip. As the full skip is moving away from the collection point, the empty skip is pulled under the discharge point. The dolly system will automatically stop once the standby skip is in position under the common discharge point as detected by the proximity sensors ZS01 and ZS02 at each end of the rails. The full skip shall now be in position to be collected by the skip truck. While the dolly system MIC07 is moving (ZS01 and ZS02 not active), the washer/compactors WHC01 and WHC02 shall be interlocked to not discharge solids until the standby skip is confirmed to be in place by a proxy switch ZS01 or ZS02.

The grit and ultrafine screenings duty skip DO02A (DO02B) shall be located under the common discharge point for the Grit Classifiers GWR01 and GWR02 and ultrafine screenings conveyor SCC01A/B and be operated on a common motorized dolly system MIC16. Once the duty skip DO02A (DO02B) is full, the operator shall direct the dolly system MIC16 left or right depending on the position of the standby empty skip. As the full skip is moving away from the collection point, the empty skip is pulled under the collection point. The dolly system will automatically stop once the standby skip is in position under the common discharge point as detected by the proximity sensors ZS03 and ZS04 at each end of the rails. The full skip shall now be in position to be collected by the skip truck. While the dolly system MIC16 is moving (ZS03 and ZS04 not active), the Grit Classifiers GWR01 and GWR02 and ultrafine screenings conveyor SCC01A/B shall be interlocked to not discharge solids until the standby skip is confirmed to be in place by a proxy switch ZS03 or ZS04.

Both motorised skip transfer systems (MIC07 and MIC16) shall be operated from handheld units hard wired to the dolly's' local weatherproof panel located on the side of the dolly. It shall be powered via hard wire on a self-winding reel connected via plug and socket to a weatherproof panel located adjacent to the skip area.

Each handheld unit shall have arrow buttons indicating the direction of the skip movement to start the repositioning activity and a "STOP" button. When an arrow button is pushed, the dolly shall continue in the selected direction until it stops against the mechanical stops. A proximity switch (ZS01, ZS02, ZS03, ZS04) at either end of the rail system shall initiate a stop sequence. The "STOP" button shall initiate an emergency stop in any direction and position. While the dolly is moving in any direction, the operator shall not be allowed to change the direction of the dolly until the "STOP" button has been engaged and the dolly comes to a complete stop.

The wall mounted panel, serving both dollies, shall have "ON/OFF" lock out isolation switches controlling the externally mounted socket with a power on indicator light and with an emergency stop.

1.2.8 Hydraulic Launder Conveyor

The Hydraulic Launder Conveyor (HLC) shall be controlled via PLC which shall be installed at the new pumps station building. Items relevant to the operation and control of the flume are shown in Piping and Instrumentation Drawing W1859-45003.

The HLC shall operate in conjunction with the screens MSR01A/B and MSR02A/B. When the screen MSR01A or MSR01B has discharged screenings to the flume the washwater valve XV01 shall open to transfer the screenings to the duty washer/compactor WHC01 (WHC02). The slide valve XV02 (XV03) shall open to the duty washer/compactor WHC01 (WHC02). When screen MSR02A (MSR01B) has discharged screenings to the flume the washwater valve XV37 (XV38) shall open to transfer the screenings to the duty washer/compactor WHC01 (WHC02). The time of operation of valves XV01, XV37 and XV38 shall be manually adjustable to allow for correct setup of washwater volume.

The slide valve shall XV02 (XV03) shall be interlocked with the operating status of the washer/compactors to enable operation in case of one or both washer compactor WHC01 (WHC02) being operational at times of peak flow. In the case of both units being operational the slide valve XV02 (XV03) shall open intermittently to allow transfer of screenings to each washer/compactor WHC01 (WHC02) in turn.

1.2.9 Screened Wastewater Sump

In general, the operating philosophy as described below will apply. All equipment shall be controlled from a PLC/SCADA system. Items relevant to their operation and control are shown on Piping and Instrumentation Drawing W1859-45005.

