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Sandgate WRP General (Functional Description - Nutrient Removal Upgrade Control) General

TMS72

18/05/2005

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CONTROL SHEET

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1. GLOSSARY OF TERMS

Term	Description
Citect	The SCADA software package used to control the equipment.
DOL	**Direct On Line electrical motor starter**
LOI	**Local Operator Interface**
OWS	**O**perator **W**ork **S**tation
NIC	**N**etwork **I**nterface **C**ard. A generic term describing the 10/100 UTP Ethernet cards used to network equipment (PCs, PLCs, printers, routers, etc).
PLC	**P**rogrammable **L**ogic **C**ontroller. A **PLC** is designed specifically to control industrial processes under industrial conditions.
PCS	**P**lant **C**ontrol **S**ystem
SCADA	**S**upervisory **C**ontrol **A**nd **D**ata **A**cquisition. A generic term for a centralized control system typically consisting of **PLC**s and control terminals.
TCP/IP	**T**ransmission **C**ontrol **P**rotocol / **I**nternet **P**rotocol. A common way of describing a suite of protocols used by devices configured with an **NIC**.
VSD	**V**ariable **S**peed **D**rive

Table 1: Glossary of Terms

2. INTRODUCTION

This document describes the functional operation of the Plant Control System for the Sandgate WWTP Nutrient Removal Upgrade Project. This document has been developed as part of the Supply of PLC & SCADA Control Systems subcontract no. BWEA_Z_7302/2.

This document is based on the BWEA's Sandgate Functional Description documents, P&I Drawings, and PLC I/O Lists.

The document addresses the standard specifications for various equipment types to ensure standardization across the various PLC systems. The document also outlines by Process Area the functionality required to be provided by the Plant Control System. These areas include:

- Flowsplitter 1
- Flowsplitter 2
- Anaerobic Zones 1 and 2
- Oxidations Ditches 1 and 2
- Final Settling Tanks 1, 2, and 3
- UV Disinfection
- Service Water System
- Activated Sludge and Scum Wasting and Thickening
- High Voltage Power Distribution
- Low Voltage Power Distribution
- Odour Control

The following existing equipment was programmed under a previous contract, however will be displayed on the plant SCADA system:

- Pump Station No.1
- Pump Station No.2
- Inlet Works
- Digesters
- Ancillary Items
- General Purpose Pump Stations

3. REFERENCES

3.1. BWEA P&ID Drawings

486/5/5-S3D100	P&ID Legend	Rev P5
486/5/5-S3D101	Primary Settling Tanks P&ID	Rev P4
486/5/5-S3D102	Flowsplitter 2 & Anaerobic Zone P&ID	Rev P5
486/5/5-S3D103	Bioreactor 1 P&ID	Rev P6
486/5/5-S3D104	Bioreactor 2 P&ID	Rev P6
486/5/5-S3D105	Final Settling Tank 1 P&I Diagram	Rev P5
486/5/5-S3D106	Final Settling Tank 2 P&I Diagram	Rev P5
486/5/5-S3D107	Final Settling Tank 3 P&I Diagram	Rev P5
486/5/5-S3D108	UV Disinfection and Service Water P&I Diagram	Rev P5
486/5/5-S3D109	WAS Pumpstation P&ID	Rev P5
486/5/5-S3D110	WAS Dewatering P&ID	Rev P5
486/5/5-S3D111	Sludge Hopper P&ID	Rev P5
486/5/5-S3D112	Compressed Air P&ID	Rev P4
486/5/5-S3D113	Polyelectrolyte Make-up and Storage P&ID	Rev P5
486/5/5-S3D114	Polyelectrolyte Dosing P&ID	Rev P5
486/5/5-S3D115	Blower P&ID	Rev P4

3.2. PLC I/O Lists

Sandgate I/O List – Bioreactor 1 MCC PLC	Rev P2
Sandgate I/O List – Sludge MCC PLC	Rev P2
Sandgate I/O List – Service Water MCC PLC	Rev P2
Sandgate I/O List – Bioreactor 2 MCC PLC	Rev P2
Sandgate I/O List – HV Switchgear I/O	Rev P2
Sandgate I/O List – Polymer Batching	Rev P2
Sandgate I/O List – Odour Control PLC	Rev P2
Sandgate I/O List – UV PLC	Rev P2
Sandgate I/O List – Blowers PLC	Rev P2

3.3. Vendor Package Functional Specifications

HST Blower Cepha Control Ltd - Functional Design Specification Rev 1.1

3.4. Contract Specification

Specification for PLC & SCADA Control System Upgrades	Rev 0
i.Power Solutions Tender Submission	Rev 1

3.5. Standard Specifications

Citect HMI Standards	Rev 1.5
0002788-DS001-A BWEA Sandgate WWTP Upgrade PLC Specification	Rev B

4. PROCESS OVERVIEW

The upgrade works at Sandgate WWTP include new flow-splitters, bioreactors, final settling tanks, blowers, sludge dewatering facilities, UV disinfection facilities, odour control equipment and ancillary items. The existing inlet works facility is required to remain in operation. The existing digesters are to be de-commissioned, however the control system for the digesters must remain in place as they may be recommissioned in the future. All other areas are to be decommissioned.

The Process and Instrumentation Diagrams outlining the process are included in Appendix A.

The existing control room contains an existing PLC which acts as the data concentrator for the existing plant. The equipment that is controlled via this PLC shall be maintained throughout the construction period. This PLC shall be decommissioned upon the successful completion of the new plant.

A new control room shall contain primary and standby Citect SCADA terminals with a Historian package running on a separate PC. Citect SCADA terminals shall be located in two other areas of the plant:

a. On the top floor of the Blower and Sludge building adjacent to the sludge dewatering equipment.
b. In the switchroom of the Service Water and UV areas.

The Citect SCADA system shall provide the plant mimics, operator control, alarms and trends for the day to day operation of the entire plant. All process instrumentation, Variable Speed Drive data, and setpoints will be trended by the Citect SCADA system, and will be able to be displayed on the predefined Trend Pages, or selected on the Operator configurable Trend Pages. Plant alarms will also be logged to the Alarm Log by the Citect SCADA system.

The Historian package is a data warehouse which efficiently logs large amounts of plant data. The Historian package shall be used for historical reporting and data analysis. All digital and analog data that is available on the Citect SCADA system will be logged to the Historian.

4.1. Control System Overview

The existing control system for Sandgate WWTP will be upgraded as part of this project. The existing plant at Sandgate consists of a number of GE Fanuc 90-30 PLC's operating over a Genius network and connected to a Citect SCADA system.

The new control system includes an upgrade of the existing Citect system and the inclusion of a number of Siemens S7 PLC's communicating over a plant wide Ethernet network. As well, a number of instruments, drives, soft-starters, and VSD's are connected over Profibus-DP and Profibus-PA networks. Please refer to network drawings.

New PLC's are provided for the following areas.

- Final Area
- Sludge
- Bioreactor 1
- Bioreactor 2
- High Voltage
- Blower (programmed by others)
- UV Disinfection (programmed by others)
- Poly Batching (programmed by others)

4.2. Project Staging and Transition period

This section of this document in intended to be a dynamic section to document the special cases and exceptions to the other parts of this document related to the staging and transition periods of the project. This section of the document is to be removed at the completion of the last stage of the upgrade as it will be of no further use.

The plant will be constructed and commissioned in three stages. Stage 1 commissioning will include the following areas:

a. High Voltage Network
b. Flow Splitter No.1
c. Flow Splitter No.2
d. Bioreactor No.1
e. FST No.1 and RAS Pump Station No.1
f. Blowers
g. UV Disinfection
h. Service Water Pump Station
i. WAS Pump Station No.1
j. GDD/BFP No.1
k. Poly Dosing
l. New Control Room

The existing plant will remain online until the Stage 1 equipment is commissioned. After the Stage 1 equipment is commissioned, four of the existing filters will be taken offline with the new equipment taking half of the load on the plant.

At this point, Stage 2 will commence. Stage 2a will include the following:

a. FST No.3 and RAS Pump Station No.3
b. GDD/BFP No.2
c. Odour Control System

Stage 2b will include the following equipment:

a. Bioreactor No.2
b. FST No.2 and RAS Pump Station No.2
c. WAS Pump Station No.2

The items addressed below will generally be provided by temporary system configuration to allow automatic operation of the plant during the transition periods. Generally, unavailable equipment will be either not shown of the Citect Mimics or will be greyed out so that it is clear that the equipment is not available.

4.2.1. Inlet Works

During Stage 1 and 2a of the project part of the plant flow will be directed to the existing system and the remainder will be directed to the new system via Flow Splitter 2.

During this period generally the *Influent flow* rate referred to in this document will be calculated by Influent Flow = FIT851-01 – Existing FS5 Flowmeter. Generally throughout this document this formula is to be substituted in place of Influent Flow or FIT851-01 for Stage 1 and 2a.

During stage 1 and 2a the method of detection of 3 x ADWF condition to trigger the plant bypass sequence shall be as is described in section 6.1.3.1 Flowsplitter 1 Bypass Sequence Overview.

However, the setpoints for the Bypass system will need to be adjusted to correctly bypass only flows greater that 3 x ADWF.

During stage 1 and 2a the Flow Control method described in section 6.1.3.1.1 of control of the Bypass penstock during bypass events shall not be available.

As part of the commissioning of Stage 2b the inlet works will divert all of the flow to Flow splitter 2 providing the final system design as per this document.

4.2.2. Bioreactors

During stage 1 and 2a the following equipment will not be commissioned

- Bioreactor 2.

Therefore during stage 1 and 2a the system is to automatically allow for this requirement.

4.2.3. Activated Sludge and Scum Wasting and Thickening

During stage 1 the following equipment will not be commissioned

- WAS Pump Station 2.
- GDD/BFP 2

Therefore during stage 1 the system is to automatically allow for this requirement.

4.2.4. Final Settling Tanks

During stage 1 the following equipment will not be commissioned

- FST 3 and RAS Pump Station 3.
- FST 2 and RAS Pump Station 2.

Therefore during stage 1 the system is to automatically allow for this requirement.

During stage 2a the following equipment will not be commissioned

- FST 2 and RAS Pump Station 2.

Therefore during stage 2a the system is to automatically allow for this requirement.

4.2.5. Other systems

During stage 1 the following equipment will also not be commissioned

- Odour Control

Therefore during stage 1 the system is to automatically allow for this requirement.

5. FUNCTIONAL STANDARDS

5.1. Equipment Control Modes

All controlled equipment shall generally have four control modes:

a. Off (not selectable at OWS)
b. Local Manual (not selectable at OWS)
c. Remote Manual
d. Remote Automatic

If the equipment is selected by the operator for Local Manual Control at the equipment site, then this status shall be indicated on the OWS. The operator shall be able to start and stop (or open and close) the equipment independently of the SCADA system while in this mode. The remote mode of control for equipment shall be operator selectable from the OWS. The operator shall select from Manual, and Automatic modes – the operations of these modes are defined below

5.1.1. Sequence Control

Plant Sequences are groups of equipment that run together under automatic control, according to a defined series of steps, loops, times, and interlocks. The normal operation of these sequences will be that they are constantly in running mode, but the facility exists for the operator to start and stop the operation of the sequence. Each sequence shall have "Start" and "Stop" buttons for controlling the sequence, and a Running/Stopped feedback to show the status of the sequence.

5.1.2. Equipment Availability

Controlled equipment is defined as being available if the equipment is not in the Off Mode (by selection of "Local/Off/Remote" selector switch to "Off") and it is not in a Fault state.

Process instrument is defined as being available if its signal is valid, and it is not in a critical Fault state.

5.1.3. Off Mode

This mode may be selected at the equipment site by selection the "Local/Off/Remote" selector switch to "Off". When equipment is placed in the Off Mode, the equipment shall not be able to be operated either manually or automatically by the control system, and no alarms shall be generated for this equipment.

This mode shall generally be used for maintenance purposes.

5.1.4. Local Manual Mode

The operator may select this mode by operating the "Local/Off/Remote" selector switch at the equipment site to "Local". The selection of this mode shall be indicated on the OWS. The operator shall be able to start and stop (or open and close) the equipment at the equipment site independently of the SCADA system while in this mode.

For pumps, motors and other drives, if equipment is running in Remote Manual or Automatic mode, and Local Manual mode is selected, then the equipment shall stop/close. For valves, if the valve is operating in Remote Manual or Automatic mode, and Local Manual mode is selected, then the valve shall remain in its current position.

5.1.5. Remote Manual Control Mode

For equipment to be controlled remotely, then the operator must select "Remote" at the "Local/Off/Remote" selector switch at the equipment site. The Remote Manual Mode may be selected by the operator at the OWS by selecting the "Manual" button. When equipment is placed in the Manual Mode, the equipment shall be remotely controlled manually from operator selectable

Start and Stop (or Open and Close) buttons on OWS. No remote automatic control shall occur while the equipment is in this mode.

The remote manual control of the equipment shall only be possible if the following conditions are met:

a. ***Manual Interlock Condition*** – the equipment may only be started if the defined manual interlock conditions are met.
b. ***Fault Condition*** – The equipment may only be started if the fault condition is not active.

If the equipment fails to start or stop (or open or close) within a specific time of the operator command, then the equipment shall be put into a Fault state, and an alarm shall be raised on the OWS.

If equipment is running in Remote Automatic Mode, and Remote Manual Mode is selected, then the equipment shall continue to run and it shall adjust its speed or position (if applicable) to the Manual Setpoint set on the OWS.

5.1.6. Remote Automatic Control Mode

For equipment to be controlled remotely, then the operator must select “Remote” at the “Local/Off/Remote” selector switch at the equipment site. The Remote Automatic Mode may be selected by the operator at the OWS by selecting the “Automatic” button. This mode is the “normal” mode of control for all plant. When equipment is placed in the Automatic Mode, the control of the equipment shall be defined by a series of conditions, set points, and delay times as follows:

a. ***Automatic Start/Open Condition*** –this condition is logical expression controlled by the equipment’s automatic sequence, that when true starts/opens the equipment
b. ***Automatic Interlock Condition*** – the equipment may only be started if the defined automatic interlock conditions are met.
c. ***Fault Condition*** – The equipment may only be started if the fault condition is not active.

If the equipment fails to start or stop (or open or close) within a specific time of the automatic commands, then the equipment shall be put into a Fault state, and an alarm shall be raised on the OWS.

All setpoints and times required for the logical equations for automatic sequence control shall be adjustable remotely from the OWS. The operator input for these set points shall be forced to be within a safe operating range defined for each set point.

If equipment is running in Remote Manual Mode, and Remote Automatic Mode is selected, then the equipment shall run according to the automatic conditions defined above, and it shall adjust its speed or position (if applicable) to the Automatic Setpoint.

5.1.7. Duty/Assist Control

Equipment may be in the Duty/Assist Control configuration if the process requirement is at times not able to be provided by only the duty item of equipment operating, and requires the operation of both the duty and assist equipment. Start and Stop conditions are defined for the operation of the Duty equipment, and for the Assist equipment.

If the Duty equipment is unavailable (Faulted, Disabled, or Manual Stop), then the Assist equipment is to continue operating with the duty equipment parameters. The duty is operator-selectable remotely from the OWS as Duty, Assist, and Alternate. In Alternate mode, for equipment that stops and starts, the duty will change every time both items of equipment are stopped, and for equipment that runs continuously, the duty will change when the duty equipment has been running continuously for 24 hours..

If the Duty equipment fails then duty shall failover to the Assist equipment and it shall become the new Duty equipment.

5.1.8. Duty/Standby Control

Pumps may be in the Duty/Standby Control configuration if the process requirement is able to be provided by only one pump operating. Start and Stop conditions are defined for the operation of the Duty Pump.
If the Duty Pump is unavailable (Faulted, Disabled, or Manual Stop), then the Standby Pump is to operate in place of the Duty Pump. Pump Duty is operator-selectable remotely from the OWS as Duty, Standby, and Alternate. In Alternate mode, for equipment that stops and starts, the duty will change every time both items of equipment are stopped, and for equipment that runs continuously, the duty will change when the duty equipment has been running continuously for 24 hours..

If the Duty equipment fails then duty shall failover to the Standby equipment and it shall become the new Duty equipment.

5.2. Equipment Types

5.2.1. Process Digital Inputs

The Process Digital Input is for binary instrumentation such as level, flow, or pressure switches. The switching contact for the input shall be configured so the input is active (“1”) in the desirable condition. This shall ensure that the system will be able to fail safe upon instrument failure, broken wire, or loss of power supply.

5.2.1.1. Alarms

If the process digital input is an alarm, an active ("1") signal to the SCADA system shall raise an alarm on the OWS and will require acknowledgement by the operator.

5.2.1.2. Data logging

If the process digital input is to be alarmed, then the Active, Inactive, and Acknowledge transitions shall be logged to the alarm log on Citect. The Active, and Inactive transitions of all digital inputs shall be logged within the Historian Package.

5.2.2. Process Analog Inputs

The Process Analog Input is for analog instrumentation such as level, flow, or pressure meters or transmitters that provide an analog signal to the Plant Control System. The analog signal shall be scaled as 4mA is 0% and 20mA is 100% of the calibrated range. An exception for this may be made for loop powered devices that require more power at 0% than at 100% (e.g. radar level transmitters).

The analog processing and control code shall ensure that the system will be able to fail safe upon instrument failure, broken wire, or loss of power supply.

5.2.2.1. Alarms

The following alarms may be configured, and if active shall be raised on the OWS and will require acknowledgement by the operator.

a. High Alarm
b. High-High Alarm
c. Low Alarm
d. Low-Low Alarm

e. Invalid Alarm

5.2.2.2. Data logging

If alarms are configured for the analog input, then the Active, Inactive, and Acknowledge transitions shall be logged to the alarm log on Citect. The following analog data shall be trended on the OWS and logged by the Historian Package:

a. Process Value
b. High Alarm Setpoint
c. High-High Alarm Setpoint
d. Low Alarm Setpoint
e. Low-Low Alarm Setpoint

5.2.3. Process Analog(PA) Inputs

The Process Analog(PA) Input is for analog instrumentation such as level, flow, pressure meters or transmitters, or analysers (including DO, NH4, pH, H2S, CL2, and ORP) that are linked to the Plant Control System by the Profibus PA network.

The Profibus PA interface of the instrument provides the process value as well as status data including alarms. The analog processing and control code shall ensure that the system will be able to fail safe upon instrument failure, loss of communications, or loss of power supply

5.2.3.1. Alarms

The following alarms may be configured, and if active shall be raised on the OWS, and will require acknowledgement by the operator.

a. High Alarm
b. High-High Alarm
c. Low Alarm
d. Low-Low Alarm
e. Invalid Alarm
f. Profibus Fault Alarm
g. Other instrument specific alarms

5.2.3.2. Data logging

If alarms are configured for the process input, then the Active, Inactive, and Acknowledge transitions shall be logged to the alarm log on Citect. The following analog data shall be trended on the OWS and logged by the Historian Package:

a. Process Value
b. High Alarm Setpoint
c. High-High Alarm Setpoint
d. Low Alarm Setpoint
e. Low-Low Alarm Setpoint
f. Other Instrument specific values

5.2.4. Level Transmitters

Level Transmitters shall be devices such as probes, pressure transmitters, and ultrasonic or radar level transmitters that provide an indication of the level in a reservoir, tank, well, or tower. The process value may be provided to the Process Control System by either an Analog Input signal, or as a Profibus PA communications signal as described above.

The level processing and control code shall ensure that the system will be able to fail safe upon instrument failure, broken wire, communications failure, or loss of power supply.

5.2.4.1. Alarms

The following alarms may be configured, and if active shall be raised on the OWS, and will require acknowledgement by the operator.

a. High Alarm
b. High-High Alarm
c. Low Alarm
d. Low-Low Alarm
e. Invalid Alarm
f. Profibus Fault Alarm
g. Other instrument specific alarms

5.2.4.2. Data logging

If alarms are configured for the process input, then the Active, Inactive, and Acknowledge transitions shall be logged to the alarm log on Citect. The following analog data shall be trended on the OWS and logged by the Historian Package:

a. Process Value
b. High Alarm Setpoint
c. High-High Alarm Setpoint
d. Low Alarm Setpoint
e. Low-Low Alarm Setpoint
f. Other Instrument specific values

5.2.5. Flow Meters

Flow meters shall be devices such as electromagnetic, Doppler, or ultrasonic flow meters that provide an indication of flow in a pipe or channel. The process value may be provided to the Process Control System by either an Analog Input signal, or as a Profibus PA communications signal as described above.

The flow processing and control code shall ensure that the system will be able to fail safe upon instrument failure, broken wire, communications failure, or loss of power supply.

5.2.5.1. Alarms

The following alarms may be configured, and if active shall be raised on the OWS, and will require acknowledgement by the operator.

a. High Alarm
b. High-High Alarm
c. Low Alarm
d. Low-Low Alarm
e. Invalid Alarm
f. Profibus Fault Alarm
g. Other instrument specific alarms
h. Reverse Flow Alarm

5.2.5.2. Data logging

If alarms are configured for the process input, then the Active, Inactive, and Acknowledge transitions shall be logged to the alarm log on Citect. The following analog data shall be trended on the OWS and logged by the Historian Package:

a. Process Value
b. High Alarm Setpoint
c. High-High Alarm Setpoint
d. Low Alarm Setpoint
e. Low-Low Alarm Setpoint

f. Other Instrument specific values
g. Reverse Flow Alarm Setpoint

5.2.6. Nemo Power Meters

Power Meters shall be installed for each MCC to provide power usage, phase voltages, currents and other information. The Nemo Power Meters shall be connected using a Profibus PA communications signal as described above.

5.2.6.1. Statistics

The will be no statistics calculated for this device.

5.2.6.2. Alarms

There will be no alarms configured for this device

5.2.6.3. Data logging

The following analog data shall be trended on the OWS and logged by the Historian Package:

a. L1 Current
b. L2 Current
c. L3 Current
d. Instantaneous Power
e. Instantaneous Apparent Power
f. Instantaneous Power Factor
g. Cumulative kWh
h. Maximum Demand
i. Frequency
j. L1 Voltage
k. L2 Voltage
l. L3 Voltage
m. L1 Voltage THD
n. L2 Voltage VHD
o. L3 Voltage THD
p. L1 Current THD
q. L2 Current THD
r. L3 Current THD

5.2.7. Drives

Drives are pumps, mixers, or other electric motors that shall be started by a Direct-On-Line starter and run at a fixed speed.

The DOL drive shall have the following control inputs and outputs:

a. Control Supply Available
b. Field Circuit Ready
c. Control Mode Remote
d. Control Mode Local
e. Reset
f. Running
g. Thermal Overload
h. Thermistor Fault
i. External Trips (application specific, such as Seal Failure or Low Flow Fault)
j. Run Digital Output
k. Fault Reset Digital Output

The status of the starter shall be indicated as either Stopped or Running. The mode of the starter shall be indicated as Disabled, Faulted, Manual, or Automatic. The drive state shall be limited to the following states:

Drive State	Status	Mode
0	Stopped	Off
1	Stopped	Faulted
2	Stopped	Manual
3	Running	Manual
4	Stopped	Automatic
5	Running	Automatic

The drive shall be controlled according to the standard specification for Equipment Control.

5.2.7.1. Statistics

The following statistics shall be calculated, displayed on the OWS, logged on the OWS and the Historian Package, and made available for inclusion into reports:

a. Total Number of Starts
b. Total Run Hours
c. Yesterdays Total Number of Starts
d. Yesterdays Total Run Hours

5.2.7.2. Alarms

The following alarms shall be raised on the OWS and will require acknowledgement by the operator.

a. Drive Fail to Start/Stop
b. Control Supply Not Available
c. Field Circuit Not Ready
d. Thermal Overload
e. Thermistor Fault
f. External Trips (application specific, such as Seal Failure or Low Flow Fault)

5.2.7.3. Data logging

The configured alarms' Active, Inactive, and Acknowledge transitions shall be logged to the alarm log on Citect.

5.2.7.4. Load Shedding

The load shedding algorithm has a numeric output called the *Load-Shed Setpoint* to control the re-start of the equipment after a power failure, or during lower power availability. Each drive has a *Load-Shed Number* assigned. When the *Load-Shed Setpoint* is higher than the drive's *Load-Shed Number*, then the drive is permitted to operate.

5.2.8. Soft-Start Drives

Soft-Start Drives are pumps or electric motors that shall be started by a Soft-Starter to reduce start-up current, and run at a fixed speed. A Profibus communications link is used start/stop the drive and to gather data from the Soft-Starter.

The Soft-Start drive shall have the following control inputs and outputs:

a. Control Supply Available

b. Field Circuit Ready
c. Control Mode Remote
d. Control Mode Local
e. Reset
f. Drive Running
g. Stopped with Alarm
h. Running with Alarm
i. External Trips (application specific, such as Seal Failure or Low Flow Fault)
j. Run Digital Output
k. Fault Reset Digital Output
l. Fault Codes (Drive specific)
m. Phase Currents (A,B, and C)
n. Line Voltage (A, B, and C)
o. Input Power
p. Used Thermal Capacity
q. Phase Input Failure
r. Motor Protection
s. Softstarter Overheated
t. Voltage Unbalance
u. Open Thyristor
v. Shorted Thyristor

The status of the starter shall be indicated as either Stopped or Running. The mode of the starter shall be indicated as Disabled, Faulted, Manual, or Automatic. The drive state shall be limited to the following states:

Drive State	Status	Mode
0	Stopped	Off
1	Stopped	Faulted
2	Stopped	Manual
3	Running	Manual
4	Stopped	Automatic
5	Running	Automatic

The Soft-Start drive shall be controlled according to the standard specification for Equipment Control.

5.2.8.1. Statistics

The following statistics shall be calculated, displayed on the OWS, logged on the OWS and the Historian Package, and made available for inclusion into reports:

a. Total Number of Starts
b. Total Run Hours
c. Yesterdays Total Number of Starts
d. Yesterdays Total Run Hours

5.2.8.2. Alarms

The following alarms shall be raised on the OWS and will require acknowledgement by the operator.

a. Drive Fail to Start/Stop
b. Control Supply Not Available
c. Field Circuit Not Ready
d. Thermal Overload
e. External Trips (application specific, such as Seal Failure or Low Flow Fault)
f. Other Faults (Fault Code - drive specific)

g. Communications Failure for Profibus Link

5.2.8.3. Data logging

The configured alarms' Active, Inactive, and Acknowledge transitions shall be logged to the alarm log on Citect. The following data shall be trended on the OWS and logged to the Historian Package.:

a. Phase Currents (A,B, and C)
b. Line Voltage (A, B, and C)
c. Input Power
d. Used Thermal Capacity

5.2.8.4. Load Shedding

The load shedding algorithm has a numeric output called the *Load-Shed Setpoint* to control the re-start of the equipment after a power failure, or during lower power availability. Each Soft-Start drive has a *Load-Shed Number* assigned. When the *Load-Shed Setpoint* is higher than the Soft-Start drive's *Load-Shed Number*, then the Soft-Start Drive is permitted to operate.

5.2.9. Simocode Drives

Simocode Drives are pumps, mixers, or other electric motors that shall be started by a Simcode-DP Motor Protection and Control Unit. These are generally used on motors which require some level of condition monitoring.

The Simocode Drive shall have the following control inputs and outputs:

a. Control Supply Available
b. Field Circuit Ready
c. Control Mode Remote
d. Control Mode Local
e. Reset
f. Running
g. Thermal Overload
h. Thermistor Fault
i. External Trips (application specific, such as Seal Failure or Low Flow Fault)
j. Run Digital Output
k. Fault Reset Digital Output
l. Current Asymmetrical
m. Current High Warning
n. Current Low Warning
o. Earth Fault
p. Motor Stalled
q. Fail to Start
r. Motor current

The status of the motor shall be indicated as either Stopped or Running. The mode of the mode shall be indicated as Disabled, Faulted, Manual, or Automatic. The motor state shall be limited to the following states:

Drive State	Status	Mode
0	Stopped	Off
1	Stopped	Faulted
2	Stopped	Manual
3	Running	Manual
4	Stopped	Automatic
5	Running	Automatic

The drive shall be controlled according to the standard specification for Equipment Control.

5.2.9.1. Statistics

The following statistics shall be calculated, displayed on the OWS, logged on the OWS and the Historian Package, and made available for inclusion into reports:

a. Total Number of Starts
b. Total Run Hours
c. Yesterdays Total Number of Starts
d. Yesterdays Total Run Hours

5.2.9.2. Alarms

The following alarms shall be raised on the OWS and will require acknowledgement by the operator.

a. Drive Fail to Start/Stop
b. Control Supply Not Available
c. Field Circuit Not Ready
d. Thermal Overload
e. External Trips (application specific, such as Seal Failure or Low Flow Fault)
f. Other Faults (Fault Code - drive specific)
g. Current Asymmetrical
h. Current High Warning
i. Current Low Warning
j. Earth Fault
k. Motor Stalled
l. Fail to Start
m. Communications Failure for Profibus Link

5.2.9.3. Data logging

The configured alarms' Active, Inactive, and Acknowledge transitions shall be logged to the alarm log on Citect. The following data shall be trended on the OWS and logged to the Historian Package.:

a. Motor Current

5.2.9.4. Load Shedding

The load shedding algorithm has a numeric output called the *Load-Shed Setpoint* to control the re-start of the equipment after a power failure, or during lower power availability. Each Soft-Start drive has a *Load-Shed Number* assigned. When the *Load-Shed Setpoint* is higher than the Soft-Start drive's *Load-Shed Number*, then the Soft-Start Drive is permitted to operate.

5.2.10. VSD Drives

VSD Drives are pumps or electric motors that shall be started by a Variable Speed Drive, and run at a variable speed. A communications link is used to start/stop the drive, vary the speed, and to gather data for the VSD.

The VSD drive shall have the following control inputs and outputs:

a. Control Supply Available
b. Field Circuit Ready
c. Control Mode Remote
d. Control Mode Local
e. Reset

f. VSD Ready
g. VSD Running
h. VSD Fault
i. Thermistor Fault
j. External Trips (application specific, such as Seal Failure or Low Flow Fault)
k. Run Digital Output
l. Fault Reset Digital Output
m. Fault Codes (VSD specific)
n. VSD Frequency
o. VSD Voltage
p. VSD Amps
q. VSD Input Power kW
r. VSD Motor Temperature
s. Speed Reference Output

The status of the starter shall be indicated as either Stopped or Running. The mode of the starter shall be indicated as Disabled, Faulted, Manual, or Automatic. The drive state shall be limited to the following states:

Drive State	Status	Mode
0	Stopped	Off
1	Stopped	Faulted
2	Stopped	Manual
3	Running	Manual
4	Stopped	Automatic
5	Running	Automatic

The VSD drive shall be controlled according to the standard specification for Equipment Control.

5.2.10.1. Statistics

The following statistics shall be calculated, displayed on the OWS, logged on the OWS and the Historian Package, and made available for inclusion into reports:

a. Total Number of Starts
b. Total Run Hours
c. Yesterdays Total Number of Starts
d. Yesterdays Total Run Hours

5.2.10.2. Alarms

The following alarms shall be raised on the OWS and will require acknowledgement by the operator.

a. Drive Fail to Start/Stop
b. Control Supply Not Available
c. Field Circuit Not Ready
d. Thermal Overload
e. Thermistor Fault
f. External Trips (application specific, such as Seal Failure or Low Flow Fault)
g. VSD Fault
h. Other Faults (Fault Code - drive specific)
i. Communications Failure for Profibus Link

5.2.10.3. Data logging

The configured alarms' Active, Inactive, and Acknowledge transitions shall be logged to the alarm log on Citect. The following data shall be trended on the OWS and logged to the Historian Package.:

a. VSD Frequency
b. VSD Voltage
c. VSD Amps
d. VSD Input Power kW
e. VSD Temperature
f. Speed Reference Output

5.2.10.4. Load Shedding

The load shedding algorithm has a numeric output called the *Load-Shed Setpoint* to control the re-start of the equipment after a power failure, or during lower power availability. Each VSD drive has a *Load-Shed Number* assigned. When the *Load-Shed Setpoint* is higher than the VSD drive's *Load-Shed Number*, then the VSD Drive is permitted to operate.

5.2.11. Controlled Valves

Controlled Valves are valves that shall be positioned as either opened or closed. A controlled valve shall have the following control inputs and outputs:

a. Opened Digital Input
b. Closed Digital Input
c. Open Digital Output
d. Close Digital Output

The status of the valve shall be indicated as either Closed or Opened. The mode of the valve shall be indicated as Disabled, Faulted, Manual, or Automatic. The valve state shall be limited to the following states:

Drive State	Status	Mode
0	Closed	Off
1	Closed	Faulted
2	Closed	Manual
3	Opened	Manual
4	Closed	Automatic
5	Opened	Automatic

The controlled valve shall be controlled according to the standard specification for Equipment Control.

5.2.11.1. Statistics

The following statistics shall be calculated, displayed on the OWS, logged on the OWS and the Historian Package, and made available for inclusion into reports:

a. Total Number of Openings
b. Total Open Hours

5.2.11.2. Alarms

The following alarms shall be raised on the OWS and will require acknowledgement by the operator.

a. Valve Fail to Open Fault

b. Valve Fail to Close Fault

5.2.11.3. Data logging

The configured alarms' Active, Inactive, and Acknowledge transitions shall be logged to the alarm log on Citect.

5.2.12. Modulating Valves

Modulating Valves are valves that shall be positioned to an opened position, generally 0 to 100%.. A controlled valve shall have the following control inputs and outputs:

a. Position Reference Output

The status of the valve shall be indicated as either Closed or Opened, with the Position Reference shown on the OWS. The mode of the valve shall be indicated as Disabled, Faulted, Manual, or Automatic. The valve state shall be limited to the following states:

Drive State	Status	Mode
0	Closed	Off
1	Closed	Faulted
2	Manual Setpoint	Manual
3	Automatic Setpoint	Automatic

The modulating valve shall be controlled according to the standard specification for Equipment Control.

5.2.12.1. Statistics

The following statistics shall be calculated, displayed on the OWS, logged on the OWS and the Historian Package, and made available for inclusion into reports:

a. Total Number of Starts

5.2.12.2. Alarms

The following alarms shall be raised on the OWS and will require acknowledgement by the operator.

a. Valve Fail To Reach Position

5.2.12.3. Data logging

The configured alarms' Active, Inactive, and Acknowledge transitions shall be logged to the alarm log on Citect. The following data shall be trended on the OWS and logged to the Historian Package:

a. Position Reference
b. Manual Setpoint

6. PROCESS SYSTEMS

6.1. Inlet Works

6.1.1. Process Overview

The existing inlet works at Sandgate will not be modified with the exception of the addition of a flowsplitter (Flowsplitter 1) to the outlet of the works. This section covers the additional works only. The existing inlet works functional description is attached as Appendix B.

Flowsplitter 1 is located adjacent to the inlet works. Its function is to split the flow between Flowsplitter 2 (and hence the treatment plant) and the outfall, to provide for wet weather bypass.

During Stages 1 and 2a of construction, flow to the existing plant will be from Flowsplitter 1 to the existing Flowsplitter 5. The flow to the existing plant will be measured with the existing flowmeter (FIT-85501), and this flow quantity shall be taken into consideration when calculating the relevant equations.

Flowsplitter 1 receives flows of up to 7 times the Average Dry Weather Flow (ADWF). The flowsplitter directs flows of up to 3xADWF to the bioreactors. When flows are higher than 3xADWF the additional flow (up to 4xADWF) is directed to the wet weather bypass.

6.1.2. Equipment

6.1.2.1. Equipment List

Tag	Equipment	Range	Type	Make & Model	Comment
FIT-PS101	Existing Inlet Pump Station 1 Flowmeter	0–700 L/s	FM		
FIT-PS201	Existing Inlet Pump Station 2 Flowmeter	0–700 L/s	FM		
FIT-PS202	Existing Inlet Pump Station 2 Flowmeter	0–1500 L/s	FM		
LIT-85102	Flowsplitter 1 Level Sensor	0-1.6 m	LT		
FIT-85102	Plant Feed Flowmeter	0-1000 L/s	FM		
FCV-85103	Existing Flow Control Valve	0-100 %	-		
FCV-85101	Flowsplitter 1 Modulating Penstock	RL7.43-RL8.05	MV		
LSH-85104	Bypass Level Switch		DI		
AIT-85106	Flow Splitter 1 pH Sensor	1-14	AI		
FIT-85501	Flow Splitter 5 Flow Meter	0-1200 L/s	FM		

6.1.2.2. Process instrumentation

6.1.2.2.1. Existing Inlet Pump Station 1 Flowmeter (FIT-PS101)

This flowmeter measures the flow from Pumpstation No.1 to the Inlet Works. This device operates as a Standard Flowmeter, and shall be controlled as outlined in the functional standards. The process value of this device is filtered, and is scaled from 0 to 700 L/s.

6.1.2.2.2. Existing Inlet Pump Station 2 Flowmeter No.1 (FIT-PS201)

This flowmeter measures the flow from Pumpstation No.2 to the Inlet Works. This device operates as a Standard Flowmeter, and shall be controlled as outlined in the functional standards. The process value of this device is filtered, and is scaled from 0 to 700 L/s.

6.1.2.2.3. Existing Inlet Pump Station 2 Flowmeter No.2 (FIT-PS202)

This flowmeter measures the flow from Pumpstation No.2 to the Inlet Works. This device operates as a Standard Flowmeter, and shall be controlled as outlined in the functional standards. The process value of this device is filtered, and is scaled from 0 to 1500 L/s.

6.1.2.2.4. Flowsplitter 1 Level Sensor (LIT-85102)

This level sensor measures the level of raw sewerage in Flowsplitter 1. This device operates as a Standard Level Transmitter, and shall be controlled as outlined in the functional standards. The process value of this device is filtered, and is scaled from 0 to 1.6 metres.

A high level alarm (LAH-85102) is generated when the process value exceeds the *Flowsplitter 1 High Level* setpoint.

6.1.2.2.5. Plant feed Flowmeter (FIT-85102)

This flowmeter measures the flow from Flowsplitter 1 to Flowsplitter 2. This device operates as a Standard Flowmeter, and shall be controlled as outlined in the functional standards. The process value of this device is filtered, and is scaled from 0 to 1000 L/s.

6.1.2.2.6. Existing Plant feed Flowmeter (FIT-85501)

This flowmeter measures the flow from Flowsplitter 1 to Flowsplitter 5. This device operates as a Standard Flowmeter, and shall be controlled as outlined in the functional standards. The process value of this device is filtered, and is scaled from 0 to 1200 L/s.

6.1.2.2.7. Bypass Level Switch (LSH-85104)

This level switch generates an alarm (*LAH-85104*) when raw sewerage is detected in the bypass channel. This device operates as a Standard Digital Process Input, and is controlled as outlined in the functional standards.

6.1.2.2.8. Flow Splitter 1 pH Sensor (AIT-85106)

This pH sensor measures the pH in Flowsplitter 1. This device operates as a Standard Process Analog Input, and shall be controlled as outlined in the functional standards. The process value of this device is filtered, and is scaled from 1 to 14.

6.1.2.3. Controlled Equipment

6.1.2.3.1. Existing Flow Control Valve (FCV-85103)

This flow control valve is not utilised. This valve shall remain open under all conditions.

6.1.2.3.2. Flowsplitter 1 Modulating Penstock (FCV-85101)

This penstock limits the flow to the plant during high flow periods by bypassing a portion the raw sewerage flow to the outfall. This device operates as a Standard Modulating Valve, and shall be controlled as outlined in the functional standards. The automatic operation of this device is controlled by the Flowsplitter 1 Bypass and Flowsplitter 1 Dry Weather Penstock Modulation sequences.

6.1.3. Automatic Control

6.1.3.1. Flowsplitter 1 Bypass Sequence Overview

All flow and level controls in this flowsplitter are based on flow measurements averaged over the *Measurement Averaging Time*. This is to reduce the effects of spike flows. Influent flow to the bioreactors is measured by the plant feed flowmeter (*FIT-85102*).

The automatic wet weather bypass sequence shall commence when at least two of the following three conditions are met:

a. Greater than 3xADWF is recorded by the Existing Plant Feed Flowmeter (*FIT-85101*) and the new Plant Feed flowmeter (*FIT-85102*) for the *Bypass Measurement Delay Period* continuously;
b. The summation of the Inlet Pump Station 1 and 2 flowmeters (*Influent Flow Rate*) is greater than 3.0xADWF for the *Bypass Measurement Delay Period* continuously.
c. The level measurement in the flowsplitter exceeds *Bypass Level* as measured by *LIT-85102*.

The automatic wet weather bypass sequence shall stop when the condition defined above is not met for the *Bypass Sequence Stop Delay*. When the bypass sequence stops, the penstock shall return to the *Penstock Park Position.*

The penstock is parked at a level (*Penstock Park Position*) that sends 3.2xADWF to the bioreactors and the remainder to the plant bypass. Either the level in the flowsplitter (*LIT-85102*), or flow to the bioreactors (*FIT-85102*) can be used (operator enterable) to control the penstock movement.

A PID control function is used with a deadband. The deadband reduces the frequency of adjustment of the penstocks, and reduces wear and subsequent failure of the penstock driving components. When the present value is within the Penstock deadband (Level or Flow, depending on operating arrangement) of the setpoint, the PID controller tracks the level or flow. When the present value is more than Penstock deadband from the setpoint, the PID controller modulates the penstock to achieve setpoint. A loop delay (*Penstock delay time*) is also used to further dampen the modulation of the penstock.

The Operator also may select from two methods of control at the OWS:

a. Flow Control
b. Level Control

Under both methods of control the modulating penstock shall start in the *Normal Operation Position*. At the *Normal Operation Position* flow will just start to bypass at 3xADWF.

6.1.3.1.1. Flow Control

When the Bypass sequence is activated, and the Flow Control method is selected, the loop shall control the penstock height to achieve 3xADWF to the plant as measured by the flowmeter *FIT-85102*.

The penstock shall move to achieve set point only when the present value is more than *Penstock Flow Deadband* from the setpoint. A loop delay (*Penstock delay time*) is also used to further dampen the modulation of the penstock.

The Bypass Sequence shall only enter Flow Control mode if all flowmeters (*FIT-85102, FIT-PS101, FIT-PS201, FIT-PS202, FIT-85501*) are available. Once in Flow Control mode the Bypass Sequence shall automatically switch to Level Control mode if flowmeter FIT-85102 becomes unavailable.

6.1.3.1.2. Level Control

When the Bypass sequence is activated, and the Level Control method is selected, the loop shall control the penstock height to achieve the 3xADWF level in the Flowsplitter as measured by the level transmitter *LIT-85102*.

The penstock shall move to achieve set point only when the present value is more than *Penstock Level Deadband* from the setpoint. A loop delay (*Penstock delay time*) is also used to further dampen the modulation of the penstock.

If the level transmitter (*LIT-85102*) is not available, then the method of control shall automatically be set as Flow Control.

6.1.3.2. Bypass Weir Minimum Level Setpoint

Irrespective of the control mode, the bypass weir shall not be lowered beyond the Bypass Weir Minimum Level Setpoint

6.1.3.3. Flowsplitter 1 Dry Weather Penstock Test Modulation Sequence

As wet weather events that involve flows greater then 3xADWF may occur many months apart, a regular schedule is required to modulate the penstock ensuring its availability at all times. To ensure that sewage is not bypassed when the flow to the plant is less than 3xADWF, this can only occur during low flow conditions.

