SSM084

STANDARD ELECTRICAL SPECIFICATION

STANDARD
SEWAGE PUMPING STATION

FUNCTIONAL SPECIFICATION

Current Stakeholder List

NAME AND POSITION	ACTION	SIGNATURE	DATE
KEN VAHEESAN QUU MANAGER, ENGINEERING SERVICES OPERATIONS, MAJOR PROJECTS	APPROVE		
MALCOLM BARRETT LEADER CONTROL SYSTEMS OPERATIONS SERVICE DELIVERY	APPROVE		
HOWARD WITTEN OPERATIONS MANAGER EAST SERVICE DELIVERY, CULLEN AVE, EAGLE FARM	APPROVE		
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CHRIS WOODROW CUSTOMER SERVICE COORDINATOR ELECTRICAL OPERATIONS - SERVICE DELIVERY	APPROVE		
MICHAEL BARTON PRINCIPAL ENGINEER ASSET MAINTENANCE OPERATIONS – ASSET MANAGEMENT	APPROVE		

Original Stakeholder Approval

NAME AND POSITION	ACTION	SIGNATURE	DATE
Alexander Witthoft Project Design Manager Projects: Engineering Services	Recommend	Original Signed (Version 1.00)	27/07/2006
Rahim Janfadah Elect Engineering Manager Projects: Engineering Services	Concur	Original Signed (Version 1.00)	27/07/2006
Peter Sherriff Team Leader Networks Services: Operations Control Systems	Concur	Original Signed (Version 1.00)	14/08/2006
Jeff Say Technical Support Networks Services: Mechanical and Electrical Services	Concur	Original Signed (Version 1.00)	23/08/2006
Peter Casey Manager System Planning: Asset Management	Concur	Original Signed (Version 1.00)	04/10/2006
Anu Atukorala Operations Manager Networks Services: Water & Sewerage System Operations	Concur	Original Signed (Version 1.00)	04/09/2006
Rob Edwards Manager Network Services Sewerage Network Services Water	Concur	Original Signed (Version 1.00)	05/09/2006
Michael Barton Manager Networks Services: Maintenance Planning	Concur	Original Signed (Version 1.00)	04/09/2006
Ravi Chopra Senior Project Manager Projects: Project Management	Approve	Original Signed (Version 1.00)	04/10/2006

Revision Control

REVISION NUMBER	DATE	REVISION DETAILS	RESPONSIBLE OFFICER
0.00	Feb 2006	Developed from "SPSS2 Functional Specification 1-20.doc "	Alex Witthoft
0.01-0.10	Feb–Mar 2006	Continuous development of new standard	Alex Witthoft
0.10	31 March 2006	Issued for peer review	Alex Witthoft
0.15	31 March 2006	Issued for review by Electrical Design Manager	Alex Witthoft
0.16	31 March 2006	Incorporated comments from Electrical Design Manager and Issued for initial review by stakeholders	Alex Witthoft
0.20	30 April 2006	Incorporated comments from Stakeholders	Alex Witthoft
0.30	26 May 2006	Issued to Programmer for final review and to commence programming of RTU for Test Bed.	Alex Witthoft
0.40	6 June 2006	Final Modification to Self Diagnostic Section	Alex Witthoft
0.90	26 July 2006	Modifications during programming	James Morrison
1.00	**26 July 2006**	**FOR CONSTRUCTION ISSUE** **Issued to Stakeholders for Approval**	**Alex Witthoft**
1.01	23 October 2006	Re-named to SSM084 (from SSM081) due to conflict	Alex Witthoft
1.02	9 November 2006	Added RTU Heartbeat (Section 3.4.10) Modified Section 1.2.6 to Incorporate Old Option M (MTS). Modified Section 1.2.13 to now reflect New Option M (Odour Control).	Alex Witthoft
1.03	5 December 2006	Added Section 1.2.18 Option R: Telemetry Radio Added Section 1.2.19 Option S: Ultrasonic Level Sensor	Alex Witthoft
1.04	14 May 2007	Modified Section 1.1 Overview (typo) Added Ultrasonic level sensor to table 2 in section 1.3	Alex Witthoft
1.05	25 June 2007	Modified Section 1.2.13 Odour Control (Carbon Scrubber) Modified Section 1.2.19 Ultrasonic Level Sensor from mandatory for new installations to optional. Added Section 1.2.20 Double Sided Board Added Section 1.2.21 Delivery Pressure Gauge Added Section 1.2.22 Chemical Dosing	Alex Witthoft
1.10	23 July 2007	The following sections were modified as a result of enhancements recommended from the RCM (Reliability Centred Maintenance) Analysis and the Bench Testing of the Code. 1.2.5 Option E: Station Dry Well Sump Pump and Level Indication 1.2.6 Option F: Station Permanent Generator (ATS & Control Connections) 1.7.3 Pump Duty Selection 1.7.5 Pump Interlock (Option O) 1.8.1 Electrode Test 1.8.2 Wet Well Calibration Test 3.4.8 Probe Test 3.4.12 Sewer Pump (Including Options A,B &C) 3.4.16 Generator Monitoring (Option F)	Alex Witthoft
1.11	14 August 2007	Merged Option B and C (Moisture in Stator and Temperature) Moved Option D to Option C (Reflux) Added new Option D (Manhole Surcharge Imminent	Alex Witthoft
1.12	31 August 2007	Modified 1.8.1 & 3.4.9 - Include activation of the pump interrupt relays on test relay failure.	Alex Witthoft
1.13	27 November 2007	Added 1.2.16 Option O2 : Generator Pump Interlocking. Modified 1.2.15 Option O1 : Pump Interlocking, Modified 1.9 Generator Exercise functionality.	Gerard Anderson

