Epsom Spring Gully
Recycled Water Pumping & Treatment Facility

Functional Description
3552306 - F000 - I - 001

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1. INTRODUCTION

1.1. General

This functional description describes the process control functions for the following facilities currently being installed under the Coliban Water Recycled Water Pumping and Treatment Facility, including the following major process items:

- Low Lift Pump Station [including the feed pipeline]
- Class A Processing Train
- UF/RO Processing Train
- Bendigo Mining Limited feed stream
- High Lift Pump Station
- Pipeline to Spring Gully Reservoir

This functional description shall be read in conjunction with and incorporate all I/O as required by the:

- I/O Schedule
- Loop drawings and motor schematic drawings
- P & ID's

1.2. Definitions

1.2.1. Control System Definitions

Interlock - A device or function used to help prevent a machine from harming its operator or damaging itself by stopping the machine when tripped. While interlocks can be something as sophisticated as curtains of infrared beams and photo-detectors, they are often just switches. They are usually connected to a computer based control system.

Start permissive – An interlock tested by a control system. If the condition of the interlock is favourable, the software may permit another device or function to change state. If the condition of the interlock is unfavourable, the software will prohibit the other device or function from changing state.

Run permissive - An interlock tested by a control system. If the condition of the interlock is favourable, the software may permit another device or function to remain in its present state. If the condition of the interlock is unfavourable, the software will force another device or function to change state.

Alarm - A device or function that signals the existence of an abnormal condition by means of an audible or visible discrete change, or both, intended to attract attention.

Mask – A function preventing an alarm in a situation where the alarm is spurious e.g. a low flow alarm is masked when the supply pump is stopped.

1.2.2. Operation & Plant Definitions

BEP = Best Efficiency Point

BML = Bendigo Mining Limited

BWRP = Bendigo Water Reclamation Plant

CAMS = Campaspe Asset Management Services (being Coliban Water's operator)

CCT = Chlorine Contact Tank (TK200-90).

CIP = Clean in Place – application of chemicals to clean surfaces and pores of membranes

Class A – Process train to produce Class A recycled water quality with no UF or RO process

CoGB – City Of Greater Bendigo

EC_{BML} = Conductivity of BML stream

FAC = Free active Chlorine

FAT = Factory Acceptance Test

HLPS = High Lift Pumping Station

HMI = Human Machine Interface

K_f = Flow Correction Factor

K_Q = Quality Correction Factor

LLPS = Low Lift Pumping Station

L/S = Litres/sec. flow [11.574 L/S = 1 ML/D]

Milestone 1 = first project stage that will operate all the RWPTF plant except for the UF/RO process. No control of final water TDS will operate

Milestone 2 = second project stage that will operate all the RWPTF plant including the UF/RO process, RWPTF control of final water TDS will be implemented

ML/D = MegaLitres/Day flow

NTU_{BML} = Turbidity of Bendigo Mine Stream

PCS = Programme Control System

PID = Process and Instrumentation Diagram

POR = Preferred Operating Region

PQP = Plant Quality Permissive [maximum allowed TDS & NTU signals].

Q_A = Flow set point through Class A plant

Q_{NFA} = Net Water Flow available to the RWPTF after Perseverance Mine take-off.

Q_{OPS} = Class A Flow Set Point requested by plant operations

Q_Q = Class A Flow Set Point determined by quality requirements

Q_{BML} = Incoming Flow from Bendigo Mine to Final Water Tank

Q_{UFRO} = Flow through membrane plant

Q_{HLPS} = Actual Flow ex the High Lift Pump Station

Q_{THLPS} = Theoretical Flow ex the High Lift Pump station when Class A flow is at Q_Q – the quality maximum

RO = Reverse osmosis – membrane application to remove dissolved solids

RWPTF = Recycled Water Pumping and Treatment Facility

TDS = Total Dissolved Solids (salt)

TWL = Top Water Level

UF = Ultrafiltration – membrane application to remove ultra fine particles

UV = Ultraviolet disinfection

UVT = Ultraviolet transmittance

2. FUNCTIONAL DESCRIPTION OVERVIEW

2.1. General Control Principles

2.1.1. Access Security Levels

The control system will be configured to allow changes to certain parameters by certain personnel with approved authority.

The three levels of authority are as follows:

- Operation for all normal plant operations.
- Supervisor for key plant inputs and settings that need to be managed and changed in a controlled way.
- Restricted for software control parameters, which should only be modified by trained software personnel.

Access to functions specified in this document are “Operations” access unless specifically identified as “Supervisor” or “Restricted”.

2.1.2. Equipment Control Methods

For the control purposes, the following modes are referred to throughout this Functional description and are defined below.

The following descriptions, identifiers and icon tags are described for functional purposes. Coliban Water has established standard HMI tags symbols and other conventions. If the descriptions below differ from that in the existing SCADA, then the existing SCADA symbols, tag icons, engineering units and conventions shall be used. Also refer to 2.5.1 for S.C.A.D.A. requirements.

- **Running or open**, while a device is running or a valve is open it shall be indicated in the HMI as Green.
- **Stopped or Closed**, while a device is stopped or a valve is closed it shall be indicated in the HMI as Red.
- **Fault,** devices that are in fault condition shall be indicated in the HMI by a yellow colour.
- **Manual mode**, this is generally selected at the MCC motor cell and depending on the motor arrangement, either starts the motor when selected to manual via the motor cell circuitry or enables local control via the local VSD control panel. Typical applies to motors. Manual mode is indicated in the HMI by a small hand and an “L” icon tag on the device to indicate the device is in Local manual mode. In Manual mode, all P.L.C. interlocks are not effective.
- **Automatic Mode**, this mode allows the P.L.C. to start and stop the motor and is selected at the MCC cell. Typically applies to motors. This is the normal mode for operation and requires a tag on the device in the HMI. A dedicated digital input from a ready relay indicates to the P.L.C. that the motor cell selector switch is in Auto and all hardwired interlocks are removed.

- **Off Mode**, this mode is selected on the MCC Cell and disables the motor from receiving operating, **Note,** selecting off on the selector switch is not an effective mean of isolation.
- **Sequence mode**, this mode is selected at the HMI and all allows the motor to be controlled according to the process control software in the P.L.C. This applies to motors and actuated valves. This is the normal mode for operation and requires a tag on the device in the HMI.
- **Operator mode**, this mode allows the operator to operate the device via the HMI but cannot override the interlock conditions. This applies to motors and actuated valves. This mode is similar to manual except the HMI only has control of the device. Operator mode is indicated in the HMI by a small hand icon tag on the device.
- **Maintenance mode**, this mode allows the operator to control the device via the HMI and all interlocks are bypassed in this mode. Maintenance mode is indicated in the HMI by a small spanner icon tag on the device. Maintenance mode can only be instigated when the associated device is not operating as part of the general plant sequence.
- **Valve Position Override**, this mode shall be used to override a valve position feedback signal for either the closed or open position. Valve Position Override mode will allow the operator to override a selected valve position switch and the HMI will log the event, operator initiating the event and tag the device for maintenance. The device can then be returned to sequence mode with the override in place. A visual inspection is required before instigating an override.

2.1.2.1. Typical VSD Pump Motor Control

VSD motor control has three primary modes selected by a field auto/manual switch:

Auto

Manual

Off

In auto, the drive is enabled to take commands from the PLC DeviceNet communications. The status of the auto/manual switch is reported to the PLC via a dedicated digital input. In auto mode, indicated to the PLC via the dedicated Ready Relay digital input, the PLC will provide three further modes of control:

Sequence

Operator

Maintenance

The motor/drive shall transfer bumplessly from the PLC sequence modes to the other PLC control modes and vice versa if the sequence request is the same as the manual control request.

1. In manual mode, indicated to the P.L.C. via a dedicated digital input, the drive shall be operated only by the local VSD control panel. In Manual mode, all P.L.C. interlocks are ineffective.

2. Fault reset of the drive is possible by a reset button input in the drive panel or via the PLC communications. The fault status of the drive is indicated to the PLC via DeviceNet communications and issued as an alarm in the Citect HMI and next to motor HMI symbol as F. Fault status of the drive is also indicated in the motor control panel.

3. The drive receives its speed set point via the PLC or through the local drive LCD control panel. The speed set point and actual motor speed is indicated numerically in Hz in the Citect HMI.

4. The run status of the drive is indicated to the PLC via DeviceNet communications.

5. In automatic mode, if the motor has been asked to run and run feedback not observed for some adjustable time, a fail to start alarm will be issued and indicated. The alarm will be cleared by a motor independent fault reset or global motor reset. The drive/motor reset in the field will not reset this fault.

6. In automatic mode, if the motor has been asked to stop and the run feedback is still observed for some adjustable time, a fail to stop alarm will be issued and indicated. The alarm will be cleared by a motor independent fault reset or global motor reset. The drive/motor reset in the field will not reset this fault.

7. An interlock condition will be indicated as letters IL next to the motor HMI symbol.

8. Local indicators for drive ready (auto), running and fault are provided in the motor control panel.

9. Bump testing shall be carried out by selection of local manual on the MCC and initiating a jog forward signal on the VSD keypad.

10. Motor/drive status signals are used to calculate and display starts and hours run today and automatically roll into starts and hours run yesterday at midnight (12:00AM) each day.

11. Power consumption, trending, and total consumed energy for each drive/motor shall be provided in the Citect HMI, the VSD shall provide the data for trending to the P.L.C. via devicenet.

12. Alarms, the following alarms shall be generated for each Motor controlled by VSD:

    - Failed to start, Level 2
    - Failed to stop, Level 2
    - Motor/Starter Fault, Level 2
    - Communications Fault, Level 2
    - VSD Fault, Level 2

13. P.L.C. Interlocks are listed in the Functional requirements section of this document. There are hardwired devices that energise the run relay, they are:

    - Motor Circuit breaker (closed)

- Emergency stop switches (closed)
- Seal failure relay energised (Submersible pumps only)
- Mode switch in Auto

2.1.2.2. Normal Pumping Control

1. The motor control has three primary modes selected by a field auto/manual switch:

Auto

Manual

Off

In auto, the starter is enabled to take commands from the PLC digital I/O. The status of the auto/manual switch is reported to the PLC via a dedicated digital input. When the drive is in manual mode the pump will run with Interlocks bypassed until the selector is removed from manual. In auto mode, indicated to the PLC via the dedicated Ready Relay digital input, the PLC will provide two further modes of control, PLC sequence mode and PLC maintenance mode. These modes will be set and indicated on a popup controller for the motor in the HMI. It shall be possible for the motor/drive to bumplessly transfer from the PLC sequence modes to the other PLC control modes and vice versa. The PLC maintenance mode is a special case of PLC operator mode where interlock conditions are bypassed. In sequence mode the pump will start when the interlocks are satisfied.

2. An overload is present in the motor starter circuit and where fitted, a RCD in the socket outlet, if the overload or RCD operates, the P.L.C. cannot receive a motor ready signal.

3. The run status of the motor is indicated to the PLC via Digital input.

4. P.L.C. Interlocks are listed in the Functional requirements section of this document. There are hardwired devices that energise the ready relay, they are:
   - Motor Circuit breaker (closed)
   - Emergency stop switches (closed)
   - Seal failure relay energised (Submersible pumps only)
   - Mode switch in Auto
   - Overloads, RCD, and other protective devices.

5. In automatic mode, if the motor has been enabled and contactor feedback is not observed for some adjustable time, a fail to enable alarm will be issued and indicated. The alarm will be cleared by a motor independent fault reset or global motor reset.

6. In automatic mode, if the motor has been asked to stop and the run feedback is still observed for some adjustable time, a fail to stop alarm will be issued and indicated. The alarm will be cleared by a motor independent fault reset or global motor reset.

7. An interlock condition will be indicated as letters IL next to the motor HMI symbol.

8. Motor/drive status signals are used to calculate and display starts and hours run today and automatically roll into starts and hours run yesterday at midnight (12:00AM) each day.