The dry weather penstock test modulating philosophy is as follows:

For the penstock to modulate during dry weather the following conditions must be met:

a. The time shall be the *Plant Bypass Penstock Modulation Test Time*;
b. AND the *Influent Flow Rate* must be below the *Plant Bypass Influent Test Flow Rate*

When the above conditions are met, modulate the penstock down to the *Plant Bypass Penstock Modulation Distance (i.e the distance between the penstock and the current water level)*, which reflects the level of the penstock above the water level, then immediately return the penstock to the *Park Position*.

During the dry weather plant bypass penstock modulating operation, the penstock will be immediately returned to the Park Position if a plant bypass is detected by either:

a. the position of the Plant Bypass penstock (FCV-*85102*) is less than the non-filtered level in FlowSplitter No.1 (*LIT-85102*),
b. OR level is detected in the bypass channel (*LSH-85104).*

The penstock shall perform this routine at regular intervals as determined by the *Plant Bypass Penstock Modulation Frequency*.

6.1.3.4. Control System Flow

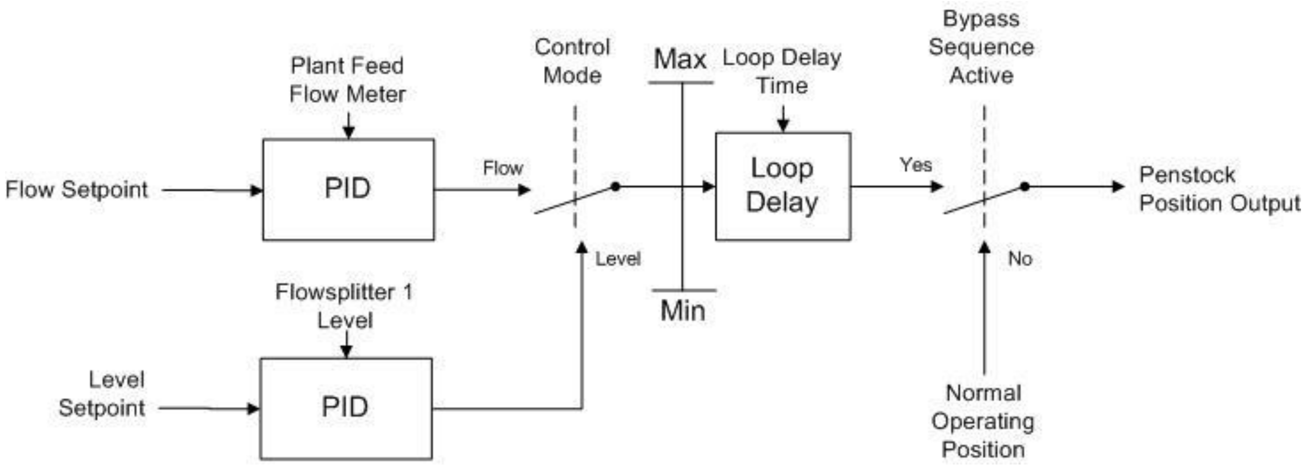


Figure 1: Penstock Automatic Control Algorithm

6.1.4. Monitoring

The following is displayed on the OWS:

a. Each of the alarms listed
b. PS1 Flowmeter (FIT-PS101) Flow L/s
c. PS2 Flowmeter No.1 (FIT-PS201) Flow L/s
d. PS2 Flowmeter No.2 (FIT-PS202) Flow L/s
e. PS2 Total Flow Rate (FIT-PS201 + FIT-PS202)
f. Influent Flow Rate L/s
g. Bypass flow L/s
h. Plant feed flowmeter (FIT-85102) L/s
i. Flowsplitter 1 level (m AHD)
j. Penstock (PS-85101) position (m AHD)
k. Totalised flow to plant per day (reset each day) ML/d (FIT-85102)
l. Totalised bypass flow per day (reset each day) ML/d (both values as calculated)

6.1.5. Calculations

6.1.5.1. Influent Flow Rate

The *Influent Flow Rate* is the combined flow from PS1 and PS2:

Q_{in} = FIT-PS101 + FIT-PS201 + FIT-PS202

6.1.5.2. Bypass Flow

The *Bypass Flow* may be quantified by subtraction of flow to plant from the total flow received at the plant (after bypass):

$Q_{bypass1}$ = FIT-PS101 + FIT-PS201 + FIT-PS202 - FIT-85102

For the interim period Flow splitter 5 flowmeter (*FIT-85501*) is also subtracted from $Q_{bypass1}$ to calculate the correct bypass flow.

6.1.6. Setpoints

Setpoint Description	Default Value	Security Level
Plant Bypass Penstock Modulation Test Time	4:30 am	Operator
Plant Bypass Penstock Modulation Test Frequency (days)	once per week	Operator
Plant Bypass Penstock Modulation Test Level	20 cm	Operator

Plant Bypass Influent Test Flow Rate	200 L/s	Operator
Method of Control (Level or Flow)	auto level control	Operator
Flowsplitter 1 High Level	RL 7.99m	Restricted access level 1
Measurement Averaging Time	60 seconds	Restricted access level 1
Bypass Measurement Delay Period	5 minutes	Restricted access level 1
Penstock Level Deadband	20mm	Restricted access level 1
Penstock Flow Deadband	0.2xADWF	Restricted access level 1
Penstock delay time	10 seconds	Restricted access level 1
Bypass Level Setpoint	corresponding to 3xADWF	Restricted access level 1
Normal Operation Position (of Penstock, 3xADWF)	RL 7.94	Restricted access level 1
Penstock Park Position (3.2xADWF)	RL 7.96	Restricted access level 1
Average Dry Weather Flow (ADWF)	25 ML/d	Restricted access level 2
Bypass Sequence Stop Delay	5 minutes	Operator
Bypass Weir Minimum Level Setpoint	RL 7.43	Restricted access level 2

6.1.7. Process Alarms and Interlocks

6.1.7.1. Flowmeter Failed

Tag	Equipment	Action
FIT-PS101	Pump Station 1 Flowmeter	Change Sequence mode to level control
FIT-PS201	Pump Station 2 Flowmeter	Change Sequence mode to level control
FIT-85102	Plant Feed Flowmeter	Change Sequence mode to level control

This alarm shall be generated if the flowmeter becomes unavailable. This alarm type is Priority 10. If the Flowsplitter 1 Bypass Sequence is operating in AUTO flow control operation, then the sequence mode will automatically change to level control. The OWS shall indicate the change in mode due to this alarm.

6.1.7.2. Level Sensor Failed

Tag	Equipment	Action
LIT-85102	Flow Splitter 1 Level Sensor	Change Sequence mode to flow control

This alarm shall be generated if the level sensor becomes unavailable, or the process value is outside of a set range. This alarm type is Priority 10. If the Flowsplitter 1 Bypass Sequence is operating in AUTO level control operation, then the sequence mode will automatically change to flow control. The OWS shall indicate the change in mode due to this alarm.

6.1.7.3. Level Sensor High Level

Tag	Equipment	Action
LAH-85102	Flow Splitter 1 Level Sensor	

This alarm shall be generated if the level process value exceeds *Flowsplitter 1 high level*. This alarm is Priority 2.

6.1.7.4. Out of Range

Tag	Equipment	Action
FIT-85102	Plant Feed Flowmeter	

This alarm shall be generated if:

a. the *Influent Flow Rate* is greater than 5% different, for over 5 minutes continuously, to the *Plant Feed Flow Rate* (*FIT-85102*);
b. AND bypass is not occurring, as indicated by the *Bypass Penstock Position* being greater than or equal to level in Flowsplitter 1 (*LIT-85102*).
c. OR level is not detected by the bypass level indicator (*LSH-85102)*

This alarm is Priority 10.

6.1.7.5. Bypass Activated

Tag	Equipment	Action
FCV-85001	Modulating Penstock	

This alarm shall be generated if:

a. the position of bypass modulating weir (*FCV-85102*)is lower than the water level in flowsplitter 1 (*LIT-85102*) by 5mm for 1 minute ;
b. AND either the *Influent Flow Rate* is greater than the *Plant Feed Flow Rate* (*FIT-85102*) by 5% for 5 minutes continuously;
c. OR if level is detected by bypass level indicator (LSH-85104).

This alarm is Priority 6.

6.1.7.6. Bypass Activated and Low Flow to Plant

Tag	Equipment	Action
FCV-85001	Modulating Penstock	

This alarm shall be generated if:

a. the position of the penstock (*FCV-85102*) is lower than the water level in flowsplitter 1 (*LIT-85102*) by 5mm for 1 minute,
b. AND either the flow to plant as measured by FIT-85102 is less than 3xADWF for 1 minute OR the level in the flowsplitter 1 is less than 3xADWF Level Setpoint by more than 5mm for 1 minute.
c. OR the *Influent Flow Rate* is more than 5% greater than the *Plant Feed Flow Rate* (*FIT-85102*) for 1 minute, AND the *Plant Feed Flow Rate* (*FIT-85102*) is less than 3xADWF for 1 minute.

This alarm is Priority 2.

6.1.7.7. High Flow to Plant

Tag	Equipment	Action
FIT-85102	Plant Feed Flowmeter	

This alarm shall be activated if the *Plant Feed Flow Rate* (*FIT-85102*) is greater than 3.2xADWF continuously for 10 minutes. This alarm is Priority 2 and shall remain latched on until reset from the OWS.

6.1.7.8. Dry Weather Penstock Modulation Sequence Failure

Tag	Equipment	Action
FIT-85102	Plant Feed Flowmeter	

This alarm shall be generated if:

a. The modulation sequence does not occur on the specific day;
b. OR The penstock does not achieve the plant bypass penstock modulation distance

This alarm is Priority 10 and shall remain latched on until reset from the OWS.

6.1.8. Trend Pages

The following trends shall be displayed on the Influent and Bypass Flows trend page:

a. PS1 Flowmeter No.1 (FIT-PS101) Flow (L/s)
b. PS2 Flowmeter No.2 (FIT-PS201) Flow (L/s)
c. PS2 Flowmeter (FIT-PS202) Flow (L/s)
d. PS Total Flow Rate (FIT-PS201 + FIT-PS202) (L/s)
e. Influent Flow Rate (L/s)
f. Bypass 1 flow (L/s)
g. Plant Feed Flowmeter flow (FIT-85102) (L/s)

The following trends shall be displayed on the Influent and Bypass Daily Flows trend pages:

a. Totalised flow to plant per day (reset each day) ML/d (FIT-85102)
b. Totalised bypass flow per day (reset each day) ML/d

The following trends shall be displayed on the Flowsplitter 1 levels trend page:

a. Flowsplitter 1 level (m AHD)
b. Penstock (PS-85101) position (m AHD)

6.1.9. Statistical Data

The following statistical data shall be available for reports:

a. Daily Totalised Flow - PS1 Flowmeter No.1 (FIT-PS101) (ML)
b. Daily Totalised Flow - PS2 Flowmeter No.2 (FIT-PS201) (ML)
c. Daily Totalised Flow - PS2 Flowmeter No.2 (FIT-PS202) (ML)
d. Daily Totalised Flow – PS2 (FIT-PS201 + FIR-PS202) (ML)
e. Daily Totalised Flow - *Influent Flow Rate* (ML)
f. Daily Totalised Bypass 1 flow (ML)
g. Daily Totalised Bypass 2 flow (ML)
h. Daily Totalised flow to plant (FIT-85102) (ML)
i. Penstock (FCV-85101) Daily Run Time (Hrs)
j. Penstock (FCV-85101) Daily Number of Starts

6.2. Flowsplitter 2

6.2.1. Process Overview

Flowsplitter 2 splits raw sewage and RAS flow evenly between each bioreactor. Flowsplitter 2 also provides a mechanism to step feed a proportion of raw sewage around the anaerobic zone to the bioreactor, and to take a bioreactor offline. Raw sewage is fed to Flowsplitter 2 by gravity from Flowsplitter 1. RAS is pumped to Flowsplitter 2 by the RAS pump stations.

The flowsplitter splits the raw sewage and RAS equally between the two anaerobic zones. Raw sewage is mixed with the RAS before being fed to each anaerobic zone. A proportion of raw influent can be split equally between the bioreactors before combination with the RAS, assisting in nitrogen removal.

6.2.2. Equipment

6.2.2.1. Equipment List

Tag	Equipment	Range	Type	Make & Model	Comment
SG-85201	Slide Gate to Bioreactor 1	0-100%			
SG-85202	Slide Gate to Bioreactor 2	0-100%			
SB-85201	Stop Board to Anaerobic Zone 1				
SB-85202	Stop Board to Anaerobic Zone 2				
SB-85203	Stop Board to Anaerobic Zone 1 from RAS Chamber				
SB-85204	Stop Board to Anaerobic Zone 2 from RAS Chamber				
-	Graduated Scale on Slide Gate Board to Anaerobic Zone 1	0-100%			
-	Graduated Scale on Slide Gate to Anaerobic Zone 2	0-100%			

6.2.2.2. Process instrumentation

There is no process instrumentation in this area.

6.2.2.3. Controlled Equipment

There is no controlled equipment in this area.

6.2.3. Manual Control

The splitter incorporates six control points, directing flow:

a. to combined raw sewage and RAS chamber 1 (from raw sewage chamber)
b. to combined raw sewage and RAS chamber 2 (from raw sewage chamber)
c. to bioreactor 1 (from raw sewage chamber)
d. to bioreactor 2 (from raw sewage chamber)
e. to anaerobic zone 1 (from combined raw sewage and RAS chamber 1)
f. to anaerobic zone 2 (from combined raw sewage and RAS chamber 2)

The control points to the anaerobic zones and combined raw sewage and RAS chambers are stop boards. The control points to the bioreactors are slide gates.

The stop boards (SB-85201, SB-85202, SB-85203, SB-85204) are used to isolate the bioreactor/s. (Note that an anaerobic zone alone cannot be isolated, without the bioreactor also being isolated.)

To manually shut down the bioreactor, the stop boards and slide gate for that bioreactor are manually closed. To isolate Bioreactor 1 (Anaerobic Zone 1 and Bioreactor 1) slide gate SG-85201 and stop boards SB-85201 and SB-85203 are closed. To isolate Bioreactor 2 (Anaerobic Zone 2 and Bioreactor 2) slide gate SG-85202 and stop boards SB-85202 and SB-85204 are closed.

To manually start up a bioreactor, the stop boards and slide gates for that bioreactor are manually opened. To start up Bioreactor 1 (Anaerobic Zone 1 and Bioreactor 1) stop boards SB-85201 and SB-85203 are opened. To start up Bioreactor 2 (Anaerobic Zone 2 and Bioreactor 2) stop boards SB-85202 and SB-85204 are opened.

The slide gates (SG-85201, SG-85202) are opened to step feed a proportion of raw sewage and hence carbon around the anaerobic zone. This should achieve higher levels of nitrogen removal (possibly at the expense of excess biological phosphorus removal). The slide gates are also used to isolate a bioreactor. A graduated scale is provided on each slide gate to enable the operator to measure the proportion of flow bypassing the anaerobic zone. This value will be manually entered into the control system by the Operator (*Step Feed Proportion 1(%)* and *Step Feed Proportion 2(%)*).

6.2.4. Automatic Control

There is no automatic control of this area.

6.2.5. Monitoring

The following is displayed on the OWS:

a. Feed to Flowsplitter 2 (FE-85102) L/s
b. Step Feed Proportion Bioreactor 1 (As entered by Operator)
c. Step Feed Proportion Bioreactor 2 (As entered by Operator)
d. Flows out of Flowsplitter 2 to Anaerobic Zone 1. (From calculation)
e. Flows out of Flowsplitter 2 to Bioreactor 1. (From calculation)
f. Flows out of Flowsplitter 2 to Anaerobic Zone 2. (From calculation)
g. Flows out of Flowsplitter 2 to Oxidation Ditch 2. (From calculation)

6.2.6. Calculations

At the OWS, the operator will manually input the *Step Feed Proportion 1 (%)* and *Step Feed Proportion 2 (%)*. The system will determine the flows out of Flowsplitter 2 for display purposes as follows:

6.2.6.1. Flows from Flowsplitter 2

Flow to Anaerobic Zone 1 = $1/N_{bio}$* Q_{in} **(1- *Step Feed Proportion1/100* *** *0.593*)

Flow to Anaerobic Zone 2 = $1/N_{bio}$* Q_{in}*(1- *Step Feed Proportion2/100 * 0.593*)

Flow to Bioreactor 1 = $1/N_{bio}$* Q_{in*} *Step Feed Proportion1 * 0.593*

Flow to Bioreactor 2 = $1/N_{bio}$* Q_{in*} *Step Feed Proportion2 * 0.593*

Where:

Q_{in}	Feed to Flowsplitter 2 (*FIT-85102*) L/s
Step Feed Proportion 1	Proportion of step feed to Bioreactor 1 %
Step Feed Proportion 2	Proportion of step feed to Bioreactor 2 %
$1/N_{bio}$	No. of Bioreactors On-Line

Note: these calculations are to be performed in BR1 PLC

6.2.7. Setpoints

Setpoint Description	Default Value	Security Level
Step Feed Proportion 1	0%	Operator
Step Feed Proportion 2	0%	Operator

6.2.8. Process Alarms and Interlocks

No alarms or interlocks are required for Flowsplitter 2.

6.2.9. Trend Pages

The following trends shall be displayed on the Flowsplitter 2 trend page:

a. Feed to Flowsplitter 2 (FIT-85102) L/s
b. Step Feed Proportion Bioreactor 1 (As entered by Operator)
c. Step Feed Proportion Bioreactor 2 (As entered by Operator)
d. Flows out of Flowsplitter 2 to Anaerobic Zone 1 (From calculation)
e. Flows out of Flowsplitter 2 to Bioreactor 1 (From calculation)
f. Flows out of Flowsplitter 2 to Anaerobic Zone 2 (From calculation)
g. Flows out of Flowsplitter 2 to Bioreactor 2 (From calculation)

6.2.10. Statistical Data

The following statistical data shall be available for reports:

a. Totalised feed to Flowsplitter 2 (FIT-85102) ML/d
b. Step Feed Proportion Bioreactor 1 (As entered by Operator)
c. Step Feed Proportion Bioreactor 2 (As entered by Operator)
d. Totalised flow out of Flowsplitter 2 to Anaerobic Zone 1 ML/d
e. Totalised flow out of Flowsplitter 2 to Bioreactor 1 ML/d
f. Totalised flow out of Flowsplitter 2 to Anaerobic Zone 2 ML/d
g. Totalised flow out of Flowsplitter 2 to Bioreactor 2 ML/d

6.3. Anaerobic Zone

6.3.1. Process Overview

The anaerobic zone stimulates the release of previously stored phosphorus, and the simultaneous uptake of VFA. This allows the polyphosphate accumulating organisms to achieve an energy advantage, resulting in the net uptake of phosphorus in the bioreactor.

Flow from Flowsplitter 2 flows by gravity to the anaerobic zones. Flow from the anaerobic zones to the bioreactors is also by gravity.

Each anaerobic zone shares common walls with its adjoining bioreactor. Each anaerobic tank is divided into four complete mixed cells. Each cell is fitted with a submersible mixer to keep the mixed liquor in suspension.

6.3.2. Equipment

6.3.2.1. Equipment List

Tag	Equipment	Range	Type	Make & Model	Comment
MX-30101	Anaerobic Zone 1 Mixer 1	On/Off			
MX-30102	Anaerobic Zone 1 Mixer 2	On/Off			
MX-30103	Anaerobic Zone 1 Mixer 3	On/Off			
MX-30104	Anaerobic Zone 1 Mixer 4	On/Off			
MX-30201	Anaerobic Zone 2 Mixer 1	On/Off			
MX-30202	Anaerobic Zone 2 Mixer 2	On/Off			
MX-30203	Anaerobic Zone 2 Mixer 3	On/Off			
MX-30204	Anaerobic Zone 2 Mixer 4	On/Off			

6.3.2.2. Process instrumentation

There is no process instrumentation in this area.

6.3.2.3. Controlled Equipment

6.3.2.3.1. Anaerobic Zone 1 Mixers 1,2,3,4 (MX-30101, MX-30102, MX-30103, MX-30104)

These Mixers are submersible mixers that mix the anaerobic zone cell to keep the mixed liquor in suspension. These devices operate as a Simocode Drive, and are controlled as outlined in the functional standards. The automatic operation of these devices is controlled by the Anaerobic Zone 1 Sequence.

6.3.2.3.2. Anaerobic Zone 2 Mixers 1,2,3,4 (MX-30201, MX-30202, MX-30203, MX-30204)

These Mixers are submersible mixers that mix the anaerobic zone cell to keep the mixed liquor in suspension. These devices operate as a Simocode Drive, and are controlled as outlined in the functional standards. The automatic operation of these devices is controlled by the Anaerobic Zone 2 Sequence.

6.3.3. Automatic Control

Flow to and from the anaerobic zones is by gravity.

Manual stop boards are used for isolation of the bioreactors. Note that anaerobic zones cannot be isolated without the adjacent bioreactor also being isolated.

6.3.3.1. Anaerobic Zone 1 Sequence

When this sequence is enabled, by placing Bioreactor No.1 On-Line, all available Mixers will run continuously. The start-up of the mixers are sequenced, with a 2 second delay between mixer starts.

6.3.3.2. Anaerobic Zone 2 Sequence

When this sequence is enabled, by placing Bioreactor No.2 On-Line, all available Mixers will run continuously. The start-up of the mixers are sequenced, with a 2 second delay between mixer starts.

6.3.4. Monitoring

The following functions/indications are available at the OWS:

a. Each of the alarms listed
b. Flows in/out of each anaerobic zone (as calculated for Flowsplitter 2)

6.3.5. Calculations

There are no calculations required for this area.

6.3.6. Setpoints

There are no setpoints required for this area.

6.3.7. Process Alarms and Interlocks

6.3.7.1. Mixer Failure

Tag	Equipment	Action
MX-30101	Anaerobic Zone 1 Mixer 1	
MX-30102	Anaerobic Zone 1 Mixer 2	
MX-30103	Anaerobic Zone 1 Mixer 3	
MX-30104	Anaerobic Zone 1 Mixer 4	
MX-30201	Anaerobic Zone 2 Mixer 1	
MX-30202	Anaerobic Zone 2 Mixer 2	
MX-30203	Anaerobic Zone 2 Mixer 3	
MX-30204	Anaerobic Zone 2 Mixer 4	

This alarm shall be generated if the mixer becomes unavailable. This alarm type is Priority 10.

6.3.7.2. Anaerobic Zone No.1 - 2 Mixers Failed

Tag	Equipment	Action
MX-30101	Anaerobic Zone 1 Mixer 1	
MX-30102	Anaerobic Zone 1 Mixer 2	
MX-30103	Anaerobic Zone 1 Mixer 3	
MX-30104	Anaerobic Zone 1 Mixer 4	

This alarm shall be generated if 2 or more mixers are not running. This alarm type is Priority 1.

6.3.7.3. Anaerobic Zone No.2 - 2 Mixers Failed

Tag	Equipment	Action
MX-30201	Anaerobic Zone 2 Mixer 1	
MX-30202	Anaerobic Zone 2 Mixer 2	
MX-30203	Anaerobic Zone 2 Mixer 3	
MX-302104	Anaerobic Zone 2 Mixer 4	

This alarm shall be generated if 2 or more mixers are not running. This alarm type is Priority 1.

6.3.8. Trend Pages

The following trends shall be displayed on the Anaerobic Zone 1 trend page:

a. Flow through Anaerobic zone 1
b. Anaerobic zone 1 Mixer 1 running
c. Anaerobic zone 1 Mixer 2 running
d. Anaerobic zone 1 Mixer 3 running
e. Anaerobic zone 1 Mixer 4 running

The following trends shall be displayed on the Anaerobic Zone 2 trend page:

a. Flow through Anaerobic zone 2
b. Anaerobic zone 2 Mixer 1 running
c. Anaerobic zone 2 Mixer 2 running
d. Anaerobic zone 2 Mixer 3 running
e. Anaerobic zone 2 Mixer 4 running

6.3.9. Statistical Data

The following statistical data shall be available for reports:

a. Anaerobic zone 1 Mixer 1 Run Time (Hrs)
b. Anaerobic zone 1 Mixer 2 Run Time (Hrs)
c. Anaerobic zone 1 Mixer 3 Run Time (Hrs)
d. Anaerobic zone 1 Mixer 4 Run Time (Hrs)
e. Anaerobic zone 2 Mixer 1 Run Time (Hrs)
f. Anaerobic zone 2 Mixer 2 Run Time (Hrs)
g. Anaerobic zone 2 Mixer 3 Run Time (Hrs)
h. Anaerobic zone 2 Mixer 4 Run Time (Hrs)
i. Anaerobic zone 1 Mixer 1 No. Of Starts
j. Anaerobic zone 1 Mixer 2 No. Of Starts
k. Anaerobic zone 1 Mixer 3 No. Of Starts
l. Anaerobic zone 1 Mixer 4 No. Of Starts
m. Anaerobic zone 2 Mixer 1 No. Of Starts
n. Anaerobic zone 2 Mixer 2 No. Of Starts
o. Anaerobic zone 2 Mixer 3 No. Of Starts
p. Anaerobic zone 2 Mixer 4 No. Of Starts

6.4. Bioreactors

6.4.1. Process Overview

Two bioreactors receive anaerobic zone effluent and, in the event of raw influent bypassing the anaerobic zone, some quantity of raw sewage. Flow to and from the bioreactors is by gravity. The bioreactors incorporate aerated sections, which nitrify the wastewater, and anoxic sections, which denitrify the wastewater.

Blowers supply air to diffusers which are laid in the aerated section of each bioreactor.

Mechanical mixers generate a velocity approximately equal to 0.3m/s. This velocity keeps the solids in suspension and recycles the mixed liquor between the aerated and anoxic sections of the ditch.

Dissolved Oxygen (DO) is measured at three locations in both ditches and is utilised for aeration control and monitoring. An ammonia analyser is present in one Bioreactor (a second analyser may be included in the second ditch in the future), which is utilised for aeration control and monitoring. Control is provided for an ammonia meter in both Bioreactors for future use. Oxidation-reduction potential (ORP) is measured at two locations, and pH is monitored in Bioreactor 1. Temperature is monitored in both ditches.

6.4.1.1. Blower and Aeration System

The aeration system consists of 5 HST blowers, three larger size s6000 series and two smaller size s2500 series. The different blower sizes are required to meet the diurnal and long term range of airflows required at the plant.

The blower system feeds Aquablade diffusers in each bioreactor. Air to each bioreactor is supplied through the bioreactor's aeration pipe work from the common aeration header. The aquablade diffusers are arranged in two grids per bioreactor.

Grid 1 contains a dense grid of diffusers and is used to increase the dissolved oxygen (DO) in the ditch rapidly. Grid 2 contains sparsely-laid diffusers and is utilised to maintain the DO level in the ditch. Each grid is controlled via an air control valve to achieve a DO (or ammonia) setpoint. The second grid in each bioreactor incorporates a swing zone to extend or reduce this zone, which is controlled via an on/off valve (refer to Figure 2 – Schematic of Aeration System).

The airflow rates to each aeration grid are measured for purposes of process control, monitoring/optimisation. Pressure and temperature are measured in the air flow line for correction of air flow measurements. The diffuser back pressure is measured to determine the degree of fouling or degradation of the aeration diffusers.

6.4.1.2. Mixers

Each bioreactor contains a series of submersible mixers to keep the mixed liquor rotating in the bioreactor. The operator can switch mixers on/off locally or via the OWS.

6.4.1.3. Instrumentation

Several analysers are provided in the bioreactors for control and optimisation of the process.

The following are provided for plant monitoring and optimisation:

a. Oxidation Reduction Potential (ORP) (Bioreactor 1 only)
b. Temperature (T)
c. pH (Bioreactor 1 only)

The following analysers are provided for control:

a. Dissolved Oxygen (DO) (Three meters in each Bioreactor)

b. Ammonia (NH_4) (Bioreactor 1 only)

6.4.1.4. Bioreactor 1 PLC To Blower PLC Interface

Automatic Control of the Blowers is performed by a Siemens S7 PLC supplied as part of the Blower Control Package. The Blower PLC requires the value and status of a number of points to be passed to it from the Bioreactor 1 PLC using PLC-PLC communications. The data to be passed from the Bioreactor 1 PLC to the Blower PLC is summarised below.

a. Manifold Pressure Value (PIT-83001)
b. Manifold Pressure Instrument Status (Healthy/Failed)
c. Manifold Pressure Setpoint
d. Number of Bioreactors On-Line (0,1, or 2)
e. Watchdog Counter

6.4.2. Equipment

6.4.2.1. Blower and Aeration System

Tag	Equipment	Range	Type	Make & Model	Comment
BL-83101	HST Aeration Blower 1	0-100%			
BL-83201	HST Aeration Blower 2	0-100%			
BL-83301	HST Aeration Blower 3	0-100%			
BL-83401	HST Aeration Blower 4	0-100%			
BL-83501	HST Aeration Blower 5	0-100%			
PIT-83001	Pressure Transmitter in Common Aeration Header	0-100 kPa			
TIT-83001	Temperature Transmitter in Common Aeration Header	0-100degC			
	Air Isolation Valves on each Bioreactor Air Header Inlet	0-100%			
FCV 31102	Air Control Valve (modulating) on Bioreactor 1 Grid 1	0-100%			
FCV31103	Air Control Valve (modulating) on Bioreactor 1 Grid 2	0-100%			
FCV31112	1 Swing zone Air Valve (on/off) on Bioreactor 1 Grid 2b	On/Off			
FIT31102	Air Flow Meter in Bioreactor 1 Grid 1	0-7000 Sm3/Hr			
FIT31103	Air Flow Meter in Bioreactor 1 Grid 2	0-8500 Sm3/Hr			
PDIT31108	Differential Wet Pressure Station Bioreactor 1 Grid 1	0-50kPa			
PDIT31110	Differential Wet Pressure Station Bioreactor 1 Grid 2	0-50kPa			
AIT31102	Bioreactor 1: Zone 1 DO meter	0-10 mg/L			
AIT31103A	Bioreactor 1: Zone 2 DO meter	0-10 mg/L			
AIT31103B	Bioreactor 1: Anoxic zone DO meter	0-10 mg/L			
AIT31115	Ammonia Meter Bioreactor 1	0-10 mg/L			
	40 Air isolation valves on each dropper in Bioreactor 1				

FCV 32102	Air Control Valve (modulating) on Bioreactor 2 Grid 1	0-100%			
FCV32103	Air Control Valve (modulating) on Bioreactor 2 Grid 2	0-100%			
FCV32112	Swing zone Air Valve (on/off) on Bioreactor 2 Grid 2b	On/Off			
FIT32102	Air Flow Meters in Bioreactor 2 Grid 1	0-7000 Sm3/Hr			
FIT32103	Air Flow Meters in Bioreactor 2 Grid 2	0-8000 Sm3/Hr			
PDIT32108	Differential Wet Pressure Station Bioreactor 2 Grid 1	0-50 kPa			
PDIT32110	Differential Wet Pressure Station Bioreactor 2 Grid 2	0-50 kPa			
AIT32102	Bioreactor 2: Zone 1 DO meter	0-10 mg/L			
AIT32103A	Bioreactor 2: Zone 2 DO meter	0-10 mg/L			
AIT32103B	Bioreactor 2: Anoxic zone DO meter	0-10 mg/L			
AIT32115	Ammonia Meter Bioreactor 2 (not supplied at this time)	0-10 mg/L			
	40 Air isolation valves on each dropper in Bioreactor 2				

6.4.2.2. Equipment List - Mixers

Tag	Equipment	Range	Type	Make & Model	Comment
MX-31001	Bioreactor 1 Mixer 1				
MX-31002	Bioreactor 1 Mixer 2				
MX-31003	Bioreactor 1 Mixer 3				
MX-31004	Bioreactor 1 Mixer 4				
MX-31005	Bioreactor 1 Mixer 5				
MX-31006	Bioreactor 1 Mixer 6				
MX-31007	Bioreactor 1 Mixer 7				
MX-32001	Bioreactor 2 Mixer 1				
MX-32002	Bioreactor 2 Mixer 2				
MX-32003	Bioreactor 2 Mixer 3				
MX-32004	Bioreactor 2 Mixer 4				
MX-32005	Bioreactor 2 Mixer 5				
MX-32006	Bioreactor 2 Mixer 6				
MX-32007	Bioreactor 2 Mixer 7				

6.4.2.3. Equipment List - Instrumentation

Tag	Equipment	Range	Type	Make & Model	Comment
AIT-31105	Bioreactor 1 ORP Transmitter 1	-500 – 500 mV			
AIT-31106	Bioreactor 1 ORP Transmitter 2	-500 – 500 mV			
AIT-31102	Bioreactor 1 Temperature Transmitter	0 – 50 degC			
AIT-31114	Bioreactor 1 pH meter	1 -14			
AIT-32102	Bioreactor 2 Temperature Transmitter	0 – 50 degC			

6.4.2.4. Process instrumentation

6.4.2.4.1. Pressure Transmitter in Common Aeration Header (PIT-83001)

This transmitter measures the pressure in the common aeration header, prior to the air flow being split between the two bioreactors. This device operates as a Standard Process Analog Input, and shall be controlled as outlined in the functional standards. The process value of this device is filtered, and is scaled from 0 – 100 kPa.

6.4.2.4.2. Temperature Transmitter in Common Aeration Header (TIT-83001)

This transmitter measures the temperature in the common aeration header, prior to the air flow being split between the two bioreactors. This device operates as a Standard Process Analog Input, and shall be controlled as outlined in the functional standards. The process value of this device is filtered, and is scaled from 0 – 100 degC

6.4.2.4.3. Bioreactor 1 DO meter 1 (AIT31102)

This D.O. meter measures the dissolved oxygen content in situ in Grid 1 of Bioreactor 1. This device operates as a Standard Process Analog Input, and shall be controlled as outlined in the functional standards. The process value of this device is filtered, and is scaled from 0 to 10 mg/L.

6.4.2.4.4. Bioreactor 1 DO meter 2 (AIT31103A)

This D.O. meter measures the dissolved oxygen content in situ in Grid 2 of Bioreactor 1. This device operates as a Standard Process Analog Input, and shall be controlled as outlined in the functional standards. The process value of this device is filtered, and is scaled from 0 to 10 mg/L.

6.4.2.4.5. Bioreactor 1 DO meter 3 (AIT31103B)

This D.O. meter measures the dissolved oxygen content in situ in the Anoxic area of Bioreactor 1. This device operates as a Standard Process Analog Input, and shall be controlled as outlined in the functional standards. The process value of this device is filtered, and is scaled from 0 - 10 mg/L.

6.4.2.4.6. Bioreactor 1 Air Flow Meter in Grid 1 (FIT31102)

This air flow meter measures the air flow to the aeration headers in Grid 1 of Bioreactor 1. This device operates as a Standard Process Analog Input, and shall be controlled as outlined in the functional standards. The process value of this device is filtered, and is scaled from 0 - 7000 Sm3/hr

6.4.2.4.7. Bioreactor 1 Air Flow Meter in Grid 2 (FIT31103)

This air flow meter measures the air flow to the aeration headers in Grid 2 of Bioreactor 1. This device operates as a Standard Process Analog Input, and shall be controlled as outlined in the functional standards. The process value of this device is filtered, and is scaled from 0 – 8500 Sm3/hr

6.4.2.4.8. Bioreactor 1 Differential Wet Pressure Station Grid 1 (PDIT31108)

This transmitter measures the differential pressure across the diffusers in Grid 1 of Bioreactor 1. This device operates as a Standard Process Analog Input, and shall be controlled as outlined in the functional standards. The process value of this device is filtered, and is scaled from 0 – 50kPa.

6.4.2.4.9. Bioreactor 1 Differential Wet Pressure Station Grid 2 (PDIT31110)

This transmitter measures the differential pressure across the diffusers in Grid 2 of Bioreactor 1. This device operates as a Standard Process Analog Input, and shall be controlled as outlined in the functional standards. The process value of this device is filtered, and is scaled from 0 – 50kPa

6.4.2.4.10. Bioreactor 1 pH meter (AIT31114)

This meter measures the pH in situ in Bioreactor 1. This device operates as a Standard Process Analog Input, and shall be controlled as outlined in the functional standards. The process value of this device is filtered, and is scaled from 1 - 14

6.4.2.4.11. Bioreactor 1 ORP Transmitters 1 and 2 (AIT31105, AIT31106)

This analyser measures the Oxidation Reduction Potential (ORP) in situ within Bioreactor 1. This device operates as a Standard Process Analog Input, and shall be controlled as outlined in the functional standards. The process value of this device is filtered, and is scaled from -500 to 500 (mV).

6.4.2.4.12. Bioreactor 1 Ammonia Analyser (AIT31115)

This analyser measures the ammonia content in situ in Bioreactor 1. This device operates as a Standard Process Analog Input, and shall be controlled as outlined in the functional standards. The process value of this device is filtered, and is scaled from 0 to 10 mg/L.

6.4.2.4.13. Bioreactor 2 DO meter 1 (AIT32102)

This D.O. meter measures the dissolved oxygen content in situ in Grid 1 of Bioreactor 2. This device operates as a Standard Process Analog Input, and shall be controlled as outlined in the functional standards. The process value of this device is filtered, and is scaled from 0 to 10 mg/L.

6.4.2.4.14. Bioreactor 2 DO meter 2 (AIT32103A)

This D.O. meter measures the dissolved oxygen content in situ in Grid 2 of Bioreactor 2. This device operates as a Standard Process Analog Input, and shall be controlled as outlined in the functional standards. The process value of this device is filtered, and is scaled from 0 to 10 mg/L.

6.4.2.4.15. Bioreactor 2 DO meter 3 (AIT32103B)

This D.O. meter measures the dissolved oxygen content in situ in the Anoxic area of Bioreactor 2. This device operates as a Standard Process Analog Input, and shall be controlled as outlined in the functional standards. The process value of this device is filtered, and is scaled from 0 to 10 mg/L.

6.4.2.4.16. Bioreactor 2 Air Flow Meter in Grid 1 (FIT32102)

This air flow meter measures the air flow to the aeration headers in Grid 1 of Bioreactor 2. This device operates as a Standard Process Analog Input, and shall be controlled as outlined in the functional standards. The process value of this device is filtered, and is scaled from 0 – 7000 Sm3/hr

6.4.2.4.17. Bioreactor 2 Air Flow Meter in Grid 2 (FIT32103)

This air flow meter measures the air flow to the aeration headers in Grid 2 of Bioreactor 2. This device operates as a Standard Process Analog Input, and shall be controlled as outlined in the functional standards. The process value of this device is filtered, and is scaled from 0 – 8500 Sm3/hr

6.4.2.4.18. Bioreactor 2 Differential Wet Pressure Station Grid 1 (PDIT32108)

This transmitter measures the differential pressure across the diffusers in Grid 1 of Bioreactor 2. This device operates as a Standard Process Analog Input, and shall be controlled as outlined in the functional standards. The process value of this device is filtered, and is scaled from 0 – 50 kPa

6.4.2.4.19. Bioreactor 2 Differential Wet Pressure Station Grid 2 (PDIT32110)

This transmitter measures the differential pressure across the diffusers in Grid 2 of Bioreactor 2. This device operates as a Standard Process Analog Input, and shall be controlled as outlined in the functional standards. The process value of this device is filtered, and is scaled from 0 – 50 kPa

6.4.2.4.20. Bioreactor2 Ammonia Analyser (AIT32115)

This analyser measures the ammonia content in situ in Bioreactor 2. This device operates as a Standard Process Analog Input, and shall be controlled as outlined in the functional standards. The process value of this device is filtered, and is scaled from 0 to 10 mg/L. This device is not currently installed, and may be installed in the future.

6.4.2.4.21. Bioreactor 1 Temperature Transmitter (TIT32102)

This analyser measures the temperature in Bioreactor 2 and is linked to Bioreactor No.2 DO Meter No.1. This device operates as a Standard Process Analog Input, and shall be controlled as outlined in the functional standards. The process value of this device is filtered, and is scaled from 0 to 100 degC.

6.4.2.5. Controlled Equipment

6.4.2.5.1. Bioreactor 1 Mixers 1,2,3,4,5,6,7 (MX-31001, MX-31002, MX-31003, MX-31004, MX-31005, MX-31006, MX-31007)

These Mixers are submersible mixers that mix the bioreactor to keep the mixed liquor in suspension and provide recirculation. These devices operate as a Simocode Drive, and are controlled as outlined in the functional standards. The automatic operation of these devices is controlled by the *Bioreactor 1 Mixing Sequence*.

6.4.2.5.2. Bioreactor 2 Mixers 1,2,3,4,5,6,7 (MX-32001, MX-32002, MX-32003, MX-32004, MX-32005, MX-32006, MX-32007)

These Mixers are submersible mixers that mix the bioreactor to keep the mixed liquor in suspension and provide recirculation. These devices operate as a Simocode Drive, and are controlled as outlined in the functional standards. The automatic operation of these devices is controlled by the *Bioreactor 2 Mixing Sequence*.

6.4.2.5.3. HST Aeration Blowers 1,2,3,4,5 (BL-83101, BL-83201, BL-83301, BL-83401, BL-83501)

These blowers are part of a packaged system. The operation of these devices is defined in Appendix C. The automatic operation of the blower system is controlled by the *Blower Control Sequence*.

6.4.2.5.4. Air Isolation Valves on each Bioreactor Air Header Inlet

These valves are manually operated valves. There is no interfacing of these devices to the control system.

6.4.2.5.5. Air Control Valve (modulating) on Bioreactor 1 Grid 1 (FCV 31102)

This valve controls the air flow to Grid 1 of Bioreactor 1. This device operates as a Standard Modulating Valve, and is controlled as outlined in the functional standards. The automatic operation of this device is controlled by the *Dissolved Oxygen Control Sequence* and the *Bumping Sequence*.

6.4.2.5.6. Air Control Valve (modulating) on Bioreactor 1 Grid 2 (FCV31103)

This valve controls the air flow to Grid 2 of Bioreactor 1. This device operates as a Standard Modulating Valve, and is controlled as outlined in the functional standards. The automatic operation of this device is controlled by the *Dissolved Oxygen Control Sequence* and the *Bumping Sequence*.

6.4.2.5.7. Swing zone Air Valve (on/off) on Bioreactor 1 Grid 2b (FCV31112)

This valve controls the air flow to Grid 2b of Bioreactor 1. This device operates as a Standard Control Valve, and is controlled as outlined in the functional standards. The automatic operation of this device is controlled by the *Dissolved Oxygen Control Sequence* and the *Bumping Sequence*.

6.4.2.5.8. Air Control Valve (modulating) on Bioreactor 2 Grid 1 (FCV 32102)

This valve controls the air flow to Grid 1 of Bioreactor 2. This device operates as a Standard Modulating Valve, and is controlled as outlined in the functional standards. The automatic operation of this device is controlled by the *Dissolved Oxygen Control Sequence* and the *Bumping Sequence*.

6.4.2.5.9. Air Control Valve (modulating) on Bioreactor 2 Grid 2 (FCV32103)

This valve controls the air flow to Grid 2 of Bioreactor 2. This device operates as a Standard Modulating Valve, and is controlled as outlined in the functional standards. The automatic operation of this device is controlled by the *Dissolved Oxygen Control Sequence* and the *Bumping Sequence*.

6.4.2.5.10. Swing zone Air Valve (on/off) on Bioreactor 2 Grid 2b (FCV32112)

This valve controls the air flow to Grid 2b of Bioreactor 2. This device operates as a Standard Control Valve, and is controlled as outlined in the functional standards. The automatic operation of this device is controlled by the *Dissolved Oxygen Control Sequence* and the *Bumping Sequence*.