The level in the Screened Wastewater Sump shall be continuously monitored on the PLC/SCADA system by LT13. The level output shall be used to control the submersible mixers MIX01 and MIX02 and the bioreactor feed pumps PMP01A/B/C/D taking suction from the sump. The level shall be measured using an ultrasonic probe that will also be used to measure the flowrate (over a weir) of the emergency overflow channel from the sump. This flowrate calculation shall be performed in the PLC/SCADA system based on the design of the weir. The flow shall also be totalized (FQI13). High

level conditions shall alarm on the SCADA system to alert the operators of an overflow condition. An additional level switch (LSH02) shall detect high level conditions as back-up should the level probe fail.

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. Flow to each fluidization line shall be controlled by solenoid valves (XV31/XV32/XV33/XV34) which will operate on an adjustable timer basis. Only one fluidization line will operate at a time. Each fluidization line shall terminate with a suitably sized nozzle to create turbulence pushing sediment towards the pump suctions.

The Bioreactor Feed Pumps PMP01A/B/C/D shall be controlled from the PLC/SCADA system. The pumps shall operate as 3 duty/1 standby supplying the existing set of bioreactors. The duty pumps shall be selected by the operator on the SCADA by selecting a check box or similar method. In the future, an additional set of bioreactors shall be constructed. Three new pumps will be installed to supply the new set of reactors and will operate as a 3 duty/1 standby. There shall be a common standby pump PMP01D shared between each bioreactor pump set. The pumps PMP01A/B/C/D will operate on VSDs. The stop/start and pump speed will be varied based on the level in the sump, measured by LT13, to ensure that the sump level stays within a setpoint range. The duty pump shall be rotated on an adjustable interval basis. If a low level is reached in the sump, the pumps PMP01A/B/C/D shall stop. The flow at the discharge of each pump shall be measured by low flow switches FSL01/FSL02/FSL03/FSL04. If a low flow condition is reached, the respective pump PMP01A/B/C/D will be stopped. Flow switches FSL01/FSL02/FSL03/FSL04 shall be hardwired to control their respective pumps even if there is a failure on the PLC. Pump PMP01A/B/C/D shall be supplied with integral safety switches that will be interlocked to stop each pump for:

- High bearing temperature
- Mechanical seal leak detected
- Motor housing leak detected
- High thermal winding temperature
- Motor thermal protection
- High vibration detected

The above interlocks shall be hardwired to stop the respective pump PMP01A/B/C/D.

Once the second set of bioreactors are installed, in addition to controlling the level in the sump, the pumps PMP01A/B/C/D shall be able to be controlled based on the flow set point to each set of bioreactors. It is envisaged that the flow will be measured at the inlet to each reactor set and be used to adjust the number of duty pumps as well as the pump speeds of the respective bioreactor set. Although this functionality is only required in the future, an allowance must be made in the current electrical and automation design.

The dry well of the bioreactor feed pumps shall be protected from flooding by a set of duty/standby sump pumps PMP04A/B. Any unwanted leakages will be collected in the dry well sump. Level switch LS01 installed in the dry well sump will detect high and low level. The duty dry well sump pumps shall be started automatically at high level in the dry well sump and stopped automatically at low level in the dry well sump. If high level is maintained in the sump for a certain time limit (adjustable on PLC) the standby sump pump PMP04A/B shall start to assist the duty pump in bringing down the level in the sump.

2 DEWATERING BUILDING

2.1 Process Description

Waste Activated Sludge (WAS) is pumped at a maximum rate of 150 m³/h from the existing WAS sump by duty/standby, self-priming, centrifugal pumps. The WAS goes through a set of macerators and heavy solids separators to cut stringy material or remove any foreign matter from the sludge that could damage the centrifuges downstream. After maceration, the WAS enters the Centrifuge Feed Tank which acts as a header tank supplying the centrifuge feed pumps.