9. Alarms, the following alarms shall be generated for each motor :
   - Failed to start, Adjustable Delay, Level 2
   - Failed to stop, Adjustable Delay, Level 2
   - Motor/Starter Fault, Level 2

2.1.2.3. Actuated Valve control (VA200-15)

1. The valve has four operator modes selected by the operator, they are:

   Sequence Mode

   Operator mode

   Maintenance mode

   Valve Position Override mode

   These modes will be set and indicated on a popup controller for the valve in the HMI. It shall be possible for the valve to bumplessly transfer from the PLC sequence modes to the other PLC control modes and vice versa.

2. The position status of the valve is indicated to the PLC via dedicated Digital inputs for valve closed and open.

3. When the valve has been signalled to change state and the position confirm feedback observed has not confirmed the new valve position after a pre set expected actuation time, fail to operate alarms will be as follows:
   - Fail to open, Level 1
   - Fail to Close, Level 1
   - Limits failure, Level 2

   The alarm shall be cleared by a valve independent fault reset or global valve reset. The actuation time shall be made adjustable via a pop up screen for each valve.

4. The operator shall have the ability via the HMI to select “Valve Position Override” mode. To implement this mode the operator shall be required to enter his name as authorisation and advise maintenance staff of this action. The override event shall be logged. Refer to 2.1.2.

5. An interlock condition will be indicated as letters IL next to the valve HMI symbol.

6. Valve status signals are used to calculate and display operations today and automatically roll into yesterday at midnight (12:00AM) each day. Total number of operations shall be available to the operator via a pop up screen.

2.1.3. PID Loops

1. PID loops shall have the following modes of operation:

   Operator Mode

   Auto Mode

   Manual Mode

   Sequence Mode

   Auto Mode

   Manual Mode

   Operator mode shall be initiated via a HMI pop up and allows the operator to alter the PID loop set point in Auto mode, or the PID loop output in manual mode. The alterations shall be via the HMI interface.

   Sequence mode shall be initiated via a HMI pop up and allows the process software to alter the PID loop set point in Auto mode, or the PID loop output in manual mode. The operator has no input to the selection of Auto/manual in sequence mode.

2. The transition between auto, manual modes in both operator and sequence modes shall be bump less and no integral windup. In the Case of loops cascading, integral windup shall be avoided.

2.1.4. Analogue Inputs

1. All Analgoue input devices shall be provided with the following conversion blocks in the P.L.C. software accessible for adjustment:
   - Raw input minimum value
   - Raw input Maximum value
   - Engineering Units Minimum value
   - Engineering Units maximum value

   Access to the conversion blocks shall be supervisor level.

2. Calibration functions shall be incorporated in to the P.L.C. software to assist in instrument calibration for instruments that require re-calibration during the life of the instrument.

3. The signal from every analogue device shall be tested within suitable limits before the value is used in process. If the signal is outside the test limits, the device is determined to be faulty and a level 2 Alarm raised. The process value shall assume a fail-safe level and indicated as an analog fault The status registers associated with the analogue input channel will be used the display the health of the analogue input in the HMI. For example a broken wire or a device fault.

4. The following alarms and set points shall be configured in the HMI for each analogue input:
   - Signal high, Level 3
   - Signal high high, Level 2
   - Signal low, Level 3
   - Signal low low, Level 2
   - Signal fault (broken wire), Level 2

5. All analog inputs shall be set up for trending in SCADA. Data shall be accessible and suitable for downloading into a database and Excel spreadsheet for analysis.

2.1.5. Parallel & Standby Equipment

Some items of plant - typically pumps - are installed as sets where a number of identical or similar items, operating in parallel, are required to perform the one function.

In some instances not all the installed items are required to operate to deliver the required function. In this case, the non-operating items are considered “Standby” items.

In some instances all the installed items are required to operate only at high load. In this case, when items are not required they are also considered “Standby” items.

Where they exist, the “Standby” unit will start automatically on failure of the duty unit.

Each device shall have an adjustable maximum operating time after which the device is to be removed from duty to a standby device. When a standby device is call for duty, the device with the least operation time shall become the new duty device. The device must be in auto/sequence mode to be selected for duty.

High Lift and Low Lift Pump Operation

For each pump the following parameters are set up in the HMI:

- **% split,** the percentage of total operation hours for a 4-week period that the pump shall carry out. This is adjustable at a supervisor level. Default 100% divided by the number of pump in service.
- **Total hours,** This is the total hours that a pump has operated, this parameter can be reset at supervisor authority level.
- **4-week period hours,** running total of pump hours for the last 4 week period. Also shall be expressed as a percentage of the total of all pumps running hours for the 4-week period.

For each pump set the following parameters shall be set up in the HMI:

- **Total 4-week period hours,** this is the total pump operation hours for the running period of 4 weeks.
- **Over run time,** is the time that a pump can operate beyond its allocated 4-week period. The supervisor via the HMI can adjust this parameter, default time is 4 hrs.

The available pumps for duty (pumps in automatic and sequence modes with no faults and un isolated) shall be placed in a duty queue with the pumps with the most remaining hours for the 4 week running period at the front of the queue and the least at the back.

The duty requirements determine how many pumps shall run according to the control loop description for each pump set. See Low Lift Pump and High Lift Pump set control.

When an operating duty pump reaches its allocated running time for a 4 week period according to its % split and another pump is available in the duty queue, the pump in

operation shall continue as required until a preset adjustable time allowable "overrun time" is reached, at this time the pump is placed back in the duty queue and the next available pump is called to replace it. If no pump is available to replace it, then the pump in operation shall continue to operate.**Operational Overview**

2.2.1. Master Flow Control – Milestone 1 -Class A Only

From the completion of Milestone 1 in mid 2007 until Milestone 2 in early 2008 only the Class A treatment and pumping facilities will be operating.

The Class A treatment process and pumping facilities and the BML pipeline connection will be implemented prior to the UF/ RO process stream. The Class A and the BML flow will be operated together without any TDS control.

During this time the final water TDS level will fluctuate with the wastewater and BML inlet TDS concentration. The Class A flow rate will be set by plant operations to meet rural and CoGB demands. (Refer Section 3.16 for more detail)

2.2.2. Master Flow Control – Milestone 2 -Class A and UF/RO Operation

After completion of Milestone 2, the control philosophy will be modified to maximise recycled water production within the target TDS limits.

To achieve this:

- The UF/ RO plant will be operated at its maximum capacity at all times.
- All available BML water will be taken subject to BML water TDS < 350mg/L.

The total RWPTF flow rate may still be set by plant operations to meet rural and CoGB demands should they be less than the plant capacity for any reason.

Flow splitting between Class A and UF/RO trains will be determined continuously on the basis of the influent TDS (measured as EC) and nutrient concentration (measured intermittently via lab test). A high level [Level 2] TDS alarm in the FWT will initiate a turn down of the Class A stream. A high-high [level 1] TDS alarm will shut down the Class A stream.

The final water TDS will be used to trim the Class A flow so that the target TDS when averaged over the day is not exceeded. (Refer Section 3.16 for more detail)

Maximum Class A plant rate of change of flow permitted:

Decreasing or Increasing Flow: Recommended maximum =0.5% of the flow /minute (to be tested, adjusted and validated during commissioning)

The flow splitting calculation will incorporate:

- QNFA
- tertiary effluent TDS (from existing BWRP) and nutrient history (i.e. the water quality of the RWPTF influent),
- RO product water flow and TDS history, and
- BML water flow and TDS/nutrient history;

If the turbidity [as measured at the existing tertiary filters by AE4104] of the tertiary effluent exceeds 5 NTU for > 1 minute or the 24 hour median (noon to noon) is > 2.0 NTU, then the RWPTF [both Class A & UF/RO] must shut down. The RWPTF can start up once the tertiary effluent is < 5NTU for > 10 minutes

If the final water TDS leaving the FWT rises to a high level (500 mg/L (provisional equivalent of 900µS/cm)) for more than 1 minute then an alarm will activate and the flow set point for the Class A plant will be reduced. If the final water TDS rises to a high-high level (800mg/L (provisional equivalent of 1450µS/cm)) for more than 1 minute then the Class A plant will be shut down. During the UF backwash the RO feed water tank will balance the flow and allow the RO membrane to maintain production. During the UF or RO membrane CIP process the supply will stop. The BML and Class A water discharges into the FWT will not be affected by the shut down of the UF/RO so the CIP process will result in a reduction rather than a halt in water production. The PCS will detect the reduced flow from UF/ RO and will decrease the Class A flow rate as necessary to maintain target TDS levels.

2.3. Faults

2.3.1. Equipment Faults

When a fault is detected the equipment shall be stopped, an alarm generated and, where available, the standby unit started.

Should the standby unit be unavailable the sequence must be halted and an alarm raised.

The following faults as a minimum will be derived for each piece of equipment as appropriate.

- Drive unavailable (i.e. no Ready or Manual signal, indicates motor selected to of or circuit breaker open).
- Drive faulted (i.e. VSD fault)
- Drive failed to start (i.e. pump no flow, process check)
- Valve failed to open
- Valve failed to close
- Valve indeterminate position fault i.e. NEITHER (open or closed) OR (open and closed)
- Deviation from setpoint alarms for all PID controlled flow and level loops. The amount of deviation permitted will be determined for each individual loop.
- Motor fault, when in auto mode and P.L.C. calls for a motor to run, the motor runs and then run signal is lost.

2.3.2. Alarm Status

Alarms will be raised where process conditions deviate from the required set point by a determined amount or where values cross a certain predetermined value.

Alarms will be classified into the following types:

- Level 1 Critical alarms that are likely to cause the plant to shut down or significantly change the way the plant operates.

e.g. will cause the shut down of either the UF/RO plant or the Class A system. Requires operator attention.

- Level 2 Alarms that will change the way the plant operates or warns of imminent Level 1 alarm condition. Operator attention likely to be required.
- Level 3 Alarms that are of lower criticality where corrective action can be delayed but should not be ignored. Immediate operator attention not required.

2.4. Conventions

Pressures referred to in this document are all gauge pressures unless identified otherwise.

Values for set points and alarms are all provisional values and must be verified for suitability during commissioning.

2.5. HMI Requirements

2.5.1. S.C.A.D.A.

The new plant additions shall be incorporated into the existing CITECT SCADA system and a new operator station added.

Additional to the requirements listed in the scope of work, the HMI shall:

- Replicate the existing SCADA screen icons and symbols currently used by Coliban Water
- Display screens showing major plant areas based on the P & ID drawings and cover the entire process.
- Incorporate easy and logical navigation between screens and the main menu systems as per Coliban Water site standard.
- Display all equipment status/fault and process measurements with units.
- Provide access to operator mode control.
- Be configures to allow all screens to update within a maximum time of 1 second.
- Filter alarms by area.

All operator actions via the SCADA shall be logged with date, time, device name, sequence and log in level.

All data entry points shall be validated i.e. flow range 0 to 30ML per day.

2.5.2. RTU

The pipeline control and monitoring systems require the use of the RTU network at Coliban Water.

The integrator shall provide programming to bidirectional interface the Epsom Spring Gully Recycled Water Pumping and Treatment Facility with the RTU network.

The integrator shall insure that all information flow occurs in a timely manner for providing real time control of valves etc.

All RTU connected equipment shall be displayed and alarmed on all relevant Citect systems.

The integrator shall ensure licensing and tags are sufficient for the application and advise Coliban Water accordingly.

Refer to the Drawings, I/O list and Coliban Water SCADA Specification (Appendix F of the scope of work document).

3. FUNCTIONAL REQUIREMENTS

3.1. Group Starts and Shutdowns Required

3.1.1. Group Start

The Group Start starts the operation of the RWPTF from the Low Lift Pump Station through to the Final Water Tank. The High Lift Pump Station will operate under its own independent control loop as it will respond to both the RWPTF and the Bendigo Mine input flows by maintaining a level setpoint in the FWT.

This group start manages the start-up operation of all control loops involved in delivering water to the Final Water Tank via the RWPTF.

Refer to Section 3.17 for details of Group Start-up.