6.4.2.5.11. 40 Air isolation valves on each dropper in Bioreactor 1

These valves are manual operated valves. There is no interfacing of these devices to the control system. The operator is required to manually enter the number of open valves in the system.

6.4.2.5.12. 40 Air isolation valves on each dropper in Bioreactor 2

These valves are manual operated valves. There is no interfacing of these devices to the control system. The operator is required to manually enter the number of open valves in the system.

6.4.3. Automatic Control

The blowers are controlled as a unit to supply air to meet a header pressure setpoint. Air flow to the bioreactors is controlled by the modulation of air control valves to meet a DO setpoint, in each zone.

The aeration grids in each bioreactor are as follows:

Grid 1	Zone 1	Aerobic Zone 1
Grid 2	Zone 2a	Aerobic Zone 2
	Zone 2b	Swing Zone 2

DO meter 1 provides information used for control of air to zone 1 (via control valve 1 – CV1). DO meter 2 provides information used for control of air to zone 2 (via control valve 2 – CV2). Control valve 3 (CV3) can be turned on/off to achieve the DO meter 2 setpoint. DO meter 3 is provided for monitoring purposes only. The Ammonia (NH_4) meter can be used to modulate the DO setpoints in both bioreactors.

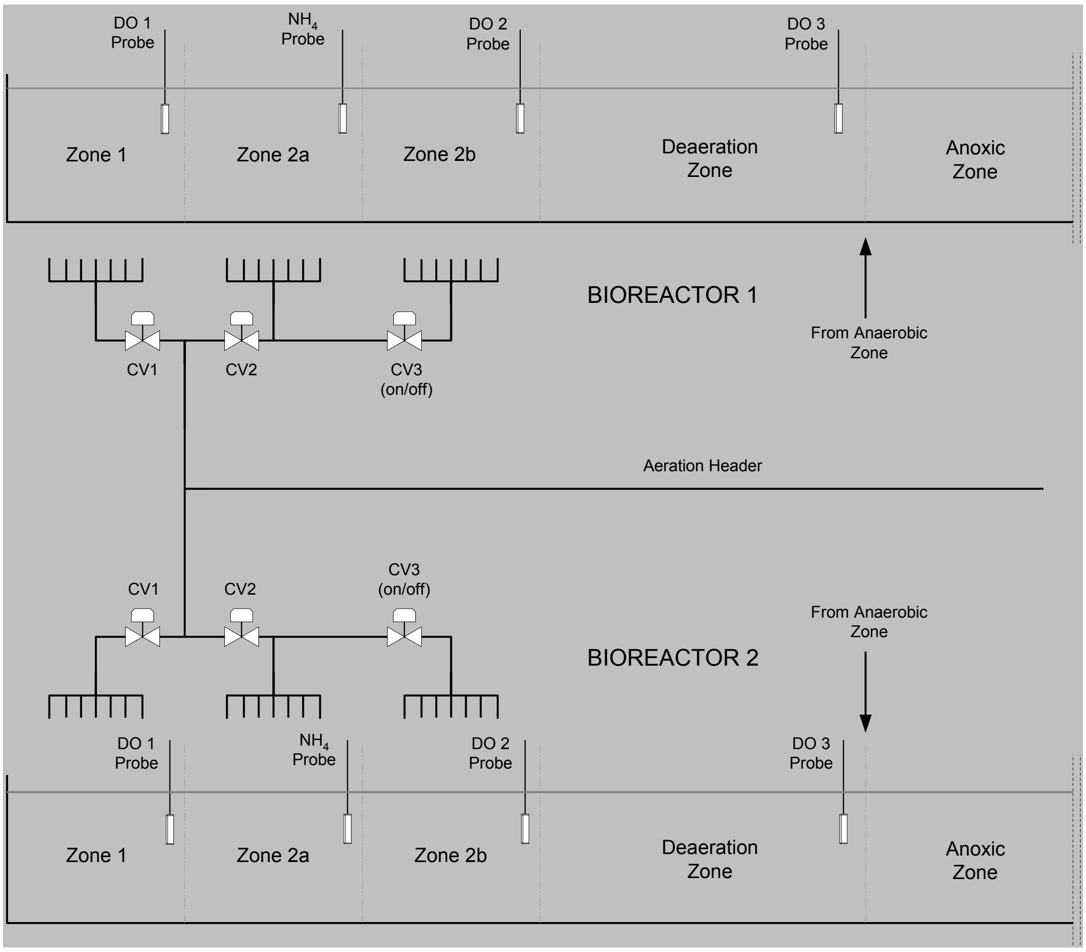


Figure 2 - Schematic of Aeration System

6.4.3.1. Dissolved Oxygen Setpoint Control Sequence

The dissolved oxygen concentration in each zone of each bioreactor can be either manually set to a constant value or modulated to optimise plant performance. Three operator selectable options exist DO Setpoint Control:

a. Constant DO Setpoint
b. Automatic DO Setpoint Schedule
c. Ammonia Controlled DO Setpoint

In *Constant DO Setpoint Mode*, the operator enters a setpoint value for each aeration zone on the OWS. This value does not change unless changed by the operator. The value is adjustable in the range of 0 to 10 mg/L. A setpoint of zero indicates that no air is to be supplied to that zone.

In *Automatic DO Setpoint Schedule Mode*, the DO setpoint is automatically varied for each zone up to 24 times a day, according to an automatic *DO setpoint schedule*. This is in order to cater for the variation in required dissolved oxygen from peak loads to low loads throughout the daily cycle.

The operator can schedule the DO setpoint throughout the day by entering the settings in a DO setpoint schedule table for each aeration zone in each bioreactor. The value is adjustable in the range of 0 to 10 mg/L. A DO setpoint can be entered for each 1 hour daily period. The time period is defined as being from one start time to the next start time (eg. 6:00 to 7:00).

An example table is shown below for Bioreactor 1: Zone 1. Similar tables shall be provided for Bioreactor 1:Zone 2, Bioreactor 2:Zone1, and Bioreactor 2:Zone.2

Time Start	DO Setpoint (mg/L)
00:00	1.0
01:00	1.0
02:00	1.0
03:00	1.1
04:00	1.2
05:00	1.3
06:00	1.5
07:00	2.0
..	..
22:00	1.0
23:00	1.0

In *Ammonia Controlled DO Setpoint Mode*, ammonia is monitored in one of the Bioreactors (and/or the other Bioreactor in the future). Control is provided from either or all bioreactors. If a meter is not present in a ditch it is treated as unavailable. The DO setpoint for Grid 1 and 2 is controlled to achieve an ammonia set point.

If only one ammonia meter is available, the setpoints for both ditches are controlled by this meter. If an ammonia meter is available in both ditches, the setpoints for both ditches can be controlled independently, or to the average of the ammonia readings, as selected by the Operator. The ammonia setpoint is manually entered by the operator.

This function modulates the DO setpoint of the aeration grids in Bioreactors 1 and 2. Under ammonia control, the ammonia analyser(s) compares the ammonia concentration in the bioreactor(s) to the ammonia setpoint. The PID loop is slow acting, and on an increase in ammonia it increases the DO setpoint, and similarly on a decrease in ammonia it decreases the DO setpoint. The output of the loop is a DO setpoint for the Bioreactor(s). This is a very slow loop making infrequent changes to the DO setpoint. The DO setpoint will also be limited to a safe operating range (through the use of minimum and maximum values for the DO setpoint for each zone)

If two ammonia meters have been installed and one ammonia meter fails, the one available signal will be used for control of both bioreactors. Separate Ammonia controllers shall exist for each

Bioreactor. Failure of all ammonia meters will result in control reverting to the Operator enterable Constant DO setpoint values for each aeration grid.

6.4.3.2. Dissolved Oxygen Control Sequence

Each aeration grid (in each bioreactor) operates to a DO setpoint as measured by a dedicated DO meter for that grid. A third DO meter is provided in each ditch for process monitoring.

Under AUTO mode two options exist for the aeration control algorithm, Cascade Loop Control and Single Loop Control. Either algorithm can be used to control the bioreactor to the setpoint in each zone.

Alternatively the operator will be able to manually enter a valve position or air flow rate required in each zone.

Under both Cascade Loop Control and Single Loop control, the swing zone valve will be controlled (on/off) to aid Grid 2 of each bioreactor to meet DO setpoint.

In the event that the control system fails, or communications is lost, the aeration zone equipment will continue to operate based on the last communicated signal.

The aeration control valves will all fail in the last known position.

6.4.3.2.1. Grid 1 Control

To achieve automatic DO control, the DO controller is selected to AUTO mode at the OWS.
Two different control algorithms will be available to use in the control:

a. Cascade Control,
b. Single Loop Control

Under both these control algorithms the DO is automatically controlled to the DO setpoint provided by the *Dissolved Oxygen Setpoint Control Sequence*.

In *Cascade Loop Control Mode*, two PID loop controllers are cascaded to provide the following control:

Loop 1. DO is measured in the grid and compared with the DO setpoint value. The DO Controller outputs a flow setpoint to the air flow controller. This is the slower acting loop.

Loop 2. The air flow controller compares the output of the DO controller to the air flow rate. The aeration control valve position is modulated to achieve the flow rate setpoint generated by the DO controller. This is the faster acting loop.

In *Single Loop Control Mode*, a single PID loop controller adjusts the aeration control valve position to achieve the DO setpoint for the zone. The air flow rate is not used in single loop control.

Loop 1. DO is measured in the grid and compared with the DO setpoint value.
The control valve position is modulated to maintain the DO setpoint.

The maximum and minimum air flow rate will be capped to each zone to protect the diffusers and associated pipe work from high flow conditions, and to provide an even aeration pattern during low flow conditions. The maximum and minimum caps are outlined in the table below. These caps will only be enabled when the DO control is in Cascade mode. The caps will be modified to account for the number of droppers turned on in each zone. This will be manually entered by the operator.

	Minimum Air Flow per dropper (Sm3/h)	**Maximum Air Flow per dropper (Sm3/h)**
Grid 1	*28*	*480*
Grid 2 (Swing Valve Open)	*10*	*360*
Grid 2 (Swing Valve Closed)	*10*	*360*

The following diagram indicates the control system data flow for Grid 1 DO control:

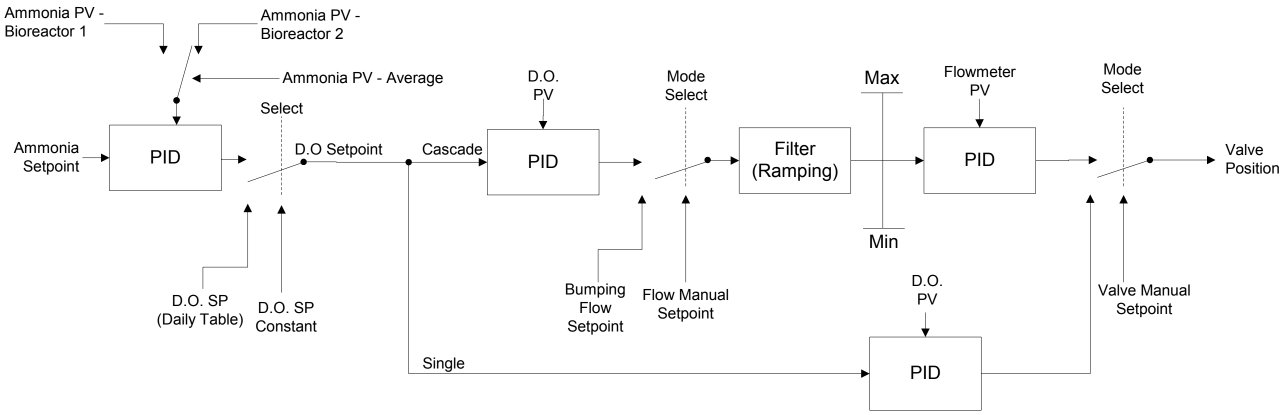


Figure 3 - Grid 1 Valve Control System Flow

6.4.3.2.2. Grid 2 Control

Grid 2 operates similarly to Grid 1 with exception to the source of the DO setpoint. Grid 2 of each Bioreactor has two options for DO Setpoint:

- Default DO Setpoint
- Ratio Mode

The DO Setpoint used is determine by the Grid 2 Setpoint Selection Algorithm. In Default Mode, the Constant DO Setpoint or the DO Setpoint Daily Schedule can be selected. In both cases, however, if the Zone 2 DO Setpoint is greater than the Zone 1 DO Setpoint, then the Zone 1 DO Setpoint is used for Grid 2 Control.

Under Ratio mode, the DO setpoint of each Bioreactor's Zone 2 shall be a fixed ratio of Zone 1. This ratio is operator configurable and will be bounded by minimum and maximum values. The following diagram indicates the control system data flow for Grid 2 DO control:

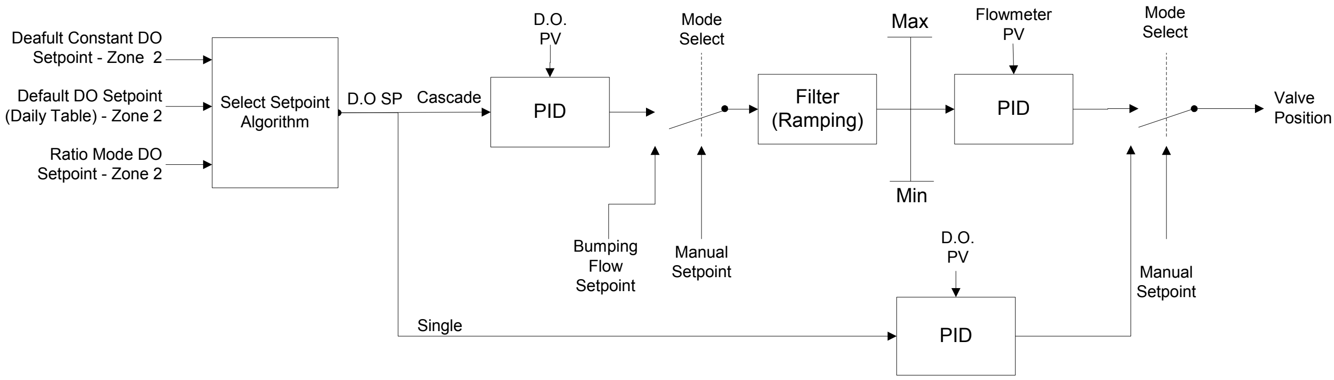


Figure 4 Grid 2 Valve Control System Flow

6.4.3.2.3. Grid 2b Control

When the *Swing Zone Operation* is selected to AUTO the swing zone is controlled (on/off) to aid in the control of Grid 2 to its DO setpoint.

The swing valve operates under the following control philosophy:

Swing Valve Closes when:

a. The air flow rate to Grid 2 is less than 110% of the minimum air flow rate for Grid 2a and 2b for a period greater than 10 minutes, and
b. The DO value as measured by DO probe 2 is 110% or greater than its setpoint for a period greater than 10 minutes, and
c. The bumping sequence has not selected this zone for bumping.

Swing Valve Opens when:

a. The air flow rate to Grid 2b is greater than 130% of the minimum air flow rate for Grid 2a and 2b for a period greater than 5 minutes, or
b. The bumping sequence has selected this zone for bumping.

The minimum air flow rate for Grid 2a and 2b is the minimum air flow per dropper multiplied by the number of open droppers.

6.4.3.3. Air Flow Rate Control

The operator will be able to individually select each aeration control zone to control to an Air Flow Rate setpoint as opposed to a DO setpoint. When Air Flow Rate Control is enabled, DO control for that zone will be disabled.

The air flow rate will be bound to the upper and lower limits outlined above.

6.4.3.4. Blower Control Sequence

The speed of the blowers and the number operating is modulated to meet a header pressure setpoint in the aeration manifold. The option exists for the pressure setpoint to be either a constant value or an optimised setpoint. The Blower Control Sequence has the following two operator selectable modes:

a. Constant Set Point Mode
b. Blower Control Zone Set Point Mode – Optimised Mode

In *Constant Set Point Mode*, the operator enters the desired header pressure set point that the blowers are required to maintain. The header pressure must be kept within limits *(Header pressure minimum – header pressure maximum).*

The *Blower Control Zone Set Point Mode – Optimised Mode* utilises the *Most Open Valve Control Algorithm* in order to minimise header pressure in the system and therefore reduce operating costs and to bring the control valves into their controllable range. The header pressure must also be kept within limits *(Header pressure minimum – Header pressure maximum).*

In *Blower Control Zone Set Point Mode – Optimised Mode*, the manifold pressure set point is varied by a reverse acting PID loop to maintain the most open aeration control valve at the fully open position (set during commissioning – i.e. 70% open). The aeration zone with the most open valve is called the Blower Control Zone. The variation in the header set point when operating under this mode is relatively slow. All operational bioreactor aerated zones are continuously compared against each other to determine the Blower Control Zone.

The option also exists on the OWS for the operator to manually select the blower control zone.

Aeration control valves will only be considered in the *Most Open Valve Control Algorithm* if they are available. The valves will be unavailable if any of the following conditions are true:

a. The air control valve is not in auto mode, or
b. Its DO signal is invalid, or
c. Its air flow signal is invalid.

The following diagram indicates the control system data flow for the Blower Control Sequence:

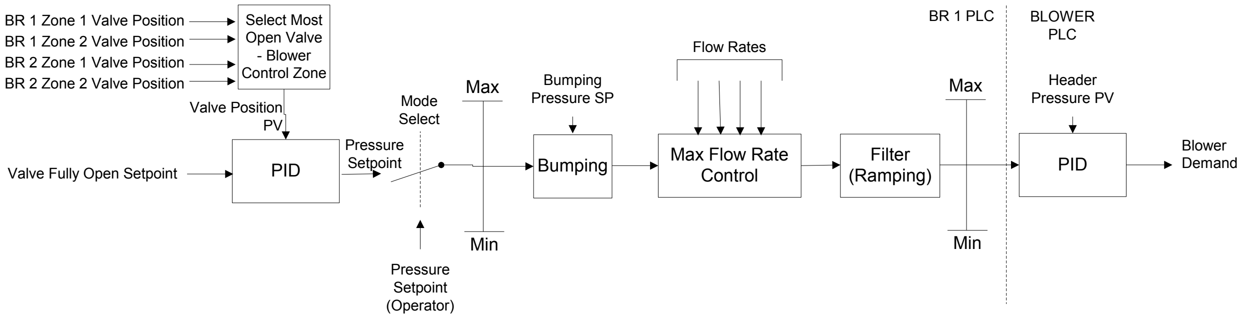


Figure 5 Blower Control System Flow

The operation of the Max Flow Rate Control algorithm is given in Clause 6.4.7.3.

6.4.3.5. Bumping Sequence

The *Bumping Sequence Interval Time* represents the time between complete Bumping Sequence starts. This time is adjustable between 1 and 30 days (<u>Operator Enterable</u>).

The *Bumping Sequence Start Time* is operator selectable. This parameter represents the time that the first aerated zone bumping operation is initiated. The *Bumping Sequence Start Set Point* is operator adjustable in the range of 0:00 hours to 23:59 hours.

The delay between grid bumping start times is operator adjustable between 0 and 24:00 hours (*Bumping delay period*).

It shall be possible for to Disable the Bumping Sequence through the OWS.

When the Bumping Sequence starts, each aeration grid is individually and sequentially bumped starting from Grid 1 on Bioreactor 1 and finishing with Grid 2 on Bioreactor 2.

The Bump Sequence for Zone 2 in each Bioreactor will include opening the Swing Zone Valve such that the entire of Grid 2 operates as a single unit.

When diffusers are required to be bumped, the output of the blowers is required to increase to supply the necessary additional air. On initiation of a bumping sequence for each zone, the Header Pressure Setpoint is increased by the *Bumping Pressure Setpoint* (determined during commissioning). On completion of the bumping sequence for each zone, the increase to the Header Pressure Setpoint is removed, and the Blower Control Sequence will resume normal operation.

The following control of the aeration valves within the current bumping zone will occur during the Bumping Sequence:

a. The airflow to the zone ramps up (by slowly opening the aeration control valve) to a software set *bump flow setpoint* as measured by the air flowmeter dedicated to the aeration control valve. This bump flow setpoint is per dropper. Since the number of diffusers per dropper differs between Zone 1 and 2, independent Bump Flow Setpoints are required. The flow for the zone is determined based on the number of droppers entered as on by the operator.

b. The *bump flow setpoint* is maintained for a *bump time* (operator-set), after which the aeration control valve returns to normal auto control. After the *bumping delay period*, the next zone goes into bump mode. The *bump time* is adjustable in the range of 0 to 30 minutes.

Note the importance of slowly ramping the flow-rate during bump mode. If the ramping reduces too quickly the blower surge protection could operate or if the ramping increases too quickly the flow setpoint could be over-shot, which may cause damage to the diffuser system.

A Priority 10 Alarm shall be raised if the bumping sequence for a particular Zone is skipped.

The bump flow-rates are as follows:

Zone	**Bioreactor 1 (Sm^3/h)** **Flow per dropper**	**Bioreactor 2 (Sm^3/h)** **Flow per dropper**
Zone 1	*420*	*420*
Zone 2 – Swing On	*350*	*350*

6.4.3.6. Diffuser Back Pressure Monitoring

Through normal operation of the diffusers in the aeration grids, foreign particles in the mixed liquor slowly accumulate on the surface of the diffuser. Over time these particles gradually block or foul the air path through the diffuser, thereby reducing the airflow through the diffusers. This in turn requires a higher header pressure (more energy) to achieve the same airflow and changes the oxygen transfer efficiency.

In order to determine when the diffusers require cleaning, a back-pressure monitoring system is incorporated. This system logs the pressure loss through the diffusers at all airflow ranges and averages the daily data. The operator must enter the number of droppers open. The airflow per dropper is then logged against the back pressure measured for all airflow ranges. By reviewing the log of pressures and flows, it can be determined when the diffusers are fouled and a diffuser clean can be scheduled.

This functionality shall be provided through the Plant Historian.

6.4.3.7. Bioreactor 1 Mixing Sequence

When this sequence is enabled, all available Mixers will run continuously. The start-up of the mixers are sequenced, with a 2 second delay between mixer starts.

6.4.3.8. Bioreactor 2 Mixing Sequence

When this sequence is enabled, all available Mixers will run continuously. The start-up of the mixers are sequenced, with a 2 second delay between mixer starts.

6.4.4. Monitoring

The following is displayed on the OWS:

a. Each of the alarms listed
b. Total Air Flowrate to each bioreactor (Sm3/h) (flows summated from both zones)
c. DO Concentration of each DO Probe (mg/L)
d. Ammonia level in Bioreactor 1 (and 2 – for future use)(mg/L)
e. Pressure in each Bioreactor air header (kPa)
f. Aeration Header Pressure (kPa)
g. Aeration Header Pressure Setpoint (kPa)
h. Dynamic wet pressure for each grid
i. Last measured ORP signal
j. Last measured Temperature signal
k. Last measured pH signal
l. Air flow rate for each grid

6.4.5. Calculations

6.4.6. Setpoints

Setpoint Description	Default Value	Security Level
Grid 1 DO Setpoint Control Mode: Constant DO Setpoint Scheduled DO Setpoint	Constant /	

Ammonia Controlled DO SP		
Grid 2 DO Setpoint Control Mode Constant DO Setpoint Scheduled DO Setpoint Ratio Controlled DO Setpoint	Constant /	
Constant DO Setpoint – Zone 1	2	Operator
Constant DO Setpoint – Zone 2	2	Operator
DO Setpoint Schedule (6 Hourly Intervals) – Zone 1	2	Operator
DO Setpoint Schedule (6 Hourly Intervals) – Zone 2	2	Operator
Ammonia Setpoint	0.8	Operator
Ammonia Control Mode selection: Bioreactor No.1 Bioreactor No.2 Average control	Bioreactor No.1	Operator
Ratio of DO Setpoints Bioreactor 1: Zone2/Zone1	25%	Operator
Ratio of DO Setpoints Bioreactor 2: Zone2/Zone1	25%	Operator
Number of droppers open : Bioreactor 1 Grid 1 Bioreactor 1 Grid 2a Bioreactor 1 Grid 2b Bioreactor 2 Grid 1 Bioreactor 2 Grid 2a Bioreactor 1 Grid 2b	 16 12 12 16 12 12	Operator
Blower Control Sequence Mode Selection: Blower Control – Constant setpoint Mode Blower Control zone – Optimised Mode	Constant/	Operator
Blower Control Zone Selection	Manual	Operator
Bumping sequence interval time	30 d	Operator
Bumping sequence start time	6:00	Operator
Bump time	15 minutes	Operator
Bumping delay period	60 minutes	Operator
Controlling Valve Fully Open Position	70%	Restricted access level 1
Blower control zone Minimum Change time	10 minutes	Restricted access level 1
DO deviation alarm	20%	Restricted access level 1
Header pressure set point	50 kPa	Restricted access level 1
Header pressure minimum	45 kPa	Restricted access level 2
Header pressure maximum	60 kPa	Restricted access level 2

Swing zone lag time	10 minutes	Restricted access level 1
Mode of Control: Cascade control Single loop control	Cascade/	Restricted access level 2
Maximum air flowrates to Zone 1 (per dropper)	320	Restricted access level 2
Minimum air flowrates to Zone 1 (per dropper)	28	Restricted access level 2
Maximum air flowrates to Zone 2 (per dropper)	210	Restricted access level 2
Minimum air flowrates to Zone 2 (per dropper)	10	Restricted access level 2
Bump flowrates to Zone 1 (per dropper)	420	Restricted access level 2
Bump flowrates to Zone 2 (per dropper)	330	Restricted access level 2
Bumping header pressure setpoint		Restricted access level 2
Minimum DO Setpoint	1.0	Restricted access level 1
Maximum DO Setpoint	3.0	Restricted access level 1

6.4.7. Process Alarms and Interlocks

6.4.7.1. DO Control Deviation Alarm

Tag	Equipment	Action
AIT31102	Bioreactor 1: Zone 1 DO meter	
AIT31103A	Bioreactor 1: Zone 2 DO meter	
AIT32102	Bioreactor 2: Zone 1 DO meter	
AIT32103A	Bioreactor 2: Zone 2 DO meter	

Deviation High or Deviation Low alarms shall be generated if the measured DO is more than 20% higher or lower (Restricted Access Level 1 enterable) than the DO setpoint continuously for 10 minutes, if the aeration controller is in AUTO mode. This alarm type is Priority 10

6.4.7.2. DO High Alarm for each DO Control Loop

Tag	Equipment	Action
AIT31102	Bioreactor 1: Zone 1 DO meter	
AIT31103A	Bioreactor 1: Zone 2 DO meter	
AIT32102	Bioreactor 2: Zone 1 DO meter	
AIT32103A	Bioreactor 2: Zone 2 DO meter	

A High alarm shall be generated if the measured DO is greater than a High Alarm Setpoint. This alarm type is Priority 10

6.4.7.3. High Flow Alarm for each Aeration Zone

Tag	Equipment	Action
FIT-31102	Bioreactor 1 Air Flow Meter 1	
FIT-31103	Bioreactor 1 Air Flow Meter 2	
FIT-32102	Bioreactor 2 Air Flow Meter 1	
FIT-32103	Bioreactor 2 Air Flow Meter 2	

A High alarm shall be generated if the measured flow rate to any zone (per dropper) is greater than the specified maximum airflow per dropper. This alarm type is Priority 10. The blower pressure setpoint shall slowly ramp down until the flow rate is 5% less than the Maximum Allowable Flow per dropper. The Header Pressure setpoint shall remain fixed at this level until the Alarm is reset at the OWS or is overridden by another high flow condition in any other aeration zone.

6.4.7.4. Aeration Header Pressure Transmitter Failure

Tag	Equipment	Action
PIT-83001	Pressure Transmitter in Common Aeration Header	Blowers to continue at last blower speed

An alarm shall be generated if the transmitter reads out of a set range. This alarm type is Priority 6. The blowers will continue to operate at last blower speed.

6.4.7.5. DO Meter Failed

Tag	Equipment	Action
AIT31102	Bioreactor 1: Zone 1 DO meter	
AIT31103A	Bioreactor 1: Zone 2 DO meter	
AIT32102	Bioreactor 2: Zone 1 DO meter	
AIT32103A	Bioreactor 2: Zone 2 DO meter	

An alarm shall be generated if the transmitter reads out of a set range, or a fault signal is received. This alarm type is Priority 10. If the controlling DO meter fails (DO meter 1 or 2) and the aeration system is operating in AUTO control, the bioreactor zone containing the failed DO meter shall mimic the valve position of the corresponding zone in the other bioreactor.

6.4.7.6. Airflow Transmitter Failed

Tag	Equipment	Action
FIT-31102	Bioreactor 1 Air Flow Meter 1	
FIT-31103	Bioreactor 1 Air Flow Meter 2	
FIT-32102	Bioreactor 2 Air Flow Meter 1	
FIT-32103	Bioreactor 2 Air Flow Meter 2	

An alarm shall be generated if the transmitter reads out of a set range. This alarm type is Priority 16. The associated Airflow Control Valve control shall change to Single Loop mode with bumpless transfer. The Bump Sequence for the affected Bioreactor shall be prevented from occurring

6.4.7.7. Differential pressure high

Tag	Equipment	Action
PDIT31108	Differential Wet Pressure Station Bioreactor 1 Grid 1	
PDIT31110	Differential Wet Pressure Station Bioreactor 1 Grid 2	
PDIT32108	Differential Wet Pressure Station Bioreactor 2 Grid 1	
PDIT32110	Differential Wet Pressure Station Bioreactor 2 Grid 2	

An alarm shall be generated if the differential pressure recorded exceeds the maximum differential pressure setpoint. This alarm type is Priority 10.

6.4.7.8. Ammonia Analyser Fault Alarm

Tag	Equipment	Action
AI31115	Ammonia Meter Bioreactor 1	
	Ammonia Meter Bioreactor 2	

An alarm shall be generated if there is an internal fault with the ammonia analyser. If in Ammonia Controlled DO Setpoint Mode, control shall revert to Constant DO Setpoint Mode, or if another probe is available then the signal from that probe shall be used.

6.4.7.9. Mixer Failure

Tag	Equipment	Action
MX-31001	Bioreactor 1 Mixer 1	
MX-31002	Bioreactor 1 Mixer 2	
MX-31003	Bioreactor 1 Mixer 3	
MX-31004	Bioreactor 1 Mixer 4	
MX-31005	Bioreactor 1 Mixer 5	
MX-31006	Bioreactor 1 Mixer 6	
MX-31007	Bioreactor 1 Mixer 7	
MX-32001	Bioreactor 2 Mixer 1	
MX-32002	Bioreactor 2 Mixer 2	
MX-32003	Bioreactor 2 Mixer 3	
MX-32004	Bioreactor 2 Mixer 4	
MX-32005	Bioreactor 2 Mixer 5	
MX-32006	Bioreactor 2 Mixer 6	
MX-32007	Bioreactor 2 Mixer 7	

This alarm shall be generated if the mixer becomes unavailable. This alarm type is Priority 6.

6.4.7.10. Bioreactor No.1 - 2 Mixers Failed

Tag	Equipment	Action
MX-30101	Bioreactor 1 Mixer 1	
MX-30102	Bioreactor 1 Mixer 2	
MX-30103	Bioreactor 1 Mixer 3	
MX-30104	Bioreactor 1 Mixer 4	
MX-30105	Bioreactor 1 Mixer 5	
MX-30106	Bioreactor 1 Mixer 6	
MX-30107	Bioreactor 1 Mixer 7	

This alarm shall be generated if 2 or more mixers are not running. This alarm type is Priority 1.

6.4.7.11. Bioreactor No.2 - 2 Mixers Failed

Tag	Equipment	Action
MX-30201	Bioreactor 2 Mixer 1	
MX-30202	Bioreactor 2 Mixer 2	
MX-30203	Bioreactor 2 Mixer 3	

MX-30204	Bioreactor 2 Mixer 4	
MX-30205	Bioreactor 2 Mixer 5	
MX-30206	Bioreactor 2 Mixer 6	
MX-30207	Bioreactor 2 Mixer 7	

This alarm shall be generated if 2 or more mixers are not running. This alarm type is Priority 1.

6.4.8. Trend Pages

The following trends shall be displayed on the Blower Optimisation trend page:

a. Control valve position (%)
b. Blower header pressure (kPa)
c. Blower 1 Speed (%)
d. Blower 2 Speed (%)
e. Blower 3 Speed (%)
f. Blower 4 Speed (%)
g. Blower 5 Speed (%)

The following trends shall be displayed on the Diffuser Back Pressure Monitoring trend page:

a. Header Pressure (kPa)
b. Header Temperature (degC)
c. Zone 1 Back pressure (kPa)
d. Aeration Zone 1 airflow (m3/Hr)
e. Aeration Zone 1 air control valve position (%)
f. Zone 2 Back pressure (kPa)
g. Aeration Zone 2 airflow (m3/Hr)
h. Aeration Zone 2 air control valve position (%)

These trends shall be displayed for both Bioreactor 1 and Bioreactor 2.

The following trends shall be displayed on the Aeration Control trend page:

a. Bioreactor 1 Grid 1 meter DO level (mg/L)
b. Bioreactor 1 Grid 2 meter DO level (mg/L)
c. Bioreactor 1 Anoxic Zone DO level (mg/L)
d. Bioreactor 2 Grid 1 meter DO level (mg/L)
e. Bioreactor 2 Grid 2 meter DO level (mg/L)
f. Bioreactor 2 anoxic zone DO level (mg/L)
g. Ammonia level in Bioreactor 1 (mg/L)

The following trends shall be displayed on the ORP trend page:

a. ORP meter start anoxic zone (mV)
b. ORP meter end anoxic zone (mV)

The following Trends shall be displayed on the Bioreactor 1 Instrumentation trend page:

a. ORP meter 1(Bioreactor 1) (mV)
b. ORP meter 2 (Bioreactor 1) (mV)
c. Temperature (Bioreactor 1) (degC)
d. pH (Bioreactor 1)

e. Dissolved Oxygen, DO meter 1 (Bioreactor 1) (mg/L)
f. Dissolved Oxygen, DO meter 2 (Bioreactor 1) (mg/L)
g. Dissolved Oxygen, DO meter 3 (Bioreactor 1) (mg/L)
h. Ammonia (Bioreactor 1) (mg/L)

.
The following Trends shall be displayed on the Bioreactor 2 Instrumentation trend page:

a. Temperature (Bioreactor 2) (degC)
b. Dissolved Oxygen, DO meter 1 (Bioreactor 2) (mg/L)
c. Dissolved Oxygen, DO meter 2 (Bioreactor 2) (mg/L)
d. Dissolved Oxygen, DO meter 3 (Bioreactor 2) (mg/L)

6.4.9. Statistical Data

The following statistical data shall be available for reports through the Plant Historian:

a. Bioreactor 1 Grid 1 meter average DO level (mg/L)
b. Bioreactor 1 Grid 2 meter average DO level (mg/L)
c. Bioreactor 1 Anoxic Zone average DO level (mg/L)
d. Bioreactor 1 Ammonia Average (mg/L)
e. Bioreactor 2 Grid 1 meter average DO level (mg/L)
f. Bioreactor 2 Grid 2 meter average DO level (mg/L)
g. Bioreactor 2 Anoxic zone average DO level (mg/L)
h. Bioreactor 2 Ammonia Level Average (mg/L)
i. Daily Average Temperature (degC)
j. Daily Average ORP for each analyser (mV)
k. Daily Average pH
l. Daily total Air Flow-rate (Sm3/Hr)
m. Daily Total Air Flow-rate for each Bioreactor (Sm3/Hr)
n. Daily Total Air Flow-rate for each Grid (Sm3/Hr)

6.5. Activated Sludge and Scum Wasting and Thickening

6.5.1. Process Overview

Activated sludge is wasted from the bioreactors to maintain a desired sludge age in the system, while scum is removed to prevent an unacceptable accumulation. The wasted sludge and scum is thickened and dewatered prior to offsite disposal.

The plant consists of two bioreactors, and two anaerobic zones. The sludge for the plant is common, having been combined before splitting between each bioreactor.

The sludge wasting and thickening system shall be capable of automatic operation. It is intended that wasting, thickening and dewatering will happen without direct operator intervention when the site is unattended.

It is intended that the operator will select:

a. A sludge age and hence the volume of sludge to be wasted each day;
b. Days on which sludge is wasted;
c. A sludge wasting start time;
d. A poly dosing rate;
e. A WAS flow rate;
f. Other options/selections as necessary.

The control system will then:

a. Automatically start the WAS pumps, poly dosing system, BFP/GDD and other ancillary equipment, according to a defined schedule;
b. Shut down operation in accordance with a defined schedule, when wasting is complete, when the sludge hopper is full or on receipt of an error/fault signal;

This section considers the following control sub-units:

a. Activated sludge wasting;
b. Scum removal from the bioreactor;
c. Polyelectrolyte make up and dosing;
d. Sludge thickening and dewatering;
e. Sludge loading bay.

6.5.1.1. Activated Sludge Wasting Overview

Waste activated sludge (WAS) is drawn directly from the aerobic zones of each bioreactor on a daily (normally weekday) basis and directed to sludge thickening and dewatering (combined gravity drainage deck and belt filter press, GDD/BFP). Two variable speed centrifugal pumps, connected in a duty/standby configuration are available for each ditch. Each set of pumps is directly connected to an individual GDD/BFP, and it is intended to operate both GDD/BFP units simultaneously. However since each set of pumps and GDD/BFP has sufficient capacity, and the sludge is common, (i.e. between the bioreactors) sludge wasting requirements can be met from a single ditch and to a single GDD/BFP.

In auto control the volume of sludge to be wasted will be determined from an operator entered S*ludge Age*. Alternatively, the operator may directly enter a W*asting Volume*. Further the operator will nominate the *Days of the week for sludge wasting* to occur, and will select a *Starting time for sludge wasting* on those days. Wasting and dewatering will occur unattended if required.

Two sludge wasting systems exist. Under normal operation, WAS from Bioreactor 1 will be directed to GDD/BFP 1, with the filtrate returned to the aerobic zone of Bioreactor 1. Similarly

WAS from Bioreactor 2 will be processed by GDD/BFP 2 with filtrate returned to the aerobic zone of Bioreactor 2. The operator will select a WAS pump flow rate for each WAS pump station and GDD/BFP set.

Interconnecting pipe work allows for either bioreactor WAS pump station to feed either or both GDD/BFPs. Interconnecting pipe work also allows for either GDD/BFP to return filtrate to either or both bioreactors. These connections require the adjustment of manual valves. No provision for either scenario is made under AUTO control. If required to operate under these modes, all units will be operate under MANUAL control.

The duty GDD/BFP and WAS pump station sets will operate at their respective WAS pump flow rate setpoints, from the start time until the required WAS volume is wasted, or until the next waste start time. Capacity must also exist in the sludge hopper for sludge wasting to occur. If any equipment becomes unavailable, the available system will continue to operate until the daily WAS volume has been achieved (or until the next waste start time). If any equipment becomes available prior to the daily WAS volume being achieved, it will also operate at its WAS pump flow rate setpoint in order to achieve the daily WAS volume. Similarly, if the sludge hopper level is reduced from full, prior to the next sludge wasting time, wasting will recommence in an attempt to achieve the required WAS volume.

6.5.1.2. Scum Removal

6.5.1.2.1. Scum Removal from FST's

Scum is trapped in several locations around the plant, in particular in the bioreactors and in the Final Settling Tanks (FSTs). Scum trapped in the FSTs is directed to a collection system by the movement of the clarifier bridge, from where it is pumped to the bioreactors. This occurs 24 hours per day.

Refer to Section 6.6.4.3 for description of operation.

6.5.1.2.2. Scum Removal from Bioreactors

Scum harvesters located in the bioreactors scrape the scum from the surface and pump it to the pressure side of the WAS pumps for dewatering and ultimate disposal from the GDD/BFPs. **Each scum harvester is directly connected to a GDD/BFP and consequently can only operate when the corresponding sludge wasting system and GDD/BFP are operating.** Wash water is provided to the scum harvester when in operation.

The scum harvester traps surface scum behind a fixed baffle plate. This scum is directed up a beach using a flite and chain scraper system that deposits the scum in a hopper. A helical rotor pump then directs the sludge from the hoper to the BFP/GDD for dewatering and disposal.

This is a package unit but only for operation in Manual and Timer modes. For a description of the operation of the system in these modes, refer to Appendix H. The Scum Removal System can also be operated in Remote mode which hands control to the Plant SCADA System.

In Remote mode the system shall be controlled in either Timer or Manual Mode. In Timer mode the Scum Harvester system is stopped and started based on a Scum Harvester Run Time and Scum Harvester Stop Time. In manual mode the Scum Harvester system is controlled by a manual Start/Stop command from the SCADA system.

6.5.1.3. Polyelectrolyte Make up and Dosing

Polyelectrolyte (Poly) is supplied to the GDD/BFPs to assist in thickening and dewatering of the sludge.

Poly is stored as a powder in a storage tank and made up with potable water in the Poly Mixing Tank. Liquid poly is then pumped by the transfer pumps to the Poly Dosing Tank for use. This system is provided as a package, and its description is contained in Appendix H.

Two poly dosing systems are provided to pump poly from the dosing tank to the GDD/BFPs, one for each wasting system, . Poly dosing system 1 is dedicated to GDD/BFP1 whilst Poly dosing system 2 is dedicated to GDD/BFP2. Each dosing system includes a manually flow controlled dilution water system. The dilution water operates only when the poly dosing pumps are running.

6.5.1.4. Sludge Thickening and Dewatering

Two combined gravity drainage decks/belt filter presses (GDD/BFPs) are provided to thicken and dewater the waste activated sludge (WAS).

The GDD/BFPs are housed on the second floor of the combined blower/sludge dewatering building. WAS, scum and polyelectrolyte are mixed in the pipeline feeding the GDD/BFPs. Service water is also provided to clean the belts. The dewatered sludge is fed to a hopper which discharges to heavy vehicle trailers for disposal off site. Filtrate is returned to the aerobic zone of the bioreactor from which the sludge was wasted.

Under normal operation, WAS from Bioreactor 1 will be directed to GDD/BFP1, with the filtrate returned to the aerobic zone of Bioreactor 1 and similarly WAS from Bioreactor 2 will be processed by GDD/BFP2 with filtrate returned to Bioreactor 2.

6.5.1.5. Sludge Human Machine Interface (HMI)

A Siemens TP270 touch panel shall be installed for the Sludge Thickening and Dewatering System. The touch panel shall be connected to the Siemens PLC and the Power monitor located in the Sludge Handling MCC via a Profibus DP loop.

The local control panel will include start and stop controls for the drives associated with the sludge wasting system. It will also include an Emergency stop button for each train which, when pressed, will turn off all equipment associated with the wasting sequence

The following data will be able to be entered by operators via the HMI:

- Wasting Sequence Start – this will be a HMI push-button and will override the time of day start sequence for that particular day. Time of day start will be selectable via the SCADA system only (not in HMI). Wasting will stop based on selected volume/sludge age for that day,
- Wasting Sequence Stop (will result in a controlled shutdown and will override the automatic stop on volume wasted)
- Wasting Override Time Setpoint – stops the sequence if the required volume of sludge has not been wasted in a set time.
- WAS Pumps Flow Rate setpoint
- Poly pumps flow rate setpoint
- Selector for Scum Feed control (On/Off)
- Local alarm reset
- All setpoints will be password protected.