WAS is pumped from the Centrifuge Feed Tank to a set of duty/standby centrifuges using dedicated progressive cavity pumps at 65m³/h and 1 wt.% solids. Polyelectrolyte solution at 0.2 wt.% is combined with the WAS at the inlet of each centrifuge at between 3-6 m³/h. WAS is dewatered to a minimum solid's concentration of 16 wt.% using high efficiency, horizontal, decanter centrifuges. Dewatered sludge cake is discharged at 3.9 m³/h from each centrifuge using shaftless screw conveyors before being pumped with duty/standby cake pumps to a set of cake storage silos. Poly lubrication is supplied at the discharge of each cake pump to assist with pumping the cake. There are two concrete sludge cake storage silos with a working volume of 120 m³ each. Sludge is discharged from the silos to collection trucks using live bottom screws at a rate of 60 m³/h.

Solid polyelectrolyte powder is dissolved into solution using two duty/standby polymer make up units. Each polymer make-up unit makes up poly solution at 0.2 wt.% using a two-chamber system where each tank alternates between make-up tank and mixing tank. Each polymer make-up system can deliver a maximum of 6 m³/h of polymer solution with a minimum maturation time of 60 minutes.

2.2 Control Narrative

2.2.1 Waste Activated Sludge Transfer

In general, the operating philosophy as described below will apply. All equipment shall be controlled from a PLC/SCADA system. Items relevant to their operation and control are shown on Piping and Instrumentation Drawings W1859-45001.

The duty/(standby) WAS transfer pump PMP04A (PMP04B) shall operate on VSD and the speed shall be adjusted based on the level in the existing WAS sump, measured by LT06, to maintain the sump level within a set point band (adjustable). A new ultrasonic level meter will be installed at the sump under this contract for this purpose. The WAS transfer pumps PMP04A (PMP04B) will operate as duty/standby and will automatically switch over based on operational hours. When a low level on

LT06 is reached in the sump, the duty pump will automatically stop. If a high level on LT01 is reached at the Centrifuge Feed Tank, the WAS transfer pumps PMP04A (PMP04B) will stop. A low flow switch, FSL01 and FSL02, shall be installed on the discharge of transfer pump PMP04A and PMP04B respectively. If a low flow is registered on either switch, the respective pump shall stop. The existing manually actuated valve on the inlet feed line to the WAS sump shall be replaced with a new motorized knife gate valve VX33. This valve will be interlocked to close when a high high level is reached on LT06.

The macerator unit MAC01A (MAC01B) will only run when the duty WAS transfer pump PMP04A (PMP04B) is running. It shall be possible to run either macerator unit MAC01A/B in series with either transfer pump. The macerator units MAC01A (MAC01B) shall contain automatic reverse technology to reverse the cutting blades when a blockage (high torque on XS03 (XS04) or current) is registered. If auto reverse does not clear the blockage after an adjustable time delay, an alarm will be generated on the SCADA system, and the duty WAS transfer pump will stop. The macerator units MAC01A (MAC01B) will have technology that can automatically detect the wear on the blades and provide indication/alert on the SCADA system when the blades need to be replaced.

2.2.2 Centrifuge Feed Tank

In general, the operating philosophy as described below will apply. All equipment shall be controlled from a PLC/SCADA system. Items relevant to their operation and control are shown on Piping and Instrumentation Drawing W1859-45001.

The level in the Centrifuge Feed Tank will be monitored and displayed on the SCADA system by LT01. The level (LT01) in the tank will be used to set the flow rate set point of the Centrifuge Feed Pumps PMP01A/B. The Centrifuge Feed Pumps PMP01A and PMP01B operate on VSD's, and the speed will be adjusted based on the flowrate setpoint and the flowrate measured value as detected by FE01 and FE03 respectively. On each centrifuge feed pump (PMP01A and PMP01B), it shall be possible to either set a flowrate setpoint or to obtain a cascade setpoint from the level in the centrifuge feed tank, LT01. When high level is reached on the Centrifuge Feed Tank LT01, an alarm will be generated on the SCADA system. When a high high level is reached on LT01, an interlock will stop the duty WAS Transfer Pump PMP04A (PMP04B) upstream. When a low level is reached on LT01, an alarm will be generated on the SCADA system. When a low low-level alarm is reached, the Centrifuge Feed Pumps PMP01A/B will be interlocked to stop. High LSH01 and low LSL01 level switches situated on the tank will be used for alarming and interlocking should the level transmitter in the Centrifuge Feed Tank LT01 fail.