3.1.2. Group Shut

Group Shut manages the shutdown of the RWPTF from the Low Lift Pump Station through to the Final Water Tank. The High Lift Pump Station will continue to operate under its own control as it will respond to both the RWPTF and the Bendigo Mine input flows.

Refer to Section 3.18 for details of Group Shut.

3.2. Potable Water System

The potable water system is used for service of the amenities building and the safety shower.

This system operates manually & there are no automated controls.

3.3. Fire Services

The fire services are supplied from the main water pipeline discharge.

This system operates manually & there are no automated controls.

3.4. Service Water System Control

3.4.1. Overview

The service water system provides recycled water for two primary purposes around the plant:

- Dilution of chemicals being dosing into the main process
- Water for general hosing functions

The services water system is an integral package supplied by others and for the purposes of control can be considered a self-contained package with the following outputs for monitoring purposes.

System Set point: 3 Bar [g]

Monitored Inputs:

- Service Water Pressure, **(PT000-01)**
- Pump Set Fault, **(XA000-01)**
- Service Water System Fault, **(XA000-02)**

Alarms shall be generated from the above inputs:

- Deviation alarm (0.3 Bar, 2 sec. Delay), Level 3,**(PC 000-01)**
- High Level Alarm (3.5 Bar, 2 sec. Delay), Level 3,**(PAH PC000-01)**
- Low Level Alarm (2.7 Bar, 2 sec. Delay), Level 3,**(PAL PC000-01)**
- Low Low Level Alarm (2.5 Bar, 2 sec. Delay), Level 2, **(PALL PC000-01)**
- Pump Failure,
- System Fault,

Refer to Loop Drawing 3552306-000-I-031, Refer to P & ID 3552306-000-PR005

3.5. Low Lift Pump Set Control

3.5.1. Overview

The Low Lift Pump Set (Pumps PU-100-10, PU-100-20, PU-100-30, PU-100-40 [the jockey pump]) delivers water at the required pressure and flows to the UF/RO plant and also to the Chlorine Contact Tank.

The pump set operates the appropriate number of pumps to deliver the required volume of water for distribution to the two process trains.

The pump set will run under pressure control to deliver a set pressure to the two control valves that feed the UF Feed Tank and the Chlorine Contact Tank.

3.5.1.1. Flow Splitting

The two control valves that feed the UF Feed Tank and the Chlorine Contact Tank will then operate to share the water between the two processes based on a maintaining the correct level in the UF/RO plant feed tank and the remainder going to the Chlorine Contact Tank.

3.5.2. Wet Well Pump Control

Low Lift Pump Set Control

Control System Feature	Requirement Description	Value
1. Controller Identifier	PC100-00 (refer P&ID 3552306-100-PR001)	
2. Operation Method	Runs when plant is in "Auto"	
3. Initiation	Starts under operator initiation of "System Group Start 1" or if operator initiates loop individually via the HMI The pumps must not be initiated if the Wet Well level [LT100-01] corresponds to a level below the high weir in TK100-01	LAL LT100-01 *value to be determined at commissioning*
4. Loop Set Points	PID Loop set Point SP1 PC100-00 The pressure set point will be optimised during commissioning by ensuring that the 2 control valves downstream [VC 100-02 & VC100-03] are not more than 25% closed. This may require the pressure set point to vary with flow.	0.4 Bar *(initial setting only for commissioning)*
5. Start Permissive Interlocks	■ PLC is in "Auto". ■ All equipment involved in this loop is in connected & healthy (*Note: Only 1 of the 4 pumps is required to be healthy to permit the system to start subject to minimum flow restrictions- see last point in this section)* ■ Pump station Wet Well low level LSL 100-01 not activated ■ Pump station Wet Well low level LSL LT100-01 not activated ■ Pumps will start individually and run up to speed over "Rise Time". Subsequent pumps will wait for "Delay Time" and will then start if the set point pressure is not achieved. Refer to section 2.1.5 for duty standby operation. ■ The jockey pump will only be used if the set point for FC100-02 is < large pumps minimum ■ CCT Inlet Control Valve [VC100-02] < set amount open ■ Control Valve VC100-03 must be set to > 10%	Rise Time = 15sec. Delay Time= 5 sec Max. Flow Set Point for jockey pump use : 5.5ML / day Set Amount: 20% *(initial setting only confirm at commissioning)*

Control System Feature	Requirement Description	Value
	open for Milestone 2 ■ If Q_{NFA} is less than 5.5ML/D AND the jockey pump is not available [i.e. "off line"] then the plant cannot start.	
6. Run Permissive Interlock	■ All start permissive interlock situations excluding CCT inlet valve requirement ■ The initiation of a PSH and FSL alarm on any individual of the 4 pumps will cause that pump to shut down. The pump cannot be part of the sequence till operators reset this alarm condition ■ LSL100-01 – Low Level in pump well - Shut one pump at a time with Delay Time between shutting down till LSL signal not activated.	Valve VC100-02 to remain closed till pressure deviation condition is removed On for 5 sec Delay Time =10 sec
7. Alarms	Deviation Alarm PC100-00 Level 3 PSH 100-10/20/30/40 Level 3 FSL 100-10/20/30/40 Level 3 Pump VSD speed Deviation Level 2 Pump failure [any of 4 pumps] Level 2 If all pumps fail Level 1 Pumps operating outside preferred speed range Level 2	0.2 Bar 2 sec delay 0.7 Bar 5 sec delay 2 ML/D & 5 sec delay Motor RPM <60%- or >102% of full speed <60% to - >100%
8. Overrides	**Note:** When total flow into RWPTF [as measured by the sum of FT100- 02 plus all FTs on the UF permeate outlets] is < 3ML/day the UF feed tank level set point will be raised to allow overflow back to the LLPS wet well [refer UF/RO System Feed Control].	
9. Alarm Masking	- When loop PC100-00 is not on - For time delay after loop is initiated - PSH & FSL of each individual pump when that pump is not on.	10 seconds
10. Control Algorithm	The pump set must operate as a single system selecting the most appropriate number of pumps and pumps speeds to deliver the set point pressure per pump supplier's instructions. Refer section 3.5.3 for more detail. Operation outside the required range will cause a Level 2 Alarm.	

Control System Feature	Requirement Description	Value
11. Monitoring	The HMI must permit starting of this loop as part of Group Start 1 and also as a stand alone loop. Access to all set point and alarm values and the status of the four pumps (including the operating speed of the pump VSDs) will be required.	
12. Hand Access	All alarms [refer Item 7] will operate. All Start permissive & run permissive interlocks will be bypassed.	
13. Alarm Response	The HMI must prompt the plant operator when alarms activated [refer item 7] to determine likely causes of alarms and that interlocked overrides are being initiated.	
14. Shutdown	On initiation of the shutdown instruction for this loop, pumps that are operating will shut off in a staggered sequence. Pumps shutting off will individually ramp down to 50% of maximum pump RPM over maximum of 60 seconds (subject to pump manufacturer approval) and then power will be shut off	Time between a pump completing its shutdown to the next pump starting its shutdown: 10 sec

3.5.3. Pump Set Operation

The pump set will operate at speeds to maintain operation within the preferred operation region. This region is defined on the graph below as the area between the Lower and Upper Limits.

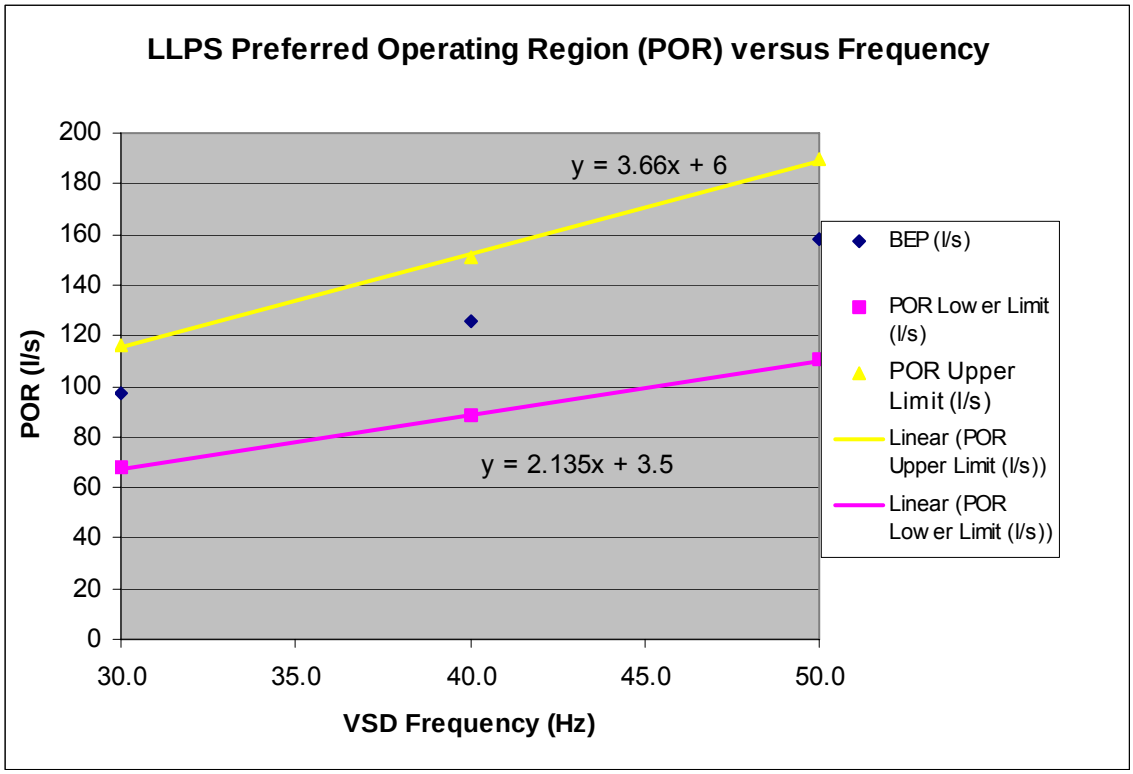
The LLPS flow will be determined by the following:

Flow from FT100-02 plus the flow to the UF/RO plant received from the membrane plantPLC. The total flow will be divided by the number of pumps operating [ignoring the jockey pump] at any time. This will allow the system to determine a flow per pump [in l/s] and a VSD operation frequency. This should be compared to the data plotted below.

If the pumps are operating above the top line [POR Upper limit] then another pump must be started and a new operating point at a lower frequency will be found. If the jockey pump is not running then this should be the pump selected to be started. This new point should be within or closer to the preferred operating range.

If the pumps are operating below the bottom line [POR Lower limit] then a pump must be stopped and a new operating point at a higher frequency will be found. If the jockey pump is running, then this should be the pump shut off. This new point should be within or closer to the preferred operating range.

Pumps should not operate continuously at a VSD frequency outside the range shown on the graph.



3.6. Class A System Feed Control

3.6.1. Overview

The Class A system takes a stream of water from the Low Lift pumps and feeds it to the Class A process. The flow is controlled to a set rate by measuring the flow via flowmeter number **FT100-02** and using control valve number **VC100-02** to keep the flow at the required level.

The flow set point will be set via an algorithm as part of the master control system [see sections 3.16]. The flow set point will be determined by comparing the flow required by plant operations [Q_{ops}] to the maximum flow allowed as determined by quality requirements [Q_Q] and the maximum flow allowed based on water availability in the wet well [Q_w].