Displays on the HMI will include:

- All setpoints mentioned above
- Current sludge volume wasted
- Target sludge volume to be wasted
- WAS Flow rate
- WAS & Scum flow rate
- Poly flow rate

Individual control of drives will not be available via the HMI – they will be available via the local control panel.

6.5.1.6. Sludge Loading Overview

Dewatered sludge cake is fed by gravity chute from the GDD/BFPs to a sludge hopper, which is sized to accommodate two trailer loads of cake. The intent of the hopper is to allow rapid sludge loading and to eliminate the need to maintain trailers on site. It also allows sludge dewatering a measure of independence from vehicle movements.

The sludge loading system is a manual process, though has been designed to allow future implementation of fully automatic operation.

The truck driver parks the truck in the sludge loading bay underneath a sludge hopper. A roller door at the entry must be closed after the truck is in position for the system to operate. The sludge hopper consists of 4 hopper doors which will be setup in banks of 2. The driver shall have the ability to select all four doors to operate or select one of two pairs. The Operator will then be able to direct the doors to open/close via pushbuttons.

The sludge loading control panel shall be located on the truck driver's platform external to the loading facility.

A key lock switch will allow switching from "Automatic/Normal/Off/Maintenance". The driver's key will only switch from "Off" to "Normal" or "Automatic" and back again. Authorised maintenance personnel will only be permitted to switch into "Maintenance" mode. At this stage "Automatic" will be labelled "Future – Automatic"

There will be a number of safety interlocks that will need to be in place before the system will operate. Safety interlocks will include:

a. Roller door must be closed before hopper doors will open.
b. Truck must be in position before hopper doors will open.
c. Emergency stop not activated
d. Low level alarm in hydraulic reservoir not activated.

Sensing of the truck being in position will be achieved by the sensing of two separate horizontal beams, installed at an appropriate height for the truck to trigger the beam. In order for the truck to be deemed to be in position both beams must be triggered. Both beams must trigger before both hoppers are enabled.

6.5.2. Equipment

6.5.2.1. Equipment List - Activated Sludge Wasting

Tag	Equipment	Range	Type	Make & Model	Comment
PU-38010	Bioreactor 1 WAS Pump 1	24.3 – 61.3 L/s			
PU-38020	Bioreactor 1 WAS Pump 2	24.3 – 61.3 L/s			
PU-38110	Bioreactor 2 WAS Pump 1	24.3 – 61.3 L/s			
PU-38120	Bioreactor 2 WAS Pump 2	24.3 – 61.3 L/s			
FSL-38011	WAS Pump 1 Low Flow Switch				

FSL-38021	WAS Pump 2 Low Flow Switch				
FSL-38111	WAS Pump 1 Low Flow Switch				
FSL-38121	WAS Pump 2 Low Flow Switch				
FIT-38010	Bioreactor 1 WAS Flowmeter	0-60 L/s			
FIT-38030	Bioreactor 2 WAS Flowmeter	0-60 L/s			
FIT-38020	Scum and WAS from OD 1 Flowmeter	0-60 L/s			
FIT-38040	Scum and WAS from OD 2 Flowmeter	0-60 L/s			

6.5.2.2. Equipment List - Scum Removal

Tag	Equipment	Range	Type	Make & Model	Comment
SH-313-01	Bioreactor 1 Scum Harvester				
PU-313-01	Bioreactor 1 Scum Pump				
FCV-31201	Bioreactor 1 Scum Harvester Wash Water Valve				
	Bioreactor 2 Scum Harvester				
	Bioreactor 2 Scum Pump				
	Bioreactor 2 Scum Harvester Wash Water Valve				

6.5.2.3. Equipment List - Poly Make Up and Dosing

Tag	Equipment	Range	Type	Make & Model	Comment
	Poly Make Up System				
VB-615-01	Poly Vibrator				
CV-615-01	Poly Feeder				
MX-615-01	Hopper Agitator				
BL-615-01	Poly Blower				
LIT-615-06	Poly Mixing Tank Level Transmitter				
LSLA-615-06	Poly Mixing Tank Level Switch No.1				
LSHA-615-06	Poly Mixing Tank Level Switch No.2				
LSHHA-615-06	Poly Mixing Tank Level Switch No.3				
PU-614-01	Poly Transfer Pump				
	Poly Dosing System				
FCV-61610	Poly dosing trainsystem 1: Service Water 1 Flow Control Valve				
PU-61510	Poly Dosing Pump 1 – System 1				
PU-61511	Poly Dosing Pump 2 – System 1				
FIT-61510	Poly Dosing System 1 Flowmeter	0-100 L/min			
MX-61510	Poly Dosing System 1 Inline Mixer				
FCV-61620	Poly dosing trainsystem 2: Service Water 2 Flow Control Valve				

PU-61520	Poly Dosing Pump 3 – System 2				
PU-61521	Poly Dosing Pump 4 – System 2				
FIT-61520	Poly Dosing System 2 Flowmeter	0-100 L/min			
MX-61520	Poly Dosing System 2 Inline Mixer				

BWEA To confirm for Poly Makeup

6.5.2.4. Equipment List - Sludge Thickening and Wasting

Tag	Equipment	Range	Type	Make & Model	Comment
CV-610-10	GDD No.1				
CV-610-20	GDD No.2				
CV-611-10	BFP No.1				
CV-611-20	BPF No.2				
LSL-61010	GDD No.1 High Level Switch				
LSL-61020	GDD No.2 High Level Switch				
PSL-61010	GDD No.1 Low Pressure Switch				
PSL-61020	GDD No.2 Low Pressure Switch				
ZS-61010A	GDD No.1 Tracking Left Position Switch				
ZS-61010B	GDD No.1 Tracking Right Position Switch				
ZS-61020A	GDD No.1 Tracking Left Position Switch				
ZS-61020B	GDD No.2 Tracking Right Position Switch				
ZSS-61010A	GDD No.1 Safety Switch 1				
ZSS-61010B	GDD No.1 Safety Switch 2				
ZSS-61020A	GDD No.2 Safety Switch 1				
ZSS-61020B	GDD No.2 Safety Switch 2				
PSL-61110	BFP No.1 Low Pressure Switch				
PSL-61120	BFP No.2 Low Pressure Switch				
ZS-61110A	BFP No.1 Tracking Left Position Switch				
ZS-61110B	BFP No.1 Tracking Right Position Switch				
ZS-61120A	BFP No.1 Tracking Left Position Switch				
ZS-61120B	BFP No.2 Tracking Right Position Switch				
ZSS-61110A	BFP No.1 Safety Switch 1				
ZSS-61110B	BFP No.1 Safety Switch 2				
ZSS-61120A	BFP No.2 Safety Switch 1				
ZSS-61120B	BFP No.2 Safety Switch 2				
FCV-610-10	Service Water Control Valve No.1				
FCV-610-20	Service Water Control Valve No.2				
PU-614-10	Service Water Booster Pump 1				
PU-614-20	Service Water Booster Pump 2				
FSL–614-10	Service Water Booster Pump				

	1 Low Flow Switch				
FSL–614-20	Service Water Booster Pump 2 Low Flow Switch				
CP-870-01	Compressor 1				
CP-870-02	Compressor 2				
FCV-61030	GDD No.1 Air Control Valve				
FCV-61040	GDD No.1 Air Control Valve				

6.5.2.5. Equipment List - Sludge Loading

Tag	Equipment	Range	Type	Make & Model	Comment
LIT-616-10A	Sludge Hopper Level Indicating Transmitter 1				
LIT-616-10B	Sludge Hopper Level Indicating Transmitter 2				
ZS-61601A	Front Hopper No.1 Open Position Switch				
ZS-61601B	Front Hopper No.1 Close Position Switch				
ZS-61601C	Front Hopper No.2 Open Position Switch				
ZS-61601D	Front Hopper No.2 Close Position Switch				
ZS-61601E	Rear Hopper No.1 Open Position Switch				
ZS-61601F	Rear Hopper No.1 Close Position Switch				
ZS-61601G	Rear Hopper No.2 Open Position Switch				
ZS-61601H	Rear Hopper No.2 Close Position Switch				
AIT-61611	Hydrogen Sulphide (H2S) Analyser				
AIT-61612	Ammonia (NH4NH3) Analyser				
ZS-616-02B	Vehicle Position Sensor No.1				
ZS-616-02C	Vehicle Position Sensor No.2				
WIT-616-10	Hopper Load Cell				
ZS-61602A	Front Roller Door Shut				
ZS-61602D	Rear Roller Door Shut				
LSL-61603	Hydraulic Reservoir Low Level Switch				
PS-61601	Low Hydraulic Pressure Switch				

6.5.2.6. Process instrumentation

6.5.2.6.1. WAS Pump 1,2,3,4 Low Flow Switch (FSL-380-11, FSL-380-21, FSL-380-31, FSL-380-41)

This flow switch indicates when there is flow from the WAS Pump. This device operates as a Standard Process Digital Input, and shall be controlled as outlined in the functional standards.

A low flow alarm is generated when the pump has been running for 30 seconds and the flow switch has not detected flow.

6.5.2.6.2. Bioreactor 1, 2 WAS Flowmeter (FIT-380-10, FIT-380-30)

This flowmeter measures the flow from the WAS Pumpstation to the Sludge Wasting Building. This device operates as a Standard Flowmeter, and shall be controlled as outlined in the functional standards. The process value of this device is filtered, and is scaled from 0 to 60 L/s.

6.5.2.6.3. Scum and WAS from Bioreactor 1, 2 Flowmeter (FIT-380-20, FIT-380-40)

This flowmeter measures the flow from the WAS Pumpstation and Scum Removal system the Sludge Wasting Building. This device operates as a Standard Flowmeter, and shall be controlled as outlined in the functional standards. The process value of this device is filtered, and is scaled from 0 to 60 L/s.

6.5.2.6.4. Poly Dosing System 1, 2 Flowmeter (FIT-615-10, FIT-615-20)

This flowmeter measures the flow from the WAS poly pumps to the GDD. This device operates as a Standard Flowmeter, and shall be controlled as outlined in the functional standards. The process value of this device is filtered, and is scaled from 0 to 100 L/min.

6.5.2.6.5. Service Water Booster Pump 1, 2 Low Flow Switch (FSL–614-10, FSL–614-20)

This flow switch indicates when there is flow from the Service Water Booster Pump. This device operates as a Standard Process Digital Input, and shall be controlled as outlined in the functional standards.

A low flow alarm is generated when the pump has been running for 30 seconds and the flow switch has not detected flow.

6.5.2.6.6. Hopper Load Cell (WIT-616-10)

This load cell measures the weight of the sludge hopper. This device operates as a Standard Process Analog Input, and shall be controlled as outlined in the functional standards. The process value of this device is filtered, and is scaled from 0 to 105 t.

6.5.2.6.7. Sludge Hopper Level Sensors 1,2 (LIT-616-10A, LIT-616-10B)

This level sensor measures the level of the sludge hopper. This device operates as a Standard Process Analog Input, and shall be controlled as outlined in the functional standards. The process value of this device is filtered, and is scaled from 0 to 2 m.

6.5.2.6.8. Vehicle Position Sensors 1, 2 (ZS-616-02B,ZS-616-02C)

These sensors shall detect the presence of the sludge loading trailer. The sensors create two separate horizontal beams at a height appropriate for the truck to trigger the beam when in location.

6.5.2.7. Controlled Equipment

6.5.2.7.1. WAS Pump 1, 2, 3, 4 (PU-380-10, PU-380-20, PU-380-30, PU-380-40)

These pumps waste sludge from the Bioreactors to the Sludge Wasting system. These devices operate as a Standard Variable Speed Drive, and are controlled as outlined in the functional standards. The automatic operation of these devices is controlled by the *Sludge Wasting Sequence*.

6.5.2.7.2. Scum Harvester Packages – Bioreactor 1, 2 (SH-313-01, PU-313-01, FCV-312-01)

The Scum Harvester, Scum Pump, and Scum Harvester Wash Water Valve collect scum from Bioreactor and pump it to the pressure side of the WAS pumps for dewatering and disposal. In Timer or Local modes this equipment is controlled by the Scum Harvester package. In Remote mode this equipment is controlled externally through the SCADA system.

6.5.2.7.3. Poly Dosing Pump 1, 2, 3, 4 (PU-615-10, PU-615-11, PU-615-20, PU-615-21)

These pumps dose poly from the poly dosing tank to the GDD/BFP systems. These devices operate as a Standard Variable Speed Drive, and are controlled as outlined in the functional standards. The automatic operation of these devices is controlled by the *Poly Dosing Sequence*.

6.5.2.7.4. GDD/BFP 1 (CV-610-10, CV-611-10)

These devices provide dewatering facilities and are provided as a package. The automatic operation of these devices is controlled by the *Sludge Wasting Sequence*.

6.5.2.7.5. GDD/BFP 2 (CV-610-20, CV-611-20)

These devices provide dewatering facilities and are provided as a package. The automatic operation of these devices is controlled by the *Sludge Wasting Sequence*.

6.5.2.7.6. Service Water Control Valve 1, 2 (FCV-610-10, FCV-610-20)

This valve controls the service water flow to GDD/BFP systems. These devices are open/close control only and do not have any position or status feedback.

6.5.2.7.7. Service Water Booster Pump 1, 2 (PU-614-10, PU-614-20)

These pumps boost the service water pressure to the GDD/BFP systems. These devices operate as a Standard Drive, and are controlled as outlined in the functional standards. The automatic operation of these devices is controlled by the *Sludge Wasting Sequence*.

6.5.2.7.8. Sludge Hopper Doors 1, 2, 3, 4 (ZSO-616-30, ZSO-616-50)

The hopper doors allow sludge cake to fall from the hopper to the truck for loading. These devices operate as a Standard Control Valve, and are controlled as outlined in the functional standards. The automatic operation of these devices is controlled by the *Sludge Loading Sequence* and is treated as independent pairs.

6.5.2.7.9. Poly dosing System 1, 2: Service Water Flow Control Valve (FCV-616-10, FCV-616-20)

These valves control the service water flow for the poly dilution. This device operates as a Standard Control Valve, and is controlled as outlined in the functional standards. The automatic operation of this device is controlled by the *Poly Dosing Sequence*.

6.5.2.7.10. GDD Air Control Valves (FCV-610-30, FCV-610-40)

These valves control air flow to the GDD/BFP's. This device operates as a Standard Control Valve, and is controlled as outlined in the functional standards. The automatic operation of this device is controlled by the *Sludge Wasting Sequence.*

6.5.3. Automatic Control

6.5.3.1. Sludge Wasting Sequence

Note that <u>either</u> the WAS <u>or</u> the WAS and Scum flowmeters can be selected by the operator as the controlling flowmeter.

Each of the Sludge Wasting Systems (WAS Pump Station, GDD/BFP, Service Water, and Poly Dosing) shall be selected as either Duty, Standby, or Off. If a Sludge Wasting System is selected to Duty, then it shall operate under the following conditions:

a. Time is after T_{start} (and before the next T_{start})
b. Sludge wasting system is selected in Duty;
c. All equipment required to operate the sludge waste system is available (i.e. WAS pump station, poly dosing system, service water, and dedicated GDD/BFP);
d. the amount of sludge wasted that day is less that the total daily WAS volume
e. the sludge hopper level is less than full for that system

If a Sludge Wasting System is selected to Standby, then it shall operate under the following conditions:

a. The Duty sludge wasting system is unavailable;
b. Time is after T_{start} (and before the next T_{start})
c. Sludge wasting system is selected in Standby;
d. All equipment required to operate the sludge waste system is available (I.e. WAS pump station and dedicated GDD/BFP);
e. the amount of sludge wasted that day is less that the total daily WAS volume
f. the sludge hopper level is less than full for that system

If a Sludge Wasting System is selected to off, then it shall not be permitted to operate. The Sludge Wasting System shall not be permitted to start if the inflow to the plant is less than 80 l/s. If however wasting is occurring and the flow falls to less than 80 l/s, wasting may continue unaffected.

6.5.3.1.1. Sludge Wasting Days and Time of Wasting Start

The SCADA shall provide a table, listing each day of the week and allowing the operator to select which days sludge wasting is to occur. It is anticipated that wasting will occur on weekdays but will be possible to waste on any day. The controller shall determine the number of wasting days per week from this table.

The table shall also include the starting time for wasting, which shall be operator adjustable. Starting times may be different on each day. A 24 hour clock timing system shall be used.

6.5.3.1.2. Sludge Wasting Volume Determination (Daily WAS Volume)

Two modes shall be operator selectable for specifying the quantity of WAS to be pumped to the GDD/BFPs:

a. *Mode 1:* Sludge age control;
b. *Mode 2:* Direct specification of the total daily volume.

In *Mode 1: Sludge Age Control*, the operator enters the sludge age required and the control system determines the daily WAS volume.

In *Mode 2: Direct Specification of the Total Daily WAS Volume*, in this mode the operator will directly enter the required wasting rate for the day (Q_{WAS}) [ML/d].

6.5.3.1.3. WAS Pump Station Flowrate

The operator enters the WAS pump flow rate for each WAS pump station (q_{WASPS1} and q_{WASPS2} or $q_{WAS+ScumPS1}$ and $q_{WAS+ScumPS2}$) which is the GDD/BFP feed rate. These values shall be adjustable from both the SCADA and the remote local control panel located near the GDD/BFP. It shall be possible to enter different flows for each WAS pumpstation.

6.5.3.1.4. WAS Totaliser

A totaliser shall monitor the amount of sludge wasted and the amount remaining to be wasted each day.

6.5.3.1.5. Pump Speed Control

The control system shall adjust the operating speed of the duty WAS pumps to maintain the selected instantaneous flow rates for each WAS pump station (q_{WASPS1} and q_{WASPS2} or $q_{WAS+ScumPS1}$ and $q_{WAS+ScumPS2}$).

6.5.3.2. Sludge Wasting System Start-Up Sequence

When a Sludge Wasting System has been requested to start the following start up sequence shall be initiated.

1. Open GDD Air Control Valve
2. Start Belt Filter Press/GDD
3. Open Service Water Booster Valve
4. Start Service Water Booster Pump
5. Start Poly Dosing System
6. Start WAS Pump Station

For the Start-Up Sequence described above delay times between the operation of each piece of equipment shall be configurable from the OWS.

6.5.3.3. Sludge Wasting System Shutdown Sequence

When a Sludge Wasting System has been requested to stop the following shutdown sequence shall be initiated.

1. Stop WAS Pump Station
2. Stop Poly Dosing System
3. After delay of x minutes, Stop Belt Filter Press/GDD
4. Stop Service Water Booster Pump
5. Close Service Water Booster Valve
6. Close GDD Air Control Valve

For the Shutdown Sequence described above delay times between the operation of each piece of equipment shall be configurable from the OWS.

6.5.3.4. Scum Removal Sequence

The Scum Harvester System is an external package which can be selected to operate in either Remote/Local/Timer Modes. In Local and Timer modes, operation is provided by the package. In Remote mode operation is controlled externally through a single Scum Harvester Remote Start command.

When in Remote Mode the Scum Harvester System shall be controlled externally through the SCADA system. The system will be able to operate in either Remote Manual Mode or Remote Timer Mode.

In Remote Timer mode the system shall be alternatively turned on and off according to two SCADA setpoints, Scum Harvester Run Time and Scum Harvester Stop Time.

In Remote Manual mode the system shall be able to be manually started and stopped by the operator.

The Scum Harvester system will only be able to operate when its connected GDD/BFP is running.

6.5.3.5. Poly Dosing Sequence

The poly dosing sequence will operate when the associated Sludge Wasting Sequence is running. This sequence shall flow pace the poly dosing to the flow of WAS to the GDD/BFP. Each poly system shall operate independently of each other in all modes. The operator shall be able to specify mode and different values for both poly systems or individually for each poly system.

The desired *poly concentration* (C_{poly}) will be determined during commissioning, and may be assumed constant so far as the control system is concerned. However, this value shall be entered to the SCADA system, and shall be able to be modified.

Two modes shall be operator selectable from the local panel and the OWS for specifying the quantity of poly to be pumped to each GDD/BFP:

a. *Mode 1:* Specification of the mass ratio of poly to the mass of solids dewatered on the GDD/BFP.
b. *Mode 2:* Direct specification of the poly flowrate.

In Mode *1(Mass Ratio of Poly to Solids)*, the operator will enter the following information:

a. Mixed liquor suspended solids (MLSS) concentration. It is intended that this would occur weekly upon receipt of laboratory results.
b. The required mass ratio of poly (in kg) to sludge (in dry tonnes) fed to the GDD/BFP system.

The control system shall use this information to determine the poly dosing flow rate based on the flow to the GDD/BFP and the MLSS. This information shall be displayed on the SCADA and shall be adjustable from both the SCAD and the Sludge HMI.

The control system shall control the flow rate of poly from the poly make up system to achieve the required dose rate using the following algorithm:

$M_{WAS} = q_{WAS} * C_{MLSS} * (60/1,000,000)$

$M_{poly} = \alpha * M_{WAS}/1,000$

$q_{poly} = M_{poly} * 100/C_{poly}$

Where:

M_{WAS}	Instantaneous waste sludge mass flowrate [kg/min]
q_{WAS}	Instantaneous waste sludge volume flowrate [L/s]
C_{MLSS}	Mixed liquor suspended solids concentration [mg/L] (operator enterable)
60/1,000,000	Conversation factors, mg to kg and s to min.
M_{poly}	Instantaneous poly mass flowrate [kg/min]
α	Poly to sludge mass ratio [kg/t] (operator enterable)
1,000	Conversion factor kg to t
q_{poly}	Poly volume flowrate [L/min]
C_{poly}	Poly dosing tank concentration (i.e before dilution) [%] (operator enterable)
1,000,000	Conversion factor mg to kg

One percent poly concentration is equivalent to 10,000 mg/L.

In *Mode 2 (Direct Specification of the Poly Flowrate)*, the operator shall enter the poly flow rate for each poly dosing system. These values shall be adjustable from both the SCADA and the remote local control panel. It shall be possible to enter different flows for each pump independently.

After pumping and metering, but before contact with the sludge, the poly can be diluted with service water. The Operator will set the dilution rate manually by manipulating a manual control valve in reference to a rotameter. A solenoid valve (fail shut) controls the flow of dilution water to each dosing system.

The control system shall open the appropriate dilution water solenoid valve on start up of the poly dosing pump. This valve shall remain open at all times while the poly pump is running. The valve(s) shall shut when the poly dosing pump(s) stop.

6.5.3.6. Sludge Loading Sequence

A key lock switch will allow switching of Sludge Loading operation between Automatic/Normal/Off/Maintenance modes. The driver's key will only switch from "Off" to "Normal" or "Automatic" and back again. Authorised maintenance personnel will only be permitted to switch into "Maintenance" mode. At this stage "Automatic" will be labelled "Future – Automatic".

The key switch switched to "Normal" operation will:

a. Open FCV-61601 solenoid and;
b. Start the hydraulic pump, PU-616-01.

If low pressure is detected at PS-61601 then open solenoid FCV-61602 until the pressure is OK. This operation charges the accumulator. During this time, inhibit all other operations.

Note: FCV-61601 remains open whilst power is available, or the Emergency Close is activated. In the event of a power failure, FCV-61601 provides stored Hydraulic pressure from the accumulator to close the hopper doors.

If the Control Mode Selector switch is left in the Normal Position for 15 minutes, the Hydraulic Pump shall be switched off to prevent hydraulic oil overheating.

If the Control Mode Selector Switch is moved to the Off Position, the hoppers door shall close and the accumulator shall remain charged by closing FCV-61601.

6.5.3.6.1. Hopper Selection

A rotary select switch, in conjunction with truck position sensors, ZS-61602B and ZS-60602C mounted in the loading bay, will allow selection of "Front/Rear/Both" hopper doors. Refer to „Sensing of Truck Position' for further details.

6.5.3.6.2. Hopper Gate Activation: Automatic & inching

Pushbuttons will provide a hopper door "Inch Open" and "Inch Close" function. Inching will only occur when the pushbutton is kept depressed. Hopper doors may be closed automatically through pressing "Close" Once. Any gates open will automatically close. To open and close the Hopper doors the following solenoids are activated, dependant on the hopper selection switch position and truck being in position.

		Solenoid Activated / Deactivated

		'1' Denotes Active '0' Denotes Deactivated			
Hopper Selector Position	**Function**	**FCV-61603 Front Hopper Open Solenoid**	**FCV-61604 Front Hopper Close Solenoid**	**FCV-61605 Rear Hopper Open Solenoid**	**FCV-61606 Rear Hopper Close Solenoid**
Front Only	Open	1	0	0	0
	Close	0	1	0	0
Rear Only	Open	0	0	1	0
	Close	0	0	0	1
Both	Open	1	0	1	0
	Close	0	1	0	1

The close sequences will occur until detection of gates closed by respective gate position sensors, ZS-61601B/D/F/H.

6.5.3.6.3. Emergency Close

A mushroom head "Emergency close" will slam the hopper doors closed. The emergency close will be hardwired to solenoids and will give remote indication of emergency condition. To facilitate a rapid close, solenoid FCV-61601 is deactivated to allow the accumulator pressure to close the hopper doors.

The presence of the Truck (ZS-61602B and ZS-60602C) and roller door status (ZS-61602A and ZS-61602D) is ignored for this operation.

6.5.3.6.4. Gas Detection

Ammonia (AIT-61612) and Hydrogen Sulfide (AIT-61611) levels are monitored in the sludge loading bay to determine if it is safe to enter. The gas analysers are mounted in the Local Control Panel. Individual analog signals are provided back to the PLC. The PLC will provide a common safe/unsafe levels indication to red/green lights at both ends of the loading bay and at the local control panel.

a. The H2S gas concentration analogue input shall be scaled between the range of 0.0 ppm at 4 mA and 50.0 ppm at 20 mA.
b. A "Hydrogen Sulphide Level High" alarm shall be raised when the H2S gas concentration rises above the high level alarm setpoint (10ppm)
c. The Ammonia gas concentration analogue input shall be scaled between the range of 0.0 ppm at 4 mA and 100.0 ppm at 20 mA.
d. An "Ammonia Level High" alarm are raised shall be raised when the Ammonia gas concentration rises the high level alarm setpoint (25ppm)
e. A "Sludge Unloading Bay Gas Concentration Unsafe" alarm shall be raised if either of the H2S or Ammonia high alarms is raised. When the "Sludge Loading Bay Gas Concentration Unsafe" alarm is active the "Gas Level Safe" PLC output shall be de-energised (State "0" Fail Safe).
f. When the H2S and/or Ammonia gas concentration has fallen below the high alarm setpoint for 0-5min time period (an adjustable value – initially 3min), the "Sludge Unloading Bay Gas Concentration Unsafe" alarm shall become inactive and the "Gas Level Safe" PLC output shall be energised (State "1").

6.5.3.6.5. Local Indication

1	Power Available lamp	10	Roller doors closed lamp
2	Hydraulic pump run lamp	11	Digital display showing the weight in the sludge hopper
3	Accumulator Pressure Low lamp	12	Digital display showing the concentration of ammonia gas

4	Hydraulic Pump Fault lamp	13	Digital display showing the concentration of H2S gas
5	Front Hoppers fully open lamp	14	Gas level safe lamp
6	Front Hoppers Fully Closed lamp	15	Gas level unsafe lamp
7	Rear Hopper Fully Open lamp	16	Low hydraulic fluid level lamp
8	Rear Hopper Fully Closed lamp	17	Low Accumulator pressure lamp
9	Truck in position - Front Hopper Ready, Rear Hopper Ready		

6.5.3.6.6. Maintenance Mode

In maintenance mode the operator is responsible to manually drive the gates to the desired position before selecting maintenance mode.

The maintenance position will energise solenoid FCV-61607 to allow the accumulator pressure to drain. All other operations are inhibited.

6.5.3.6.7. Front Hopper / Rear Hopper Ready

These lamps shall indicate that all safety interlocks are in place and the truck is in position for the relevant hopper.

6.5.3.6.8. Safety interlocks

There will be a number of safety interlocks that will need to be in place before the system will operate. Safety interlocks will include:

a. Roller door must be closed before hopper doors will open.
b. Truck must be in position before hopper doors will open.
c. Emergency stop not activated
d. Low level alarm in hydraulic reservoir not activated.

6.5.3.6.9. Sensing of truck in position

This will be achieved by the sensing of two separate horizontal beams, installed at an appropriate height for the truck to trigger the beam. In order for the truck to be deemed to be in position, both beams must trigger simultaneously before any hoppers are enabled.

<u>**Truck Position Lights**</u>

<u>Two lights shall be provided to indicate to driver that truck is in position for Front Hopper or Rear Hopper Filing.</u>

6.5.3.7. Poly Make Up Sequence

The Poly Makeup Sequence functionality is provided in a PLC supplied by others.

6.5.4. Monitoring

The following information is displayed on the OWS for the WAS pumpstation:

a. Each alarm listed.
b. For each WAS pump:
    - Running or stopped
    - REMOTE or LOCAL mode selected at the MCC
    - Failed
    - Description of failure
c. For each WAS Pump Station
    - Flowmeter Selection (WAS or WAS and scum)
    - WAS flowrate for each of the two WAS flowmeters (L/s) or instrument fault.
    - WAS flowrate Setpoint (L/s)
    - WAS and scum flowrate for each of the two WAS and scum flowmeters (L/s) or instrument fault.
    - WAS and scum flowrate Setpoint (L/s)
    - Range of acceptable flowrates for each WAS pump station
d. Volume wasted for each Bioreactor as a totalised valve (kL) – reset daily
e. Volume remaining to be wasted per day
f. Time of completion
g. Mode Selection: 1(Sludge Age Control), 2(Daily Volume)
h. Sludge Age
i. Q_{WAS} Daily WAS volume required
j. Days of week for sludge wasting (toggle table)
k. Starting time for wasting (toggle table)
l. Duty/Standby/Off mode

The following information is displayed on the OWS for the Poly Dosing / Poly Make Up System:

a. Each of the alarms listed.
b. The range of acceptable flowrates for each poly dosing pump
c. MLSS
d. Mode 1 (mass ratio) or Mode 2 (flowrate)
e. GDD/BFP 1: Ratio of Poly (kg) to sludge (t) (kg/t)
f. GDD/BFP 1: Q_{POLY} (Poly flowrate) (l/s)
g. GDD/BFP 1: C_{POLY} (Poly concentration) (%)
h. GDD/BFP 2: Ratio of Poly (kg) to sludge (t) (kg/t)
i. GDD/BFP 2: Q_{POLY} (Poly flowrate) (l/s)
j. GDD/BFP 2: C_{POLY} (Poly concentration) (%)
k. Level Poly Mixing Tank (%)
l. Level Poly Dosing Tank (%)

The following information is displayed on the OWS for the Sludge Loading:

a. Each of the alarms listed.
b. GDD/BFP 1 Hopper Level
c. GDD/BFP 2 Hopper Level
d. Vehicle position sensors

The following information is displayed on the OWS for each Hopper Level detector:

a. The percentage fullness at each sensor, as a percentage of the distance between the hopper floor and the BFP/GDD cutout level %.
b. A combined (i.e. the average from both sensors) percentage fullness %;
c. Sludge loading bay 1 Level (m)
d. Sludge loading bay 2 Level (m)
e. Load Cell weight (t)
f. The status of the sludge hopper, i.e. idle, filling, emptying or filling and emptying. (Determined by status of the clam shell and GDD/BFPs)

6.5.5. *Calculations*

6.5.5.1. Daily WAS Quantity

The daily quantity required shall be calculated as follows:

Q_{WAS} = (V_B/Sludge Age)*(7/D)

Where:

Q_{WAS}	Daily WAS volume required [m^3/d]
V_B	Total bioreactor volume (39,200/2)*N_{bio} [m^3]
Sludge Age	Sludge Age {to be set by the operator} [d]
D	No of days per week on which wasting will occur {as per toggle table} [#]
7	No. of days per week [#]
N_{bio}	No of Bioreactors On-Line

6.5.5.2. Time To Complete

If the system is not wasting, and wasting is complete then Time To Complete shall be greyed out.

If the system is not wasting, and wasting is not complete then Time To Completion shall be the anticipated time to complete based on the entered WAS setpoints.

If the system is wasting, the current instantaneous flow rate shall be used to calculate the expected time to complete of sludge wasting using the following algorithm:

t_{ops} = ($Q_{WAS, R}$ * F)/(q_{WASPS1} + q_{WASPS2})

Where:

t_{ops}	Expected wasting time [hr]
q_{WASPS1}	Instantaneous flowrate for each operating WAS pumpstation [L/s]
F	Unit conversion factor (1000/3600) {Conversion of m^3 to L & s to hr}
$Q_{WAS,R}$	Remaining daily WAS volume required [m^3/d] (Q_{WAS} if $t_{current} \ll t_{start}$)

Note that if the WAS and Scum flowmeters are selected these flowmeters will replace the WAS flowmeters in this calculation.

6.5.6. *Setpoints*

6.5.6.1. WAS Pump Station

Setpoint Description	Default Value	Security Level
q_{WASPS1}WAS flowrate Pump Station 1	47.6 L/s	Operator
q_{WASPS2}WAS flowrate Pump Station 2	47.6 L/s	Operator
$q_{WAS+ScumPS1}$WAS and scum flowrate Pump Station 1	50 L/s	Operator
$q_{WAS+ScumPS2}$WAS and scum flowrate Pump Station 2	50 L/s	Operator
Flowmeter Selection (WAS or WAS and scum)	WAS	Operator
Mode Selection: 1(Θ Control), 2(Daily Volume)	Mode 1:Sludge Age control	Operator
Θ Sludge Age	20 days	Operator

Q_{WAS} Daily WAS volume required	2,744 m^3/d	Operator
Days of week for sludge wasting (toggle table)	Mon-Fri	Operator
T_{start} Starting time for wasting (toggle table)		Operator
Duty/Standby/Off Selection		Operator
Plant Inflow Rate Was Disable	80l/s	Restricted access Level 2

6.5.6.2. Poly Dosing

Setpoint Description	Default Value	Security Level
MLSS	3000	Operator
Mode 1 (mass ratio) or Mode 2 (flowrate)	Mode 1	Operator
System 1: Ratio of Poly (kg) to sludge (t)	6:1	Operator
System 1: Q_{POLY} (Poly flowrate)		Operator
System 1: C_{POLY} (Poly concentration)	0.25	Operator
System 2: Ratio of Poly (kg) to sludge (t)	6:1	Operator
System 2: Q_{POLY} (Poly flowrate)		Operator
System 2: C_{POLY} (Poly concentration)	0.25	Operator

6.5.6.3. Sludge Loading

Setpoint Description	Default Value	Security Level
Hopper full (high level)	80 t	Operator
Hopper empty (low level)	15t	Operator
Load cell maximum weight	105 t	Operator
Hydrogen Sulphide Level High Setpoint	10	Operator
Ammonia Level High	25	Operator

6.5.6.4. Scum Removal

Setpoint Description	Default Value	Security Level
Scum Harvester System No.1 Run Time	0 Minutes	Operator
Scum Harvester System No.1 Stop Time	60 Minutes	Operator
Scum Harvester System No.2 Run Time	0 Minutes	Operator
Scum Harvester System No.2 Stop Time	60 Minutes	Operator

6.5.7. *Process Alarms and Interlocks*

6.5.7.1. WAS Pump Low Flow Alarm

Tag	Equipment	Action
FAL-380-11	WAS Pump 1 Flow Alarm Low	Stop Duty Pump, Start Standby Pump
FAL-380-21	WAS Pump 2 Flow Alarm Low	Stop Duty Pump, Start Standby Pump
FAL-380-31	WAS Pump 3 Flow Alarm Low	Stop Duty Pump, Start Standby Pump
FAL-380-41	WAS Pump 4 Flow Alarm Low	Stop Duty Pump, Start Standby Pump

This alarm shall be generated if the pump has been running for 30 seconds and the flow switch has not detected flow. This alarm type is Priority 6. When the alarm is activated, the duty pump shall stop immediately. If both the duty and standby pumps are in AUTO mode, the standby pump shall become the duty pump and shall start.

6.5.7.2. WAS Pump Failed

Tag	Equipment	Action
PU-380-10	WAS Pump 1	Stop Duty Pump, Start Standby Pump
PU-380-20	WAS Pump 2	Stop Duty Pump, Start Standby Pump
PU-380-30	WAS Pump 3	Stop Duty Pump, Start Standby Pump
PU-380-30	WAS Pump 4	Stop Duty Pump, Start Standby Pump

This alarm shall be generated if the pump shuts down or fails to start. This alarm type is Priority 6. The controller shall automatically start the standby pump.

6.5.7.3. WAS Flow Control Failed

Tag	Equipment	Action
FIT-380-10	Bioreactor 1 WAS flowmeter	Shut down Bioreactor 1 Wasting Sequence
FIT-380-30	Bioreactor 2 WAS flowmeter	Shut down Bioreactor 2 Wasting Sequence
FIT-380-20	Bioreactor 1 WAS and scum flowmeter	Shut down Bioreactor 1 Wasting Sequence
FIT-380-40	Bioreactor 2 WAS and scum flowmeter	Shut down Bioreactor 2 Wasting Sequence

This alarm shall be generated if:

a. the bioreactor's wasting system is operating in AUTO mode,
b. AND the WAS flowrate measured by the WAS flowmeter (or the WAS and scum flowmeter – which ever is controlling) has been more than 20 % different from the setpoint value continuously for 15 minutes.

This alarm type is priority 6. The bioreactor's wasting system shall be shutdown.

6.5.7.4. WAS Flowmeter Failed

Tag	Equipment	Action
FIT-380-10	Bioreactor 1 WAS flowmeter	Shut down Bioreactor 1 Wasting Sequence
FIT-380-30	Bioreactor 2 WAS flowmeter	Shut down Bioreactor 2 Wasting Sequence
FIT-380-20	Bioreactor 1 WAS and scum flowmeter	Shut down Bioreactor 1 Wasting Sequence
FIT-380-40	Bioreactor 2 WAS and scum	Shut down Bioreactor 2 Wasting Sequence

	flowmeter	

This alarm shall be generated if a fault is reported from the WAS flowmeter indicating a failure. This alarm is Priority 6. The bioreactor's wasting system shall be shut down

6.5.7.5. Volume Wasted Incorrect

Tag	Equipment	Action
	Sludge Wasting Sequence 1	
	Sludge Wasting Sequence 2	

This alarm shall be generated if the total volume wasted before next starting time is more than 15% different from the Q_{WAS} setpoint. This alarm is Priority 6.

6.5.7.6. Time To Complete Incorrect

Tag	Equipment	Action
FIT-380-10	Sludge Wasting Sequence 1	
FIT-30-30	Sludge Wasting Sequence 2	

This alarm shall be generated if the *Time To Complete* is beyond the next start time. This alarm is Priority 10.

6.5.7.7. H2S and NH4 High Alarms

Tag	Equipment	Action
AIT-61611	Hydrogen Sulphide (H2S) Analyser	Turn On Sludge Loading Bay Gas Concentration Unsafe lamp
AIT-61612	Ammonia (NH4NH3) Analyser	Turn On Sludge Loading Bay Gas Concentration Unsafe lamp

A High Alarm shall be generated if the measure Hydrogen Sulphide or Ammonia level is greater than a High Alarm Setpoint. This alarm type is Priority 10.

6.5.7.8. Hydraulic Reservoir Low Level Alarm

Tag	Equipment	Action
LSL-61603	Hydraulic Reservoir Low Level Switch	Disable all operations

A Hydraulic Reservoir Low Level Alarm shall be generated if the low level switch LSL-61603 is activated. This alarm type is Priority 10.

6.5.7.9. Hydraulic Pressure Low Alarm

Tag	Equipment	Action
PS-61601	Hydraulic Pressure Low Switch	Disable all operations

A Hydraulic Pressure Low Alarm shall be generated if the low level switch PS-61601 is activated. This alarm type is Priority 10.

6.5.7.10. GDD/BFP Belt Tracking Alarm

Tag	Equipment	Action

ZS-61010A	GDD No.1 Tracking Left Position Switch	Stop GDD No.1
ZS-61010B	GDD No.1 Tracking Right Position Switch	Stop GDD No.1
ZS-61020A	GDD No.2 Tracking Left Position Switch	Stop GDD No.2
ZS-61020B	GDD No.2 Tracking Right Position Switch	Stop GDD No.2
ZS-61110A	BFP No.1 Tracking Left Position Switch	Stop BFP No.1
ZS-61110B	BFP No.1 Tracking Right Position Switch	Stop BFP No.1
ZS-61120A	BFP No.2 Tracking Left Position Switch	Stop BFP No.2
ZS-61120B	BFP No.2 Tracking Right Position Switch	Stop BFP No.2

A Belt Tracking Alarm shall be generated if a belt tracking position switch is activated and remains activated for 5 seconds. This will cause the relevant BFP/GDD to stop. This alarm type is Priority 6. Once activated, a belt tracking alarm will prevent a BFP/GDD from starting.

6.5.7.11. GDD/BFP Low Air Pressure Alarm

Tag	Equipment	Action
PSL-61110	BFP No.1 Low Pressure Switch	Stop BFP No.1
PSL-61120	BFP No.2 Low Pressure Switch	Stop BFP No.1
PSL-61010	GDD No.1 Low Pressure Switch	Stop GDD No.2

A Low Air Pressure Alarm shall be generated if a Low Pressure Switch is activated and remains active for 30 seconds. This will cause the relevant BFP/GDD to stop. This alarm type is Priority 6. Once activated, a Low Air Pressure Alarm will prevent a BFP/GDD from starting.

6.5.7.12. GDD High Level Alarm

Tag	Equipment	Action
LSH-61010	GDD No.1 High Level Switch	Stop WAS Pump Station No.1
LSH-61020	GDD No.2 High Level Switch	Stop WAS Pump Station No.2

A GDD High Level Alarm shall be generated if a High Level Switch is activated. This will cause the relevant WAS Pump Station to stop. This alarm type is Priority 6.

6.5.7.13. GDD/BFP and service water booster pumps Interlock

Tag	Equipment	Action
CV-610-10/ CV-611-10	GDD/BFP 1 not running	Stop WAS Pump 1 and 2
CV-610-20/ CV-611-20	GDD/BFP 2 not running	Stop WAS Pump 3 and 4
PU-614-10	Service Water Booster Pump 1	Stop WAS Pump 1 and 2

	not running	
PU-614-20	Service Water Booster Pump 2 not running	Stop WAS Pump 3 and 4

The WAS pumps shall be interlocked such that if their corresponding GDD/BFP or service water booster pump is not operating, the WAS pumps shall not be able to be operated in auto mode.

6.5.7.14. Equipment Fault

Tag	Equipment	Action
PU-615-10	Poly Dosing Pump 1	Stop Duty Pump, Start Standby Pump
PU-615-11	Poly Dosing Pump 2	Stop Duty Pump, Start Standby Pump
PU-615-20	Poly Dosing Pump 3	Stop Duty Pump, Start Standby Pump
PU-615-21	Poly Dosing Pump 4	Stop Duty Pump, Start Standby Pump
FIT-615-10	Poly Dosing System 1 Flowmeter	Stop Sludge Wasting Sequence 1
FIT-615-20	Poly Dosing System 2 Flowmeter	Stop Sludge Wasting Sequence 2

If a Duty pump fails the Standby Pump shall start. If both the Duty and Standby Pumps Fail then the associated Sludge Wasting System shall shut down. This alarm is Priority 10.