1.14	13th May 2008	Corrected typo in 1.1.2 Modified 1.8.1 Electrode Test Corrected 3.4.13 Added Red Lion display pictures for sections 5.1 – 5.5 Added RTU Battery Fail functionality Added Dry Well strobe light functionality Added Generator transition stop all pumps functionality (including Surch Imm mode) to overcome faults experienced at Sandgate Rd Modified Pressure, Current, Flow High/Low, Generator Fuel alarm generation to include an analog alarm duration timer	Kevin Ng Gerard Anderson
2.00	**26th July 2010**	**Accepted all changes from previous revisions and reset font colour.** **Updates to reflect SPi2f_06 version code and various requested changes.**	**Jake Stoll**
2.01	5th November 2010	Version 2.00 review comments and updates incorporated. Alarms & Events and Calculations & Feedback sections point listing updated against UUTS SCADA. Point descriptions to be added in future revisions.	Jake Stoll
2.02	7th January 2011	Updated Stakeholder list and issued document for update on Q-Pulse.	Peter Sherriff
2.11	30 June 2011	AS BUILT for version 7 code. All cosmetic and structural changes have been accepted. All sections with Track Changes now represent changes to the ISAGRAF code.	Alex Witthoft
2.12	12 October 2011	Updated Option P: Wet Well Washer to reflect implemented code	Dallas Wallace
2.13	2nd March 2012	Modified Backup Communications time period from 60 to 85 mins (15min background poll where report by exception issue + 10 min operator handling time + 60 min KPI)	Dallas Wallace
3.00	**29th July 2012**	**Update to Standard as part of Cardno Contract to deliver 27 sites Modification Include the incorporation of the following:** • Variable Speed Drive Option • 3rd Pump Option • Dewatering Pump for Emergency Storage • Power Meter	**Alex Witthoft (for Gerard Anderson)**
3.10	11th August 2012	Comments included from Workshop #3 for the SPRI11 contract to deliver 27 Sites.	Alex Witthoft (for Gerard Anderson)
3.11	26th October 2012	Updated signoff sheet and document consultation list.	Gerard Anderson
3.12	15th November 2012	Modified based on Field Services comments JS – Emails 10/8/12 and 26/10/12. DWW – Email 1/11/2012, 2 x 20/11/12 and 21/11/12 PDD – Email 29/10/2012 Addition of 2.1.4.2 Station Inhibit Mode Addition of 2.1.5 Controlled Pump Dpwn Mode Addition of 2.1.6 'Time to overflow' mode Addition of 2.1.7 'Station Run At Max' mode Modified generator test and emergency storage details as per emails	Gerard Anderson
3.13	22nd January 2013	Modified based on Field Services comments PD – Emails 17/1/13. Added H2 Dual flowmeter site Option. Ammended signoff sheet.	Gerard Anderson
3.14	3rd October 2013	General formatting and editing	Rejeehan Prebaharan Gerard Anderson