3.6.2. Flow Control

Class A Water Flow Control

Control System Feature	Requirement Description	Value
1. Controller Identifier	FC100-02 on P&ID 3552306-100-PR001	
2. Operation Method	Runs when plant is in "Auto"	
3. Initiation	Starts under operator initiation of "System Group Start 1" or if operator initiates loop individually via the HMI	
4. Loop Set Points	PID Loop set Point SP1 FC100-02 Refer Section titled "Master Flow Control Systems" 2.2 & 3.16 Note that the Setable flow range should initially be restricted until the operating capacity of the Class A train is confirmed at the higher level.	Initial Reduced Range: 1-9.9 ML/D =[11.6-114 L/S] Final Setable Flow Range 1– 12.2 ML/D *=[11.6-141 L/S]*
5. Start Permissive Interlocks	■ PLC is in "Auto". ■ All equipment involved in this loop are connected & healthy ■ Final Water tank high high level LSH 300-10 not activated ■ UV system inlet valve VA200-15 is open ■ Sodium Hypochlorite dosing system is healthy – see 3.9 ■ Sodium Metabisulphite dosing system is healthy – see 3.10 ■ UV system is healthy. – see 3.8 ■ BWRP effluent Plant Quality Permissive *Note: Other signals will be required. These permissives will be combined in the BWRP separately and a single "Permissive" signal will be sent to the RWPTF.* ■ CCT high high level LSH200-90 not on	Turbidity AE4104 < 5NTU
6. Run Permissive Interlock	All start permissive interlock situations FT100-02 High High Flow Free Chlorine AT200-91 shut down if Free Chlorine pre CCT AT200-90 Level 1	13.5 ML/D <0.4mg/L for >60sec >20 or <3.0mg/L

Control System Feature	Requirement Description	Value
	Temperature TT 100-04 Level 1	<10°C for > 60secs
7. Alarms	Deviation Alarm FC100-02 Level 3	0.5 ML/ D [6L/s] 10sec delay
	FAH FC100-02 High Flow Level 2	Set pt plus 1 ML/D, 5 sec delay
	FAL FC100-02 Low Flow Level 2	Set pt less 30% ML/D, 5sec delay
	LSH 200-90 High Level in Chlorine Contact Tank Level 2	Switch location (CCT overflow weir crest)
	Free Chlorine AT200-91 Level 2	0.42mg/L
	Free Chlorine pre CCT AT200-90 Level 2	<3 mg/L
	TAL Low Temperature Level 2	≤ 12°C
8. Overrides	LSH 200-10 High level in the chlorine contact tank. Level 2	Reduce FC100-02 set point by 5% per minute till alarm condition removed. This value becomes the new Q_{OPS} and Master Flow Control resumes .
	When LAL LT100-01 is activated, then LT100-01 will be used to send a maximum flow allowed signal to the set point of FC100-02. LT100-01 will be the master cascade loop controller controlling FC100-02 setpoint as long as LALLT100-01 is activated.	
	UV Unit Lamp Fault Status (refer to 3.8.2)	
	■ Level 1 – Reduce flow set point FC100-02 by	98%
	■ Level 2 – Reduce flow set point FC100-02 by	96%
	■ Level 3 – Reduce flow set point FC100-02 by	94%
9. Alarm Masking	- When loop FC100-02 is not on - For time delay after loop is initiated	10 seconds
10. Control Algorithm	Control algorithm will set a maximum flow set point to meet quality requirements. Operations may set a flow set point The system will select the lesser of the two.	
11. Monitoring	The HMI must permit starting of this loop as part of Group Start 1 and also as a stand alone loop. Access to all set point and alarm values and the output position requested of the control valve will be required.	

Control System Feature	Requirement Description	Value
12. Hand Access	All alarms [refer Item 7] will operate. All Start permissive & run permissive interlocks will be bypassed.	
13. Alarm Response	See overrides. In the event of flow alarms, the operator may need to lower the flow set point to allow the system to maintain stable flow.	

3.7. UF/RO System Feed Control

3.7.1. Overview

The UF/RO system takes a stream of water from the Low Lift pumps and feeds it to the UF/RO membrane process. The flow is controlled to maintain a set level **(LT 100-02)** in the UF/RO Feed Tank (an external input signal that will become an input to the control system in Milestone 2) and using control valve number **(VC100-03)** to keep the tank level at the required height.

The tank level set point will be set in the RWPTF plant control system.

Note:

In **Milestone 1** operation, **this loop will not operate** and this control valve will not be operational.

This operation description refers to operations required in **Milestone 2**

3.7.2. Control Valves

Control Valves, VC100-03 & VC100-02, are able to be modulated to open to any position from 0 – 100%.

3.7.3. Flow Control

UF/RO System Feed Control

Control System Feature	Requirement Description	Value
1. Controller Identifier	LC100-03 on P&ID 3552306-100-PR001	
2. Operation Method	Runs when plant is in "Auto"	
3. Initiation	Starts under operator initiation of "System Group Start 1" or if operator initiates loop individually via the HMI	
4. Loop Set Points	PID Loop Set Point SP1 LC100-03	Level Required: 80%of Tank Volume [80% of Tank level output]
5. Start Permissive Interlocks	■ PLC is in "Auto". ■ All equipment involved in this loop are connected & healthy	
6. Run Permissive Interlock	All start permissive interlock situations	
7. Alarms	LAH LT[UF Feed Tank] Level 2 LAL LT[UF Feed Tank] Level 2 LAHH LT[UF Feed Tank] Level 1 LALL LT[UF Feed Tank] Level 1	90% Tank Vol 10sec delay 60% Tank Vol 10sec delay 95% Tank Vol 10sec delay 40% Tank Vol 10sec delay
8. Overrides	In event of Level 1 alarms [see Alarms] then ■ For High Level VC100-03 must close ■ For Low Level. VC100-02 must close A signal must be sent to membrane plant to gradually slow the required flow. Return to previous setpoint settings when level is above alarm Level 2 setting. ■ When total flow into RWPTF [as measured by the sum of FT100- 02 plus all FTs on the UF permeate outlets] is < 3ML/day the UF feed tank level set point [SP1 LC100-03] will be raised to allow overflow back to the LLPS wet well.	over no more than 20 sec. over no more than 30 sec Reduce flow to UF/RO by 10% of max flow each minute after VC100-02 is closed. LT setpoint : Overflow centerline level + 400mm
9. Alarm Masking	- For time delay after loop is initiated	10 seconds

Control System Feature	Requirement Description	Value
10. Control Algorithm	None applicable.	
11. Monitoring	The HMI must permit starting of this loop as part of Group Start 1 and also as a stand alone loop. Access to all set point and alarm values and the output position requested of the control valve will be required.	
12. Hand Access	All alarms [refer Item 7] will operate. All Start permissive & run permissive interlocks will be bypassed.	
13. Alarm Response	See overrides. .	

3.8. UV System Control

3.8.1. Overview

The UV system doses ultraviolet light into the Class A flow. It is a process that has its own control system but interfaces with the master control system.

The UV system alarms must be transmitted to the master controller, and master control requirements regarding starting and stopping and the Class A flow rate must be sent to the UV controller.

Actuated Valve VA 200-15 can be set to either shut [0%] or open [100%]. The valve has limit switches to confirm its position back to the PCS.

The following alarms will be provided by the UV system vendor. Level 1 alarms as listed below require that the Class A train be shut down and valve (**VA200-15**) must close.

The following alarms are associated with Tag **(UV 200-15)** and are obtained from the UV control system by device net.

Level 1 Alarms:

- Inadequate (low-low) UV validated dose or UV general fault
- Multiple lamp failure (more than two lamps in a bank fail)
- High water level for > 15 seconds
- Low water level for > 15 seconds
- Power Failure

Level 2 Alarms:

- Low UV validated dose
- Adjacent lamp failure

- Low-low UV intensity
- Low-low UV transmittance
- Ground fault interruption

Level 3 Alarms:

- Individual lamp failure
- Low UV intensity
- Low UV transmittance
- Low operational dose

Start-up and shutdown strategies for this equipment are determined by equipment supplier [Wedeco] requirements.

3.8.2. Lamp Failure

If a lamp pair / ballast fails in the UV unit, the appropriate alarm shall be raised and the following steps shall be taken.

The UV unit control system shall first attempt to change the duty bank from the bank with the lamp fault to a standby bank. If this can be accomplished, the alarm raised above shall be continued until the failed lamp / ballast can be fixed and the alarm reset. If the duty bank can not be changed then the flow rate through the UV unit shall be decreased to:

$Flow_{DECREASED}$ = Flow * Reduced Flow rate Reduction (See table below)

In the case of only one lamp pair / ballast failing in any one bank, the table below shows each of the different scenarios and the corresponding Lamp Fault Status signal and flow rate reduction required for each. The UV unit in each of these cases shall:

- Either raise a Level 2 alarm 'Adjacent Lamp Failure' or a Level 3 alarm 'Individual Lamp Failure' as appropriate
- Provide the RWPTF SCADA system with the appropriate Lamp Fault Status signal.
- Obtain the altered flow signal FT100-02 for the UV unit PLC to determine banks in service and lamp power output. The flow signal shall be altered from FLOW to FLOW / reduced flow rate percentage.

The SCADA system on receiving these signals shall:

- Reduce the flow rate to the UV unit according to the Lamp Fault Status signal supplied. This shall be achieved by partially closing VC100-02.
- Display the alarm, lamp fault status information and percentage of reduced flow on the HMI.

Lamp Fault Status	Case	Number of banks in service	Number of banks with lamps out of service	Number of lamps out of service in any one bank	Flow rate reduction
1	1 pair in 3 banks	3	1	2	98%
2	2 pairs in 3 banks	3	2	2	96%
3	3 pairs in 3 banks	3	3	2	94%

If more than one lamp pair / ballast is faulty in any operating bank then the UV unit shall raise the Level 1 alarm 'Multiple lamp failure (more than two lamps in a bank fail)'. On receiving this alarm the SCADA system shall shut down the Class A train.

When a lamp fault is cleared, the UV unit logic shall be restarted, the UV flow rate changed from FLOW/reduced flow rate percentage to FLOW/1.0 and the flow rate from the LLPS shall be reset.

3.9. Sodium Hypochlorite Dosing Control

3.9.1. Overview

The Sodium Hypochlorite Dosing system delivers the chemical into the Class A water stream upstream of the Chlorine Contact Tank inlet. The system delivers the chemical at the rate required to achieve a set point chlorine residual [AT200-91] post the Chlorine Contact Tank (CCT).

The system consists of a pair of chemical pumps in parallel that have both adjustable stroke length and pump motor speed. The pumps are set-up to run as "Operation" and "Stand-by". Only one pump will need to operate at any time to meet flow requirements and must obey plant Operation/Stand-by control rules.

The pumps come with their own control system to determine appropriate pump stroke and speed. These requirements will be determined by the pump's internal control but the flow must meet the plant requirements.

The control instructions detailed below must operate seamlessly with the package control system delivered by the dosing pump supplier to deliver an operating system that delivers the functions required.