6.5.7.15. Poly Dilution Service Water Solenoid Valve Fault

Tag	Equipment	Action
FCV-616-10	Service Water 1 Flow Control Valve	
FCV-616-20	Service Water 2 Flow Control Valve	

This alarm shall be generated if the dilution water solenoid valve either fails to open or fails to close. No other action need be taken in either case. This valve is air actuated and shall fail closed. This alarm type is Priority 10.

6.5.7.16. Poly Dosing Flow Control Failure

Tag	Equipment	Action
FIT-615-10	Poly Dosing System 1 Flowmeter	
FIT-615-20	Poly Dosing System 2 Flowmeter	

This alarm shall be generated if the poly dosing system is operating in AUTO mode and the poly dosing flowrate measured by the poly dosing flowmeter has been more than 20 % different from the setpoint value continuously for 15 minutes. This alarm type is Priority 10.

6.5.7.17. Poly Dosing Low Flow Alarm

Tag	Equipment	Action
FSL-615-10	Poly Dosing Pump 1 Flow Alarm Low	Stop Pump
FSL-615-11	Poly Dosing Pump 2 Flow Alarm Low	Stop Pump
FSL-615-20	Poly Dosing Pump 3 Flow Alarm Low	Stop Pump

FSL-615-21	Poly Dosing Pump 4 Flow Alarm Low	Stop Pump

This alarm shall be generated if the pump has been running for 30 seconds and the flow switch has not detected flow. This alarm type is Priority 10. When the alarm is activated, the pump shall stop immediately. If both the duty and standby pumps are in AUTO mode, the standby pump shall become the duty pump and shall start.

This alarm is generated if the low flow switch associated with the pump is activated. Priority 10

When the alarm is activated, the operating pump will stop immediately.

6.5.7.18. GDD/BFP Interlock

Tag	Equipment	Action
CV-610-10/ CV-611-10	GDD/BFP 1 not running	Stop Sludge Wasting System No.1
CV-610-20/ CV-611-20	GDD/BFP 2 not running	Stop Sludge Wasting System No.2
PU-614-10	Service Water Booster Pump 1 not running	Stop Sludge Wasting System No.1
PU-614-20	Service Water Booster Pump 2 not running	Stop Sludge Wasting System No.2
PU-380-10/ PU-380-20	WAS Pump 1 or 2	Stop Poly Pump 1 and 2
PU-380-30/ PU-380-40	WAS Pump 3 or 4	Stop Poly Pump 3 and 4

The poly dosing system cannot operate unless the WAS pump/s, GDD/BFP and service water booster pumps for that system are also operating.

6.5.7.19. Abnormal Shutdown

Tag	Equipment	Action
CV-610-10/ CV-611-10	GDD/BFP 1	
CV-610-20/ CV-611-20	GDD/BFP 2	

This alarm shall be generated if the GDD/BFP unit/s are shutdown by an abnormal failure or interlock.

6.5.7.20. WAS Pumps/Service Water Booster Pumps Failure

Tag	Equipment	Action
PU-614-10	Service Water Booster Pump 1 not running	Stop GDD/BFP 1
PU-614-20	Service Water Booster Pump 2 not running	Stop GDD/BFP 2
PU-380-10/ PU-380-20	WAS Pump 1 and 2	Stop GDD/BFP 1
PU-380-30/ PU-380-40	WAS Pump 3 and 4	Stop GDD/BFP 2

The GDD/BFPs shall shutdown if a failure is detected with any of the operating WAS Pumps or Service Water Booster Pumps for that GDD/BFP system.

6.5.7.21. Load Cell

Tag	Equipment	Action
WIT-616-10	Hopper Load Cell	Stop GDD/BFP 1 and 2

Both GDD/BFP shall stop when the full weight is measured in the hopper.

6.5.7.22. Sludge Hopper Level Sensor 1

Tag	Equipment	Action
LIT-616-10A	Level Sensor 1	Stop GDD/BFP 1

GDD/BFP 1 shall stop when the full height is measured in the hopper.

6.5.7.23. Sludge Hopper Level Sensor 2

Tag	Equipment	Action
LIT-616-10B	Level Sensor 2	Stop GDD/BFP 1

GDD/BFP 2 shall stop when the full height is measured in the hopper.

6.5.7.24. Hopper Filling Interlock: GDD/BFP 1

Tag	Equipment	Action
LIT-616-10A	Hopper Level Sensor	Stop GDD/BFP 1

On detection a high level signal from level sensor LIT-616-10A, GDD/BFP1 and all associated equipment, including, poly dosing, scum pumping and WAS pumping shall stop. The status of the hopper shall be displayed on the SCADA.

6.5.7.25. Hopper Filling Interlock: GDD/BFP2

Tag	Equipment	Action
LIT-616-10B	Hopper Level Sensor	Stop GDD/BFP 2

On detection a high level signal from level sensor LIT-616-10B, GDD/BFP2 and all associated equipment, including, poly dosing, scum pumping and WAS pumping shall stop. The status of the hopper shall be displayed on the SCADA.

6.5.7.26. Hopper Filling Interlock: GDD/BFP 1

Tag	Equipment	Action
LIT-616-10A	Hopper Level Sensor	Stop GDD/BFP 1

If the instruments fail, GDD/BFP1 and all associated equipment, including, poly dosing, scum pumping and WAS pumping shall stop. The status of the hopper shall be displayed on the SCADA.

6.5.7.27. Hopper Filling Interlock: GDD/BFP2

Tag	Equipment	Action
LIT-616-10B	Hopper Level Sensor	Stop GDD/BFP 2

If the instruments fail, GDD/BFP2 and all associated equipment, including, poly dosing, scum pumping and WAS pumping shall stop. The status of the hopper shall be displayed on the SCADA.

6.5.7.28. Trailer Present Interlock

Tag	Equipment	Action

ZS-616-02B	Vehicle Position Sensor 1	Stop Sludge Loading
ZS-616-02C	Vehicle Position Sensor 2	Stop Sludge Loading

Sludge loading will be prevented, in all modes, if a truck is not detected as being in position.

6.5.8. Trend Pages

The following trends shall be displayed on the Sludge Wasting Instantaneous trend page:

a. WAS flowrate Pump Station 1 L/s
b. WAS flowrate Pump Station 2 L/s
c. WAS and scum flowrate Pump Station 1 L/s
d. WAS and scum flowrate Pump Station 2 L/s

The following trends shall be displayed on the Sludge Wasting Long-term trend page:

a. Sludge Age (Setpoint)
b. Sludge Age (Calculated)
c. Volume Wasted/day (total for the plant) ML/d
d. Volume wasted/day (bioreactor 1) ML/d
e. Volume wasted/day (bioreactor 2) ML/d

The following trends shall be displayed on the Poly Make up and Dosing trend page:

a. System 1: Ratio of Poly (kg) to sludge (t) (kg/t)
b. System 1: Q_{POLY} (Poly flowrate) (l/s)
c. System 1: C_{POLY} (Poly concentration) (%)
d. System 2: Ratio of Poly (kg) to sludge (t) (kg/t)
e. System 2: Q_{POLY} (Poly flowrate) (l/s)
f. System 2: C_{POLY} (Poly concentration) (%)

The following trends shall be displayed on the Sludge Loading trend page:

a. Sludge Hopper Level 1
b. Sludge Hopper Level 2
c. Load Cell weight
d. Clam Shells Open/Close/Intermediate

6.5.9. Statistical Data

The following statistical data shall be available for daily reports:

a. Totalised Volume wasted/day (total for the plant) (ML/d)
b. Totalised Volume wasted/day (bioreactor 1) (ML/d)
c. Totalised Volume wasted/day (bioreactor 2) (ML/d)
d. Average Sludge Age for the day (d)
e. Totalised System 1: Q_{POLY} (Poly flowrate) (l/d)
f. Totalised System 2: Q_{POLY} (Poly flowrate) (l/d)
g. Totalised Poly usage kg/d
h. Total number of clamshell opens/day
i. No of Poly Batch Make Ups per day (to be confirmed when data from Poly Batching PLC is determined)

6.6. Final Settling Tanks

6.6.1. Process Overview

Mixed liquor is split evenly from the two Bioreactors to the three final settling tanks (FSTs). Two thirds of the discharge flow from Bioreactor 1 is directed to FST1, with the remaining third directed to FST3. Similarly, two thirds of the flow from Bioreactor 2 is directed to FST2 with the remaining flow directed to FST3.

The FSTs create quiescent conditions suitable for the settlement and separation of the activated sludge from the final effluent. The settled sludge is pumped to the bioreactors as return activated sludge (RAS); while the clarified supernatant overflows the FST launders and flows under gravity to the UV disinfection unit.

Sludge settling to the floor of the unit is collected and scraped to the sludge hopper in the centre of the FST using a log spiral scraper supported off a full diameter bridge. Variable speed drives are available to adjust the scraper (bridge) rotational speed. Sludge is pumped from the hopper and returned to the bioreactors via flowsplitter 2. Each FST is fitted with a dedicated RAS pump station, consisting of duty/standby pumps. The RAS flow from each FST is monitored using a flowmeter and controlled to a setpoint flowrate or paced at a set ratio to plant inflow.

Scum removal is provided for each FST. A log spiral skimmer attached to the bridge directs scum to a single peripheral beach from where it is pumped to the bioreactors for eventual removal using the scum harvester. Scum from FST's 1 & 3 is directed to Bioreactor 1, while that from FST 2 is directed to Bioreactor 2. In the unexpected event of Bioreactor 1 being taken offline, scum will not be removed from FST 3. Submerged scum beaches are used to ensure a positive suction for the efficient removal of scum.

A high pressure service water spray bar is attached to the bridges to automatically clean the effluent launders. One spray bar will be installed on each bridge. There is no operator access to the launders for FST's 1 and 2. High pressure service water is also provided at various points for use by the Operations staff. Spray bars are also provided over the Energy Dissipating Inlet to prevent the build up of scum.

Provision has been made to take FSTs offline using stopboards located in the ditch discharge channels. The FST's can be taken offline without taking a bioreactor offline, however if a bioreactor is taken offline, the enclosed FST will also be taken offline.

6.6.2. Equipment

6.6.2.1. Equipment List - Final Settling Tank 1

Tag	Equipment	Range	Type	Make & Model	Comment
PU-420-10	RAS PS1 Pump 1	67-220 L/s			
PU-420-20	RAS PS1 Pump 2	67-220 L/s			
FIT-42001	FST1 RAS Flowmeter	0-335 L/s			
FSL-42002	FST1 Flow Switch (RAS Pump1)				
FSL-42003	FST1 Flow Switch (RAS Pump2)				
LSH-42004	RAS PS1 – High Level				

PU-40101	FST1 Scum Pump				
SP-40101	FST1 Scraper Bridge	1-5 m/min			
ZS-40101	FST1 Bridge Position Indicator				
SB-31004	Stopboard				
FCV-401-21	FST1 Service Water Control Valve				
LSH-42005	Flowmeter Sump High Level Switch				

6.6.2.2. Equipment List - Final Settling Tank 2

Tag	Equipment	Range	Type	Make & Model	Comment
PU-421-10	RAS PS2 Pump 1	67-220 L/s			
PU-421-20	RAS PS2 Pump 2	67-220 L/s			
FIT-42101	FST2 RAS Flowmeter	0-335 L/s			
FSL-42102	FST1 Flow Switch (RAS Pump1)				
FSL-42103	FST1 Flow Switch (RAS Pump2)				
LSH-42104	RAS PS2 - High Level				
PU-40201	FST2 Scum Pump				
SP-40201	FST2 Scraper Bridge	1-5 m/min			
ZS-40201	FST2 Bridge Position Indicator				
SB-32004	Stopboard				
FCV-402-21	FST 2 Service Water Control Valve				

6.6.2.3. Equipment List - Final Settling Tank 3

Tag	Equipment	Range	Type	Make & Model	Comment
PU-422-10	RAS PS3 Pump 1	67-220 L/s			
PU-422-20	RAS PS3 Pump 2	67-220 L/s			
FIT-42201	FST3 RAS Flowmeter	0-335 L/s			
FAL-42202	FST3 Flow Switch (RAS Pump1)				
FAL-42203	FST3 Flow Switch (RAS Pump2)				
LSH-42204	RAS PS3 - High Level				
PU-40301	FST3 Scum Pump				
SP-40301	FST3 Scraper Bridge	1-5 m/min			
ZS-40301	FST3 Bridge Position Indicator				
SB-31005	Stopboard				
SB-31004	Stopboard				
SB-32005	Stopboard				
SB-32004	Stopboard				
FCV-403-21	FST 3 Service Water Control Valve				

6.6.2.4. Process instrumentation

6.6.2.4.1. FST1 Bridge Position Indicator (ZS-40101)

This position switch indicates when the FST Bridge is at a defined position – this signal is active twice for one rotation of the bridge. This device operates as a Standard Process Digital Input, and shall be controlled as outlined in the functional standards.

6.6.2.4.2. FST1 RAS Flowmeter (FIT-42001)

This flowmeter measures the flow from the RAS Pumpstation 1 to Flowsplitter 2. This device operates as a Standard Flowmeter, and shall be controlled as outlined in the functional standards. The process value of this device is filtered, and is scaled from 0 to 335 L/s.

6.6.2.4.3. FST1 Flow Switch (RAS Pump1) (FSL-42002)

This flow switch indicates when there is flow from FST 1 RAS Pump 1. This device operates as a Standard Process Digital Input, and shall be controlled as outlined in the functional standards.

A low flow alarm (FAL-42002) is generated when the pump has been running for 30 seconds and the flow switch has not detected flow.

6.6.2.4.4. FST1 Flow Switch (RAS Pump2) (FSL-42003)

This flow switch indicates when there is flow from FST 1 RAS Pump 2. This device operates as a Standard Process Digital Input, and shall be controlled as outlined in the functional standards.

A low flow alarm (FAL-42003) is generated when the pump has been running for 30 seconds and the flow switch has not detected flow.

6.6.2.4.5. RAS PS1 – High Level (LSH-42004)

This level switch indicates when there is high level in the RAS Pumpstation 1. This device operates as a Standard Process Digital Alarm, and shall be controlled as outlined in the functional standards.

6.6.2.4.6. Flowmeter Sump High Level Switch (LSH-42005)

This level switch indicates when there is level in the Flowmeter Sump. This device operates as a Standard Process Digital Alarm, and shall be controlled as outlined in the functional standards.

6.6.2.4.7. FST2 Bridge Position Indicator (ZS-40201)

This position switch indicates when the FST Bridge is at a defined position – this signal is active twice for one rotation of the bridge. This device operates as a Standard Process Digital Input, and shall be controlled as outlined in the functional standards.

6.6.2.4.8. FST2 RAS Flowmeter (FIT-42101)

This flowmeter measures the flow from the RAS Pumpstation 2 to Flowsplitter 2. This device operates as a Standard Flowmeter, and shall be controlled as outlined in the functional standards. The process value of this device is filtered, and is scaled from 0 to 335 L/s.

6.6.2.4.9. FST 2 Flow Switch (RAS Pump1) (FSL-42102)

This flow switch indicates when there is flow from FST 2 RAS Pump 1. This device operates as a Standard Process Digital Input, and shall be controlled as outlined in the functional standards.

A low flow alarm (FAL-42102) is generated when the pump has been running for 30 seconds and the flow switch has not detected flow.

6.6.2.4.10. FST2 Flow Switch (RAS Pump 2) (FSL-42103)

This flow switch indicates when there is flow from FST 2 RAS Pump 2. This device operates as a Standard Process Digital Input, and shall be controlled as outlined in the functional standards.

A low flow alarm (FAL-42103) is generated when the pump has been running for 30 seconds and the flow switch has not detected flow.

6.6.2.4.11. RAS PS2 - High Level (LSH-42104)

This level switch indicates when there is high level in the RAS Pumpstation 2. This device operates as a Standard Process Digital Alarm, and shall be controlled as outlined in the functional standards.

6.6.2.4.12. FST3 Bridge Position Indicator (ZS-40301)

This position switch indicates when the FST bridge is at a defined position – this signal is active twice for one rotation of the bridge. This device operates as a Standard Process Digital Input, and shall be controlled as outlined in the functional standards.

6.6.2.4.13. FST3 RAS Flowmeter (FIT-42201)

This flowmeter measures the flow from the RAS Pumpstation 3 to Flowsplitter 2. This device operates as a Standard Flowmeter, and shall be controlled as outlined in the functional standards. The process value of this device is filtered, and is scaled from 0 to 335 L/s.

6.6.2.4.14. FST3 Flow Switch (RAS Pump1) (FSL-42202)

This flow switch indicates when there is flow from FST 3 RAS Pump 1. This device operates as a Standard Process Digital Input, and shall be controlled as outlined in the functional standards.

A low flow alarm (FAL-42202) is generated when the pump has been running for 30 seconds and the flow switch has not detected flow.

6.6.2.4.15. FST3 Flow Switch (RAS Pump2) (FSL-42203)

This flow switch indicates when there is flow from FST 3 RAS Pump 2. This device operates as a Standard Process Digital Input, and shall be controlled as outlined in the functional standards.

A low flow alarm (FAL-42203) is generated when the pump has been running for 30 seconds and the flow switch has not detected flow.

6.6.2.4.16. RAS PS3 - High Level (LSH-42204)

This level switch indicates when there is level in the RAS Pumpstation 3. This device operates as a Standard Process Digital Alarm, and shall be controlled as outlined in the functional standards.

6.6.2.5. Controlled Equipment

6.6.2.5.1. RAS PS1 Pump 1, 2 (PU-420-10, PU-420-20)

These Pumps return sludge from FST1 to Flowsplitter 2. These devices operate as a Standard Variable Speed Drive, and are controlled as outlined in the functional standards. The automatic operation of these devices is controlled by the *RAS Pumpstation Sequence* for FST1.

6.6.2.5.2. FST1 Scum Pump (PU-40101)

This Pump pumps the scum from FST1 scum collector to Flowsplitter 2. This device operates as a Standard Drive, and is controlled as outlined in the functional standards. The automatic operation of this device is controlled by the *FST Scum Sequence* for FST1.

6.6.2.5.3. FST1 Scraper Bridge (SP-40101)

This bridge scrapes settled sludge to the sludge hopper in the centre of the FST. This device operates as a Standard Variable Speed Drive, and is controlled as outlined in the functional standards, except that the Bridge speed control is to be located on or near the bridge, and is not to be adjustable from the OWS. The automatic operation of this device is controlled by the *FST Bridge Sequence* for FST1.

6.6.2.5.4. FST1 Service Water Control Valve (FCV-401-21)

This valve controls the service water flow to the high pressure service water spray bar that is attached to the FST Bridge to automatically clean the effluent launders. This device operates as a Standard Control Valve, and is controlled as outlined in the functional standards. The automatic operation of this device is controlled by the *Launder Spray Sequence* for FST1.

6.6.2.5.5. RAS PS2 Pump 1, 2 (PU-421-10, PU-421-20)

These Pumps return sludge from FST2 to Flowsplitter 2. These devices operate as a Standard Variable Speed Drive, and are controlled as outlined in the functional standards. The automatic operation of these devices is controlled by the *RAS Pumpstation Sequence* for FST2.

6.6.2.5.6. FST2 Scum Pump (PU-40201)

This Pump pumps the scum from FST2 scum collector to Flowsplitter 2. This device operates as a Standard Drive, and is controlled as outlined in the functional standards. The automatic operation of this device is controlled by the *FST Scum Sequence* for FST2.

6.6.2.5.7. FST2 Scraper Bridge (SP-40201)

This bridge scrapes settled sludge to the sludge hopper in the centre of the FST. This device operates as a Standard Variable Speed Drive, and is controlled as outlined in the functional standards, except that the Bridge speed control is to be located on or near the bridge, and is not to be adjustable from the OWS. The automatic operation of this device is controlled by the *FST Bridge Sequence* for FST2.

6.6.2.5.8. FST 2 Service Water Control Valve (FCV-402-21)

This valve controls the service water flow to the high pressure service water spray bar that is attached to the FST Bridge to automatically clean the effluent launders. This device operates as a Standard Control Valve, and is controlled as outlined in the functional standards. The automatic operation of this device is controlled by the *Launder Spray Sequence* for FST2.

6.6.2.5.9. RAS PS3 Pump 1, 2 (PU-422-10, PU-422-20)

These Pumps return sludge from FST3 to Flowsplitter 2. These devices operate as a Standard Variable Speed Drive, and are controlled as outlined in the functional standards. The automatic operation of these devices is controlled by the *RAS Pumpstation Sequence* for FST3.

6.6.2.5.10. FST3 Scum Pump (PU-40301)

This Pump pumps the scum from FST3 scum collector to Flowsplitter 2. This device operate as a Standard Drive, and is controlled as outlined in the functional standards. The automatic operation of this device is controlled by the *FST Scum Sequence* for FST3.

6.6.2.5.11. FST3 Scraper Bridge (SP-40301)

This bridge scrapes settled sludge to the sludge hopper in the centre of the FST. This device operates as a Standard Variable Speed Drive, and is controlled as outlined in the functional standards, except that the Bridge speed control is to be located on or near the bridge, and is not to be adjustable from the OWS. The automatic operation of this device is controlled by the *FST Bridge Sequence* for FST3.

6.6.2.5.12. Stopboards (SB-31005, SB-31004, SB-32005, SB-32004)

There is no remote control of these devices. These devices are controlled manually as described in *Stopboard Control*.

6.6.2.5.13. FST 3 Service Water Control Valve (FCV-403-21)

This valve controls the service water flow to the high pressure service water spray bar that is attached to the FST Bridge to automatically clean the effluent launders. This device operates as a Standard Control Valve, and is controlled as outlined in the functional standards. The automatic operation of this device is controlled by the *Launder Spray Sequence* for FST3.

6.6.3. Manual Control

6.6.3.1. Stopboard Control

Stopboards are provided at each bioreactor outlet in order to isolate a FST. Two lines are provided from each bioreactor to FST3 to allow required the range of flows to be achieved in the case of either FST1 or FST2 being offline.

The following description refers to Drawing No. 486/5/5S3G104 and is written for Bioreactor 1 (OD1). The description for Bioreactor 2 (OD2) is analogous. Under normal operation (all FSTs online), Stopboard SB-31004 will be located at the FST3 outlet (position SB5), while Stopboard SB-31005 will divide the overflow channel into 1/3:2/3 (Position SB3). This will allow for two thirds of OD1 effluent to be directed to FST1, and one third to FST3.

To isolate FST1 Stopboard SB-31004 is placed at the FST1 outlet (Position SB1). All other Stopboards are removed, directing all flow to FST3. Stopboards SB-32005 and SB-32004 are placed in Positions SB4 and SB5 in Bioreactor 2 to isolate FST3 from Bioreactor 2.

To isolate FST3, Stopboards SB-31004 and SB-31005 are placed in Positions SB4 and SB5 in Bioreactor 1 to isolate FST3 from Bioreactor 1. Further Stopboards SB-32004 and SB-32005 are placed in Positions SB4 and SB5 in Bioreactor 2 to isolate FST3 from Bioreactor 2.

If Bioreactor 2 is taken offline, then Stopboard SB-31005 is relocated in Position SB2 to evenly divide Bioreactor 1’s overflow channel. Stopboard SB-31005 is removed.

6.6.4. Automatic Control

6.6.4.1. FST Bridge Sequence

Each FST will have its own sequence and will operate independently. When this sequence is enabled, the FST Scraper Bridge will run continuously.

6.6.4.2. Launder Spray Sequence

Each FST will have its own sequence and will operate independently. Spraying shall commence at 2 separate Operator adjustable times (*Spray Start Time1, Spray Start Time* 2), for example 01:00 h and 14:00 h. Spraying shall then operate continuously for an Operator adjustable time (*Spray Duration 1,Spray Duration 2*).

6.6.4.3. FST Scum Sequence

Each FST will have its own sequence and will operate independently. When this sequence is enabled, the scum pump in each FST shall operate as follows:

a. The system will count the number of times the bridge position sensor, located adjacent to the scum beach, is activated. Since a full diameter bridge will be used, this will occur twice per revolution; When the count is equal to [(*FST Scum Pumping Skip Number* x 2)-1] then the scum pump will start. (This formula in the comparison ensures an odd number ensuring that the scum pump will always start on alternate sides of the bridge.)

b. After the *Scum Pump Start Delay Time (in seconds)*. The pump will operate for a SCADA adjustable time (*Scum Pump Run Time*) that will include priming and pumping. The total run time is expected to be in the order of 30-60 seconds;
c. After *Scum Pump Run Time*, the pump will stop.
d. The system will then re-commence counting the number of times the bridge position sensor is activated.

6.6.4.4. RAS Pumpstation Sequence

Each RAS Pumpstation will have its own sequence and will operate independently. When this sequence is enabled, the RAS pumps for each FST operate as detailed following.

The pumps' duty shall operate differently depending on the conditions described as follows:

a. *Normal Conditions* (all FST's in operation): the pumps shall operate in Duty/Standby Mode, as described in the functional standards, with daily swaps of the duty and standby pumps.

b. *Abnormal conditions* (more than 1 FST offline): the pumps shall operate in Duty/Assist Mode, as described in the functional standards, with daily swaps of the duty and assist pumps.

The sequence shall incorporate two operator selectable modes for the control of the RAS pumps:

a. Direct flow rate control;
b. Flow pacing control.

6.6.4.4.1. Direct Flow Rate Control

Under direct flow rate control mode, the speed of the RAS pumps will be controlled to maintain the desired flow rate, as entered by the Operator at the OWS.

Two operator selectable modes of data entry are available:

a. *A single total daily RAS flow rate [ML/d]:* Under this mode, the controller shall assume that all operating RAS pump stations will pump at the same flow rate. The OWS shall display the flow from each station and the total flow rate in [ML/d] and [L/s] as well as the ratio to the averaged influent flow rate (see Flow Pacing Control). In the event that 1 or more FST is offline, the display shall show zero flow for that RAS pump station, and shall automatically adjust the RAS flow rates such that the total flow is evenly divided between the remaining FST's.

b. *Individual RAS flow rates [ML/d]:* Under this mode, the operator will enter an individual RAS rate for each FST.

6.6.4.4.2. Flow Pacing Control

Under flow pace control mode, the controller shall adjust the speed of the RAS pumps to maintain the desired ratio between the influent flow rate and RAS flow rate on an (nearly) instantaneous basis. The ratio shall be calculated as Q_{RAS}/Q_{inf}, where Q_{RAS} is the Total RAS flow rate and Q_{inf} is the plant influent flow rate.

The influent flow rate shall be measured using the *Plant Feed Flowmeter* (*FIT-85102*). This flow shall be averaged over *a flow averaging time period* (between 30 seconds and 60 minutes) to reduce spiking in the influent flow rate. A running average, with the most recent data shall be used.

The SCADA shall provide two operator selectable modes of data entry:

a. *A single RAS ratio [#]*: Under this mode, the controller shall assume that all operating RAS pump stations will pump using the same ratio and in effect the same flowrate. The SCADA shall display the flow from each station and the total flowrate in [ML/d] and [L/s] as well as the ratio to the averaged influent flowrate. In the event that 1 or more FST is offline, the display shall show zero flow for that pump station, and shall automatically adjust the RAS flowrates such that the total flow is evenly divided between the remaining FST's.

b. *Individual RAS ratios [#]:* Under this mode, the operator will enter an individual RAS ratio for each FST. The SCADA shall display the flow from each station and the total flowrate in [m^3/d] and [L/s] as well as the ratio to the averaged influent flowrate.

$$Q_{\mathbf{ras}} = \text{RAS Ratio} \times Q_{\mathbf{inf}} / (\text{No of operating FST's})$$

In both cases, the allowable range of RAS recycle ratios shall be 0.4 to 2.3. In both cases, the operator will enter *minimum and maximum absolute flows* for each FST. In the event that flow paced control would result in a RAS flow rate outside of this range, the system shall override the flow paced control mode and limit the flow to the upper or lower maximum, as appropriate.

6.6.4.4.3. RAS Ramp Up Sequence

Incorporated into in the operating regime of the RAS pumps shall be a function that instructs a RAS pump to ramp up to full speed for a period of time (adjustable with default of 2 minutes) and then ramp back down to its pre-set speed. The operating regime shall be individually selectable (on/off) for each pair of pumps.

A RAS Pump Ramp Up Sequence shall be initiated if the following pre-requisites are active.

a. Pump has been operating less than a configurable speed for more than 1 hour (adjustable),
b. No other RAS pump is performing a Ramp Up Sequence.
c. RAS Ramp Up Sequence has been enabled for the RAS Pump Station
d. Flow is greater than minimum initiation flow rate

The sequence should be repeated indefinitely if the above conditions apply. The ramp up to full speed (100%) from the initial speed shall occur over a period of 1 minute (adjustable) regardless of the initial speed. The pump shall then run at full speed (100%) for the set period and ramp down to the initial speed, again over 1 minute. The pump shall then revert to PID control after the ramp up sequence has been completed.. These times are independent of the nominated full speed run time.

6.6.4.4.4. Control Flow Diagram

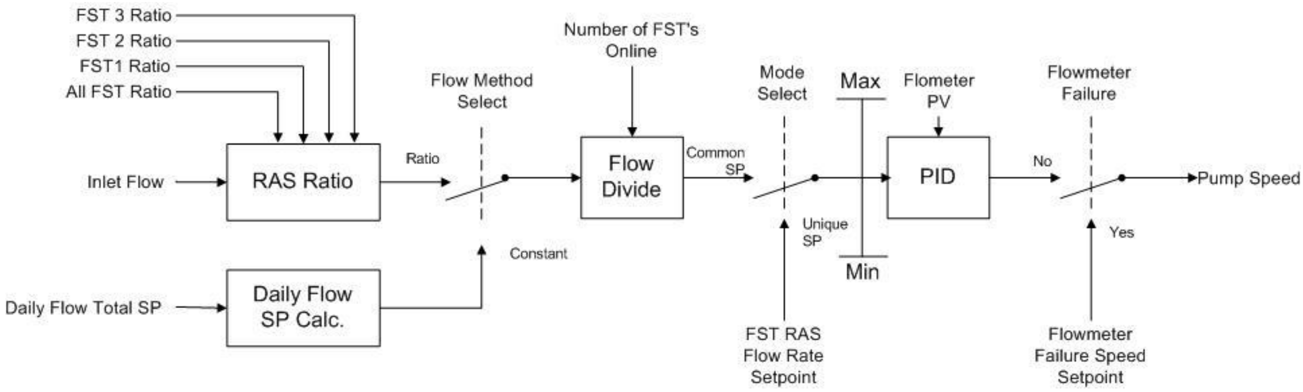


Figure 6 RAS Pump Speed Control Algorithm

6.6.5. Monitoring

The following is displayed on the OWS:

a. Each of the alarms listed
b. FSTs in operation (as entered by operator as *Final Settling Tank Operation)*
c. RAS Flowrate for each of the three FSTs (L/s), or instrument fault
d. RAS Flowrate for each of the three FSTs, as ratio of plant influent flowrate, or instrument fault.
e. Total RAS flowrate for the plant (ML/d)
f. Velocity of bridge ($V_{bridge,}$ m/min)

6.6.6. Calculations

Bridge Speed

The bridge speed shall be calculated by the control system by the following algorithm:

$V_{bridge} = d_C / (t.2)$

Where:

d_C = 141.3m (circumference of tank)
t = measured time between bridge indication (minutes)

Bridge Revolution Time

$T_{bridge} = (t.2)$

6.6.7. Setpoints

Setpoint Description	Default Value	Security Level
Spray start time 1, Spray Start Time 2	01:00 h	Operator
Spray duration 1, Spray Duration 2	3 hours	Operator
Scum Pump Run Time	45 seconds	Operator
FST Bridge Speed (0-100%)		Operator
RAS Control mode (Flow Pacing or Direct flowrate)	Flow Pacing	Operator
RAS Flowrate mode – each FST or Total	total flowrate	Operator
Total daily RAS flowrate for entire plant [ML/d]	25	Operator

Individual RAS flowrates for each FST[ML/d]	8.3	Operator
RAS Flow Pacing mode – each FST or Total	total flowrate	Operator
Single RAS ratio for all FSTs [#] (total mode)	1.0	Operator
Flow Averaging Time Period	60 seconds	Operator
RAS ratio for each FSTs [#]	1.0	Operator
Minimum absolute RAS flow per FST	67 L/s	Operator
Maximum absolute RAS flow per FST	330 L/s	Operator
Expected revolution time	60 minutes	Operator
Final Settling Tank Operation (toggle table indicating when FST online)		Operator
FST Scum Pumping Skip Number	1	Operator
Scum Pump Start Delay Time	TBA	Operator
RAS Pumpstation 1 Ramp Up Sequence Enable/Disable	Disable	Operator
RAS Pumpstation 2 Ramp Up Sequence Enable/Disable	Disable	Operator
RAS Pumpstation 3 Ramp Up Sequence Enable/Disable	Disable	Operator
RAS Ramp Up Sequence Low Speed Start	60%	Operator
RAS Ramp Up Sequence Start Delay Time	60 mins	Operator
RAS Ramp Up Sequence Ramp Time	2 mins	Operator
RAS Ramp Up Sequence Flowrate Enable	TBA	Operator
RAS Pump Speed During Flowmeter or control fail conditions – Normal Conditions	75%	Operator
RAS Pump Speed During Flowmeter or control fail conditions – Abnormal Conditions	75%	Operator
No of RAS Pumps operating During Flowmeter or control fail conditions	1	Operator

6.6.8. Process Alarms and Interlocks

6.6.8.1. RAS Lead / Duty Pump Failure

Tag	Equipment	Action
PU-420-10	RAS PS1 Pump 1	Start Standby Pump
PU-420-20	RAS PS1 Pump 2	Start Standby Pump
PU-421-10	RAS PS2 Pump 1	Start Standby Pump
PU-421-20	RAS PS2 Pump 2	Start Standby Pump
PU-422-10	RAS PS3 Pump 1	Start Standby Pump
PU-422-20	RAS PS3 Pump 2	Start Standby Pump

This alarm shall be generated if the lead or duty pump shuts down or fails to start. This alarm type is Priority 6. The controller shall automatically start the standby pump, and normal control procedures shall be maintained.

6.6.8.2. RAS Pump System Failure

Tag	Equipment	Action
PU-420-10	RAS PS1 Pump 1	Start Standby Pump
PU-420-20	RAS PS1 Pump 2	Start Standby Pump
PU-421-10	RAS PS2 Pump 1	Start Standby Pump
PU-421-20	RAS PS2 Pump 2	Start Standby Pump
PU-422-10	RAS PS3 Pump 1	Start Standby Pump
PU-422-20	RAS PS3 Pump 2	Start Standby Pump

This alarm shall be generated if the nominated lead or duty and the standby or follow pumps both shut down or fail to start. This alarm type is Priority 2.

6.6.8.3. RAS Follow Pump Failure during Abnormal Operation

Tag	Equipment	Action
PU-420-10	RAS PS1 Pump 1	
PU-420-20	RAS PS1 Pump 2	
PU-421-10	RAS PS2 Pump 1	
PU-421-20	RAS PS2 Pump 2	
PU-422-10	RAS PS3 Pump 1	
PU-422-20	RAS PS3 Pump 2	

This alarm shall be generated if the nominated follow pump shuts down or fails to start. This alarm type is Priority 6. The controller shall continue normal operation with reduced system capacity.

6.6.8.4. RAS Flow Control Failure

Tag	Equipment	Action
FIT-42001	FST1 RAS Flowmeter	Run RAS Pumps at default number and speed.
FIT-42101	FST2 RAS Flowmeter	Run RAS Pumps at default number and speed.
FIT-42201	FST3 RAS Flowmeter	Run RAS Pumps at default number and speed.

This alarm shall be generated if the flow deviates from the required flow set point by more than 20% for over 5 minutes continuously. This alarm type is Priority 6. The controller shall automatically select a fixed number of pumps to operate at a fixed speed for the affected FST.

6.6.8.5. RAS Flowmeter Failure

Tag	Equipment	Action
FIT-42001	FST1 RAS Flowmeter	Run RAS Pumps at default number and speed.
FIT-42101	FST2 RAS Flowmeter	Run RAS Pumps at default number and speed.
FIT-42201	FST3 RAS Flowmeter	Run RAS Pumps at default number and speed.

This alarm shall be generated if a RAS flowmeter fails. This alarm type is Priority 6. The controller shall automatically select a fixed number of pumps to operate at a fixed speed for the affected FST.

6.6.8.6. RAS Negative Flow

Tag	Equipment	Action
FIT-42001	FST1 RAS Flowmeter	Run RAS Pumps at default number and speed.
FIT-42101	FST2 RAS Flowmeter	Run RAS Pumps at default number and speed.
FIT-42201	FST3 RAS Flowmeter	Run RAS Pumps at default number and speed.

This alarm shall be generated if a RAS flowmeter indicates a negative flow. This alarm type is Priority 2.

6.6.8.7. Scum Pump Failure

Tag	Equipment	Action
PU-40101	FST1 Scum Pump	
PU-40201	FST2 Scum Pump	
PU-40301	FST3 Scum Pump	

This alarm shall be generated if the pump shuts down or fails to start. This alarm type is Priority 7.

6.6.8.8. Low Flow Alarm – RAS Pumps

Tag	Equipment	Action
FSL-42002	RAS PS1 Pump 1 Flow Switch	Start Standby Pump
FSL-42003	RAS PS1 Pump 2 Flow Switch	Start Standby Pump
FSL-42102	RAS PS2 Pump 1 Flow Switch	Start Standby Pump
FSL-42103	RAS PS2 Pump 2 Flow Switch	Start Standby Pump
FSL-42202	RAS PS3 Pump 1 Flow Switch	Start Standby Pump
FSL-42203	RAS PS3 Pump 2 Flow Switch	Start Standby Pump

This alarm shall be generated if the pump has been running for 30 seconds and the flow switch has not detected flow. This alarm type is Priority 6. This alarm will fault the relevant RAS pump and the pump will stop.

6.6.8.9. Low Flow Alarm – Scum Pumps

Tag	Equipment	Action

FAL-40101	FST1 Scum Pump	Scum Pump Shut Down
FAL-40202	FST2 Scum Pump	Scum Pump Shut Down
FAL-40302	FST3 Scum Pump	Scum Pump Shut Down

This alarm shall be generated if the pump has been running for 30 seconds and the flow switch has not detected flow. This alarm type is Priority 7. This alarm will fault the relevant Scum pump and the pump will stop.

6.6.8.10. Bridge Failure

Tag	Equipment	Action
SP-40101	FST1 Bridge Scraper	
SP-40201	FST2 Bridge Scraper	
SP-40301	FST3 Bridge Scraper	

This alarm shall be generated if the bridge position indicator in not triggered within the *Expected Revolution time*. This alarm type is Priority 2.

6.6.8.11. Bridge Drive Failure

Tag	Equipment	Action
SP-40101	FST1 Bridge Scraper	
SP-40201	FST2 Bridge Scraper	
SP-40301	FST3 Bridge Scraper	

This alarm shall be generated if the bridge scraper drive shuts down or fails to start. This alarm type is Priority 2.

6.6.8.12. RAS Pump Station High Level

Tag	Equipment	Action
LAH-420040	RAS PS - High Level Alarm	
LAH-42104	RAS PS - High Level Alarm	
LAH-42204	RAS PS - High Level Alarm	

This alarm shall be generated if a high level is detected in the pump station. This alarm type is Priority 10.

6.6.9. Trend Pages

The following trends shall be displayed on the Final Settling Tank Overview trend page:

a. Plant Influent Flowrate (FE-85101)
b. Total RAS flowrate for the plant (ML/d)
c. RAS Flowrate for FST 1 (L/s)
d. RAS Flowrate for FST 2 (L/s)
e. RAS Flowrate for FST 3 (L/s)

f. RAS Flowrate for FST 1, as ratio of plant influent flowrate divided by the number of FSTs online (L/s).
g. RAS Flowrate for FST 2, as ratio of plant influent flowrate divided by the number of FSTs online (L/s),
h. RAS Flowrate for FST 3, as ratio of plant influent flowrate divided by the number of FSTs online (L/s),
i. Instantaneous Total RAS Flowrate divided by the number of FSTs online (L/s)

The following trends shall be displayed on the FST 1 trend page:

a. RAS pump 1 speed
b. RAS pump 2 speed
c. RAS Flowrate (L/s)
d. RAS Flowrate, as ratio of plant influent flowrate.
e. Scum Pump operation
f. Instantaneous Total RAS flowrate for the plant (L/s)

The following trends shall be displayed on the FST 2 trend page:

a. RAS pump 1 speed
b. RAS pump 2 speed
c. RAS Flowrate (L/s)
d. RAS Flowrate, as ratio of plant influent flowrate.
e. Scum Pump operation
f. Instantaneous Total RAS flowrate for the plant (L/s)

The following trends shall be displayed on the FST 3 trend page:

a. RAS pump 1 speed
b. RAS pump 2 speed
c. RAS Flowrate (L/s)
d. RAS Flowrate, as ratio of plant influent flowrate.
e. Scum Pump operation
f. Instantaneous Total RAS flowrate for the plant (L/s)

6.6.10. Statistical Data

The following statistical data shall be available for reports:

a. Totalised Plant Influent Flowrate (FIT-85101) (ML/d)
b. Totalised RAS flowrate for the plant (ML/d)
c. Totalised RAS Flowrate for FST 1 (L/s)
d. Totalised RAS Flowrate for FST 2 (L/s)
e. Totalised RAS Flowrate for FST 3 (L/s)
f. Totalised RAS Flowrate for FST 1, as ratio of totalised plant influent flowrate divided by the number of FSTs online (L/s),
g. Totalised RAS Flowrate for FST 2, as ratio of totalised plant influent flowrate divided by the number of FSTs online (L/s),
h. Totalised RAS Flowrate for FST 3, as ratio of totalised plant influent flowrate divided by the number of FSTs online (L/s)
i. Scum Pump operations per day.
j. Total Daily RAS Flow divided by the Total Plant Influent Flow Total.

6.7. UV Disinfection System

6.7.1. Process Overview

The UV disinfection system disinfects the clarified effluent prior to discharge to Cabbage Tree Creek. UV disinfected water for use as service water is passed through micro-screen filters (see Service Water System). The UV disinfected water not used on site as service water flows by gravity through a diffuser to Cabbage Tree Creek. The UV system does not treat the plant bypass flow, which is combined in the effluent flow after the UV system.

The system is provided as a package unit and the control of the UV banks is documented in Appendix E.

The UV disinfection system is designed to fully treat flows of up to 3xADWF (75ML/d) at 50% UV transmissivity.

An ultrasonic flowmeter monitors the flow through the UV disinfection unit.

6.7.2. Equipment

6.7.2.1. Equipment List

Tag	Equipment	Range	Type	Make & Model	Comment
UV-501-01	UV Disinfection Unit				
AIT-50101	UV Channel Turbidity				
AIT-50102	UV Transmissivity				
AIT-50103	UV Intensity Bank 1				
AIT-50104	UV Intensity Bank 2				
LSL-50105	UV Channel Low Level Switch				
LIT-50106	UV Channel Level				
FIT-50107	UV Channel Flow				
AE-50106	Automatic Sampler Analyser Indicator				

6.7.2.2. Process instrumentation

6.7.2.2.1. UV Channel Low Level Switch (LSL-50105)

This level switch indicates that the level in the UV Channel is low, and requires filling with service water. This device operates as a Standard Process Digital Input, and shall be controlled as outlined in the functional standards.