The submersible mixers MIX01 and MIX02 shall be started and stopped manually from the SCADA system and run at a fixed speed. When the level in the centrifuge feed tank (LT01) drops below the limit (adjustable) or the low-level switch LSL01 is activated, MIX01 and MIX02 will stop and an alarm will be generated

2.2.3 Centrifuge

In general, the operating philosophy as described below will apply. All equipment shall be controlled from a PLC/SCADA system. Items relevant to their operation and control are shown on Piping and Instrumentation Drawings W1859-45002.

Each centrifuge CEN01 and CEN02 will be fed from its own progressive cavity feed pump PMP01A and PMP01B operating on a VSD drawing sludge from The Centrifuge Feed Tank TNK01. The centrifuge feed pump PMP01A (PMP01B) is interlocked to stop when PT01 (PT02) registers a high pressure or if the temperature switch TS01 (TS02) registers a high temperature. The flowrate of sludge can either manually be inputted as a set point or the set point can be varied in a cascade control fashion based on the level in the centrifuge feed tank TNK01 measured by LT01. The dry solids concentration to the centrifuge CEN01/CEN02 will be measured using an inline solids meter AE01/AE02. The dry solids mass flow shall be calculated on by the PLC using the measured values from AE01/AE02 and the volumetric flowrate from FE01/FE03. Centrifuge CEN01/CEN02 will have a dedicated polyelectrolyte (poly) dosing pump PMP02A/PMP02B operating on a VSD. The poly dosing pump PMP02A (PMP02B) is interlocked to stop when PT04 (PT05) registers a high pressure or if the temperature switch TS04 (TS05) registers a high temperature. The speed of the poly dosing pump PMP02A/PMP02B is controlled based on the difference between the poly setpoint flowrate and the actual flowrate measured by FE07/FE08. The poly dosing setpoint is calculated based by ratio control according to the calculated solids mass flow ($AE01 \times FE01$, $AE02 \times FE03$) to centrifuge CEN01/CEN02. The polymer dosing pump PMP02A/PMP02B is interlocked to only run when the centrifuge feed pump PMP01A/PMP01B is running. If required, the polymer solution can be further diluted by mixing it with 2nd class water in a static mixer (MIX03/MIX04) before being dosed into the centrifuge feed. A dilution ratio can be set on the PLC/SCADA system which will calculate a flowrate setpoint for the 2nd class dilution water. The flowrate of 2nd class dilution water shall be measured on FE02/FE04. The difference in the measured flowrate and the setpoint will be used to adjust flow control valve FCV01/FCV02.

Centrifuge CEN1 and CEN2 will be supplied with its own local control panel (LCP) with HMI controlling all the aspects of the equipment supplied as part of the centrifuge package. The proprietary software shall integrate with overall plant SCADA system.

The centrifuge CEN01/CEN02 shall be able to be started automatically or manually. In automatic start mode, a start signal based on the level in the centrifuge feed tank (LT01) will be sent to the centrifuge unit. In manual start mode, the operator selects start via the SCADA/HMI. When centrifuge CEN01/CEN02 is started, the scroll conveyor shall begin to turn to provide scrolling of residual solids from the bowl. After two to three minutes, the main bowl drive motor shall begin to turn, controlled by the VFD, and the bowl shall begin to accelerate. After a pre-set, adjustable timed interval, during which the bowl has reached full operating speed, the feed pump PMP01A/PMP01B and polymer pump PMP02A/PMP02B shall start automatically.

After start-up has been achieved, the scroll conveyor torque on CEN01 (CEN02) shall be controlled at a pre-set point with controller XIC05 (XIC06) while the conveyor speed is allowed to vary, within pre-set limits, in order to maximize residence time. If torque begins to vary beyond the set point, the differential speed controller SDC01 (SDC02) shall be adjusted accordingly based upon a pre-set curve supplied by the centrifuge technology supplier.