Sodium Hypochlorite Dosing Control

Control System Feature	Requirement Description	Value
1. Controller Identifier	SC200-30 on P&ID 3552306-200-PR003	

Control System Feature	Requirement Description	Value
2. Operation Method	Runs when plant is in "Auto"	
3. Initiation	Starts under operator initiation of "System Group Start 1". Note: Initiation of the pumps must be immediately preceded by activation of the service water isolation valve [VA200-84]	
4. Loop Set Points	PID Loop set Point SP1 SC200-30 controlling Chlorine Analyser AT200-91 Using cascade control with Chlorine Analyser AT200-90 as the fast [inner] loop.	Set Point = 0.3 mg/L FAC
5. Start Permissive Interlocks	■ PLC is in "Auto". ■ All equipment involved in this loop are connected & healthy ■ LLPS pumps are on and flow is detected at FT100-02 ■ Sodium Metabisulphite dosing system is healthy ■ LALL LT200-30 not Active ■ UV system is healthy. ■ FAL200-84 is not activated ■ FAH200-84 is not activated ■ BWRP effluent Quality Permissive *Note: Other signals will be required. These permissives will be combined in the BWRP separately and a single "Permissive" signal will be sent to the RWPTF.*	Minimum Measurable Level or 3% of Full level Turbidity AE4104 < 5 NTU
6. Run Permissive Interlock	All start permissive interlock situations except for - FAH200-84 is not activated plus the following: ■ FS 200-10 or 200-11 activated on operating pump ■ Temperature TT 100-04	Delay for 5 sec. < 10°C for >60 secs
7. Alarms	LAL LT200-30 Low Level Level 2 Chlorine analyser alarms as follows: ATH200-90 Level 2 ATL200-90 Level 2 ATHH200-90 Level 1 [shutdown required] ATLL200-90 Level 1 [shutdown required]	10% Tank Volume. Set pt plus 1mg/L Set pt less 1mg/L Set pt plus 2mg/L Set pt less 2mg/L

Control System Feature	Requirement Description	Value
	ATH200-91 Level 2 ATL200-91 Level 2 ATLL200-91 Level 1 [shutdown required]	Set pt + 0.5mg/L Set pt less 0.2mg/L Set pt less 0.3mg/L
8. Overrides	ATHH200-90 Level 1 [shutdown required] ATLL200-90 Level 1 [shutdown required] ATLL200-91 Level 1 [shutdown required]	Set pt plus 2mg/L Set pt less 2mg/L Set pt less 0.3mg/L
9. Alarm Masking	- FS200-10 & FS200-11 when associated pump is not operating. - For time delay after loop is initiated	 10 seconds
10. Control Algorithm	The Control algorithm requirements will set a flow set point based on Class A water Flow and free Chlorine requirements at both AT200-90 & AT200-91 as follows: The control loop will be set as cascade control. The output from AT200-91 will be used to set the set point of AT200-90. The output from AT200-90and FT100-02 will be used to set the Hypochlorite flow required. On initialisation of the loop the following values should be set: AT200-90 initial set point Hypochlorite initial flow (L/hr) required **Note:** The Hypochlorite flow must adjust to meet AT200-90 set point, and be flow paced to Class A flow as per FT100-02. AT200-91 set point must adjust slowly to meet requirements of AT200-90. The control delay between AT200-90 & AT200-91 is approximately The set point for AT200-91 will require "Supervisor" access to allow a change.	 As per loop setpoint above 15 + 0.18 * FC100-02 FLOW (L/s) 300 minutes /MLD Flow FT100-02
11. Monitoring	The HMI must permit starting of this loop as part of Group Start 1. Access to all view set point and alarm values and the metering pump stroke speed and stroke length will be required. The values of AT 200-90, AT200-91 and TT100-04 shall be recorded and accessed through the HMI.	
12. Hand Access	All alarms [refer Item 7] will operate. All Start permissive & run permissive interlocks will be bypassed.	
13. Alarm	HMI to prompt plant operator when alarms	

Control System Feature	Requirement Description	Value
Response	identified [refer item 7] - plant operator to determine likely causes for alarms and that interlocked overrides are being initiated.	
14. Shutdown	Shutoff of the pump will be per the Group Shutdown sequence and must be immediately followed by shutting of valve [VA200-84].	

3.9.2. Sodium Hypochlorite Dosing Pump Motors

The Dosing pump referred to in the description below is described as a single pump, where there are actually two pumps in a duty standby arrangement. The selection of operating pump shall be as per section 2.1.5.

The Tags for are shown for both dosing pumps 1 & 2, i.e. **(PU200-10, PU200-11)**.

1. The motor control has three primary modes selected by a field auto/manual switch:

Auto

Manual

Off

In auto, the starter is enabled to take commands from the PLC digital I/O **(MV200-10 STT, MV200-11 STT).** The status of the auto/manual switch is reported to the PLC via a dedicated digital input **(MV200-10 Rdy, MV200-11 Rdy**) for Auto and **(MV200-10 Man, MV200-11 Man)** for Manual. When the starter is in manual mode the dosing pump will run with Interlocks bypassed until the selector is removed from manual. In auto mode, indicated to the PLC via the dedicated Ready Relay digital input, the PLC will provide three further modes of control:

Sequence

Operator

Maintenance

These modes will be set and indicated on a popup controller for the motor in the HMI. It shall be possible for the motor/drive to bumplessly transfer from the PLC sequence modes to the other PLC control modes and vice versa. The PLC maintenance mode is a special case of PLC operator mode where interlock conditions are bypassed.

2. An overload is present in the motor starter circuit and an RCD in the socket outlet, if the overload operates, the P.L.C. cannot receive a motor ready signal.

3. The run status of the drive is indicated to the PLC via Digital input **(MV200-10 Run, MV200-11 Run)**.

4. In automatic mode, if the motor has been asked to run and run feedback not observed for some adjustable time, a fail to start alarm will be issued and indicated. The alarm will be cleared by a motor independent fault reset or global motor reset.

5. In automatic mode, if the motor has been asked to stop and the run feedback observed for some adjustable time, a fail to stop alarm will be issued and indicated. The alarm will be cleared by a motor independent fault reset or global motor reset.

6. An interlock condition will be indicated as letters IL next to the motor HMI symbol.

7. Motor/drive status signals are used to calculate and display starts and hours run today and automatically roll into starts and hours run yesterday at midnight (12:00AM) each day.

8. Alarms, the following alarms shall be generated for each dosing pump:

   - Failed to start, Adjustable Delay, Level 3
   - Failed to stop, Adjustable Delay, Level 2

3.10. Sodium Metabisulphite Dosing Control

3.10.1. Overview

The Sodium Metabisulphite Dosing system delivers the chemical into the Class A water stream downstream of the UV Unit outlet. The system delivers the chemical at the rate required to achieve the required chlorine residual as measured by the TAC transmitter after the UV plant.

The system consists of a pair of chemical pumps in parallel that have both adjustable stroke length and pump motor speed. The pumps are set-up to run as "Operation" and "Stand-by". Only one pump will need to operate at any time to meet flow requirements and must obey plant Operation/Stand-by control rules.

Sodium Metabisulphite Dosing Control

Control System Feature	Requirement Description	Value
1. Controller Identifier	SC200-40 on P&ID 3552306-200-PR004	
2. Operation Method	Runs when plant is in "Auto"	
3. Initiation	Starts under operator initiation of "System Group Start 1" Note: Initiation of the pumps must be immediately preceded by activation of the service water isolation valve [VA200-94]	
4. Loop Set Points	PID Loop Set Point SP1 SC200-40 controlling Chlorine Analyser AT200-28	Set Point = 0.05 mg/L TAC

Control System Feature	Requirement Description	Value
5. Start Permissive Interlocks	■ PLC is in "Auto". ■ All equipment involved in this loop are connected & healthy ■ LLPS pumps are on and flow is detected at FT100-02 ■ Sodium Hypochlorite dosing system is healthy ■ LALL LT200-40 not Active ■ UV system is healthy. ■ FAL200-94 is not activated ■ FAH200-94 is not activated ■ BWRP effluent Quality Permissive *Note: Other signals will be required. These permissives will be combined in the BWRP separately and a single "Permissive" signal will be sent to the RWPTF.*	Minimum Measurable Level or 3% of Full level Turbidity AE4104 < 5 NTU
6. Run Permissive Interlock	All start permissive interlock situations except for: - FAH200-94 is not activated plus the following: ■ FS 200-21 or 200-27 activated on operating pump	Delay for 5 sec.
7. Alarms	LAL LT200-40 Low Level Level 2 Chlorine analyser alarms as follows: ATH200-28 Level 2 ATL200-28 Level 2 ATHH200-28 Level 1 [shutdown required] ATLL200-28 Level 1 [shutdown required]	10% Tank Volume. Set pt +0.05mg/L Set pt – 0.02mg/L Set pt +0.15mg /L Not required
8. Overrides	Initiation of Level 1 alarms must alert operators that shutdown of plant is required.	
9. Alarm Masking	- FS200-21 & FS200-20 when associated pump is not operating. - For time delay after loop is initiated	30 seconds
10. Control Algorithm	The Control algorithm requirements will set a flow set point based on Class A water Flow and Total Chlorine requirements at AT200-28 as follows: The output from AT200-28 and FT100-02 will be used to set the Metabisulpite flow required. On initialisation of the loop the following values should be set: AT200-28 initial set point	As per Loop Setpoint above.

Control System Feature	Requirement Description	Value
	Metabisulphite initial flow required per L/s of water flow **Note:** The Metabisulphite flow must adjust to meet AT200-90 set point, and be flow paced to Class A flow as per FT200-02. The system will operate at the set point unless operators with "Supervisor" access change the set point.	0.0684 L/hr
11. Monitoring	The HMI must permit starting of this loop as part of Group Start 1. Access to all view set point and alarm values and the metering pump stroke speed and stroke length will be required.	
12. Hand Access	All alarms [refer Item 7] will operate. All Start permissive & run permissive interlocks will be bypassed.	
13. Alarm Response	HMI to prompt plant operator when alarms identified [refer item 7] - plant operator to determine likely causes for alarms and that interlocked overrides are being initiated.	
14. Shutdown	Shutoff of the pump will be per the Group Shutdown sequence and must be immediately followed by shutting of valve [VA200-94].	

3.10.2. Sodium Metabisulphate Dosing Pump Motors

The Dosing pump referred to in the description below is described as a single pump, where there are actually two pumps in a duty standby arrangement. The selection of operating pump shall be as per section 2.1.5.

The Tags for are shown for both dosing pumps 1 & 2, i.e. **(PU200-20, PU200-21)**.

9. The motor control has three primary modes selected by a field auto/manual switch:

Auto

Manual

Off

In auto, the starter is enabled to take commands from the PLC digital I/O **(MV200-20 STT, MV200-21 STT).** The status of the auto/manual switch is reported to the PLC via a dedicated digital input **(MV200-20 Rdy, MV200-21 Rdy**) for Auto and **(MV200-20 Man, MV200-21 Man)** for Manual. When the starter is in manual mode the dosing pump will run with Interlocks bypassed until the selector is removed from manual. In auto mode, indicated to the PLC via the dedicated Ready Relay digital input, the PLC will provide three further modes of control:

Sequence

Operator

Maintenance

These modes will be set and indicated on a popup controller for the motor in the HMI. It shall be possible for the motor/drive to bumplessly transfer from the PLC sequence modes to the other PLC control modes and vice versa. The PLC maintenance mode is a special case of PLC operator mode where interlock conditions are bypassed.

10. An overload is present in the motor starter circuit and an RCD in the socket outlet, if the overload operates, the P.L.C. cannot receive a motor ready signal.

11. The run status of the drive is indicated to the PLC via Digital input **(MV200-20 Run, MV200-21 Run)**.

12. In automatic mode, if the motor has been asked to run and run feedback not observed for some adjustable time, a fail to start alarm will be issued and indicated. The alarm will be cleared by a motor independent fault reset or global motor reset.

13. In automatic mode, if the motor has been asked to stop and the run feedback observed for some adjustable time, a fail to stop alarm will be issued and indicated. The alarm will be cleared by a motor independent fault reset or global motor reset.

14. An interlock condition will be indicated as letters IL next to the motor HMI symbol.

15. Motor/drive status signals are used to calculate and display starts and hours run today and automatically roll into starts and hours run yesterday at midnight (12:00AM) each day.

16. Alarms, the following alarms shall be generated for each dosing pump:

    - Failed to start, Adjustable Delay, Level 3
    - Failed to stop, Adjustable Delay, Level 2

3.11. High Lift Pump Set Control

3.11.1. Overview

The High Lift Pump Set (Pumps PU-300-10, PU-300-20, PU-300-30, PU-300-40) delivers flows from the Final Water Tank TK300-10 to a number of discharge points.

The pump set control operates to manage the level of water in the Final Water Tank [TK300-10].

Note:

Milestone 1 & 2 of this project will only have three pumps installed. [Pump PU300-40 is to be a future installation]. However the software should be set up with four pumps and associated flow and pressure switches. The software will be FAT tested with four pumps but the system will be commissioned with three pumps operating.

The surge tank system operates separately to ensure that changes in pump flowrates do not cause excessive pressure surges to the plant or pipeline equipment.