6.7.2.2.2. UV Channel Level Sensor (LIT-50106)

This level sensor measures the water level in the UV Channel. This device operates as a Standard Level Transmitter, and shall be controlled as outlined in the functional standards. The process value of this device is filtered, and is scaled from 0 to 100 %.

6.7.2.2.3. UV Channel Turbidity (AIT-50101)

This analyser measures the turbidity of the water in the UV Channel. This device operates as a Standard Process Analog Input, and shall be controlled as outlined in the functional standards. The process value of this device is filtered, and is scaled from 0 to 10 NTU

6.7.2.2.4. UV Channel Transmissivity (AIT-50102)

This analyser measures the transmissivity of the water in the UV Channel. This device operates as a Standard Process Analog Input, and shall be controlled as outlined in the functional standards.

6.7.2.2.5. UV Intensity Bank 1,2 (AIT-50103, AIT-50104)

This analyser measures the transmissivity of the water in the UV Channel. This device operates as a Standard Process Analog Input, and shall be controlled as outlined in the functional standards.

6.7.2.3. Controlled Equipment

There is no controlled equipment in this area.

6.7.3. Automatic Control

There is no automatic control in this area.

6.7.4. Monitoring

The following is displayed on the OWS:

a. Each of the alarms listed
b. UV Channel Level (mm)
c. UV Channel Flow (m3/h)
d. UV Penstock Postilion (0-100%)
e. UV Bank 1 Intensity (mW/cm2)
f. UV Bank 2 Intensity (mW/cm2)
g. UV Bank 1 Power Output (0-100%)
h. UV Bank 2 Power Output (0-100%)
i. Total UV Dose (mWs/cm2)
j. UV Transmission (%)
k. UV Bank 1 Running Hours
l. UV Bank 2 Running Hours
m. UV Bank 1 No. On/Off Cycles
n. UV Bank 2 No. On/Off Cycles
o. UV Channel Low Level Switch Status
p. UV Channel Turbidity (NTU)

6.7.5. Calculations

No calculations are required for this area.

6.7.6. Setpoints

There are no Setpoints required for this area.

6.7.7. Process Alarms and Interlocks

There are a number of alarms being returned from the UV PLC. These are listed in the UV Functional Specification in Appendix E.

6.7.8. Trend Pages

The following trends shall be displayed on the UV Disinfection trend page:

a. UV Channel Level Sensor (m)
b. UV Channel Turbidity (NTU)

6.7.9. Statistical Data

The following statistical data shall be available for reports:

a. UV Channel Level Sensor Average (m)
b. UV Channel Turbidity Average (NTU)

6.8. Service Water

6.8.1. Process Overview

The water to be used on site as service water is pumped from the UV disinfection discharge. The service water is filtered with disc filters, to prevent blockages of the equipment for use on site.

The Service water package consists of 2 pumps rated at 37 KW (PU-510-30 and PU-510-40) and 2 pumps rated at 18.5 KW (PU-510-10 and PU-510-20). PU-510-30/40 use fixed speed soft start motor drives and PU-520-10/20 use variable speed motor drives.

During normal operation, (ie. all pumps are available) the small pumps will operate in a duty-assist mode, while the large pumps will operate in a duty-standby configuration. During abnormal operation, (ie. when one small pump is unavailable) the large pumps will operate in a duty assist configuration.

The system will be fitted with a reseating mechanical pressure relief valve. This valve will open when the pressure exceeds its setpoint, (initially set at 80 m), and will close when the pressure falls below this value. The valve serves to protect the service water system from operating at excessive pressures and will allow continuous operation of a small pump under low flow conditions if required.

The starting, stopping and speed modulation of all service water pumps will be controlled from a pressure signal, subject to the water level in the service water pump station being sufficiently deep for safe operation.

6.8.2. Equipment

6.8.2.1. Equipment List

Tag	Equipment	Range	Type	Make & Model	Comment
PU-510-10	Service Water Pump 1				
PU-510-20	Service Water Pump 2				
PU-510-30	Service Water Pump 3				
PU-510-40	Service Water Pump 4				
PIT-52001	Pressure Transmitter				
PDIT-52002	Differential Pressure Transmitter				
FIT-52003	Flowmeter				
LSL-51001	Service water Pump Low Level Switch				
LSH-51001	Service water Pump High Level Switch				
LSLL-51001	Service water Pump Low-Low Level Switch				

6.8.2.2. Process instrumentation

6.8.2.2.1. Service Water Flowmeter (FIT-52003)

This pressure transmitter measures the service water system pressure. This device operates as a Standard Level Flowmeter, and shall be controlled as outlined in the functional standards. The process value of this device is filtered, and is scaled from 0 to 80 l/s.

6.8.2.2.2. Service Water Pressure Transmitter (PIT-52001)

This pressure transmitter measures the service water system pressure. This device operates as a Standard Level Transmitter, and shall be controlled as outlined in the functional standards. The process value of this device is filtered, and is scaled from 0 to 10 bar.

This instrument controls the operation of the service water pumps.

6.8.2.2.3. Service Water Low Level Switch (LSL-51001)

This level switch indicates that the level in the Service Water Pumpstation is low. This device operates as a Standard Process Digital Input, and shall be controlled as outlined in the functional standards.

6.8.2.2.4. Service Water High Level Switch (LSH-51001)

This level switch indicates that the level in the Service Water Pumpstation is high. This device operates as a Standard Process Digital Input, and shall be controlled as outlined in the functional standards.

6.8.2.2.5. Service Water Low-Low Level Switch (LSLL-51001)

This level switch indicates that the level in the Service Water Pumpstation is low-low. This device operates as a Standard Process Digital Input, and shall be controlled as outlined in the functional standards.

6.8.2.2.6. Service Water Disc Filter Differential Pressure Transmitter (DPIT-52002)

This pressure transmitter measures the disc filter differential pressure. This device operates as a Standard Level Transmitter, and shall be controlled as outlined in the functional standards. The process value of this device is filtered, and is scaled from 0 to 10 m.

6.8.2.3. Controlled Equipment

6.8.2.3.1. Service Water Pumps (PU-510-10, PU-510-20, PU-510-30, PU-510-40)

These pumps ensure service water system pressure is sufficient to supply the plant. PU-510-10 and PU-510-20 operate as Standard Variable Speed Drives, and are controlled as outlined in the functional standards. PU-510-30 and PU-510-40 operate as Soft Starter Drives, and are controlled as outlined in the functional standards. The automatic operation of these devices is controlled by the *Service Water Control Sequence*.

Both of the smaller pumps (PU-510-10 and PU-510-20) can operate at any one time. These pumps shall operate in a Duty/Assist configuration.

6.8.3. Automatic Control

6.8.3.1. Service Water Control Sequence

The control system shall define the following:

- *Low low pressure setpoint*;
- *Low pressure setpoint*;
- *Control pressure setpoint*;
- *High pressure setpoint*;
- *High high pressure setpoint*.

In the following sequences; duty, assist and standby are used for clarity and do not directly refer to a particular pump. This designation shall be controlled by the duty/assist and duty/standby sequences as described elsewhere.

Under normal, automatic operation (all pumps available) and for a rising demand, the control sequence shall be as follows:

- The duty variable speed pump shall start and its operating speed shall be modulated in an attempt to achieve the *control pressure setpoint* when:
    - Enabled ie. set to automatic control on the SCADA system;
    - The system pressure is less than the *Low pressure setpoint;*
    - The level in the service water pump station is greater than the *high level setpoint*.
- If, after ramping to 100% speed for the s*ervice water pump start delay time*, the system pressure remains less than the *low pressure setpoint*, the assist variable speed pump shall start. On starting, the assist variable speed pump shall ramp up, while the duty variable speed pump shall ramp down until their speeds are equal. Proceeding from this point, both the duty and assist pumps shall operate at the same speed. This speed shall be modulated in an attempt to achieve the *control pressure setpoint*.
- If, after ramping to 100% speed for the *service water pump start delay time*, the system pressure remains less than the *low pressure setpoint*, the duty fixed speed pump shall start. Simultaneously, the assist variable speed pump shall stop, while the duty variable speed pump shall modulate its speed in an attempt to achieve the *control pressure setpoint*.
- If, after ramping to 100% speed for the *service water pump start delay time*, the system pressure remains less than the *low pressure setpoint*, the assist variable speed pump shall start. On starting, the assist variable speed pump shall ramp up, while the duty variable speed pump shall begin to ramp down until their speeds are equal. Proceeding from this point, both the duty and assist pumps shall operate at the same speed. This speed shall be modulated in an attempt to achieve the *control pressure setpoint*.

For a falling demand, the shut down sequence shall be the reverse of the start up sequence, with the following alterations:

- A pump shall be stopped down if the variable speed unit(s) have operated at 60% speed for the *service water pump stop delay time*, and the system pressure remains above the *high pressure setpoint.*

- The shut down sequence shall continue until one variable speed pump remains. This pump's speed shall be modulated in an attempt to achieve the *control pressure setpoint*. The pump shall be stopped from:
    - A SCADA signal;
    - A fault signal;
    - If the water level in the service water station falls below the *low level setpoint.*

In the event that one of the variable speed pumps becomes unavailable (abnormal operation), the pump start up sequence shall be as before, but with the pumps staring in the following order:

- 1 variable speed pump;
- 1 fixed speed pump;
- 1 variable speed pump and 1 fixed speed pump;
- 2 fixed speed pumps.

The shut down sequence shall be the reverse, with one variable speed pump remaining as per the normal operation case.

The service water pump station is also fitted with three digital level sensors (multitrodes) for use in the control of the service water pumps:

- *Low low level;*
- *Low level;*
- *High level*.

The automatic control sequence shall include the following logic:

Low level signal: Stop all service water pumps, irrespective of system pressure or operation mode (ie. normal, abnormal or default).

High level signal: Enable the start of the service water control sequence. This signal allows the duty variable speed pump to start if the other start conditions are also met.

6.8.4. Setpoints

Setpoint Description	Default Value	Security Level
Service Water Pressure Low-Low Setpoint	TBA	Operator
Service Water Pressure Low Setpoint	TBA	Operator
Service Water Pressure High Setpoint	TBA	Operator
Service Water Pressure High-High Setpoint	TBA	Operator
Service Water Small Pump Low Speed Stop (%)	TBA	Operator
Service Water Control Pressure Setpoint	TBA	Operator
Service Water Pump Start Delay Time	TBA	Operator
Service Water Pump Stop Delay Time	TBA	Operator
Service Water Pumps Alarm Suppression Time	TBA	Operator

6.8.5. Process Alarms and Interlocks

6.8.5.1. Service Water Small Duty Pump Failure

Tag	Equipment	Action
PU-510-10	Service Water Small Pump 1	Start Standby Pump
PU-510-20	Service Water Small Pump 2	Start Standby Pump

This alarm shall be generated if the small duty pump shuts down or fails to start. This alarm type is Priority 6. The controller shall automatically start the standby pump, and normal control procedures shall be maintained.

6.8.5.2. Service Water Large Duty Pump Failure

Tag	Equipment	Action
PU-510-30	Service Water Large Pump 1	Start Standby Pump
PU-510-40	Service Water Large Pump 2	Start Standby Pump

This alarm shall be generated if the large duty pump shuts down or fails to start. This alarm type is Priority 6. The controller shall automatically start the standby pump, and normal control procedures shall be maintained.

6.8.5.3. Service Water Low-Low Level Alarm

Tag	Equipment	Action
LSL-51001	Service Water Pumps Low-Low	Stop All service Water Pumps

	Level Sensor	

This alarm shall be generated if the Service Water Low-Low Level sensor is triggered. On receipt of a *low- low level* signal from the service water pump station, the controller shall:

If any service water pumps are running, the controller shall:
- Immediately stop all operating service water pumps;
- Raise a Priority 6 Low Level Alarm;
- Latch out the service water pumps to prevent further operation until the alarm is manually reset by the operator.

6.8.5.4. Service Water Low Level Alarm

Tag	Equipment	Action
LSL-51001	Service Water Pumps Low Level Sensor	

This alarm shall be generated if the Service Water Low Level sensor is triggered. This alarm type is Priority 6.

6.8.5.5. Service Water High Level Alarm

Tag	Equipment	Action
LSL-51001	Service Water Pumps High Level Sensor	Enable the start of the service water control sequence

This alarm shall be generated if the Service Water High Level sensor is triggered. This alarm type is Priority 6.

6.8.5.6. Service Water Pressure Transmitter Failure

Tag	Equipment	Action
PIT-52001	Service Water Pressure Transmitter	Run Pumps using default number and speed

This alarm shall be generated if the Service Water Pressure Transmitter fails. This alarm type is Priority 6.

6.8.5.7. Service Water Low-Low, Low, High and High-High Pressure Alarms

Tag	Equipment	Action
PIT-52001	Service Water Pressure Low-Low Alarm	
PIT-52001	Service Water Pressure Low Alarm	
PIT-52001	Service Water Pressure High-High Alarm	Stop All Pumps

These alarms shall be generated when the service water pressure reaches the relevant alarm setpoint. This alarm type is Priority 10. The controller shall automatically start and stop service water pumps as per the automatic control sequence.

These alarms shall be disabled for a period of time (determined by the Service Water Pumps Alarm Suppression Time) after a pump has started or stopped.

6.8.5.8. Service Water Low-Low With All Pumps Running Alarm

Tag	Equipment	Action
PIT-52001	Service Water Pressure Low-Low with All Pump s Running Alarm	Stop All Pumps

This alarms shall be generated when the service water pressure is below the Low-Low Alarm setpoint and all Service Water Pumps are running. This alarm type is Priority 10. This alarm shall be disabled for a period of time (determined by the Service Water Pumps Alarm Suppression Time) after a pump has stopped.

6.8.6. Monitoring

The following is displayed on the OWS:

a. Each of the alarms listed
b. Service Water Flow Rate (L/s)
c. Service Water Pressure Transmitter (bar)
d. Service Water Disc Filter Differential Pressure (m)
e. Service Water Low Level Switch Status
f. For each small pump:
    - Running/Stopped
    - Speed
    - Control Mode
    - Control Circuit Available
    - Over Temperature
g. For each large pump:
    - Running/Stopped
    - Control Mode
    - Control Circuit Available
    - Over Temperature

6.8.7. Calculations

There are no calculations required for this area.

6.8.8. Trend Pages

The following trends shall be displayed on the Service Water System trend page:

a. Service Water Flow Rate (FIT-52003) L/s
b. Service Water Pressure (PIT-52001) bar
c. Service Water Disc Filter Differential Pressure (PDIT-52003) m

6.8.9. Statistics

The following statistical data shall be available for reports:

a. Daily Totalised Flow - Service Water Flow Rate (FIT-52003 (ML)
b. Service Water Pumps Number of Starts
c. Service Water Pumps Hours Run

6.9. Effluent Sodium Hypochloride Dosing System

6.9.1. Process Overview

The plant effluent is currently disinfected by chlorine dosing. When Stage 1 is commissioned all the effluent from FST1 will be UV disinfected. The existing Chlorine Building will be demolished as part of the Stage 2 works, so a temporary sodium hypochloride disinfection dosing system is required to be commissioned for the remaining effluent until Stage is completed.

Dosing System consists of:

2 dosing pumps (Duty / Standby)
2 flow switches
2 x 24V DC Indication Lamp (Pump Duty Indication)
Local Control Panel (LCP)

- Each pump requires a 4-20mA signal to set the dose point (4mA=OFF, 20mA=100% delivery). Pumps require 240V AC Single Phase (Both pumps are plugged into a double 10A GPO)
- 2 digital outputs signals are required from the PLC to provide local indication as to which pump has been selected as duty pump to run.
- Flow switches provide a pulse proportional to the flow rate, with an approximation of minimum delivery rate = 1 pulse/minute to full delivery rate = 120 pulse/min.
- The pumps are turned off by reducing the signal to 4mA only; the power to the pumps must remain on to retain the local settings.

6.9.2. Equipment

6.9.2.1. Equipment List

Tag	Equipment	Range	Type	Make & Model	Comment
PU-540-10	Effluent Sodium Hypochloride Dosing Pump 1				
PU-540-20	Effluent Sodium Hypochloride Dosing Pump 2				
FS-540-10	Effluent Sodium Hypochloride Dosing Pump 1 Flow Switch				
FS-540-20	Effluent Sodium Hypochloride Dosing Pump 2 Flow Switch				
LSH-51001	Service water Pump High Level Switch				

6.9.2.2. Process instrumentation

6.9.2.2.1. Dosing Pump Flow Switch (FS-540-10, FS-540-20)

This flow switch produces a pulse proportional to the pump flow rate and indicates that the dosing pump is operating correctly. The flow switch will pulse at a rate greater than 1pulse/min to indicate flow.

If no pulse is received within any 1 minute period, the associated pump is failed.

6.9.2.3. Controlled Equipment

6.9.2.3.1. Effluent Dosing Pumps (PU-540-10, PU-540-20)

These pumps dose sodium hypochloride to the effluent at a nominated rate. The rate of dosing is determined by the speed of the pump. The automatic operation of the pumps is controlled by the Hypo Dosing Pump Sequence.

6.9.3. Manual Control

Manual control of these pumps is not available.

6.9.4. Automatic Control

6.9.4.1. Hypo Dosing Sequence

The effluent that is not exposed to the UV disinfection (ie effluent not from FST1) is to be disinfected with sodium hypochloride, flow paced to the effluent flow. The sodium hypochloride dose rate is setpoint adjustable by the Operator. The effluent flow is to be measured by FIT-85501 Flow Splitter 5 flowmeter.

A dosing pump is selected as duty pump (Note the pumps sit idle at 4mA, there is no contactor etc. to physically select the pump). The duty pump is indicated on the dosing system LCP by lighting the appropriate Indicator lamp.

The duty dosing pump output is adjusted (4-20mA) accordingly to the effluent flowrate to deliver the desired dosing rate (mg/l of sodium hypochloride per m3 of effluent flow).

Upon pump activation the associated flow switch is monitored for pulse to indicated that the duty pump is operating. If there is no pulse after 1 minute, the duty pump is failed and a fault raised, and the standby pump is selected.

The duty pump shall change over 24 hours of continuous running.

6.9.5. Setpoints

Setpoint Description	Default Value	Security Level
Effluent Sodium Hypochloride Dosing rate	TBA	Operator
Effluent Sodium Hypochloride Duty Select	TBA	Operator

6.9.6. Process Alarms and Interlocks

6.9.6.1. Hypo Dosing Pump Fault

Tag	Equipment	Action
PU-540-10	Effluent Hypo Dosing Pump 1	Start Standby Pump
PU-540-20	Effluent Hypo Dosing Pump 2	Start Standby Pump

This alarm shall be generated if a pump is running a flow switch pulese is not detected for a period of 1 minute. This alarm type is Priority 6. The controller shall automatically start the standby pump, and normal control procedures shall be maintained.

6.10. High Voltage Switchgear

6.10.1. Process Overview

The High Voltage Switchgear provides electrical power transmission and protection to the various switchboards on site.

6.10.2. Equipment

6.10.2.1. Equipment List

Tag	Equipment	Range	Type	Make & Model	Comment
	Ringmain Feeder 1				
	Ringmain Feeder 2				
	Main Switch				
	Smoke Detector				
	Battery Charger				
	UPS				
	RMU-001-01 Isolator 1				
	RMU-001-01 Isolator 2				
	TX-001-01 Circuit Breaker				
	RMU-001-02 Isolator 1				
	RMU-001-02 Isolator 2				
	TX-001-02 Circuit Breaker				
	RMU-004-01 Isolator 1				
	RMU-004-01 Isolator 2				
	TX-004-01 Circuit Breaker				
	RMU-008-01 Isolator 1				
	RMU-008-01 Isolator 2				
	TX-008-01 Circuit Breaker				
	RMU-009-01 Isolator 1				
	RMU-009-01 Isolator 2				
	TX-009-01 Circuit Breaker				

6.10.2.2. Process instrumentation

6.10.2.2.1. Transformers (TX-001-01, TX-001-02, TX-004-01,TX-008-01, TX-009-01)

The transformer reduces the voltage from the high voltage supply network to low voltage. No remote control of this device is required. This device has the following process inputs for monitoring on the OWS:

Tag	Description	Type	Comment
	Circuit Breaker Closed	DI	Status
	Circuit Breaker Earth Switch Closed	DI	Status
	Circuit Breaker Earth Switch Open	DI	Status
	Circuit Breaker Protection Operated	DI	Alarm
	Over Temperature	DI	Alarm
	Sudden Pressure Trip	DI	Alarm

6.10.2.2.2. RMUs (RMU-001-10, RMU-001-02, RMU-004-01, RMU-008-01, RMU-009-01)

This RMU provides power from the Ring Main. No remote control of this device is required. This device has the following process inputs for monitoring on the OWS:

Tag	Description	Type	Comment
	Isolator 1 Closed	DI	
	Isolator 1 Earth Switch Closed	DI	
	Isolator 1 Earth Switch Open	DI	
	Isolator 2 Closed	DI	
	Isolator 2 Earth Switch Closed	DI	
	Isolator 2 Earth Switch Open	DI	

6.10.2.2.3. Main Switch (Q1)

This Main Switch provides power to the High Voltage network. No remote control of this device is required. This device has the following process inputs for monitoring on the OWS:

Tag	Description	Type	Comment
	Switch Opened	DI	
	Switch Closed	DI	
	Switch Tripped	DI	Alarm
	Switch Relay Fault	DI	Alarm
	Bus Zone Fault	DI	Alarm
	Phase A Current	AI	Trend
	Phase B Current	AI	Trend
	Phase C Current	AI	Trend
	Phase A/B Volts	AI	Trend
	Phase B/C Volts	AI	Trend
	Phase C/A Volts	AI	Trend
	Power Factor	AI	Trend
	kW	AI	Trend
	kWh	DI	Pulse Input

6.10.2.2.4. Ring 1 Feeder (Q2)

This Feeder provides power to one side of the High Voltage ring network. No remote control of this device is required. This device has the following process inputs for monitoring on the OWS:

Tag	Description	Type	Comment
Q2-OPN	Feeder Opened	DI	
Q2-CLS	Feeder Closed	DI	
Q2-TRIP	Feeder Tripped	DI	Alarm
Q2-FLT	Relay Fault	DI	Alarm
	Phase A Current	AI	Trend
	Phase B Current	AI	Trend
	Phase C Current	AI	Trend

6.10.2.2.5. Ring 2 Feeder (Q4)

This Feeder provides power to one side of the High Voltage ring network. No remote control of this device is required. This device has the following process inputs for monitoring on the OWS:

Tag	Description	Type	Comment
Q4-OPN	Feeder Opened	DI	Alarm
Q4-CLS	Feeder Closed	DI	Alarm
Q4-TRIP	Feeder Tripped	DI	Alarm
Q4-FLT	Relay Fault	DI	Alarm
	Phase A Current	AI	Trend
	Phase B Current	AI	Trend
	Phase C Current	AI	Trend

6.10.2.3. Controlled Equipment

There is no controlled equipment

6.10.2.4. Automatic Control

There is no automatic control required for this area.

6.10.3. Monitoring

The following is displayed on the OWS:

a. Each of the alarms listed
b. Each Transformer Status
c. Each RMU Status
d. Ring 1 Feeder Status, Amps
e. Ring 2 Feeder Status, Amps
f. Main Switch Status, Volts, Amps, and Power Factor, kWh

6.10.4. Calculations

No calculations are required for this area.

6.10.5. Setpoints

No setpoints are required for this area.

6.10.6. Alarms and Interlocks

No other alarms or interlocks are required for this area.

6.10.7. Trend Pages

The following trends shall be displayed on the Blower RMU 1 trend page:

a. Blower RMU 1 Amps

The following trends shall be displayed on the Blower RMU 2 trend page:

a. Blower RMU 2 Amps

The following trends shall be displayed on the SW, BR2 and UV RMU trend page:

a. SW, BR2 and UV RMU 2 Amps

The following trends shall be displayed on the Main Feeder trend page:

a. Main Feeder Volts
b. Main Feeder Amps
c. Main Feeder Power Factor
d. Ring Feeder 1 Amps
e. Ring Feeder 2 Amps

6.10.8. Statistical Data

No statistical data is required for this area.

6.11. External Lighting

6.11.1. Process Overview

These systems provide Street Lighting and general external lighting to the various areas of the Plant.

This includes lighting for the following:

Final Area

- Street Lights (3 Circuits)
- External Area (3 Circuits)

Bioreactor 1

- Walkways (5 Circuits)
- Street Lights (2 Circuits)
- Blower and Sludge Building External Area Lighting (1 Circuit)

FST1

- Walkways (1 Circuit)

Bioreactor 2

- Walkways (5 Circuits)
- Bioreactor 2 Switchroom External Area Lighting (1 Circuit)

FST2

- Walkways (1 Circuit)

6.11.2. Equipment

6.11.2.1. Equipment List

Tag	Equipment	Range	Type	Make & Model	Comment
LCT-003-01	BR1 Walkway Lighting Circuit 1				
LCT-003-02	BR1 Walkway Lighting Circuit 2				
LCT-003-03	BR1 Walkway Lighting Circuit 3				
LCT-003-04	BR1 Walkway Lighting Circuit 4				
LCT-003-05	BR1 Walkway Lighting Circuit 5				
LSW-003-01	BR1 Walkway Lighting Switch 1				
LSW-003-02	BR1 Walkway Lighting Switch 3				
LSW-003-03	BR1 Walkway Lighting Switch 3				
LSW-003-04	BR1 Walkway Lighting Switch 4				
LSW-003-05	BR1 Walkway Lighting Switch 5				
LCT-003-41	Sludge and Blower Building External Lighting Circuit 1				
LSW-003-41	Sludge and Blower Building				

	External Lighting Switch 1				
LSW-003-42	Sludge and Blower Building External Lighting Switch 2				
LCT-003-21	Bioreactor Street Lighting Circuit 1				
LCT-003-22	Bioreactor Street Lighting Circuit 2				
LSW-003-21	Bioreactor Street Lighting Switch 1				
LCT-005-01	BR2 Walkway Lighting Circuit 1				
LCT-005-02	BR2 Walkway Lighting Circuit 2				
LCT-005-03	BR2 Walkway Lighting Circuit 3				
LCT-005-04	BR2 Walkway Lighting Circuit 4				
LCT-005-05	BR2 Walkway Lighting Circuit 5				
LSW-005-01	BR2 Walkway Lighting Switch 1				
LSW-005-02	BR2 Walkway Lighting Switch 3				
LSW-005-03	BR2 Walkway Lighting Switch 3				
LSW-005-04	BR2 Walkway Lighting Switch 4				
LSW-005-05	BR2 Walkway Lighting Switch 5				
PEC-005-01	BR2 PEC Cell				
LCT-005-21	BR2 Switchroom External Lighting Circuit 1				
LSW-005-21	BR2 Switchroom External Lighting Switch 1				
LCT-004-21	Final Area External Lighting Circuit 1				
LCT-004-22	Final Area External Lighting Circuit 2				
LCT-004-23	Final Area External Lighting Circuit 3				
LSW-004-21	Final Area External Lighting Switch 1				
LSW-004-22	Final Area External Lighting Switch 2				
LSW-004-23	Final Area External Lighting Switch 3				
LCT-004-01	Final Area Street Lighting Circuit 1				
LCT-004-02	Final Area Street Lighting Circuit 2				
LCT-004-03	Final Area Street Lighting Circuit 3				
LSW-004-01	Final Area Street Lighting Switch 1				
PEC-004-01	Final Area PE Cell				
LCT-011-01	FST1 Walkway Lighting Circuit 1				
LSW-011-01	FST1 Walkway Lighting Switch 1				
LSW-011-02	FST1 Walkway Lighting Switch 2				

LCT-012-01	FST2 Walkway Lighting Circuit 1				
LSW-012-01	FST2 Walkway Lighting Switch 1				
LSW-012-02	FST2 Walkway Lighting Switch 2				

6.11.2.2. Process instrumentation

There is no process instrumentation.

6.11.3. Automatic Control

6.11.3.1. Street Lighting

For all areas Street Lighting shall be turned on when any of the following conditions occur.

a. All External Lights On command from SCADA
b. Street Lights On command from SCADA
c. Street Lights Lighting Switch On (PLC Input)

For all areas Street Lighting shall be turned off when any of the following conditions occur.

a. All External Lights Off command from SCADA
b. Street Lights Off command from SCADA
c. Street Light Lighting Switch Off (PLC Input)

6.11.3.2. External Area and Walkway Lighting

For all areas External Area Lighting shall be turned on when any of the following conditions occur.

a. All External Lights On command from SCADA
b. Area External Lights On command from SCADA
c. External Lighting Switch On (PLC Input)

For all areas External Area Lighting shall be turned off when any of the following conditions occur.

a. All External Lights Off command from SCADA
b. Area External Lights Off command from SCADA
c. Street Light Lighting Switch Off (PLC Input)
d. External Lighting Switch Off (PLC Input)
e. PE Cell (PLC Input)

Each of the area listed in section 6.10.1 shall have individual area SCADA controls and PLC inputs.

6.11.4. Monitoring

The following is displayed on the OWS:

a. PE Cell indication

6.11.5. Calculations

No calculations are required for this area.

6.11.6. Setpoints

No setpoints are required for this area.

6.11.7. Alarms and Interlocks
No other alarms or interlocks are required for this area.

6.11.8. Trend Pages
No trends are required for this area.

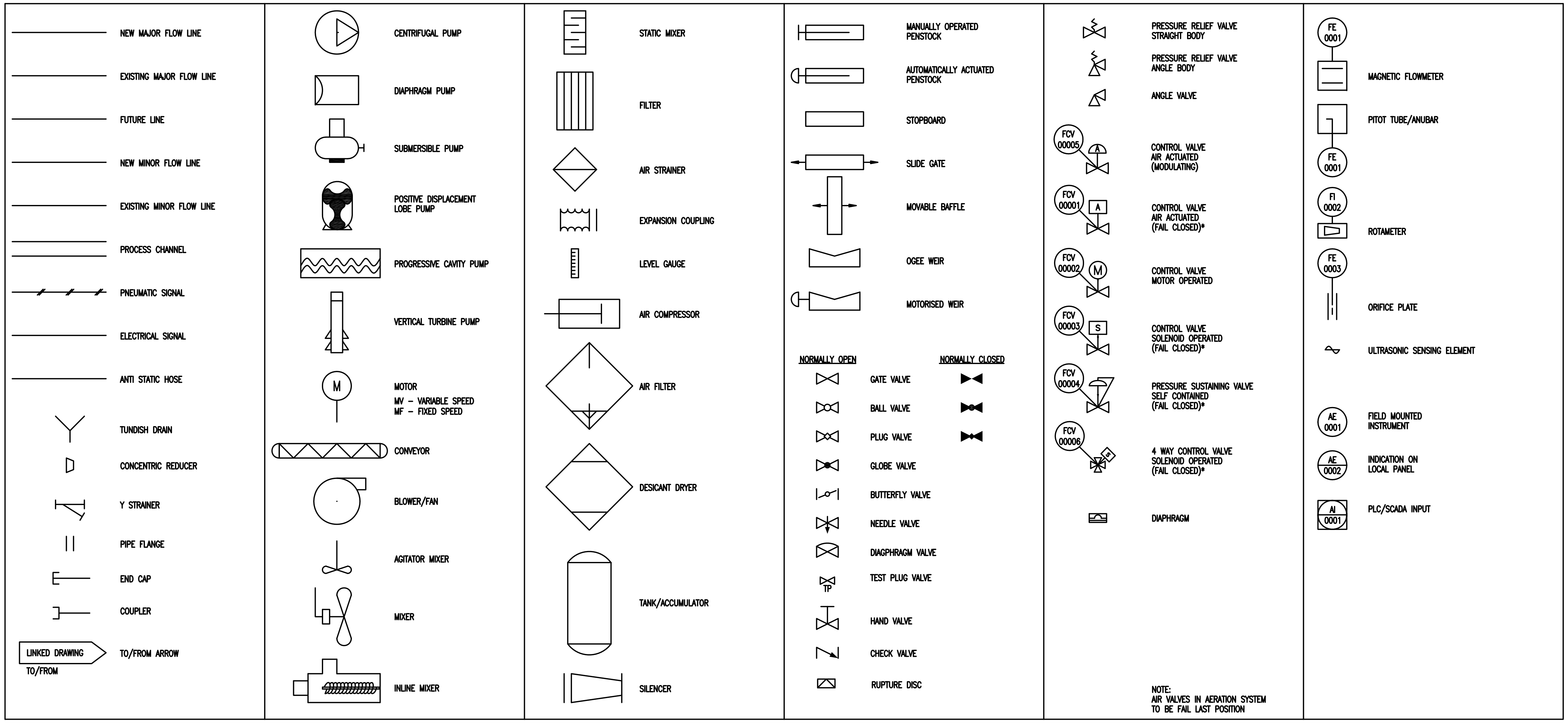
6.11.9. Statistical Data
No statistical data is required for this area.

7. APPENDICES

Appendix A. BWEA P&I Drawings

Drawings included in this appendix are the latest versions as available at the time. Any drawings used as reference for any work or design purposes must be verified for currency.

486/5/5-S3D100	P&ID Legend
486/5/5-S3D101	Primary Settling Tanks P&ID
486/5/5-S3D102	Flowsplitter 2 & Anaerobic Zone P&ID
486/5/5-S3D103	Bioreactor 1 P&ID
486/5/5-S3D104	Bioreactor 2 P&ID
486/5/5-S3D105	Final Settling Tank 1 P&I Diagram
486/5/5-S3D106	Final Settling Tank 2 P&I Diagram
486/5/5-S3D107	Final Settling Tank 3 P&I Diagram
486/5/5-S3D108	UV Disinfection and Service Water P&I Diagram
486/5/5-S3D109	WAS Pumpstation P&ID
486/5/5-S3D110	WAS Dewatering P&ID
486/5/5-S3D111	Sludge Hopper P&ID
486/5/5-S3D112	Compressed Air P&ID
486/5/5-S3D113	Polyelectrolyte Make-up and Storage P&ID
486/5/5-S3D114	Polyelectrolyte Dosing P&ID
486/5/5-S3D115	Blower P&ID



EQUIPMENT AREA CODES

AREA 1 – INLET WORKS
101 MAIN PUMP STATION
110 COMMON SCREEN CHANNEL
111 SCREEN 1 CHANNEL
112 BYPASS 1 CHANNEL
113 SCREEN 2 CHANNEL
114 BYPASS 2 CHANNEL
115 SCREEN 3 CHANNEL
116 BYPASS 3 CHANNEL
117 SCREEN 4 CHANNEL
120 SCREENINGS HANDLING
130 GRIT BYPASS CHANNEL
131 GRIT CHANNEL 1
132 GRIT CHANNEL 2
133 GRIT CHANNEL 3
140 GRIT HANDLING

AREA 2 – PRIMARY SEDIMENTATION
201 PRIMARY SETTLING TANK 1
202 PRIMARY SETTLING TANK 2
203 PRIMARY SETTLING TANK 3
204 PRIMARY SETTLING TANK 4
210 PRIMARY SLUDGE PUMP SATTION

AREA 3 – BIOREACTORS
301 ANAEROBIC ZONE 1
302 ANAEROBIC ZONE 2
303 ANAEROBIC ZONE 3
304 ANAEROBIC ZONE 4
305 ANAEROBIC ZONE 5
306 ANAEROBIC ZONE 6
310 BIOREACTOR 1 SEWAGE
311 BIOREACTOR 1 AIR
312 BIOREACTOR 1 SERVICE WATER
313 BIOREACTOR 1 SCUM
315 BIOREACTOR 1 ETHANOL
316 BIOREACTOR 1 ALUM
317 BIOREACTOR 1 LIME
320 BIOREACTOR 2 SEWAGE
321 BIOREACTOR 2 AIR
322 BIOREACTOR 2 SERVICE WATER
323 BIOREACTOR 2 SCUM
325 BIOREACTOR 2 ETHANOL
326 BIOREACTOR 2 ALUM
327 BIOREACTOR 2 LIME
330 BIOREACTOR 3 SEWAGE
331 BIOREACTOR 3 AIR
332 BIOREACTOR 3 SERVICE WATER
333 BIOREACTOR 3 SCUM
335 BIOREACTOR 3 ETHANOL
336 BIOREACTOR 3 ALUM
337 BIOREACTOR 3 LIME
340 BIOREACTOR 4 SEWAGE
341 BIOREACTOR 4 AIR
342 BIOREACTOR 4 SERVICE WATER
343 BIOREACTOR 4 SCUM
345 BIOREACTOR 4 ETHANOL
346 BIOREACTOR 4 ALUM
347 BIOREACTOR 4 LIME
350 BIOREACTOR 5 SEWAGE
351 BIOREACTOR 5 AIR
352 BIOREACTOR 5 SERVICE WATER
353 BIOREACTOR 5 SCUM
355 BIOREACTOR 5 ETHANOL
356 BIOREACTOR 5 ALUM
357 BIOREACTOR 5 LIME
360 BIOREACTOR 6 SEWAGE
361 BIOREACTOR 6 AIR
362 BIOREACTOR 6 SERVICE WATER
363 BIOREACTOR 6 SCUM
365 BIOREACTOR 6 ETHANOL
366 BIOREACTOR 6 ALUM
367 BIOREACTOR 6 LIME
370 BIOREACTOR 7 SEWAGE
371 BIOREACTOR 7 AIR
372 BIOREACTOR 7 SERVICE WATER
373 BIOREACTOR 7 SCUM
375 BIOREACTOR 7 ETHANOL
376 BIOREACTOR 7 ALUM
377 BIOREACTOR 7 LIME
380 WAS BIOREACTOR 1
381 WAS BIOREACTOR 2
382 WAS BIOREACTOR 3
383 WAS BIOREACTOR 4
384 WAS BIOREACTOR 5 & 6

AREA 4 – FINAL SEDIMANTATION
401 FST 1
402 FST 2
403 FST 3
404 FST 4
405 FST 5
406 FST 6
407 FST 7
408 FST 8
409 FST 9
410 FST 10
411 FST 11
412 FST 12
413 FST 13
414 FST 14
415 FST 15
416 FST 16
420 RAS PUMP STN.1
421 RAS PUMP STN.2
422 RAS PUMP STN.3
423 RAS PUMP STN.4
424 RAS PUMP STN.5
425 RAS PUMP STN.6
426 RAS PUMP STN.7

AREA 5 – EFFLUENT
501 UV
510 EFFLUENT PUMP STATION
520 EFFLUENT FLITRATION

AREA 6 – SLUDGE TREATMENT
601 WAS BALANCE TANK
610 GDD
611 BFP
612 GDD FLOCCULATOR
615 GDD POLYMER DOSING
614 GDD SERVICE WATER
613 GDD COMPRESSED AIR
616 GDD SLUDGE HOPPER
620 TWAS
625 HYDROLYSIS
630 PRIMARY DIGESTER 1
631 PRIMARY DIGESTER 2
632 PRIMARY DIGESTER 3
633 PRIMARY DIGESTER 4
634 STORAGE DIGESTER 1
635 STORAGE DIGESTER 2
640 CENTRIFUGE 1
641 CENTRIFUGE 2
642 CENTRIFUGE 3
643 CENTRATE
644 CENTRIFUGE POLYMER DOSING
650 CAKE HANDLING

AREA 7 – SIDESTREAM TREATMENT
701 NITROGEN REMOVAL
710 LIME DOSING

AREA 8 – MISCELLANEOUS
810 OCU1 ACID SCRUBBER
811 OCU1 ODORGUARD SCRUBBER
812 OCU1 STACK DISCHARGE
813 OCU1 SULPHURIC ACID
814 OCU1 CAUSTIC SODA
815 OCU1 SODIUM HYPOCHLORITE
816 OCU1 UTILITY WATER SUPPLY
820 OCU2 ACID SCRUBBER
821 OCU2 ODORGUARD SCRUBBER
822 OCU2 STACK DISCHARGE
823 OCU2 SULPHURIC ACID
824 OCU2 CAUSTIC SODA
825 OCU2 SODIUM HYPOCHLORITE
826 OCU2 UTILITY WATER SUPPLY
830 BLOWERS GENERAL
831 BLOWER 1
832 BLOWER 2
833 BLOWER 3
834 BLOWER 4
835 BLOWER 5
836 BLOWER 6
837 BLOWER 7
838 BLOWER 8
839 BLOWER 9
840 BLOWER 10
841 BLOWER 11
851 FLOWSPLITTER 1
852 FLOWSPLITTER 2
853 FLOWSPLITTER 3
854 FLOWSPLITTER 4
855 FLOWSPLITTER 5
856 FLOWSPLITTER 6
857 FLOWSPLITTER 7
858 FLOWSPLITTER 8
859 FLOWSPLITTER 9
860 GENERAL PURPOSE PUMP STN
870 COMPRESSED AIR
890 SAFETY SHOWER

AREA 9 – TERTIARY TREATMENT

P&IDs – DRAWING LIST – REFER TO REGISTERS FOR CURRENT REVISIONS

486/5/5–S3D101	PRIMARY SETTLING TANKS
486/5/5–S3D102	FLOWSPLITTER 2 & ANAEROBIC ZONE
486/5/5–S3D103	BIOREACTOR 1
486/5/5–S3D104	BIOREACTOR 2
486/5/5–S3D105	FINAL SETTLING TANK 1
486/5/5–S3D106	FINAL SETTLING TANK 2
486/5/5–S3D107	FINAL SETTLING TANK 3
486/5/5–S3D108	UV DISINFECTION AND SERVICE WATER
486/5/5–S3D108/2	SERVICE WATER
486/5/5–S3D109	WAS PUMP STATION
486/5/5–S3D110	WAS DEWATERING
486/5/5–S3D111	SLUDGE HOPPER
486/5/5–S3D112	COMPRESSED AIR
486/5/5–S3D113	POLYELECTROLITE MAKE–UP AND STORAGE
486/5/5–S3D114	POLYELECTROLYTE DOSING
486/5/5–S3D115	BLOWERS
486/5/5–S3N040	IONIZED AIR UNIT
486/5/5–S3Z404	SLUDGE HOPPER HYDRAULIC DIAGRAM
486/5/5–S3Z050	AIR COMPRESSOR P & ID
486/5/5–S3Z051	AIR COMPRESSOR G.A.
486/5/5–S3Z625	POLY MAKE–UP & STORAGE
486/5/5–S3Z626	POLY MAKE–UP & STORAGE

INSTRUMENT DESIGNATION LIST

AAH	ANALYSER ALARM HIGH
AE	ANALYSER ELEMENT
AC	ANALYSER CONTROL
AI	ANALYSER INDICATOR
AIT	ANALYSER INDICATING TRANSMITTER
AIC	ANALYSER INDICATOR CONTROL
C	CONDUCTIVITY (ELECTRICAL)
FAH	FLOW ALARM HIGH
FAL	FLOW ALARM LOW
FCV	FLOW CONTROL VALVE
FE	FLOW SENSING ELEMENT
FI	FLOW INDICATOR
FIT	FLOW INDICATING TRANSMITTER
FIQ	FLOW INDICATOR TOTAL
FQ	FLOW TOTAL
FS	FLOW SWITCH
FSH	FLOW SWITCH HIGH
FSHH	FLOW SWITCH HIGH HIGH
FSL	FLOW SWITCH LOW
FSLL	FLOW SWITCH LOW LOW
FT	FLOW TRANSMITTER
FX	FLOW SET POINT
G	GAUGING (DIMENSIONAL)
HS	HAND SWITCH
HY	HAND RELAY
I	CURRENT
J	POWER
KC	TIME CONTROL
KX	TIME SET POINT
LAH	LEVEL ALARM HIGH
LAHH	LEVEL ALARM HIGH HIGH
LAHHH	LEVEL ALARM HIGH HIGH HIGH
LAHHT	LEVEL ALARM HIGH HIGH TRANSMITTER
LAL	LEVEL ALARM LOW
LE	LEVEL SENSING ELEMENT
LI	LEVEL INDICATOR
LIT	LEVEL INDICATING TRANSMITTER
LLI	LEVEL LIGHT INDICATOR
LLLA	LEVEL LIGHT LOW ALARM
LS	LEVEL SWITCH
LSH	LEVEL SWITCH HIGH
LSHH	LEVEL SWITCH HIGH HIGH
LSL	LEVEL SWITCH LOW
LSLL	LEVEL SWITCH LOW LOW
LT	LEVEL TRANSMITTER
LY	LEVEL RELAY
M	MOISTURE