If the centrifuge CEN01/CEN02 is commanded to stop or a fault condition occurs, the feed pump PMP01A/PMP01B and polymer dosing pump PMP02A/PMP02B shall stop, followed by the main drive motor, allowing the bowl speed to ramp down to rest. The scroll conveyor drive shall continue running to provide discharge of residual solids from the bowl during coast down. Centrifuge CEN01/CEN02 shall be automatically flushed with 2nd class water by closing valve XV28/XV29, opening valve XV01/XV04 and running the centrifuge feed pump PMP01A/ PMP01B for a pre-set (adjustable) time. During flushing, valve XV03/XV06 will divert flush water to drain. The solids chute shall automatically be flushed separately from the feed line by opening valve XV02/XV05 and valve XV03/XV06 diverts washwater to drain for a pre-set time (adjustable).

In the event that a fault condition occurs, an alarm fault message shall be displayed on the PLC/SCADA system. 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. The following faults shall be provided as alarm conditions:

- High vibration
- Feed pump PMP01A/ PMP01B fault
- Polymer dosing pump PMP01A/ PMP01B fault
- High scroll conveyor hydraulic pressure

The following faults shall be provided as alarm and shutdown conditions:

- Bowl drive motor fault
- Excessive vibration
- Scroll conveyor drive motor fault
- Excessive scroll conveyor hydraulic pressure
- Extended feed pause
- Extended low torque idle
- Excessive oil temperature
- Low oil level
- Sludge conveyor fault/stop
- Excessive bearing temperature
- Cake conveyor SCC01A/SCC01B fault

2.2.4 Polymer Make-Up System

In general, the operating philosophy as described below will apply. All equipment shall be controlled from a PLC/SCADA system. Items relevant to their operation and control are shown on Piping and Instrumentation Drawings P&ID W1859-45002.

The entire make-up and sequence shall be automatic, with the appropriate interlocks; the only manual part shall be the loading of the poly powder (in 25 kg bags) into the powder hopper by the operator. Whilst all the drives shall be controlled from the SCADA, there shall be local stop/start for maintenance operation only.

Polymer make-up system PMT01/PMT02 shall operate as follows. The two tanks in each poly make-up system PMT01/PMT02 shall alternate between make-up and dosing tanks. When a certain level (adjustable) is reached in the dosing tank, the polymer make-up sequence shall automatically be initiated in the make-up tank. Based on a concentration set point, the dosing screw speed or run time shall be calculated to deliver the required amount of polymer powder. The correct amount of potable water, measured by a ultrasonic level probe or a flow meter (as dictated by the polymer make-up tank supplier), shall be added to the make-up tank. The mixer shall automatically start to provide agitation. Once the correct amount of polymer powder and water have been added, the solution shall mature for an adjustable maturation time. Once this time has elapsed, the batch will be available for dosing. Once the level is sufficiently low in the designated dosing tank, the control system shall switch over tanks and the full make-up tank shall become the dosing tank. The solenoid valve on the discharge of the new dosing tank will open, and the solenoid valve on the new make-up tank will close. The make-up process will then continue as before. Polymer shall be withdrawn from the full dosing tank. The make-up process will be paused if the level in poly hopper low. An alarm will be generated on the SCADA system. If a low low level is reached in a dosing tank, an alarm shall register on the SCADA system for the operators to take action.

All mixers shall stop on low level. The level in the polymer hopper shall be measured and alarm at low level on the plantwide SCADA system to alert the operators to refill the hopper. The heat tracing system on the polymer dosing screw will have feedback to the plantwide SCADA system and alarm in case of a fault or if it is turned off when the polymer make-up system is required to run. The level in each tank on the polymer make-up system shall be displayed on the plantwide SCADA system. If low level is detected on the duty polymer dosing systems PMT01/PMT02, the polymer dosing pumps PMP02A/PMP02B and the polymer lubrication pumps PMP06A/PMP06B shall stop.

The total water consumption in the polymer make-up area shall be measured with FE11 and recorded on the SCADA system.