High Lift Pump Set Control

Control System Feature	Requirement Description	Value
1. Controller Identifier	LC300-10 on P&ID 3552306-300-PR002	
2. Operation Method	Has an independent "Auto" status for this loop alone. This loop must run independently of the RWPTF.	
3. Initiation	Starts under operator initiation subject to FWT level & loop permits.	
4. Loop Set Points	PID Loop Set Point SP1 LC300-10 The level considered here is the working operating level of the Final Water Tank, between 2.2m & 3.15m above the tank base.	Level = 2.8m 60% of working range. [= 28 m^3]
5. Start Permissive Interlocks	■ Loop LC300-10 is in "Auto". ■ All equipment involved in this loop is connected & healthy (*Note: Only 1 of the 4 pumps is required to be healthy to permit the system to start)* ■ The power supply is in Normal mode. Refer to section 3.12. ■ Final Water Tank low level LT LAL 300-10 not activated ■ The four Pumps will start individually and run up to speed over "Rise Time". Subsequent pumps will wait for "Delay Time" and will then start if the set point level is not achieved. Refer to section 2.1.5 for duty standby operation. ■ The control valve on the Spring Gully Reservoir inlet or the control valve on the Spring Gully Axe Creek channel is at least partially open	Rise Time = 15sec. Delay Time= 5 sec ZS304-110 ≠ closed or ZS304-123 ≠closed
6. Run Permissive Interlock	■ All start permissive interlock situations ■ For flows ≥ 12 ML/day, VM300-75 open [ZSO300-75] - refer surge tank (3.11.3) ■ The initiation of a PSH, FSL or TTHH alarm on any one of the 4 pumps will cause that pump to shut down. The pump cannot be part of the sequence till operators reset this alarm condition ■ LT LALL300-10 – Low Low Level in Final Water Tank	On for 5 sec Delay Time =10

Control System Feature	Requirement Description	Value
	Shut one pump at a time with Delay Time between shutting down till LSL signal not activated. ■ High Turbidity AT300-23 Level 1 ■ pH deviation AT300-24 Level 1 ■ EC High AT300-25 Level 1	sec 5 NTU Acceptable Range: pH 6 – 9 >450mg/L
7. Alarms	Deviation Alarm LC300-10 Level 3 PSH 300-10/20/30/40 Level 3 FSL 300-10/20/30/40 Level 3 LT LAH300-10 High Final water tank Level 2 LT LAHH300-10 High Final water tank Level 1 PT PAH300-00 High pump set pressure Flow [FT300-00] <10 ML/D Level 2 Flow 10 - <20 ML/D Level 2 Flow 20 - <30 ML/D Level 2 Pump failure [any of 4 pumps] Level 3 2nd Pump failure [any 2 of 4 pumps] Level 2 Pumps operating outside preferred speed range Level 2 Pump Bearing temperatures. (A=D.E, B=N.D.E) Pump 1 TTHH 300-10A / 10 B Level 1 TTH300-10A / 10B Level 2 Pump 2 TTHH300-20A / 20B Level 1 TTH300-20A / 20B Level 2 Pump 3 TTHH300-30A / 30B Level 1 TTH300-30A / 30B Level 2 Pump 4 TTHH300-40A / 40B Level 1 TTH300-40A / 40B Level 2 Refer surge vessel (3.11.3)	10% Tank Volume 200 m 5 sec delay 4.5 ML/D & 5 sec delay 100% of working range 105% of working range 140 m 160m 200 m 80°C 70°C 80°C 70°C 80°C 70°C 80°C 70°C
8. Overrides	LT LAH300-10 High Final water tank Level 2 Reduce set Flow to Class A process [from LLPS] by **5% each 3 minutes** till this alarm is no longer on. Hold flow at achieved set point till Final Water tank returns to set point level & then return	100% of working range

Control System Feature	Requirement Description	Value
	to previous flow set point. LT LAHH 300-10 High High Final water tank Level 1 Shut off Class A process LSHH 300-10 High Level Switch Level 1 Shut off Membrane Plant. Water quality: ■ High Turbidity AT300-23 Level 2 ■ pH deviation AT300-24 Level 2 ■ EC High AT300-25 Level 2 Surge Vessel [TK300-70] not operating Level 2 This alarm condition includes LAH 300-71A OR B OR ZSO 300-75 is Not confirmed OPEN Flow at [FT300-00] must not exceed allowed maximum Power supply in Load Control mode. The high lift pumps must control to a different set point as described in section 3.12.	105% working range Level Switch Position (110% of working range) 4 NTU Acceptable Range: pH6.5 – 8.5 >400mg/L Refer Section 3.11.3. Power Supply mode = Load Control mode
9. Alarm Masking	- When loop LC300-10 is not on - For time delay after loop is initiated - PSH & FSL of each individual pump when that pump is not on.	15 seconds
10. Control Algorithm	When the power supply is in Normal mode, the pump set must operate as a single system selecting the most appropriate number of pumps and pumps speeds to maintain the FWT set point level per pump supplier's instructions. Determination of the speed of the pump set and the number of pumps required to run will be as per instructions in section 3.11.2.	
11. Monitoring	The HMI must permit starting of this loop as a stand alone loop. Access to all set point and alarm values and the status of the four pumps (including the operating speed of the pump VSDs and pump bearing temperatures) will be required. The value of FT300-00 shall be accessible via the HMI and shown as a trend.	
12. Hand Access	All alarms [refer Item 7] will operate. All Start permissive & run permissive interlocks will be bypassed.	Exception LALL 300-10

3.11.2. Pump Set Operation

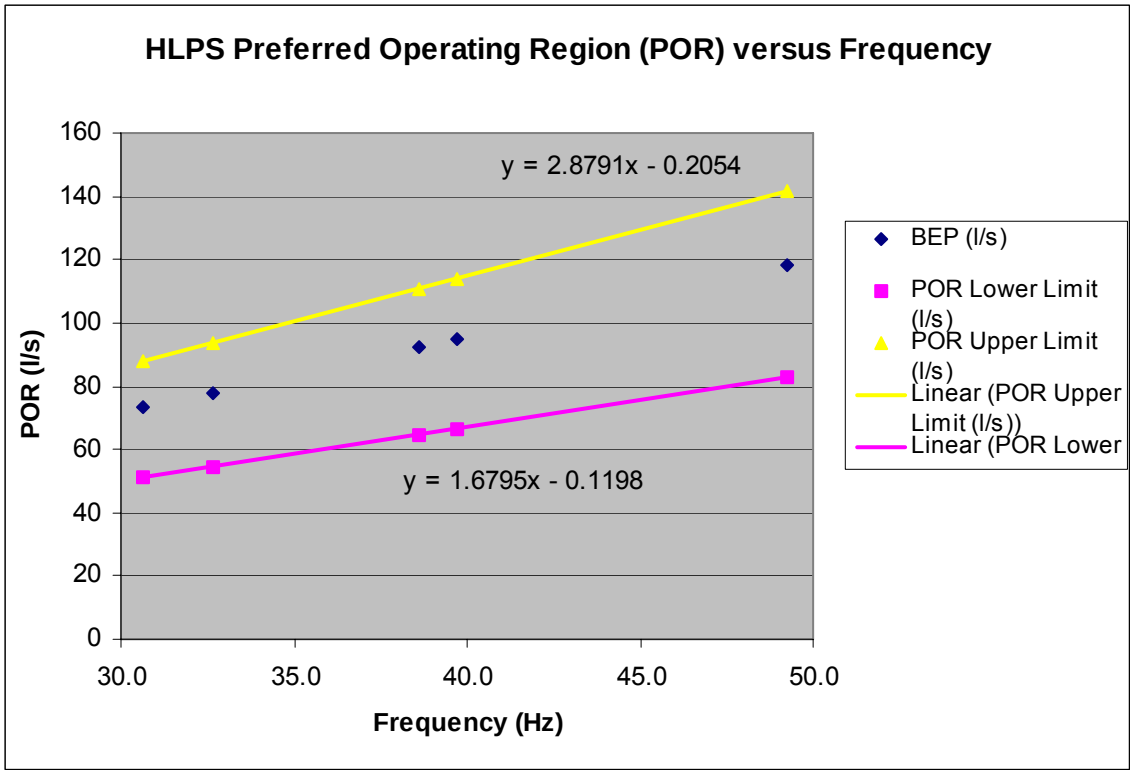
The pump set will operate at speeds to maintain operation within the preferred operation region. This region is defined on the graph below as the area between the Lower and Upper Limits.

The flow measured by FT300-00 will be divided by the number of pumps operating at any time to obtain a flow per pump [in l/s] and a VSD operation frequency. This should be compared to the data plotted below.

If the pump is operating above the top line [POR Upper limit] then another pump must be started and a new operating point at a lower frequency will be found. This new point should be within or closer to the preferred operating range.

If the pump is operating below the bottom line [POR Lower limit] then a pump must be stopped and a new operating point at a higher frequency will be found. This new point should be within or closer to the preferred operating range.

Pumps should not operate continuously at a VSD frequency outside the range shown on the graph.



3.11.3. Surge Vessel

The Surge Vessel operates independently of any control system. The vessel has a bladder to separate the air cushion from the water.

The surge vessel must be operational if total HLPS flows are greater than 12 ML/day.

The Surge Vessel is NOT operational if any of the level 2 alarms listed in the table below occur.

If any of the events in the table below occur, then the HLPS flow shall be reduced to 11.9 ML/day until the level has returned to within its acceptable range for 5 mins. In the case of LT300-71A and LT300-71B readings differing by >5% of maximum level for > 10 seconds the restriction can only be reset by "Supervisor" action.

If three Level 2 alarms occur within a one hour period, a Level 1 alarm will be raised and the HLPS flow will be restricted to 11.9 ML/day.

Some pumping conditions where the water is not delivered right to the end of the pipeline may result in a low discharge pump pressure. Offtake control valves may need adjusting to maintain the pressure above the low pressure set point.

Important: Final pipeline pressure control and monitoring comments shall be issued separately at a later date.

Control System Feature	Requirement Description	Value
1. Alarms	■ Valve VM300-75 is not confirmed as open - Level 2	ZSO 300-75 = Closed
	■ Surge Vessel level LT300-71A or LT 300-71B rises above: - Level 2	302mm above the centreline
	■ Surge Vessel level LT300-71A or LT 300-71B falls below: - Level 2	431mm below the centreline
	■ LT300-71A &LT300-71B readings differ by - Level 2	> 5%
	■ LT300-71A and LT300-71B differ by - Level 2	> 5% of the maximum level for > 10 seconds.
	■ PT300-70 High Pressure - Level 2	PT300-70 〈 2440 kPag
	■ PT300-70 Low Pressure - Level 2	PT300-70 [700kPag
2. Monitoring	The values listed below shall recorded in the SCADA system and shown on the HMI for monitoring purposes: ■ ZSO300-75 ■ LT300-71A ■ LT300-71B ■ PT300-70 The HMI shall provide indication when the surge vessel is not operational.	

3.11.4. Bendigo Mining Water Flow to Final Water Tank

Bendigo Mining Ltd (BML) will supply water to the Final Water Tank via an independent line that includes flowmeter FT300-20 as well as Turbidity, Conductivity and pH monitoring. The flow from this line cannot be controlled by the RWPTF and it can reach up to 5ML/D in flow.

If water quality from this line deviates from an acceptable level the line must be shut down manually. It may also cause the plant to shut down by shutting off the High Lift Pump Station set.

Bendigo Mining Feed Line Alarms

Control System Feature	Requirement Description	Value
3. Alarms	■ High Turbidity AT300-22 Level 2 ■ pH deviation AT300-20 Level 2 ■ EC High AT300-21 Level 2 ■ High –high Turbidity AT300-22 Level 1 ■ pH deviation AT300-20 Level 1 ■ EC High-high AT300-21 Level 1	4.5 NTU Acceptable Range: pH 6.8 – 8.2 :> 250mg/L [*provisional equiv EC=500µS/cm]* 5 NTU Acceptable Range: pH 6.5 – 8.5 350mg/L [*provisional equiv EC=700µS/cm*]
4. Monitoring	For Level 1 alarm the HMI must alert plant operators to manually shut down Bendigo Mining flow to FWT (VM300-82), divert flow to BWRP, and to advise Bendigo Mining of out-of-specification water.	

3.12. Power System Control

3.12.1. Overview

This section describes the monitoring and control of the power system that supplies power to all equipment in the RWPTF.