INSTRUMENT DESIGNATION LIST

N	INTERFACE
O	OSCILLATION
PAH	PRESSURE ALARM HIGH
PAL	PRESSURE ALARM LOW
PC	PRESSURE CONTROL
PE	PRESSURE SENSING
PD	PRESSURE DIFFERENTIAL
PDE	PRESSURE DIFFERENTIAL
PDI	PRESSURE DIFFERENTIAL
PDIT	P DIFFERENTIAL INDICATOR TRANSMITTER
PDS	PRESSURE DIFFERENTIAL SWITCH
PDSH	PRESSURE DIFFERENTIAL SWITCH HIGH
PDSL	PRESSURE DIFFERENTIAL SWITCH LOW
PI	PRESSURE INDICATOR
PIC	PRESSURE INDICATOR CONTROL
PIT	PRESSURE INDICATOR TRANSMITTER
PSH	PRESSURE SWITCH HIGH
PSHH	PRESSURE SWITCH HIGH HIGH
PS	PRESSURE SWITCH
PSL	PRESSURE SWITCH LOW
PSLL	PRESSURE SWITCH LOW LOW
PT	PRESSURE TRANSMITTER
PX	PRESSURE SET POINT
Q	QUANTITY
R	RADIATION
SAH	SPEED ALARM HIGH
SAL	SPEED ALARM LOW
SI	SPEED INDICATOR
SIC	SPEED INDICATOR CONTROLLER
SSL	UNDERSPEED SWITCH
SX	SPEED SET POINT
SY	SPEED RELAY
TE	TEMPERATURE SENSING
TI	TEMPERATURE INDICATOR
TIT	TEMPERATURE INDICATOR TRANSMITTER
TSH	TEMPERATURE SWITCH HIGH
TSL	TEMPERATURE SWITCH LOW
TT	TEMPERATURE TRANSMITTER
VS	VIBRATION SWITCH
WAH	WEIGHT ALARM HIGH
WAL	WEIGHT ALARM LOW
WE	WEIGHT SENSING
WI	WEIGHT INDICATOR

INSTRUMENT DESIGNATION LIST

WIT	WEIGHT INDICATOR TRANSMITTER
WS	WEIGHT SWITCH
XA	UNCLASSIFIED ALARM
XE	UNCLASSIFIED SENSING
XAL	UNCLASSIFIED ALARM LOW
XS	UNCLASSIFIED SWITCH
XT	UNCLASSIFIED SWITCH
YAH	TORQUE ALARM HIGH
YS	TORQUE SWITCH
YSS	TORQUE SAFETY SWITCH
ZA	POSITION ALARM
ZC	POSITION CONTROL
ZE	POSITION SENSING
ZIT	POSITION INDICATOR TRANSMITTER
ZI	POSITION INDICATOR
ZIC	POSITION INDICATOR CLOSED
ZIO	POSITION INDICATOR OPEN
ZO	POSITION OPEN
ZS	POSITION SWITCH
ZSC	POSITION SWITCH CLOSED
ZSO	POSITION SWITCH OPEN
ZSS	POSITION SAFETY SWITCH
ZX	SET POINT
ZY	POSITION RELAY

EQUIPMENT DESIGNATION LIST

ACT	ACTUATOR
BFP	BELT FILTER PRESS
BL	BLOWER
CP	COMPRESSOR
CV	CONVEYOR
FDR	FEEDER
GDD	GRAVITY DRAINAGE DECK
GT	GRIT TRAP
HV	HAND VALVE
IPS	INSTRUMENT POWER SUPPLY
MW	MOTORISED WEIR
MX	MIXER
PRV	PRESSURE RELIEF VALVE
PSV	PRESSURE SUSTAINING VALVE
PT	PENSTOCK
PU	PUMP
SC	SCREEN
SB	STOP BOARD
SV	SOLENOID VALVE
TK	TANK
UV	UV DISINFECTANT
WR	WEIR

PIPE SERVICE CODES

CL – CHLORINE
DGS – DEGRITTED SEWAGE
CP – COMPRESSED
DR – DRAINAGE
DS – DIGESTED SLUDGE
EC – ELECTRICAL CONDUIT
EW – EFFLUENT WATER
FA – FOUL AIR
FL – FILTRATE/CENTRATE
GF– GAS FEED
GR – GAS RECIRCULATION
H2S – SULPHURIC ACID
HC – HOT COOLANT (ETHYLENE GLYCOL/WATER)
HS – HUMUS SLUDGE
HW – HOT WATER
HWR – HOT WATER RETURN
ML – MIXED LIQUOR
NOCL – SODIUM HYPOCHLORITE
NOH – SODIUM HYDROXIDE
PE – POLYELECTROLITE
PL – PLANT AIR
PRA – PROCESS AIR
PRL – PROCESS LIQUID
PS – PRIMARY SLUDGE
PW – POTABLE WATER
RAS – RETURN ACTIVATED SLUDGE
RE – RECLAIMED EFFLUENT
RS – RAW SEWERAGE
S – SUSPENDED CARRIER EFFLUENT
SC – SCUM
SCW – SECONDARY WASTE WATER
SD – SLUDGE DRAIN
SE – SECONDARY EFFLUENT
SN – SUPERNATANT
SPW – SOFTENED POTABLE WATER
SR – RAW SLUDGE
SS – SECONDARY SLUDGE
SW – SERVICE WATER
SWD – STORM WATER DRAINAGE
TE – TREATED EFFLUENT
TW – TOWN WATER
TWAS – THICKENED WASTE ACTIVATED SLUDGE
WAS – WASTE ACTIVATED SLUDGE
WG – WASTE GAS
WW – WASH WATER

* NAME DENOTES SIGNATURE ON ORIGINAL DRAWING

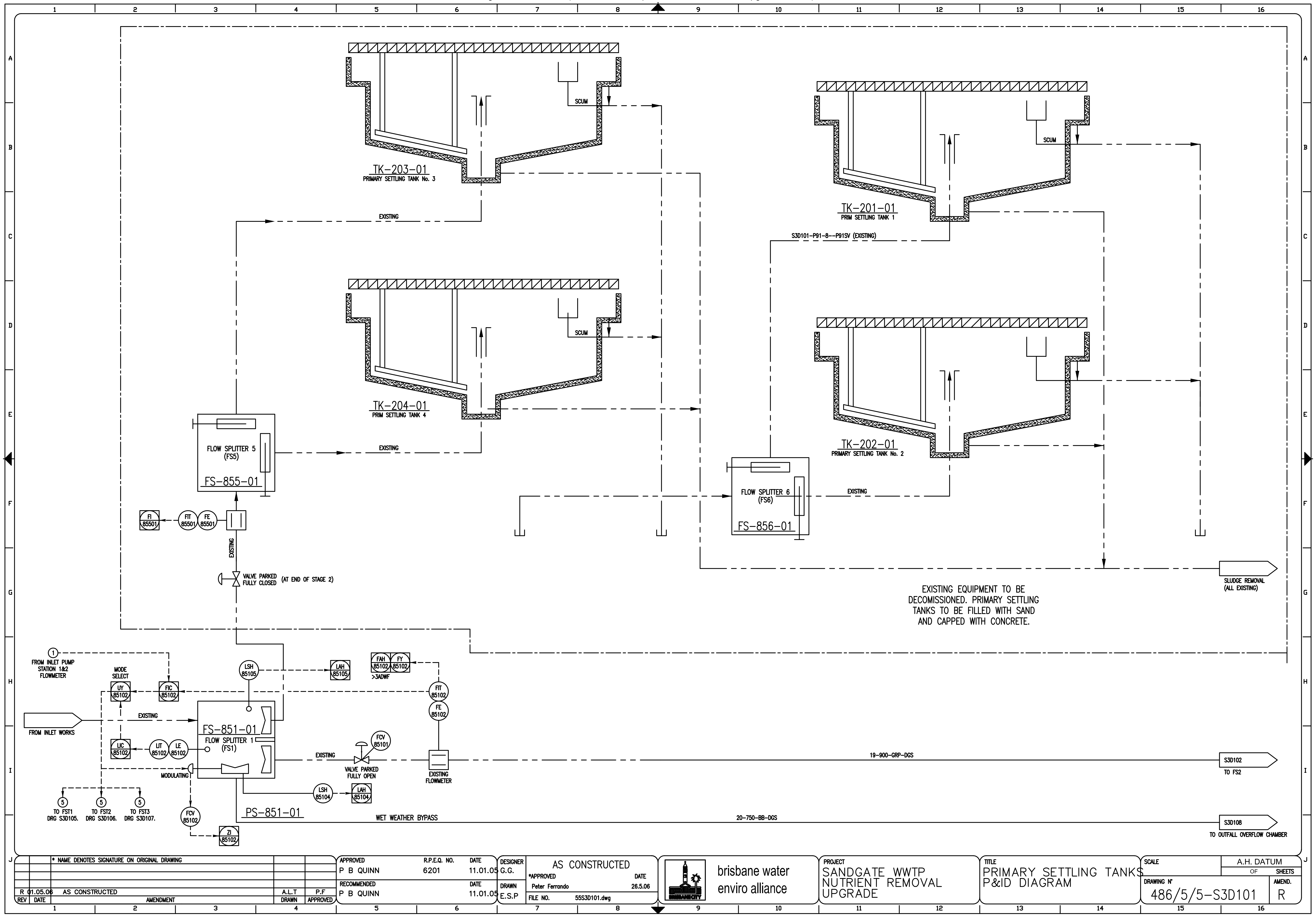
REV	DATE	AMENDMENT	DRAWN	APPROVED
R	01.05.06	AS CONSTRUCTED	A.L.T	P.F

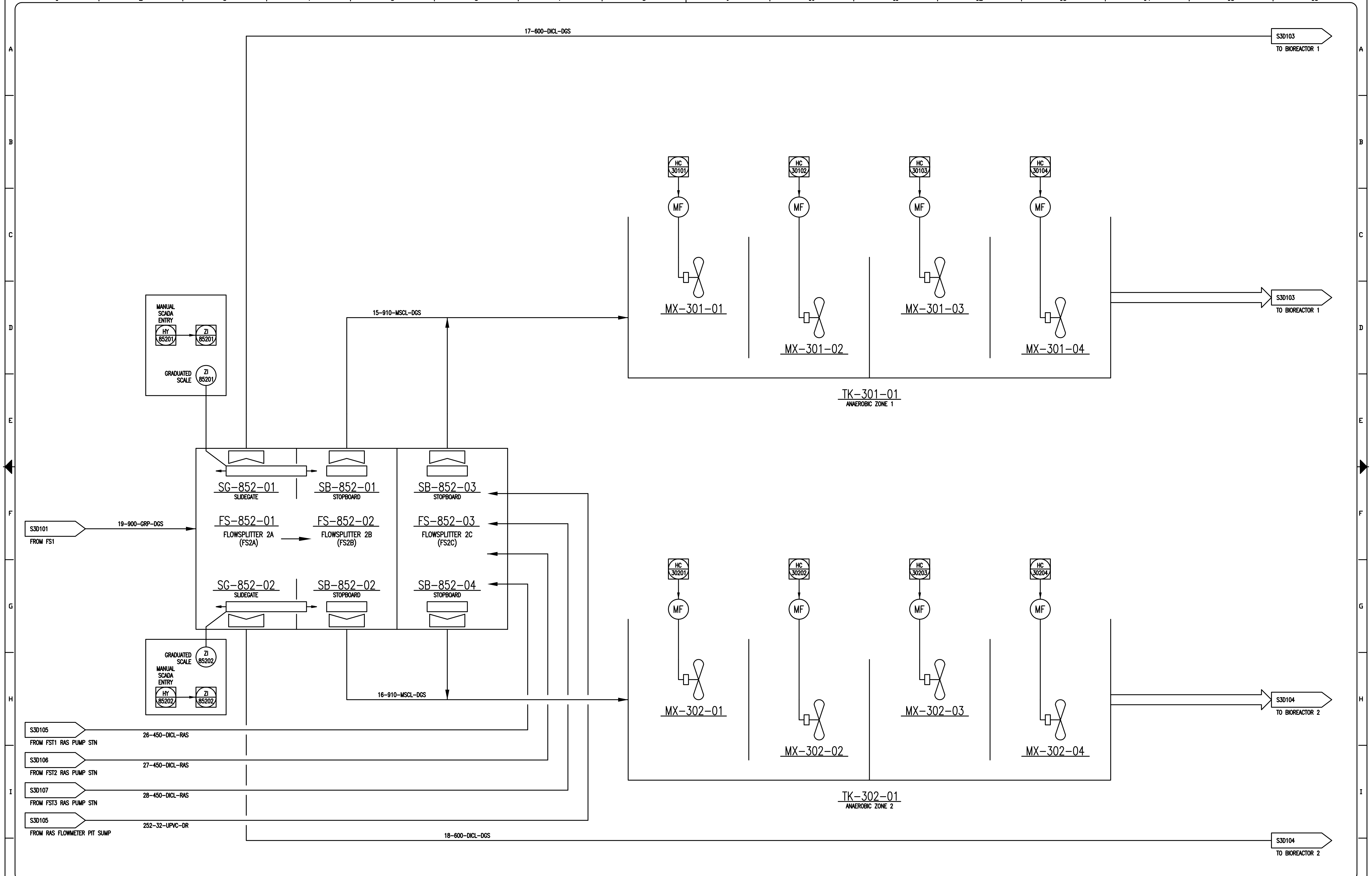
APPROVED: P B QUINN — R.P.E.Q. NO. 6201 — DATE 11.01.05
RECOMMENDED: P B QUINN — DATE 11.01.05
DESIGNER: G.G.
DRAWN: E.S.P

AS CONSTRUCTED
*APPROVED: Peter Ferrando — DATE 26.5.06
FILE NO. 55S3D100.dwg

brisbane water
enviro alliance

PROJECT: SANDGATE WWTP NUTRIENT REMOVAL UPGRADE
TITLE: P&ID DIAGRAM LEGEND
SCALE: A.H. DATUM
OF SHEETS
DRAWING Nº 486/5/5–S3D100
AMEND. R


TK-203-01
PRIMARY SETTLING TANK No. 3
SCUM
EXISTING
TK-204-01
PRIM SETTLING TANK 4
SCUM
EXISTING
FLOW SPLITTER 5 (FS5)
FS-855-01
FI 85501
FIT 85501
FE 85501
EXISTING
VALVE PARKED FULLY CLOSED (AT END OF STAGE 2)
TK-201-01
PRIM SETTLING TANK 1
SCUM
S3D101-P91-8--P91SV (EXISTING)
TK-202-01
PRIMARY SETTLING TANK No. 2
FLOW SPLITTER 6 (FS6)
FS-856-01
EXISTING
SLUDGE REMOVAL (ALL EXISTING)
EXISTING EQUIPMENT TO BE DECOMISSIONED. PRIMARY SETTLING TANKS TO BE FILLED WITH SAND AND CAPPED WITH CONCRETE.
FROM INLET PUMP STATION 1&2 FLOWMETER
MODE SELECT
UY 85102
FIC 85102
LSH 85105
LAH 85105
FAH 85102
FY 85102
>3ADWF
FIT 85102
FE 85102
FROM INLET WORKS
EXISTING
FS-851-01
FLOW SPLITTER 1 (FS1)
LIC 85102
LIT 85102
LE 85102
MODULATING
EXISTING
FCV 85101
VALVE PARKED FULLY OPEN
EXISTING FLOWMETER
19-900-GRP-DGS
S3D102
TO FS2
TO FST1 DRG S3D105.
TO FST2 DRG S3D106.
TO FST3 DRG S3D107.
LSH 85104
LAH 85104
FCV 85102
ZI 85102
PS-851-01
WET WEATHER BYPASS
20-750-BB-DGS
S3D108
TO OUTFALL OVERFLOW CHAMBER
* NAME DENOTES SIGNATURE ON ORIGINAL DRAWING
R 01.05.06 AS CONSTRUCTED A.L.T P.F
REV DATE AMENDMENT DRAWN APPROVED
APPROVED P B QUINN R.P.E.Q. No. 6201 DATE 11.01.05
RECOMMENDED P B QUINN DATE 11.01.05
DESIGNER G.G.
DRAWN E.S.P
AS CONSTRUCTED
*APPROVED Peter Ferrando DATE 26.5.06
FILE NO. 55S3D101.dwg
brisbane water
enviro alliance
PROJECT SANDGATE WWTP NUTRIENT REMOVAL UPGRADE
TITLE PRIMARY SETTLING TANKS P&ID DIAGRAM
SCALE
A.H. DATUM
OF SHEETS
DRAWING No 486/5/5-S3D101
AMEND. R



REV	DATE	AMENDMENT	DRAWN	APPROVED
		* NAME DENOTES SIGNATURE ON ORIGINAL DRAWING		
R	01.05.06	AS CONSTRUCTED	A.L.T	P.F

APPROVED: P B QUINN — R.P.E.Q. NO. 6201 — DATE 11.01.05
RECOMMENDED: P B QUINN — DATE 11.01.05
DESIGNER: G.G.
DRAWN: E.S.P

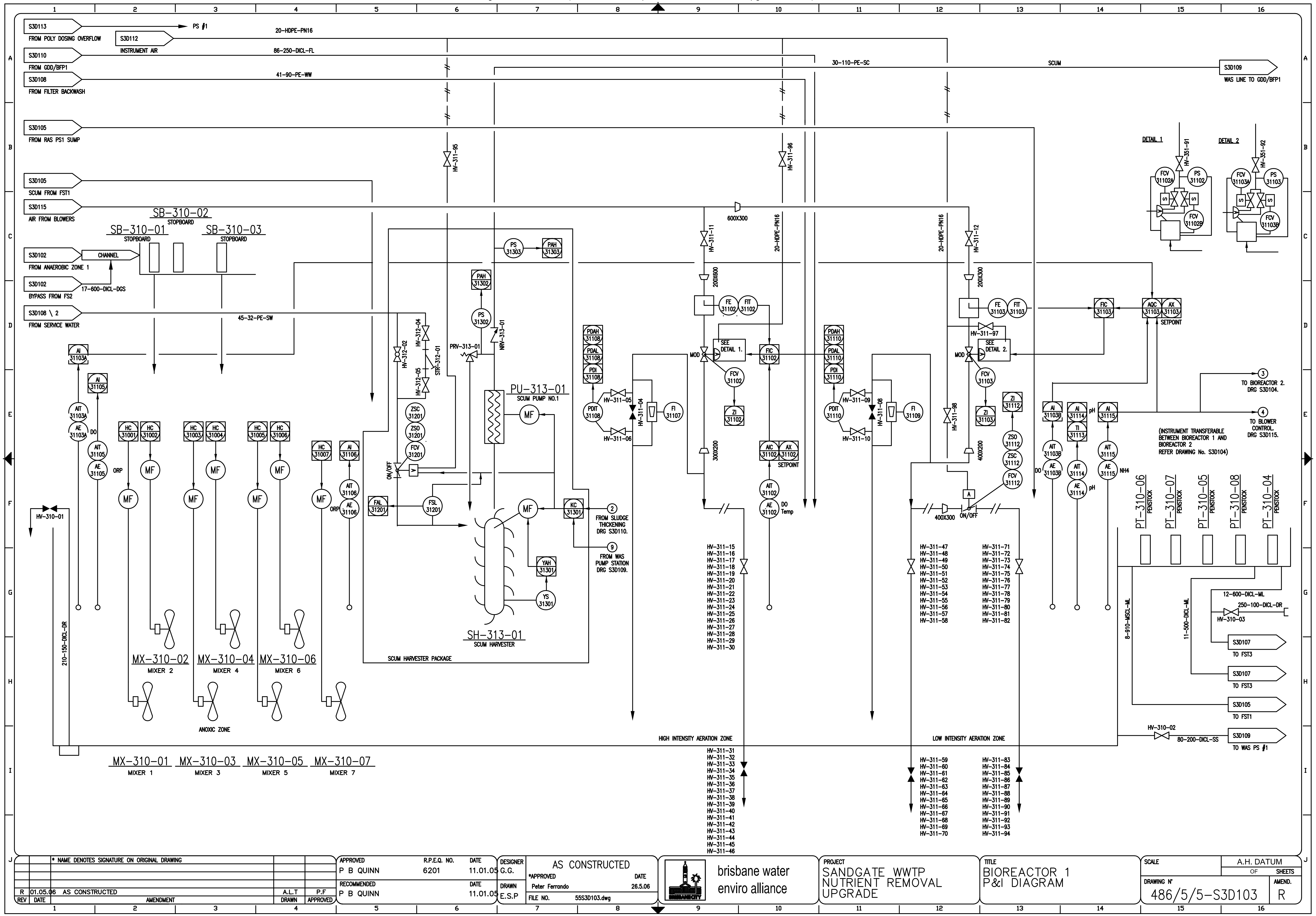
AS CONSTRUCTED
*APPROVED: Peter Ferrando — DATE 26.5.06
FILE NO. 55S3D102.dwg

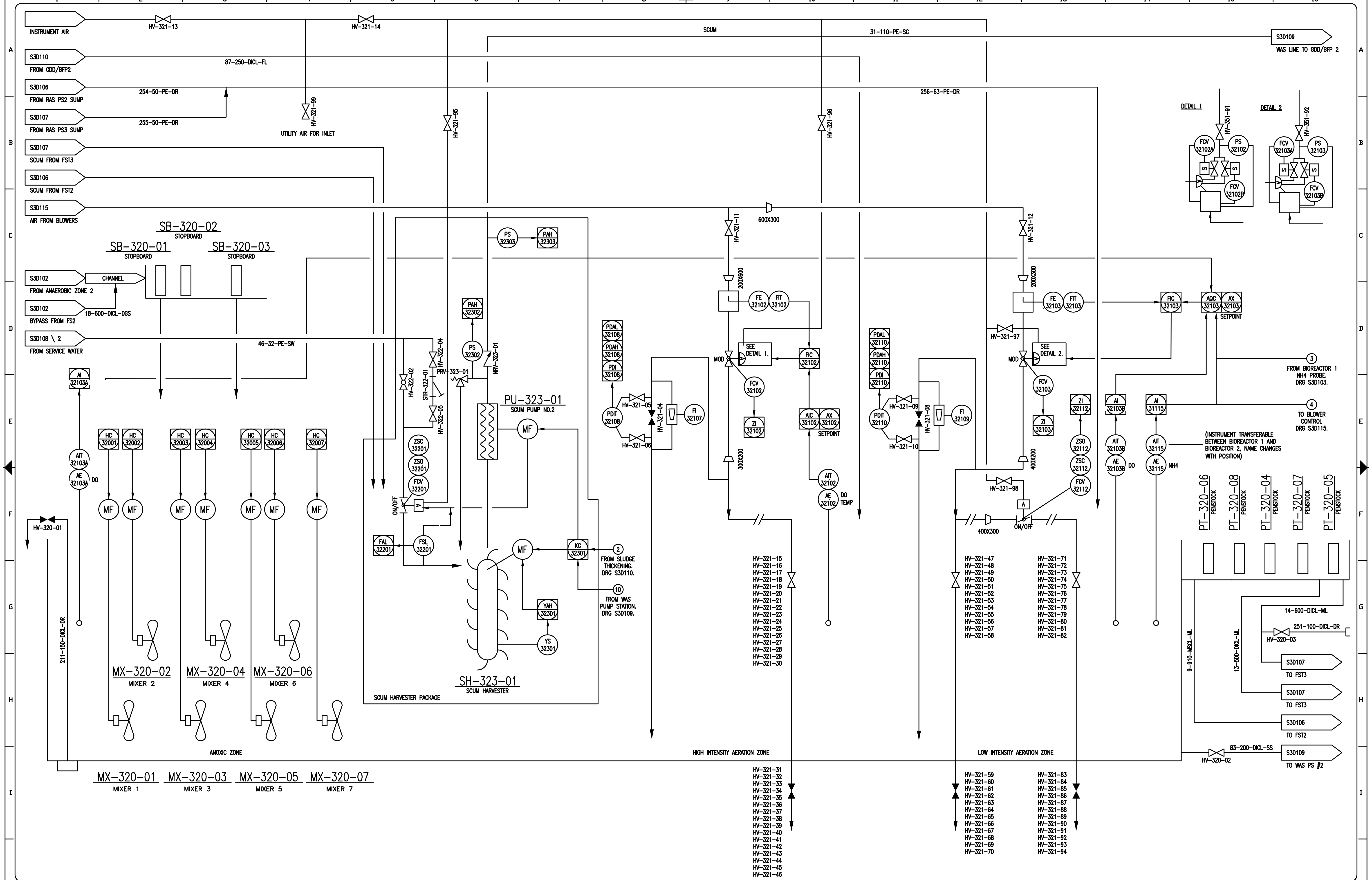
brisbane water enviro alliance

PROJECT: SANDGATE WWTP NUTRIENT REMOVAL UPGRADE

TITLE: FLOWSPLITTER 2 & ANAEROBIC ZONE P&ID DIAGRAM

SCALE: A.H. DATUM
OF SHEETS
DRAWING No: 486/5/5-S3D102
AMEND. R


S3D113
FROM POLY DOSING OVERFLOW
PS #1
S3D112
INSTRUMENT AIR
20-HDPE-PN16
S3D110
FROM GDD/BFP1
86-250-DICL-FL
S3D108
FROM FILTER BACKWASH
41-90-PE-WW
30-110-PE-SC
SCUM
S3D109
WAS LINE TO GDD/BFP1
S3D105
FROM RAS PS1 SUMP
S3D105
SCUM FROM FST1
S3D115
AIR FROM BLOWERS
600X300
S3D102
FROM ANAEROBIC ZONE 1
CHANNEL
S3D102
BYPASS FROM FS2
17-600-DICL-DGS
S3D108 \ 2
FROM SERVICE WATER
45-32-PE-SW
SB-310-01
STOPBOARD
SB-310-02
STOPBOARD
SB-310-03
STOPBOARD
DETAIL 1
DETAIL 2
PU-313-01
SCUM PUMP NO.1
SH-313-01
SCUM HARVESTER
SCUM HARVESTER PACKAGE
FROM SLUDGE THICKENING DRG S3D110.
FROM WAS PUMP STATION DRG S3D109.
MX-310-02
MIXER 2
MX-310-04
MIXER 4
MX-310-06
MIXER 6
ANOXIC ZONE
MX-310-01
MIXER 1
MX-310-03
MIXER 3
MX-310-05
MIXER 5
MX-310-07
MIXER 7
210-150-DICL-DR
HV-310-01
HIGH INTENSITY AERATION ZONE
LOW INTENSITY AERATION ZONE
HV-311-15 … HV-311-46
HV-311-47 … HV-311-70
HV-311-71 … HV-311-94
TO BIOREACTOR 2. DRG S3D104.
TO BLOWER CONTROL. DRG S3D115.
(INSTRUMENT TRANSFERABLE BETWEEN BIOREACTOR 1 AND BIOREACTOR 2 REFER DRAWING No. S3D104)
PT-310-06 PENSTOCK
PT-310-07 PENSTOCK
PT-310-05 PENSTOCK
PT-310-08 PENSTOCK
PT-310-04 PENSTOCK
8-910-MSCL-ML
11-500-DICL-ML
12-600-DICL-ML
250-100-DICL-DR
HV-310-03
S3D107
TO FST3
S3D107
TO FST3
S3D105
TO FST1
HV-310-02
80-200-DICL-SS
S3D109
TO WAS PS #1
* NAME DENOTES SIGNATURE ON ORIGINAL DRAWING
R 01.05.06 AS CONSTRUCTED A.L.T P.F
REV DATE AMENDMENT DRAWN APPROVED
APPROVED P B QUINN R.P.E.Q. NO. 6201 DATE 11.01.05
RECOMMENDED P B QUINN DATE 11.01.05
DESIGNER G.G.
DRAWN E.S.P
AS CONSTRUCTED
*APPROVED Peter Ferrando DATE 26.5.06
FILE NO. 55S3D103.dwg
brisbane water enviro alliance
PROJECT SANDGATE WWTP NUTRIENT REMOVAL UPGRADE
TITLE BIOREACTOR 1 P&I DIAGRAM
SCALE
A.H. DATUM
OF SHEETS
DRAWING No 486/5/5-S3D103
AMEND. R



* NAME DENOTES SIGNATURE ON ORIGINAL DRAWING				
R	01.05.06	AS CONSTRUCTED	A.L.T	P.F
REV	DATE	AMENDMENT	DRAWN	APPROVED

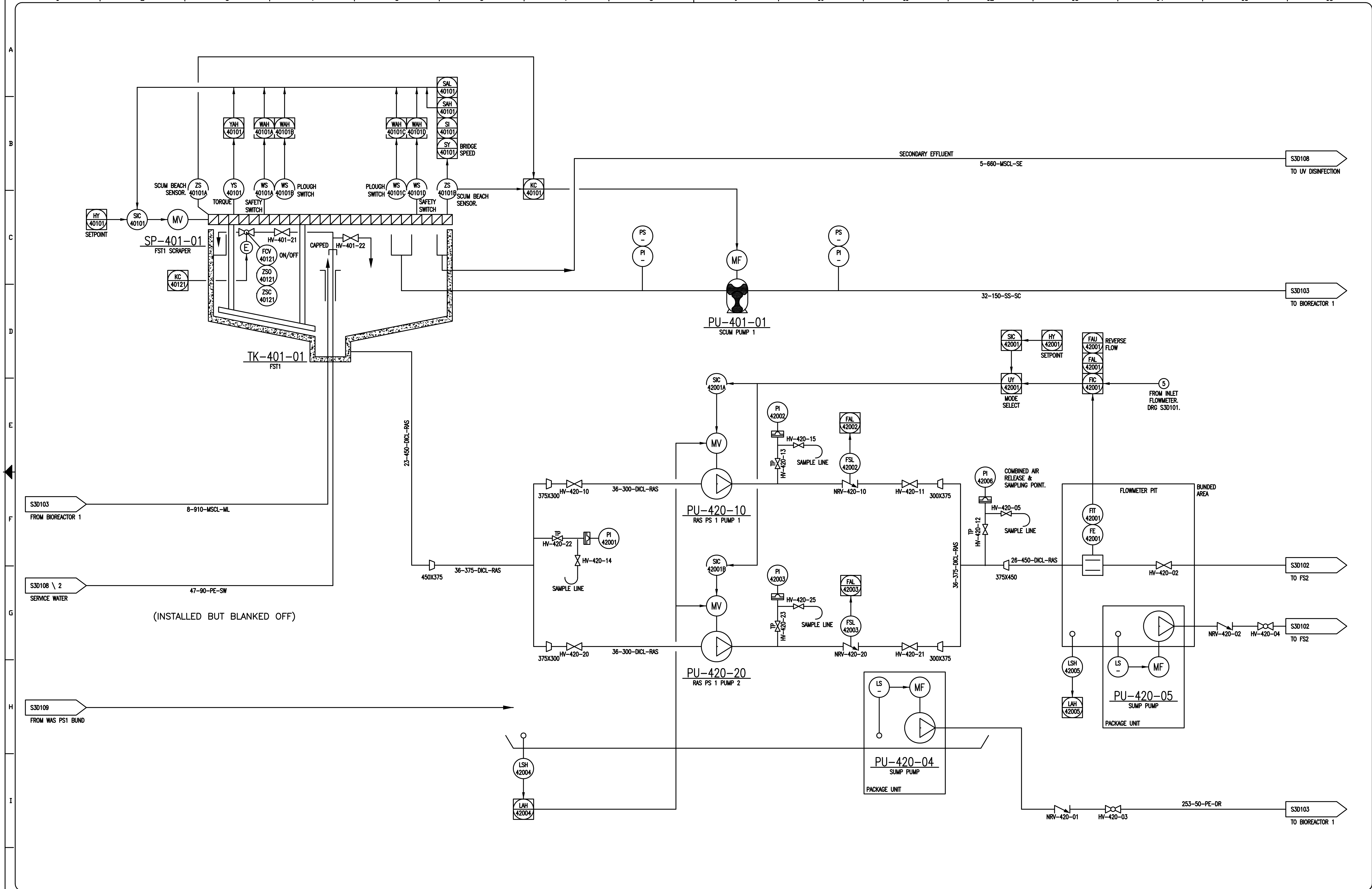
APPROVED P B QUINN — R.P.E.Q. NO. 6201 — DATE 11.01.05
RECOMMENDED P B QUINN — DATE 11.01.05
DESIGNER G.G. — DRAWN E.S.P
AS CONSTRUCTED — *APPROVED Peter Ferrando — DATE 26.5.06
FILE NO. 55S3D104.dwg

brisbane water enviro alliance

PROJECT: SANDGATE WWTP NUTRIENT REMOVAL UPGRADE

TITLE: BIOREACTOR 2 P&ID DIAGRAM

SCALE — A.H. DATUM — OF SHEETS
DRAWING N° 486/5/5-S3D104 — AMEND. R



REV	DATE	AMENDMENT	DRAWN	APPROVED
		* NAME DENOTES SIGNATURE ON ORIGINAL DRAWING		
R	01.05.06	AS CONSTRUCTED	A.L.T	P.F

APPROVED: P B QUINN — R.P.E.Q. NO. 6201 — DATE 11.01.05

RECOMMENDED: P B QUINN — DATE 11.01.05

DESIGNER: G.G.

DRAWN: E.S.P

AS CONSTRUCTED

*APPROVED: Peter Ferrando — DATE 26.5.06

FILE NO. 55S3D105.dwg

brisbane water enviro alliance

PROJECT: SANDGATE WWTP NUTRIENT REMOVAL UPGRADE

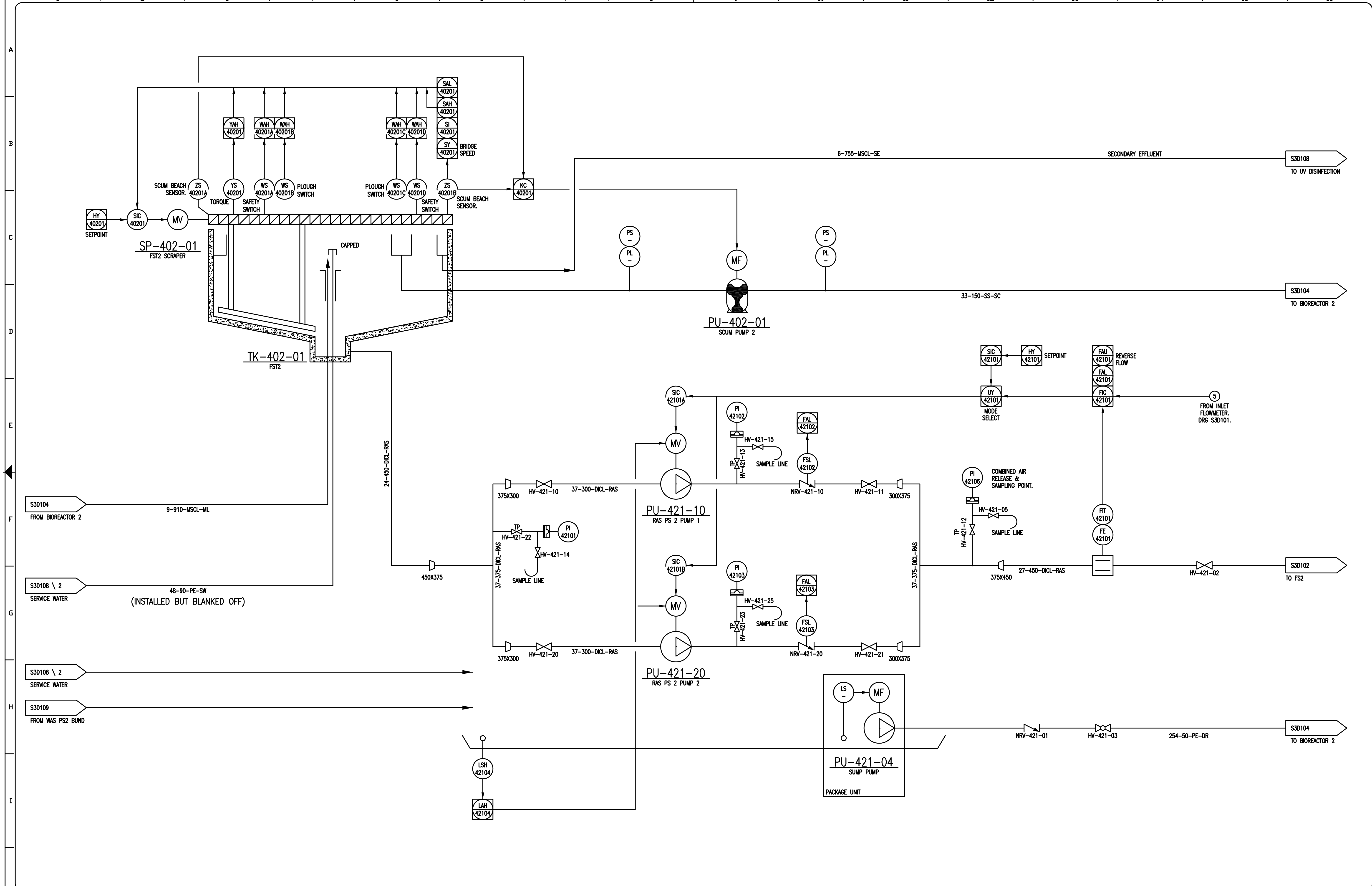
TITLE: FINAL SETTLING TANK 1 P&ID DIAGRAM

SCALE: A.H. DATUM

OF SHEETS

DRAWING Nº 486/5/5-S3D105

AMEND. R



* NAME DENOTES SIGNATURE ON ORIGINAL DRAWING					
R	01.05.06	AS CONSTRUCTED	A.L.T	P.F	
REV	DATE	AMENDMENT	DRAWN	APPROVED	

APPROVED: P B QUINN — R.P.E.Q. NO. 6201 — DATE 11.01.05
RECOMMENDED: P B QUINN — DATE 11.01.05
DESIGNER: G.G. — DRAWN: E.S.P

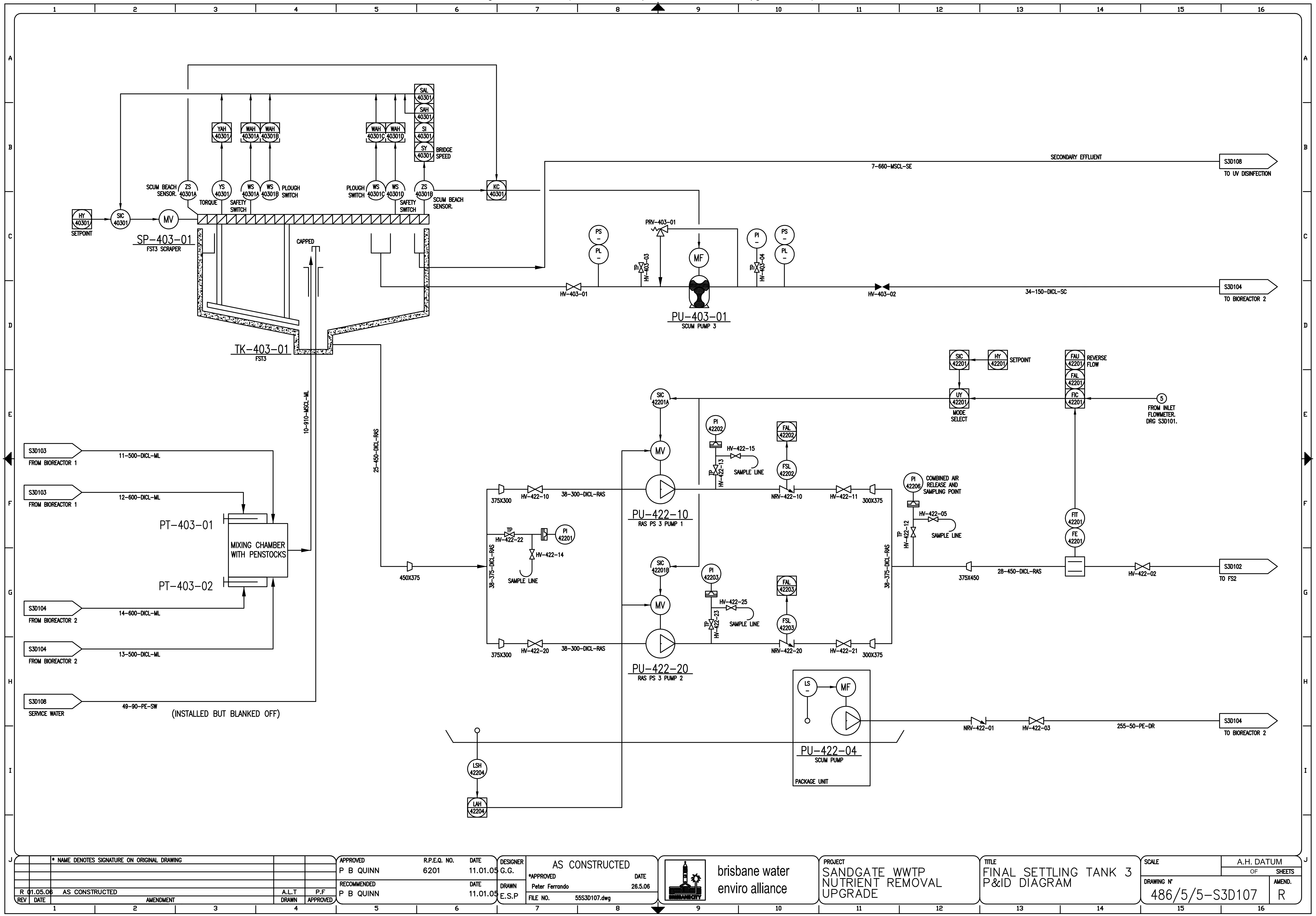
AS CONSTRUCTED
*APPROVED Peter Ferrando — DATE 26.5.06
FILE NO. 55S3D106.dwg