2.2.5 Sludge Conveying Equipment

In general, the operating philosophy as described below will apply. All equipment shall be controlled from a PLC/SCADA system. Items relevant to their operation and control are shown on Piping and Instrumentation Drawings W1859-45001 and W1859-45002 .

All conveyors shall be provided proximity switches ZS05/ZS06 to stop the conveyor SCC01A/SCC01B if the cover is out of position. An alarm shall be raised if any of the conveyors SCC01A/SCC01B fails to start or trips out during operation. It will not be possible to run the centrifuges CEN01/CEN02 if the respective sludge conveyor SCC01A/SCC01B has not started. The sludge conveyors will stop if a high level is reached in either compartment of the sludge hopper HP01 as measured by LT02/LT03. The sludge level in the hopper HP01 shall be measured using an ultrasonic probe.

The diverting flap separates the two compartments of the sludge hopper and will divert sludge to the inlet of the duty cake pump PMP03A (PMP03B). The operation of the flap shall be manual. Proxy position switches ZS01 (ZS02) shall indicate the direction of the flap and be used to interlock the pump PMP03A (PMP03B) to stop should the position not be made. This interlock shall be bypassed during flushing. The duty cake pump PMP03A (PMP03B) shall only start once a minimum sludge level (adjustable) is reached in the hopper. The speed of the pump will be controlled based on the level in the hopper. The bridge breaker BB01A (BB01B) for the duty cake pump shall automatically start once the cake pump is running. The solids concentration in the cake will be measured using solids meter AE04 (AE05) on the discharge of cake pump PMP03A (PMP03B).

When the duty cake pump starts up PMP03A (PMP03B), there will be water in the sludge line from the previous line flush when the pump stopped. A dump valve XV14(XV15) at the end of the sludge line will open while the cake pump PMP03A (PMP03B) runs (at a pre-set speed) to allow the flush water to be dumped to drain. After a certain time limit (adjustable) the dump valve will close XV14(XV15) and the valve to the inlet of the selected sludge silo XV10/XV12 (XV11/XV13) will open to commence pumping sludge into silo TNK02 (TNK03). The duty sludge cake silo (TNK02 or TNK03) shall be selected on the SCADA system. Cake pump PMP03A (PMP03B) is interlocked to stop when PT07 (PT08) registers a high high pressure or if the proximity sensor ZS03 (ZS04) on the bursting disc BD01 (BD02) is not made or if the temperature switch TS07 (TS08) registers a high temperature.

When a cake pump is changed over or the transfer of sludge stops, an automatic flush sequence will start. A valve XV16 (XV17) on the 2nd class water supply line will open and water will enter the compartment of cake pump PMP03A (PMP03B). Pump PMP03A (PMP03B) will continue to run and pump washwater through the sludge line. The dump valve XV14 (XV15) and sludge silo inlet valves XV10/XV12 (XV11/XV13) will be set on timers (adjustable) which will divert flow way from the sludge silo TNK02 (TNK03) once the volume of sludge in the pipe has been pumped through to prevent washwater from entering the silo. Washwater will be dumped to drain. The time setpoints for the valves will be calculated from the pump speed and the estimated volume of material in the piping.

The poly lubrication pump PMP06A (PMP06B) will operate as duty/standby and either pump can supply lubrication to cake pump PMP03A by opening valve XV27 or PMP03B by opening XV26. The duty poly lubrication pump PMP06A (PMP06B) shall be selected on the SCADA system. The duty poly lubrication pump PMP06A (PMP06B) will start/stop (after an adjustable timer) when the duty

cake pump PMP03A (PMP03B) starts/stops. The poly lubrication pump PMP06A (PMP06B) is interlocked to stop when PT09 (PT10) registers a high high pressure or if the temperature switch TS09 (TS10) registers a high temperature or if XV26 and XV27. The speed of the poly lubrication pumps PMP06A (PMP06B) will adjusted by VSD based on the difference between the measured polymer flowrate from FE10 and the flowrate setpoint. The flowrate of polymer lubrication can either be set at a constant flow rate set point (pumped at a fixed speed) or the flow rate setpoint can be varied based on the speed of the sludge cake pumps PMP03A (PMP03B).