All power supplied to the RWPTF is fed through switchboard RWPTF01. The power is then split and fed into two other switchboards, RWP01 and RWP02.

Switchboard RWP02 supplies power to the high lift pumps while switchboard RWP01 supplies power to all other equipment in the RWPTF.

The RWPTF has been allocated a set amount of power. The power system may only exceed this set amount for a short period of time.

3.12.2. Control

The power system operates in two different modes as follows:

- Normal mode
- Load Control mode

The power system will bumplessly transfer between these two modes.

In Normal mode, the power system shall supply the power requirements of the RWPTF. The power system shall remain in Normal mode as long as the specified power limit is not exceeded for a long period of time.

The amount of power allocated for each milestone (P_{max}) is shown below:

- Milestone 1 = 600kW
- Milestone 2 = 1300kW

When the power limit is exceeded for more than 10 seconds, the power system shall go into Load Control mode. The purpose of the Load Control mode is to bring the total power ($P_{RWPTF01}$) used by the RWPTF back down to the specified limit and maintain this limit by controlling and limiting the power used by the high lift pumps.

Normally, the high lift pumps work to control the FWT level to a specific set-point. In Load Control mode, the high lift pumps shall work to control the power used by switchboard RWP02 (P_{RWP02}) to the HLP Power set-point ($P_{HLP\ POWER\ SET\ POINT}$). The HLP Power set-point shall be calculated as shown below using the total power used by the other equipment (P_{RWP01}) and the specified maximum power level (P_{MAX})

$$P_{HLP\ POWER\ SET\ POINT} = 0.95*P_{MAX} - P_{RWP01}\ \ kW$$

This set point shall ensure that the power used on site is limited to the specified maximum level.

The system shall run in Load Control mode until the level of the FWT falls to 30% of the FWT level working range. When this occurs, the pumps shall start controlling to the FWT Level set-point SP1 LC300-10 and the power system shall return to Normal mode.

The power system values monitored shall be displayed as today and automatically roll into yesterday at midnight (12:00AM) each day.

Note:

1. The total power used by switchboard RWP02 is the sum of the power used by RWP02 bus 1 and RWP02 bus 2.
2. The actual times and FWT level is to be confirmed on site during commissioning.

Power System Control

Control System Feature	Requirement Description	Value
1. Run Permissive Interlocks	■ Normal mode: $P_{RWPTF01}$ or $P_{RWPTF01}$	≤ 600kW (P_{MAX} for milestone 1) > 600kW (P_{MAX} for milestone 1) for < 10 seconds
	■ Load Control mode: FWT level	> 2.5m (30% of the working range)
2. Alarms	■ Load Control mode Active Level 2 This alarm operates when the system goes into Load Control mode.	
3. Overrides	■ Normal mode - PRWPTF01 The power system shall go into Load Control mode and the high lift pumps shall work to control P_{RWP02} to set-point $P_{HLP\ POWER\ SET\ POINT}$.	> 600kW (P_{MAX} for milestone 1) for > 10 seconds
	■ Load Control mode – FWT level The power system shall go into Normal mode and the high lift pumps shall work to control the level of the FWT to SP1	[2.5m (30% of the working range)

Control System Feature	Requirement Description	Value
	LC300-10.	
4. Control Algorithm	The system will run in Normal mode until the Run Permissive Interlock for that mode is broken at which time the system will move into Load Control mode. The Load Control mode shall be lifted when the level of the FWT falls to 30% of the working range. The system shall then revert back to Normal mode and control to the FWT level set-point.	
5. Monitoring	The following measurements from switchboards RWPTF01, RWP01 and RWP02 shall be recorded in the SCADA system and shown on the HMI for monitoring purposes: ■ Real Power (kW) ■ Apparent Power (kVA) ■ Power Factor ■ Energy The instantaneous value of the parameters above shall be available on the operator screen and a value trend shall be available via a popup window. The power system mode and the number of changes in mode shall be recorded in the SCADA system and shown on the HMI for monitoring purposes. Note: The Energy value is an accumulative value and shall not be reset each day.	
6. Alarm Response	The HMI must indicate to the plant operator when the Load Control mode Active alarm is activated.	

3.13. Tanker Unload Pumps

Each unloading station shall display level for each tank level via a level indicator, **(LI 200-30)** for Sodium hypochlorite tank, and **(LI 200-40)** for the Sodium Metabisulphate tank.

A level 3 alarm shall be generated for each tank to advise the operator the tank is low and requires filling. The set point for the alarm shall be adjustable via the HMI.

3.13.1. Sodium Metabisulphite Unloading Pump

Refer to drawing 3552306-200-E-12. The unloading pump motor is located on the delivery trunk and receives its electrical power from a power socket, which is controlled as described below.

1. The pump motor control has three primary modes selected by a field auto/manual switch:

Auto

Manual

Off

In auto, the starter is enabled to take commands from the PLC digital I/O **(ME 200-47 SST).** The status of the auto/manual switch is reported to the PLC via dedicated digital input **(ME 200-47 Rdy and ME 200-47 Man).** When the drive is in manual mode the pump will run with Interlocks bypassed until the selector is removed from manual. In auto mode, indicated to the PLC via the dedicated Ready Relay digital input, the PLC will provide two further modes of control, PLC sequence mode and PLC maintenance mode. These modes will be set and indicated on a popup controller for the motor in the HMI. It shall be possible for the motor/drive to bumplessly transfer from the PLC sequence modes to the other PLC control modes and vice versa. The PLC maintenance mode is a special case of PLC operator mode where interlock conditions are bypassed. In sequence mode the pump will start when the interlocks are satisfied.

2. An overload is present in the motor starter circuit and an RCD in the socket outlet, if the overload operates, the P.L.C. cannot receive a motor ready signal. The RCD in not monitored by the starter or P.L.C.

3. The run status of the motor is indicated to the PLC via Digital input **(ME 200-47 Run).**

4. In automatic mode, if the motor has been enabled and contactor feedback is not observed for some adjustable time, a fail to enable alarm will be issued and indicated. The alarm will be cleared by a motor independent fault reset or global motor reset.

5. In automatic mode, if the motor has been asked to stop and the run feedback is still observed for some adjustable time, a fail to stop alarm will be issued and indicated. The alarm will be cleared by a motor independent fault reset or global motor reset.

6. An interlock condition will be indicated as letters IL next to the motor HMI symbol.

7. Motor/drive status signals are used to calculate and display starts and hours run today and automatically roll into starts and hours run yesterday at midnight (12:00AM) each day.

8. Alarms, the following alarms shall be generated for each unloading dosing pump:
   - Failed to energise socket , Adjustable Delay, Level 3
   - Failed to de-energise socket , Adjustable Delay, Level 2

9. Interlocks, required for the unloading pumps:
   - Tank High Level Switch **(LSH 200-40 = 0)**
   - Loading valve is open **(ZSO 200-46 = 1)**
   - Enough room for Filling, **(LIT 200-40 < 50%)** Adjustable via HMI. This is a start permissive interlock.

10. The unloading pump socket outlet is to be energised when the:
    - Motor starter is ready (ME200-47-RDY)
    - Interlocks described in item 9 above are satisfied.

11. The unloading pump socket outlet is to be de-energised when either of the following conditions is satisfied:
    - Tank high level switch is activated (LSH200-40 = 1)
    - Loading valve is closed (ZS200-46 = 0)

3.13.1.1. Sodium Metabisulphite Dilution

A stand-alone batch controller is used to provide dilution water, refer to drawing 3552306-200-I-044. Operation of the dilution system shall be carried out locally via the batch controller.

The following interlocks shall be provided the batch controller via output **(LA 200-88)**:

- Sodium Metabisulphite Tank level **(LSH 200-40)**
- Power supply available for Sodium Metabisulphite unloading pump (ME200-47-RUN)

The batch controller provides a running signal to the P.L.C. for run monitoring via **(FQI 200-88).**

When the Dilution system is operating and a fault in the Sodium Metabisulphiteunloading pump occurs, the Dilution system shall stop and a level 2 Alarm shall be initiated.

3.13.2. Sodium Hypochlorite Unloading Pump

Refer to drawing 3552306-200-E-11. The unloading pump motor is located on the delivery trunk and receives its electrical power from a power socket which is controlled as described below.

1. The pump motor control has three primary modes selected by a field auto/manual switch:

   Auto

   Manual

   Off

In auto, the starter is enabled to take commands from the PLC digital I/O **(ME 200-35 SST).** The status of the auto/manual switch is reported to the PLC via dedicated digital input **(ME 200-35 Rdy and ME 200-35 Man).** When the drive is in manual mode the pump will run with Interlocks bypassed until the selector is removed from manual. In auto mode, indicated to the PLC via the dedicated Ready Relay digital input, the PLC will provide two further modes of control, PLC sequence mode and PLC maintenance mode. These modes will be set and indicated on a popup controller for the motor in the HMI. It shall be possible for the motor/drive to bumplessly transfer from the PLC sequence modes to the other PLC control modes and vice versa. The PLC maintenance mode is a special case of PLC operator mode where interlock conditions are bypassed. In sequence mode the pump will start when the interlocks are satisfied.

2. An overload is present in the motor starter circuit and an RCD in the socket outlet, if the overload operates, the P.L.C. cannot receive a motor ready signal. The starter or P.L.C does not monitor the RCD.

3. The run status of the motor is indicated to the PLC via Digital input **(ME 200-35 Run).**

In automatic mode, if the motor has been enabled and contactor feedback is not observed for some adjustable time, a fail to enable alarm will be issued and indicated. The alarm will be cleared by a motor independent fault reset or global motor reset.

4. In automatic mode, if the motor has been enabled and contactor feedback is not observed for some adjustable time, a fail to enable alarm will be issued and indicated. The alarm will be cleared by a motor independent fault reset or global motor reset.

5. In automatic mode, if the motor has been asked to stop and the run feedback is still observed for some adjustable time, a fail to stop alarm will be issued and indicated. The alarm will be cleared by a motor independent fault reset or global motor reset.

6. An interlock condition will be indicated as letters IL next to the motor HMI symbol.

7. Motor/drive status signals are used to calculate and display starts and hours run today and automatically roll into starts and hours run yesterday at midnight (12:00AM) each day.

8. Alarms, the following alarms shall be generated for each unloading dosing pump:
   - Failed to energise socket , Adjustable Delay, Level 3
   - Failed to de-energise socket , Adjustable Delay, Level 2

9. Interlocks, required for the unloading pumps:
   - Tank High Level Switch **(LSH 200-30 = 0)**
   - Loading valve is open **(ZSO 200-34 = 1)**
   - Enough room for Filling, **(LIT 200-30 < 50%)** Adjustable via HMI. This is a start permissive interlock.

10. The unloading pump socket outlet is to be energised when the:
    - Motor starter is ready (ME200-35-RDY)
    - Interlocks described in item 9 above are satisfied.

11. The unloading pump socket outlet is to be de-energised when either of the following conditions is satisfied:
    - Tank high level switch is activated (LSH200-30 = 1)
    - Loading valve is closed (ZSO200-34)

3.14. Equipment Monitoring / Interlocks

The following devices are not directly related to the main process but require monitoring by the P.L.C. and alarms generated in the HMI. Interlocks provided and are not mentioned in the process. Refer to the Loops drawings and I/O schedule. Where devices are not mentioned specifically, they are to be set up in the HMI for monitoring purposes.

3.14.1. Transformers

Each transformer requires the following alarms to the HMI:

- Transformer winding temperature alarm, Level 2, **(TSH 000-01, TSH 000-04)**
- Transformer winding temperature system fault, Level 3, **(TXS 000-02, TXS 000-05).**
- Transformer fan controller fault, Level 3, **(TXS 000-03, TXS 000-06).**

3.14.2. Bund Level Switch

Each bund level switch shall generate a Level 2 alarm in the HMI indicating the tank the switch is associated with. The Bunds are:

- Main Bund Sump, **(LSHH 200-00)**
- Sodium hypochlorite Bund, **(LSH 200-01)**
- Sodium Metabisulphate, **(LSH 200-60)**

3.14.3. Backwash / Sewerage Pumping Station

The operation of the Backwash pump station is standalone. The following alarms are to be generated in the HMI.