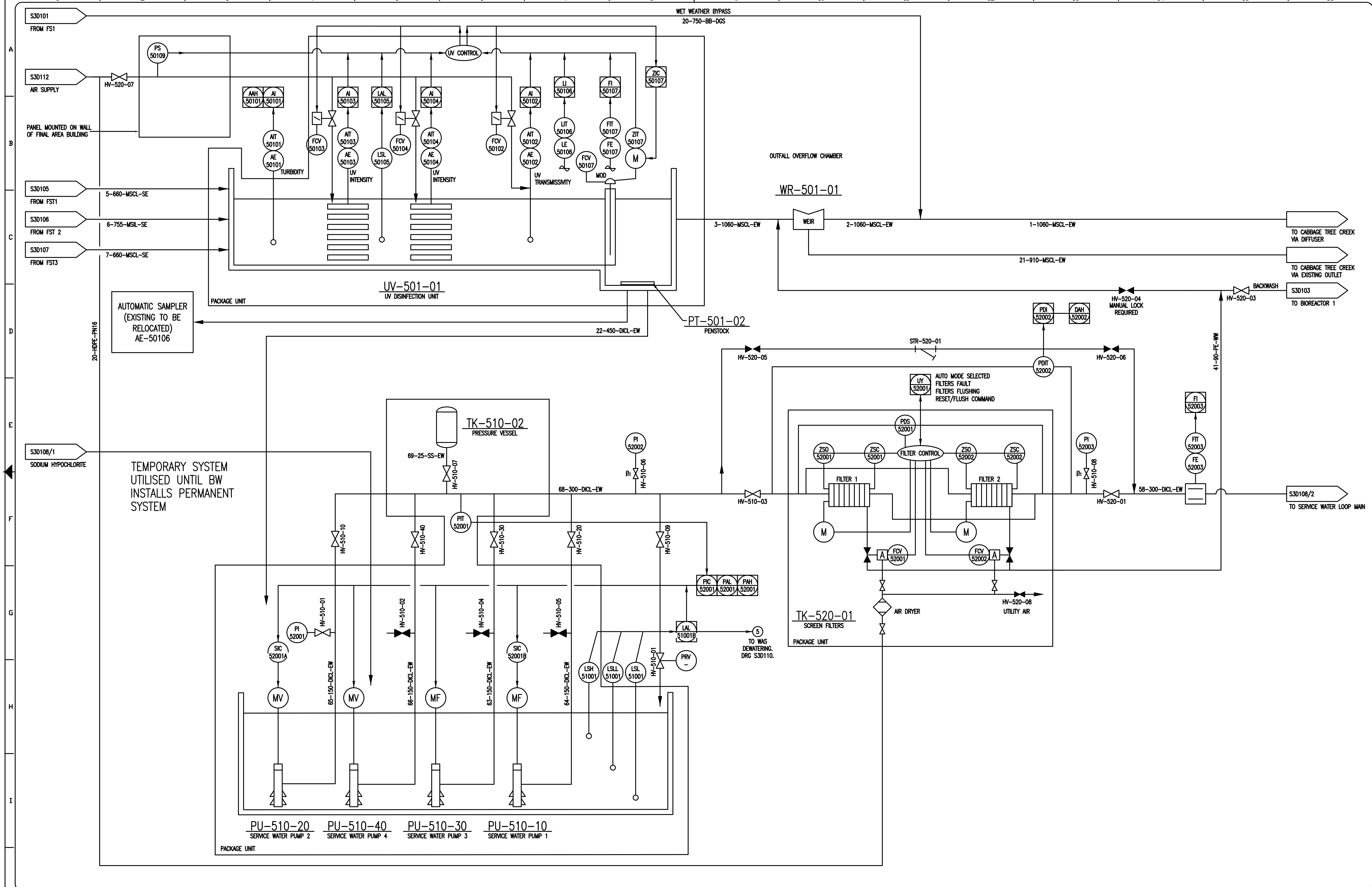
brisbane water enviro alliance

PROJECT: SANDGATE WWTP NUTRIENT REMOVAL UPGRADE

TITLE: FINAL SETTLING TANK 2 P&ID DIAGRAM

SCALE — A.H. DATUM — OF SHEETS
DRAWING Nº 486/5/5-S3D106 — AMEND. R


SAL 40301
SAH 40301
SI 40301
SY 40301 BRIDGE SPEED
YAH 40301
WAH 40301A
WAH 40301B
WAH 40301C
WAH 40301D
SCUM BEACH SENSOR. ZS 40301A
YS 40301 TORQUE
WS 40301A SAFETY SWITCH
WS 40301B PLOUGH SWITCH
PLOUGH SWITCH WS 40301C
WS 40301D SAFETY SWITCH
ZS 40301B SCUM BEACH SENSOR.
KC 40301
HY 40301 SETPOINT
SIC 40301
MV
SP-403-01
FST3 SCRAPER
CAPPED
TK-403-01
FST3
SECONDARY EFFLUENT
7-660-MSCL-SE
S3D108 TO UV DISINFECTION
PRV-403-01
PS
PL
PI
MF
TP HV-403-03
TP HV-403-04
HV-403-01
PU-403-01
SCUM PUMP 3
HV-403-02
34-150-DICL-SC
S3D104 TO BIOREACTOR 2
SIC 42201
HY 42201 SETPOINT
UY 42201 MODE SELECT
FAU 42201 REVERSE FLOW
FAL 42201
FIC 42201
5 FROM INLET FLOWMETER. DRG S3D101.
SIC 42201A
SIC 42201B
PI 42202
HV-422-15
TP HV-422-13
SAMPLE LINE
FAL 42202
FSL 42202
PI 42206 COMBINED AIR RELEASE AND SAMPLING POINT
HV-422-05
TP HV-422-12
FIT 42201
FE 42201
10-910-MSCL-ML
25-450-DICL-RAS
S3D103 FROM BIOREACTOR 1
11-500-DICL-ML
S3D103 FROM BIOREACTOR 1
12-600-DICL-ML
PT-403-01
MIXING CHAMBER WITH PENSTOCKS
PT-403-02
S3D104 FROM BIOREACTOR 2
14-600-DICL-ML
S3D104 FROM BIOREACTOR 2
13-500-DICL-ML
S3D108 SERVICE WATER
49-90-PE-SW
(INSTALLED BUT BLANKED OFF)
375X300
HV-422-10
38-300-DICL-RAS
PU-422-10
RAS PS 3 PUMP 1
NRV-422-10
HV-422-11
300X375
TP HV-422-22
PI 42201
HV-422-14
38-375-DICL-RAS
450X375
PI 42203
HV-422-25
TP HV-422-23
FAL 42203
FSL 42203
375X300
HV-422-20
PU-422-20
RAS PS 3 PUMP 2
NRV-422-20
HV-422-21
300X375
38-375-DICL-RAS
375X450
28-450-DICL-RAS
HV-422-02
S3D102 TO FS2
LS
PU-422-04
SCUM PUMP
PACKAGE UNIT
NRV-422-01
HV-422-03
255-50-PE-DR
S3D104 TO BIOREACTOR 2
LSH 42204
LAH 42204
* NAME DENOTES SIGNATURE ON ORIGINAL DRAWING
R 01.05.06 AS CONSTRUCTED A.L.T P.F
REV DATE AMENDMENT DRAWN APPROVED
APPROVED P B QUINN R.P.E.Q. NO. 6201 DATE 11.01.05
RECOMMENDED P B QUINN DATE 11.01.05
DESIGNER G.G.
DRAWN E.S.P
AS CONSTRUCTED
*APPROVED Peter Ferrando DATE 26.5.06
FILE NO. 55S3D107.dwg
brisbane water enviro alliance
PROJECT SANDGATE WWTP NUTRIENT REMOVAL UPGRADE
TITLE FINAL SETTLING TANK 3 P&ID DIAGRAM
SCALE
A.H. DATUM
OF SHEETS
DRAWING N° 486/5/5-S3D107
AMEND. R



REV	DATE	AMENDMENT	DRAWN	APPROVED
S	01.06.10	FILTER TK-520-01 REVISED – AS BUILT	DPM	G.M.
R	01.05.06	AS CONSTRUCTED	A.L.T	P.F

* NAME DENOTES SIGNATURE ON ORIGINAL DRAWING

APPROVED: P B QUINN — R.P.E.Q. NO. 6201 — DATE 11.01.05
RECOMMENDED: P B QUINN — DATE 11.01.05
DESIGNER: G.G.
DRAWN: E.S.P

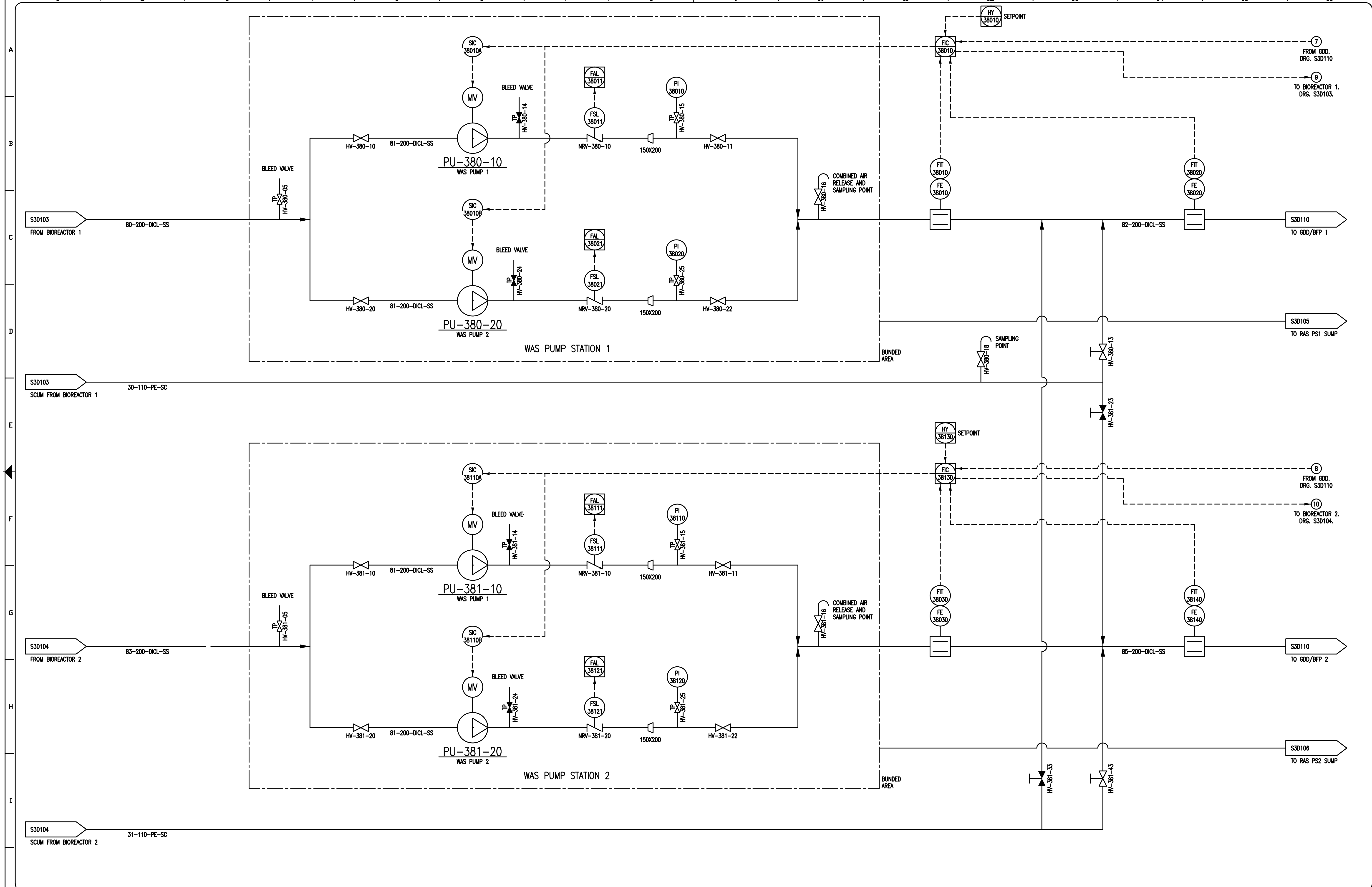
AS CONSTRUCTED
*APPROVED: Peter Ferrando — DATE 26.5.06
FILE NO. 55S3D108.dwg

brisbane water enviro alliance

PROJECT: SANDGATE WWTP NUTRIENT REMOVAL UPGRADE

TITLE: UV DISINFECTION & SERVICE WATER P&ID DIAGRAM

SCALE: A.H. DATUM — OF SHEETS
DRAWING Nº 486/5/5-S3D108 — AMEND. S



* NAME DENOTES SIGNATURE ON ORIGINAL DRAWING				
R	01.05.06	AS CONSTRUCTED	A.L.T	P.F
REV	DATE	AMENDMENT	DRAWN	APPROVED

APPROVED	R.P.E.Q. NO.	DATE
P B QUINN	6201	11.01.05
RECOMMENDED		DATE
P B QUINN		11.01.05

DESIGNER G.G.
DRAWN E.S.P

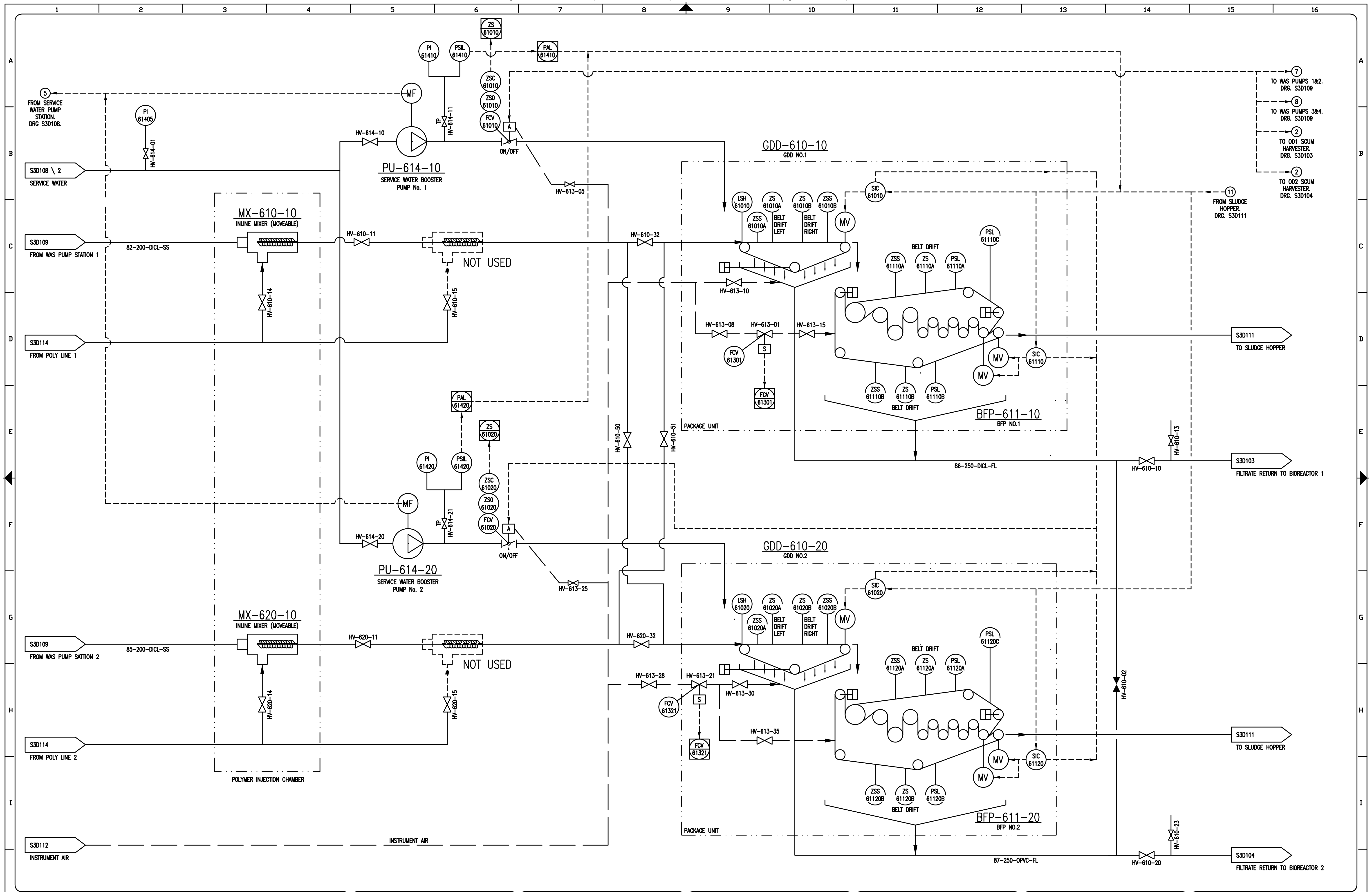
AS CONSTRUCTED
*APPROVED Peter Ferrando DATE 26.5.06
FILE NO. 55S3D109.dwg

brisbane water enviro alliance

PROJECT: SANDGATE WWTP NUTRIENT REMOVAL UPGRADE

TITLE: WAS PUMP STATION P&ID DIAGRAM

SCALE: A.H. DATUM
OF SHEETS
DRAWING Nº 486/5/5-S3D109
AMEND. R



		* NAME DENOTES SIGNATURE ON ORIGINAL DRAWING		
R	01.05.06	AS CONSTRUCTED	A.L.T	P.F
REV	DATE	AMENDMENT	DRAWN	APPROVED

APPROVED: P B QUINN — R.P.E.Q. NO. 6201 — DATE 11.01.05
RECOMMENDED: P B QUINN — DATE 11.01.05
DESIGNER: G.G.
DRAWN: E.S.P

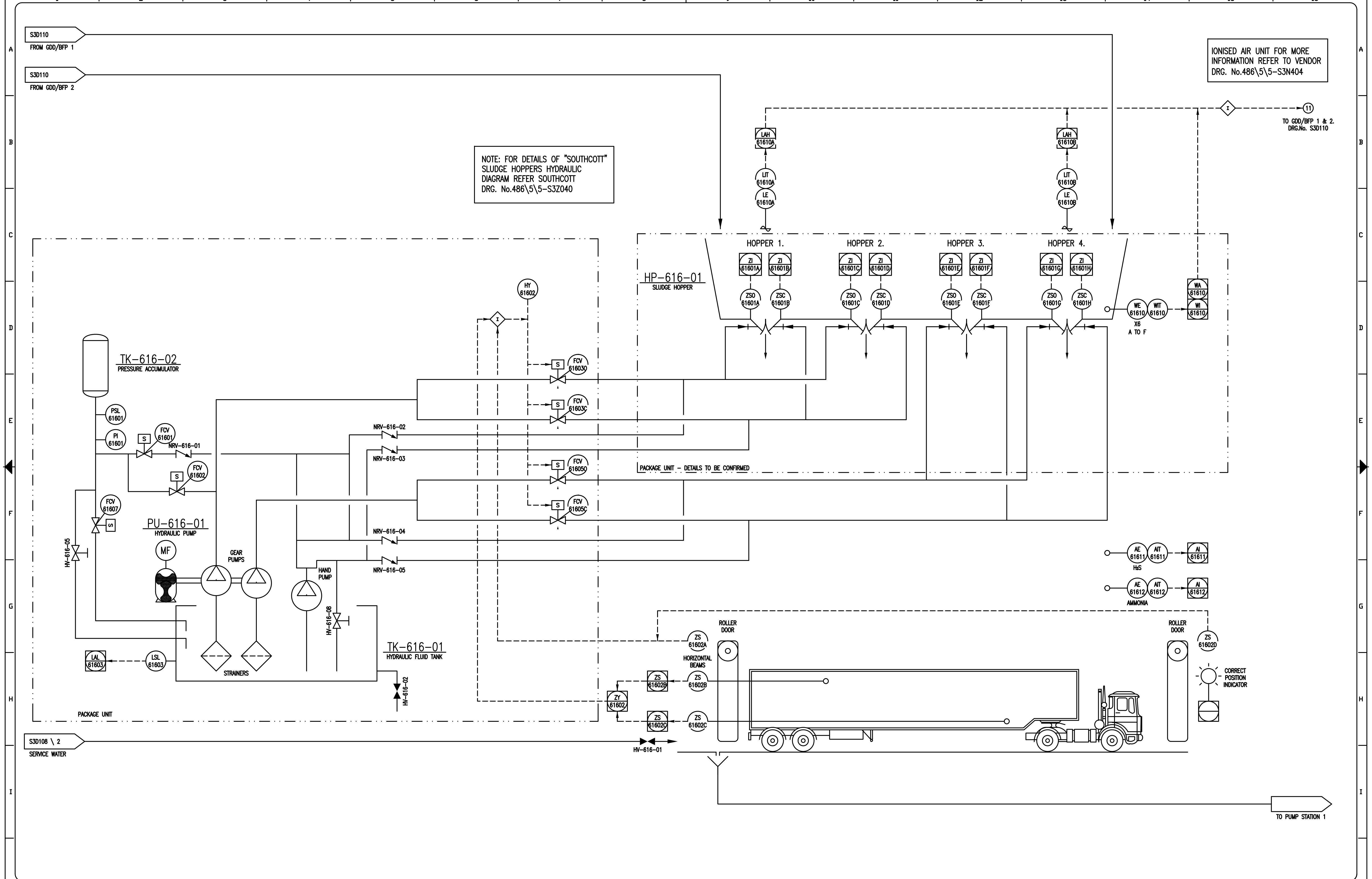
AS CONSTRUCTED
*APPROVED Peter Ferrando — DATE 26.5.06
FILE NO. 55S3D110.dwg

brisbane water enviro alliance

PROJECT: SANDGATE WWTP NUTRIENT REMOVAL UPGRADE

TITLE: WAS DEWATERING P&ID DIAGRAM

SCALE — A.H. DATUM — OF SHEETS
DRAWING N° 486/5/5-S3D110 — AMEND. R



R	01.05.06	AS CONSTRUCTED — A.L.T (DRAWN) — P.F (APPROVED)
REV	DATE	AMENDMENT

* NAME DENOTES SIGNATURE ON ORIGINAL DRAWING

APPROVED: P BQ UINN — R.P.E.Q. NO. 6201 — DATE 11.01.05
RECOMMENDED: P B QUINN — DATE 11.01.05
DESIGNER: G.G.
DRAWN: E.S.P

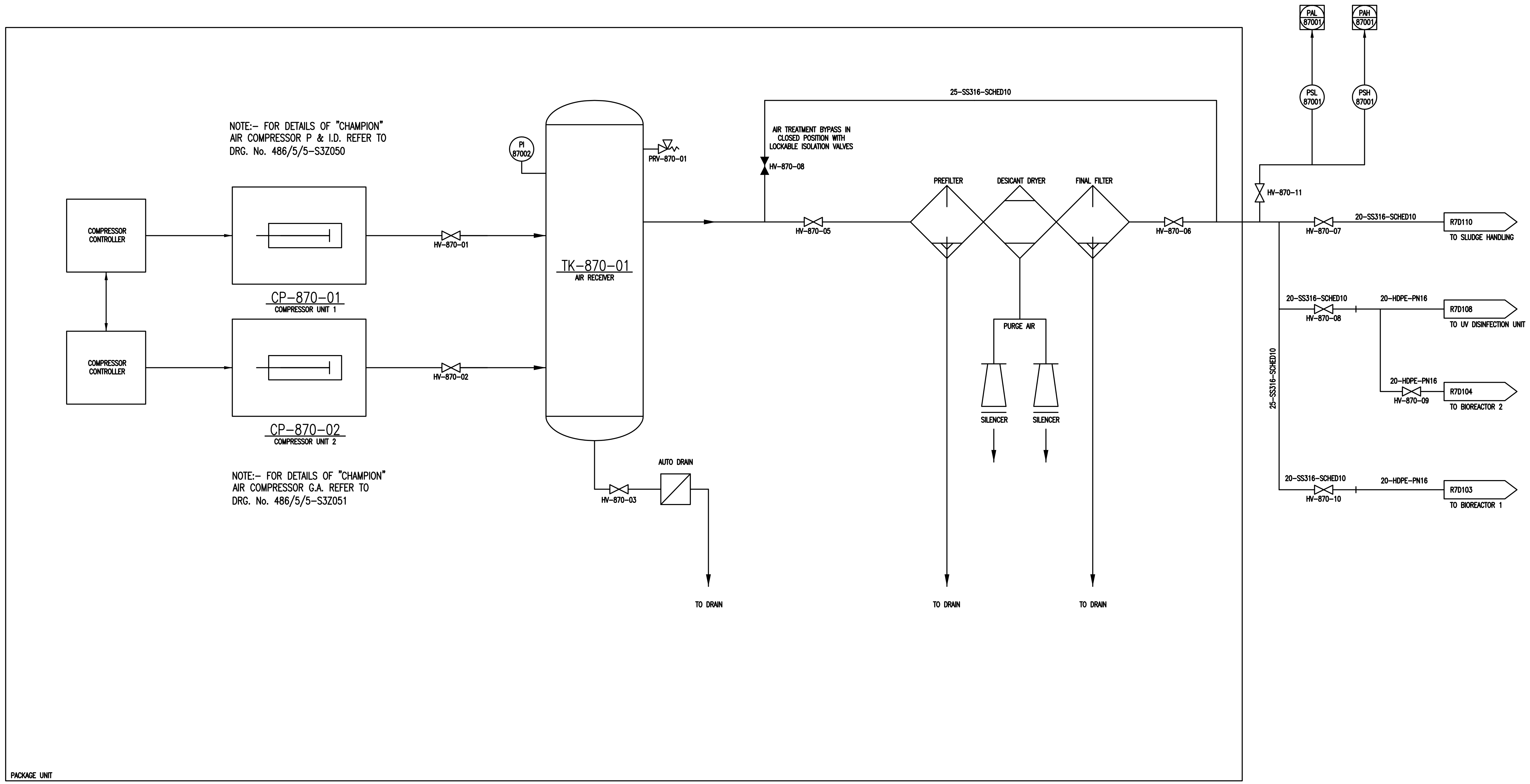
AS CONSTRUCTED
*APPROVED: Peter Ferrando — DATE 26.5.06
FILE NO. 55S3D111.dwg

brisbane water enviro alliance

PROJECT: SANDGATE WWTP NUTRIENT REMOVAL UPGRADE

TITLE: SLUDGE HOPPER P&ID DIAGRAM

SCALE: A.H. DATUM
OF SHEETS
DRAWING N°: 486/5/5-S3D111
AMEND.: R



REV	DATE	AMENDMENT	DRAWN	APPROVED
R	01.05.06	AS CONSTRUCTED	A.L.T	P.F

* NAME DENOTES SIGNATURE ON ORIGINAL DRAWING

APPROVED	R.P.E.Q. NO.	DATE
P B QUINN	6201	11.01.05
RECOMMENDED		DATE
P B QUINN		11.01.05

DESIGNER: G.G.
DRAWN: E.S.P

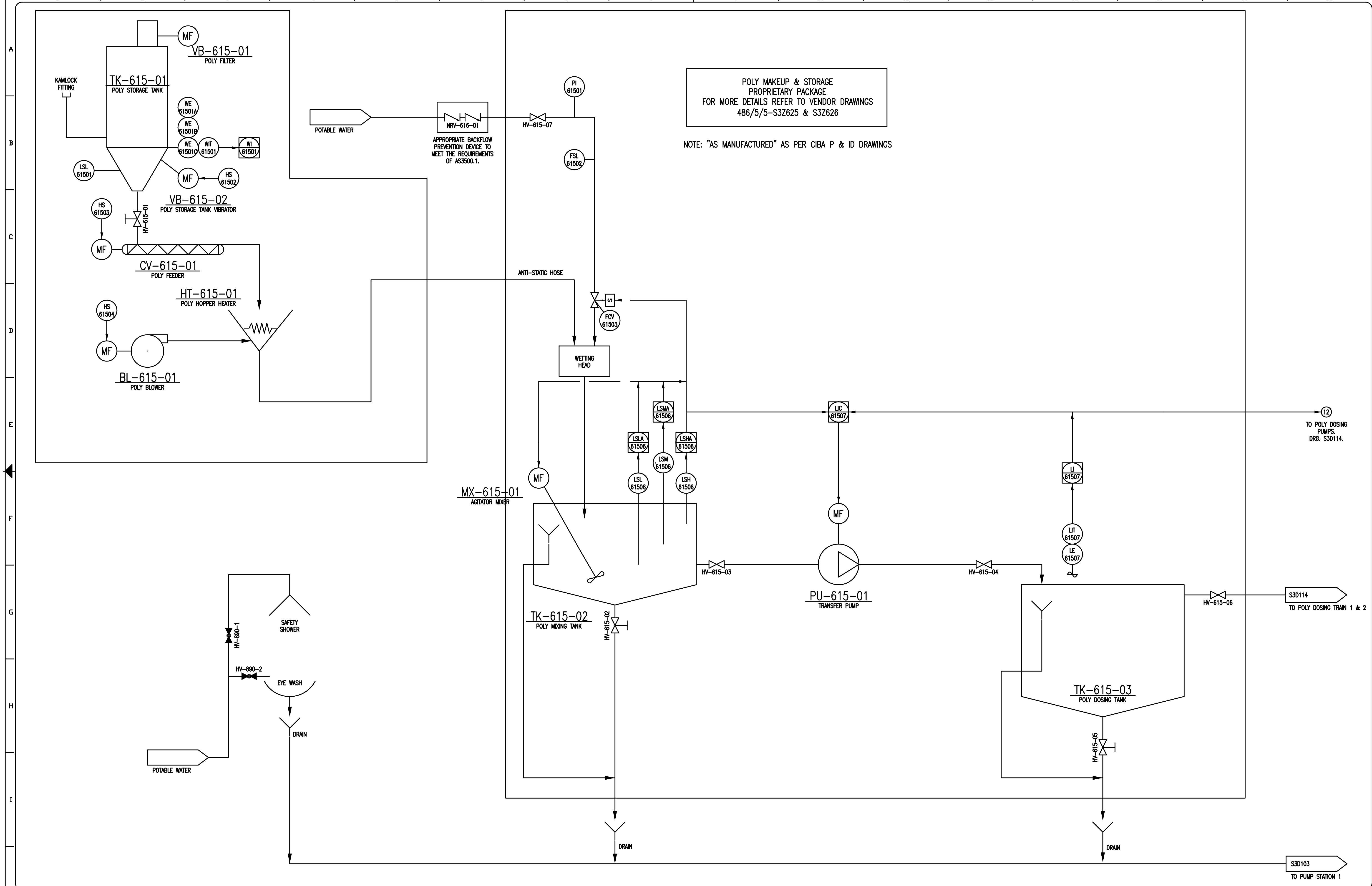
AS CONSTRUCTED
*APPROVED Peter Ferrando DATE 26.5.06
FILE NO. 55S3D112.dwg

brisbane water enviro alliance

PROJECT: SANDGATE WWTP NUTRIENT REMOVAL UPGRADE

TITLE: COMPRESSED AIR P&ID DIAGRAM

SCALE: A.H. DATUM
OF SHEETS
DRAWING N°: 486/5/5-S3D112
AMEND.: R



* NAME DENOTES SIGNATURE ON ORIGINAL DRAWING			
R 01.05.06	AS CONSTRUCTED	A.L.T	P.F
REV DATE	AMENDMENT	DRAWN	APPROVED

APPROVED: P B QUINN — R.P.E.Q. NO. 6201 — DATE 11.01.05
RECOMMENDED: P B QUINN — DATE 11.01.05
DESIGNER: G.G. — DRAWN: E.S.P

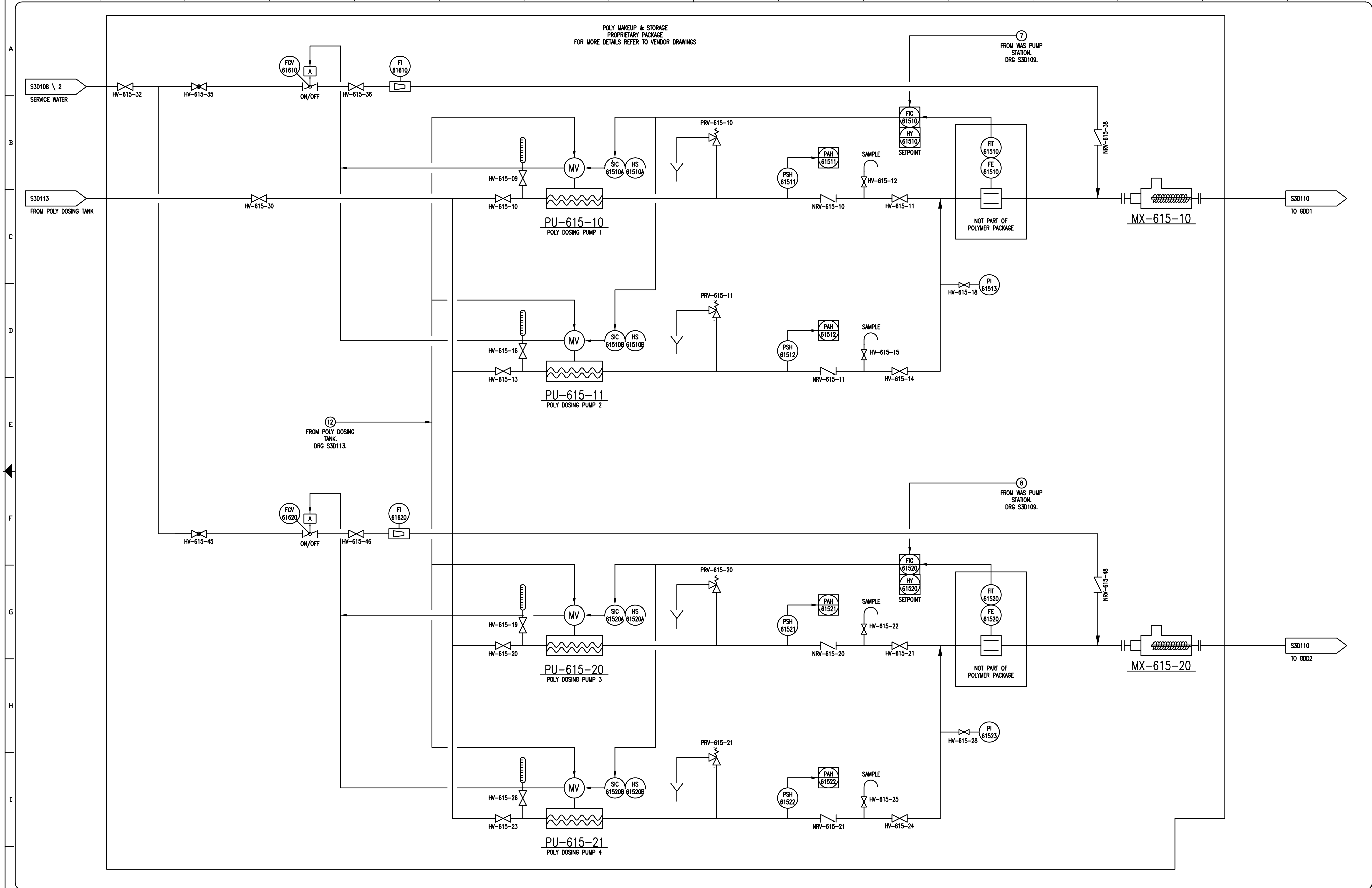
AS CONSTRUCTED
*APPROVED: Peter Ferrando — DATE 26.5.06
FILE NO. 55S3D113.dwg

brisbane water enviro alliance

PROJECT: SANDGATE WWTP NUTRIENT REMOVAL UPGRADE

TITLE: POLYELECTROLYTE MAKE-UP & STORAGE P&ID DIAGRAM

SCALE: A.H. DATUM — OF SHEETS
DRAWING Nº 486/5/5-S3D113 — AMEND. R



	* NAME DENOTES SIGNATURE ON ORIGINAL DRAWING			
R	01.05.06	AS CONSTRUCTED	A.L.T	P.F
REV	DATE	AMENDMENT	DRAWN	APPROVED

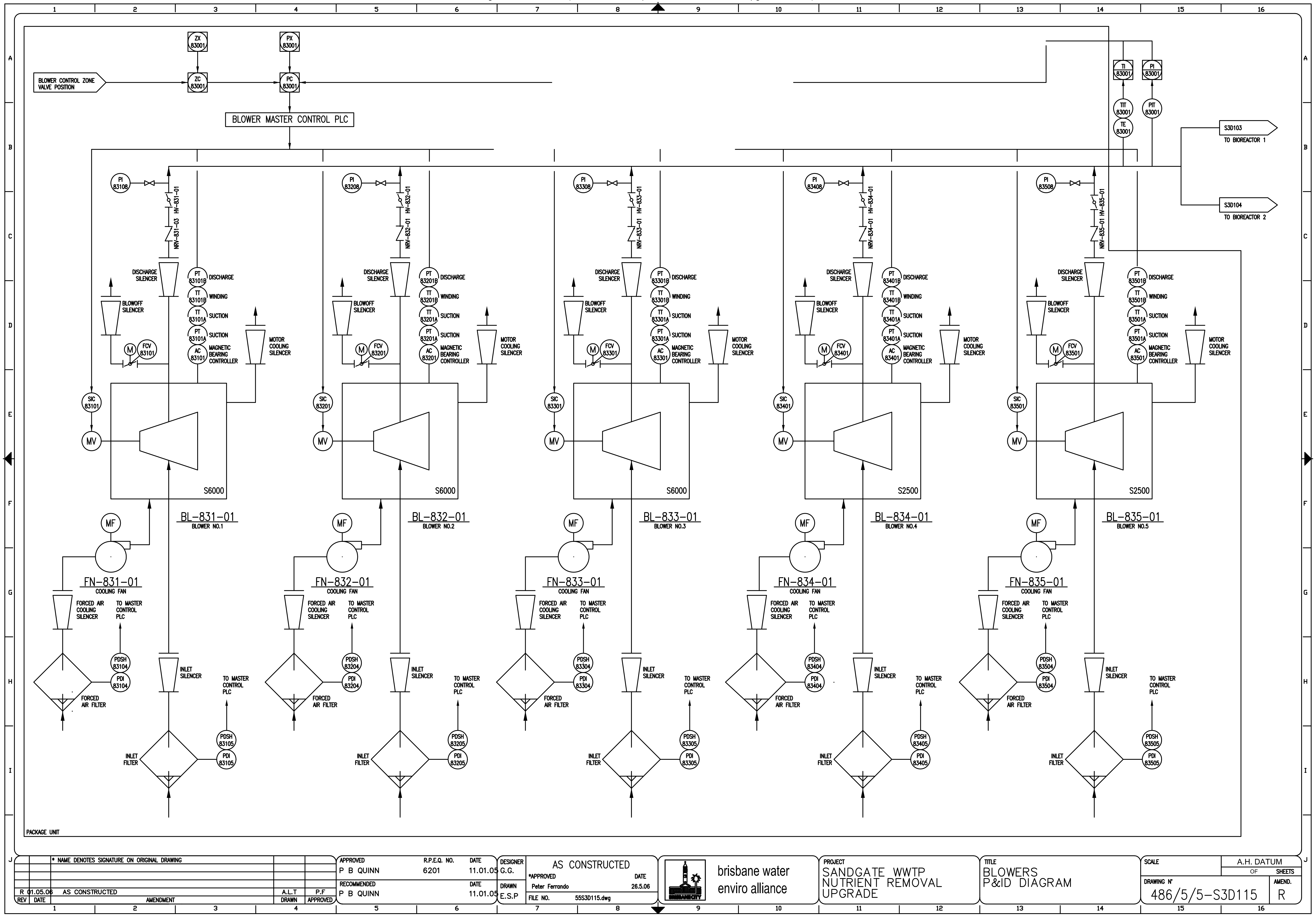
APPROVED P B QUINN — R.P.E.Q. NO. 6201 — DATE 11.01.05
RECOMMENDED P B QUINN — DATE 11.01.05
DESIGNER G.G. — DRAWN E.S.P
AS CONSTRUCTED
*APPROVED Peter Ferrando — DATE 26.5.06
FILE NO. 55S3D114.dwg

brisbane water
enviro alliance

PROJECT: SANDGATE WWTP NUTRIENT REMOVAL UPGRADE

TITLE: POLYELECTROLYTE DOSING P&ID DIAGRAM

SCALE — A.H. DATUM — OF SHEETS
DRAWING N° 486/5/5-S3D114 — AMEND. R


ZX 83001
PX 83001
BLOWER CONTROL ZONE VALVE POSITION
ZC 83001
PC 83001
BLOWER MASTER CONTROL PLC
TI 83001
PI 83001
TIT 83001
TE 83001
PIT 83001
S3D103 TO BIOREACTOR 1
S3D104 TO BIOREACTOR 2
PI 83108
PI 83208
PI 83308
PI 83408
PI 83508
HV-831-01
NRV-831-03
HV-832-01
NRV-832-01
HV-833-01
NRV-833-01
HV-834-01
NRV-834-01
HV-835-01
NRV-835-01
DISCHARGE SILENCER
BLOWOFF SILENCER
MOTOR COOLING SILENCER
PT 83101B DISCHARGE
TT 83101B WINDING
TT 83101A SUCTION
PT 83101A SUCTION
AC 83101 MAGNETIC BEARING CONTROLLER
FCV 83101
PT 83201B DISCHARGE
TT 83201B WINDING
TT 83201A SUCTION
PT 83201A SUCTION
AC 83201 MAGNETIC BEARING CONTROLLER
FCV 83201
PT 83301B DISCHARGE
TT 83301B WINDING
TT 83301A SUCTION
PT 83301A SUCTION
AC 83301 MAGNETIC BEARING CONTROLLER
FCV 83301
PT 83401B DISCHARGE
TT 83401B WINDING
TT 83401A SUCTION
PT 83401A SUCTION
AC 83401 MAGNETIC BEARING CONTROLLER
FCV 83401
PT 83501B DISCHARGE
TT 83501B WINDING
TT 83501A SUCTION
PT 83501A SUCTION
AC 83501 MAGNETIC BEARING CONTROLLER
FCV 83501
SIC 83101
SIC 83201
SIC 83301
SIC 83401
SIC 83501
MV
M
S6000
S6000
S6000
S2500
S2500
MF
BL-831-01 BLOWER NO.1
BL-832-01 BLOWER NO.2
BL-833-01 BLOWER NO.3
BL-834-01 BLOWER NO.4
BL-835-01 BLOWER NO.5
FN-831-01 COOLING FAN
FN-832-01 COOLING FAN
FN-833-01 COOLING FAN
FN-834-01 COOLING FAN
FN-835-01 COOLING FAN
FORCED AIR COOLING SILENCER
TO MASTER CONTROL PLC
PDSH 83104
PDI 83104
PDSH 83204
PDI 83204
PDSH 83304
PDI 83304
PDSH 83404
PDI 83404
PDSH 83504
PDI 83504
FORCED AIR FILTER
INLET SILENCER
INLET FILTER
PDSH 83105
PDI 83105
PDSH 83205
PDI 83205
PDSH 83305
PDI 83305
PDSH 83405
PDI 83405
PDSH 83505
PDI 83505
PACKAGE UNIT
* NAME DENOTES SIGNATURE ON ORIGINAL DRAWING
R 01.05.06 AS CONSTRUCTED A.L.T P.F
REV DATE AMENDMENT DRAWN APPROVED
APPROVED P B QUINN R.P.E.Q. NO. 6201 DATE 11.01.05
RECOMMENDED P B QUINN DATE 11.01.05
DESIGNER G.G.
DRAWN E.S.P
AS CONSTRUCTED
*APPROVED Peter Ferrando DATE 26.5.06
FILE NO. 55S3D115.dwg
brisbane water enviro alliance
PROJECT SANDGATE WWTP NUTRIENT REMOVAL UPGRADE
TITLE BLOWERS P&ID DIAGRAM
SCALE
A.H. DATUM
OF SHEETS
DRAWING No 486/5/5-S3D115
AMEND. R

Appendix B. Inlet Works Functional Specification

Appendix C. HST Blower Package Functional Specification

Appendix D. Odour Control Package Functional Specification

Appendix E. UV Disinfection Package Functional Specification

Appendix F. Service Water Package Functional Specification

Appendix G. GDD/BFP Package Functional Specification

Appendix H. Scum Wasting Package Functional Specification