2.2.6 Sludge Cake Silos

All equipment shall be controlled from a PLC/SCADA system. Items relevant to their operation and control are shown on Piping and Instrumentation Drawings W1859-45002 (60325-M-08 SHT 003).

The sludge level shall be measured in silo TNK2 (TNK3) using ultrasonic level measuring devices LT04 (LT05). Each level probe shall be installed close to the sludge inlets as this is the area where the highest sludge build up will occur. Each cake pump PMP03A/PMP03B shall discharge sludge to a separate point at the centre of the silo. If either LT04 (LT05) registers a high level, an alarm will be generated on the SCADA system for the operators to take action. If either LT04 registers a High High level, the inlet valves XV10 or XV11 (XV12 or XV13) to the silo TNK02 (TNK03) will shut which will stop the downstream dewatering process i.e. cake pumps PMP03A (PMP03B), sludge conveyors SCC01A/SCC01B, centrifuge feed pumps PMP01A/PMP01B and centrifuge CEN01/CEN02.

The total volume of sludge in the silos will be estimated from the level probe LT04 (LT05) with a correction factor to account for the sludge piles which will be set up during commissioning. The total volume will be recorded on the SCADA system and be used to calculate the amount of sludge being discharged into the sludge collection trucks. When discharging to a collection truck, the feed to the duty silo TNK02 shall be diverted to the standby silo TNK03 by closing XV10 and opening XV12 and visa versa. Alternatively, dewatering shall be temporarily stopped.

When discharging sludge from the silo TNK02 (TNK03), the discharge valve XV18 (XV19) shall be opened to the desired percentage opening by an operator at a local control panel situated above the collection truck. The operator will determine the rate of discharge by adjusting the position of valve XV18 (XV19). When the truck is full, the operator shuts valve XV18 (XV19). The discharge process can only be initiated from the outside area above the collection truck. This shall ensure that the truck is in the correct position before discharging takes place, as well as to ensure there is sufficient space in the truck to discharge to discharge sludge into.

3 REACTORS

3.1 Process Description

Hammarisdale WWTP has 6 existing biological reactors operating as a 5-Stage Bardenpho process. Aeration is supplied in the main aeration basin using four 37 kW turbine surface aerators and a 11 kW surface aerator in the re-aeration zone. Mixing in the primary and secondary anoxic zone is achieved using a submersible mixer in each of the zones.

3.2 Control Narrative

3.2.1 Surface Aerators

In general, the operating philosophy as described below will apply. All equipment shall be controlled from a PLC/SCADA system. Items relevant to their operation and control are shown on Piping and Instrumentation Drawings W1859-45006. This narrative is written for reactor 1. The control philosophy for each reactor is identical.

The speed of each surface aerator ATR01, ATR02, ATR03 and ATR04, in the main aeration zones, shall be manually adjusted from the SCADA system or via feedback from the DO probes (AE01A and AE01B) situated in the main aeration zones. There shall be two DO probes in each main aeration basin. The location of the DO probes shall be such that the 1st DO probe (AE01A) will be used to control the 1st and 2nd surface aerators (ATR01 and ATR02) and the 2nd DO probe (AE01B) shall be used to control the 3rd and 4th surface aerators (ATR03 and ATR04). The DO levels in each basin will be displayed on the SCADA system. They will alarm at high and low DO levels.

3.2.2 Mixers

In general, the operating philosophy as described below will apply. All equipment shall be controlled from a PLC/SCADA system. Items relevant to their operation and control are shown on Piping and Instrumentation Drawings W1859-45006. This narrative is written for reactor 1. The control philosophy for each reactor is identical.

The mixers MIX01 and MIX02 will be started and stopped from the SCADA. Each mixer shall alarm on the SCADA for fault or overload conditions.

4 REFERENCE DOCUMENTS

Refer P&IDs Reference Numbers :

W1859-45001
W1859-45002
W1859-45003
W1859-45004
W1859-45005
W1859-45006