- Pumping chamber high level, Level 2 **(LSH 700-60)**
- Pump fault, Level 3, **(XA 700-60)**

3.15. Pipeline

3.15.1. Overview

The pipeline can operate in two modes: “Summer” mode and “Winter” mode.

In each mode the pipeline will distribute the flow to any of the following destinations as determined by Coliban Water operations requirements:

- Knight Street
- Rosalind Park Irrigation
- Ascot Channel
- Axe Creek Channel
- Spring Gully Reservoir Inlet
- Spring Gully Axe Creek Channel
- Spring Gully Reservoir Outlet

Note that the branch pipeline (supplying Ascot Channel and Axe Creek Channel), , will not be completed for Milestone 1. A number of future connections are shown on P&ID 3552306-304-PR001 and PR002. These need to be shown on the HMI.

Plant operators will set the required flow set points to each of the required destinations and the pumping system will deliver the flow as supplied by the RWPTF.

Important: Final pipeline pressure control and monitoring comments shall be issued separately at a later date.

3.15.2. Monitoring and Control

The following main pipeline off takes requires monitoring at both Colibans Water's Head Office and at the Bendigo Water Reclamation Plant. All inputs shall be monitored.

- Knight Street Off take **(PT 304-08)**
- Rosalind Park Off take **(PT 304-60, PT 304-62)**
- Spring Gully Outlet **(PT 304-56, FT 304 100)**

The following main pipeline off takes requires monitoring and full control facilities at both Coliban Water's Head Office and at the Bendigo Water Reclamation Plant. All inputs shall be monitored. Refer to 3.15.3

- Axe Creek Channel Off take (at Spring Gully) **(Inputs PT 304-122, FT 304-123, ZS 304-123, Outputs VS 304-123A, VS 304-123B)**
- Spring Gully inlet Off take **(Input PT 304-111, FT 304-110, ZS 304-110, Outputs VS 304-110A, VS 304-110B)**

3.15.3. Off Take Control Valves

The control of the Off take valves is carried out remotely, however software maybe required to be set up in the local RTU and or P.L.C. with parameters accessible via the HMI. Refer to the loop drawings, and RTU schematics and I/O list.

3.15.3.1. Valve Positioner

Control valves on the pipeline offtakes are actuated by utilising the main pipeline water pressure. Refer to the loop drawings.

The positioner shall utilise for each valve, two solenoid outputs for open and close actuator movements, and analogue position feedback.

The following parameters shall be displayed and adjustable from the HMI in each positioner:

- **Set point position**, the desired position for the valve.
- **Position**, Valve Position feedback.
- **Max position**, Maximum position for valve, 100%,
- **Min position**, Minimum position for valve, 0%,
- **Dead Band**, Band of valve position around set point where no positioner output is initiated.
- **100% travel time**, The time the valve takes to travel from fully open to close and visa versa.

- **Max on time**, Maximum time in seconds an output signal to the open or closed solenoid can be held.
- **Min on time**, Minimum time in seconds an output signal to the open or closed solenoid can be held.
- **Alarm,** level 3 alarm is position cannot be achieved in a timely manner.

3.15.3.2. Flow Control

For each controlled offtake **(FCV 304-123, FCV 304-110)** the operator via the HMI shall determine a flow setpoint. Pending on communication performance (refer to 2.5.2) the flow control software will either be held in the RTU or the Coliban Water S.C.A.D.A.

3.15.4. Summer Mode

Flow set points to the various off-takes are determined by plant operations, with the exception of flow to Spring Gully Reservoir.

The control system will set the flow control valve to Spring Gully Reservoir to fully open [100%] and any flow in excess of the required flow to the other off-takes will flow over a weir into the reservoir.

It will be possible for plant operations to override the % open of the flow control valve to Spring Gully Reservoir. In general this will be 100% open during summer mode, but can be adjusted to increase back-pressure on the Axe Creek flow control valve if required. If the sum of the off-take flow set points is more than the pumped flow, the system pressure will drop allowing water to backflow out of the bottom of Spring Gully Reservoir,subject to the following Spring Gully Reservoir water quality levels:

- E. coli critical level > 10org / 100mL
  (Alert level at >5 org/100mL)
- Turbidity critical level = 10 NTU

If the water tested from Spring Gully Reservoir shows E. coli and turbidity levels above these critical levels then a manual override must be used to stop backfeeding from Spring Gully Reservoir. No backfeeding shall occur until clearance is given that the Spring Gully Reservoir water quality levels required are satisfied.

3.15.5. Winter Mode

Flow set points to the various off-takes are determined by plant operations. Irrigation channel off-takes will generally be zero, but can be non-zero. The required flow to Spring Gully Reservoir is set by plant operations and will generally be non-zero, until the reservoir is filled.**Alarm Functions**

Flow deviation alarms will operate on each flow transmitter associated with an off-take line from the main HLPS discharge pipeline.

Each flowmeter will have both high and low flow deviation alarms set at a deviation of +/- 10% of the set flow. Alarms will be Level 3.

A reverse flow level 1 alarm shall be generated from **(FT 300-00)** with a delay of 5 seconds.

Pressure Alarm:

The pressure at PIT304-56 will be monitored for a low pressure alarm.

PAL PIT304-56 set point : (Level 3) 0.5 Bar *(to be confirmed at commissioning)*

This alarm is intended to give early warning that the pipe may not be full.

3.16. Master Flow Control Systems

3.16.1. Milestone 1 - Class A Only

The plant required flowrate will be set by Plant Operations - Q_{ops}. The flowrate set point will become the Class A flow set point [SP FC100-02].

The plant will then operate to deliver the requested flowrate or, if insufficient water is available, as much water as can be fed to the plant based on the LLPS level control overrides that operate – refer section 3.5.2.

3.16.2. Milestone 2 - Class A and UF/RO Operation

The following inputs will be set by plant operations as part of initiating the plant flow Master Control Operation.

- Plant Flowrate required [Q_{OPS}]

The target TDS [TDS_{TARG}] of the flow leaving the HLPS will be set at:

TDS Target = 350 mg/L

Other inputs into the Master Flow Control System are:

- Expected TDS of RWPTF influent as measured by BWRP final effluent EC analyser converted to TDS [TDS_{IN}]
- Expected TDS of UF/RO discharge as measured by the RO effluent EC analyser converted to TDS [TDS_{UFRO}]
- BML flow rate as measured by FT300-20 [Q_{BML}]
- BML inflow conductivity from AT300-21 [EC_{BML}]
- UF/RO plant flowrate from FT300-10, or the available capacity if the UF/RO plant is not running [Q_{UFRO}].

The setpoint flow to the Class A train as measured at FT100-02 [Q_A], will be the smallest of the following:

(i.) $Q_A = Q_{NFA} - Q_{UFRO}$

(ii.) $Q_A = Q_{OPS} - (Q_{UFRO} + Q_{BML})$

(iii.)

$$Q_A = \frac{Q_{UFRO} (TDS_{TARG} – TDS_{UFRO}) + Q_{BML} (TDS_{TARG} – TDS_{BML})}{TDS_{IN} - TDS_{TARG}}$$

The conversions from EC to TDS will be:

- $TDS_{IN} = K_{IN} \times EC_{IN}$
- $TDS_{UFRO} = K_{UFRO} \times EC_{UFRO}$
- $TDS_{BML} = K_{BML} \times EC_{BML}$

K_{IN} will provisionally be set at 0.55, and K_{UFRO} and K_{BML} at 0.5. These factors will be revised once sufficient data has been gathered to allow more appropriate values to be determined.

The final water TDS [TDS_{FW}] as measured by the final water EC analyser [EC_{FW} as measured at AT300-25] converted to TDS will be used to trim (by cascade control) the Class A flow setpoint in accordance with the following:

- deadband range on $TDS_{FW} = TDS_{TARG} \pm 20$ mg/L
- if $TDS_{FW} > TDS_{TARG} \pm 20$ mg/L then change Q_A by 0.5%/hour after a 30 minute lag to bring TDS back within deadband range.

Where $TDS_{FW} = K_{FW} \times EC_{FW}$, with K_{FW} provisionally set at 0.5, and revised as per the K factors above.

3.17. Group Start

The RWPTF operation will be able to be started by a group start sequence that will operate as follows.

Note: Steps that can run independently in parallel are numbered with a common first digit and unique second digit. E.g. steps 1.1 and 1.2 can run independently in parallel.

3.17.1. Aborting Group Start

If any step in the group start fails to reach its transition requirements within the time specified in the group start chart below, then all operating parts of the plant must shut down per the shut down sequence, with the exception of the service water system. This system will continue to operate until specifically shut off by the operator.

Group Start Sequence

Step No.	*Item to Start*	*Prestart Requirements*	*Requirements for Transition to Next Step*
1.1	Service Water System refer 3.4	Service Water System permissives are satisfied.	System pressure is within deviation alarm limits. Maximum time allowed –from start of step - without reaching transition condition : Not Applicable
1.2	Low Lift Pump Set refer 3.5	Low Lift Pump Set permissives are satisfied. Operator request	LLPS pressure is within deviation alarm limits Maximum time allowed –from start of step - without reaching transition condition : 30 sec
2.1	UF/RO Plant & Feed (if required) refer 3.7	UF/RO Plant permissives are satisfied. Step 1.2 is Complete	UF/RO plant has been running for 60 seconds Maximum time allowed –from start of step - without reaching transition condition : 300 sec
2.2	UV system - refer 3.8	UV Plant permissives are satisfied. Step 1.2 is complete	UV system signal received that system is operational and healthy. Maximum time allowed –from start of step - without reaching transition condition : 30 sec
3	Class A feed,	Class A feed permissives are satisfied. Steps 2.1 and 2.2 are complete	Class A flow is > 50% of set point Maximum time allowed –from start of step - without reaching transition condition : 30 sec
4.1	Hypochlorite Dosing - refer 3.9	Hypochlorite Dosing permissives are satisfied. Step 3 is complete	Hypochlorite Pump system reports it is operating & healthy Maximum time allowed –from start of step - without reaching transition condition : 30 sec
4.2	MetaBisulphite Dosing – refer 3.10	MetaBisulphite Dosing permissives are satisfied. Step 3 is complete	MetaBisulphite Pump system reports it is operating & healthy Maximum time allowed –from start of step - without reaching transition condition : 30 sec

3.18. Group Shut

The group shut will close down feed to the RWPTF and all associated operations. The controlled close sequence will operate as required when a controlled closure of the plant is needed.

Note: Steps that can run independently in parallel are numbered with a common first digit and unique second digit. E.g. steps 1.1 and 1.2 can run independently in parallel.

Group Shut Sequence

Step No.	*Item to Close*	*Prior Requirements*	*Requirements for Transition to Next Step*
1	Class A feed refer 3.6	System shutdown initiated by manual request or by control override requirements.	Control Valve VC100-02 output <5% & Flow on FT Alarm if transition not reached within 30sec.
2.1	Hypochlorite Dosing refer 3.9	Step 1 is complete	Hyperchlorite pump system flow switches confirm "No flow" Alarm if transition not reached within 30sec.
2.2	MetaBisulphite Dosing refer 3.10	Step 1 is complete	Bisulphite pump system flow switches confirm "No flow" Alarm if transition not reached within 30sec.
2.3	UV system refer 3.8	Step 1 is complete	UV system signal received that system is shut down Alarm if transition not reached within 30sec.
3	UF/RO Plant & Feed refer 3.7	All steps 2 are complete	Control Valve VC100-03 output <5% and UF/RO plant confirms it is shut Alarm if transition not reached within 30sec.
4	Low Lift Pump Set refer 3.5	All steps 2 are complete and Control Valve VC100-03 output <5%	Output to all four Low Lift Pumps are confirmed as off and Pump Discharge pressure PT100-01 < 0.2 Bar Alarm if transition not reached within 30sec.

Note: Service water will not be shut off by the group shut sequence. This should be an operator initiated function.