Document Consultation

Please review this document and add your comments where necessary. To ensure that this project is completed on time, please forward you comments by the requested date to:

Gerard Anderson, Document Administrator, Level 7 Roma St Transit Centre, Brisbane

VER	FORWARDED TO	DATE SENT	REQUESTED RETURN DATE	DATE RETURNED	COMMENTS	
					REC'D (Y/N0	INCORP (Y/N)
0.15	Rahim Janfadah - TCB2 (Electrical Design Review)	29/03/06	07/04/06	03/04/06	Y	Y
0.16	Ian Dixon - Cullen Ave (System Planning Review)	10/04/06	21/04/06	21/04/06	Y	Y
0.16	Jeff Browne - Cullen Ave (Operations Review)	10/04/06	21/04/06	21/04/06	Y	Y
0.16	Peter Sherriff - Cullen Ave (Control Systems Review)	10/04/06	21/04/06	21/04/06	Y	Y
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1.00	Alex Witthoft, Rahim Janfada, Peter Sherriff, Jeff Say, Peter Casey, Anu Atukorala, Rob Edwards, Michael Barton, Ravi Chopra					
	Issued for SPi2f_06 Review					
2.00	Gerard Anderson	26/07/10	26/08/10	8/09/10	N	N
2.00	John Titmarsh	26/07/10	26/08/10	8/09/10	N	N
2.00	Paul Daley	26/07/10	26/08/10	8/09/10	Y	Y
2.00	Dallas Wallace	26/07/10	26/08/10	8/09/10	Y	Y
3.00	Cardno update meeting for group comments. Gerard Anderson, Jeff Say, Malcolm Barrett, Chris Woodrow, Simon Angus.	7/08/12	14/08/12	14/08/12	Y	Y
3.11	Jeff Say (Control Systems)	26/10/12	02/11/12	Nov 12	Y	Y
3.11	Paul Daley (Control Systems)	26/10/12	02/11/12	Nov 12	Y	Y
3.11	Dallas Wallace (Control Systems)	26/10/12	02/11/12	Nov 12	Y	Y
3.11	Malcolm Barrett (Control Systems)	26/10/12	02/11/12			
3.11	Gerard Anderson (Projects)	26/10/12	02/11/12	Nov 12	Y	Y
3.11	Chris Woodrow (Field)	26/10/12	02/11/12			
3.12	Jeff Say (Field)	27/11/12	29/11/12			
3.12	Dallas Wallace (Field)	27/11/12	29/11/12			
3.12	Malcolm Barrett (Control Systems)	27/11/12	29/11/12			
3.12	Mark Parusel (Operations)	27/11/12	29/11/12			
3.12	Chris Woodrow (Field)	10/01/13	18/01/13			
3.12	Michael Barton (Maintenance)	10/01/13	18/01/13			
3.12	Sam Bagraith (Planning)	10/01/13	18/01/13			
3.12	Mark Parusel (Operations)	10/01/13	18/01/13			

3.12	Howard Witten (Operations Manager)	10/01/13	18/01/13			
3.12	Rahim Janfada (Engineering Services)	10/01/13	18/01/13			
3.12	Ken Vahessan (Engineering Services)	10/01/13	18/01/13			
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Executive Summary

The Sewage Pumping Station Reliability Improvement project is being undertaken to provide Queensland Urban Utilities with a "standard design" for fixed and variable speed sewage pump stations. This standard design comprises a functional specification (this document) and a set of electrical design drawings.

This functional specification details the functional requirements for the control, monitoring, and telemetry of a "standard" sewage pumping station comprising fixed speed or variable speed pumps up to 90kW. It has been developed from the previous standard functional specification[i] for a two pump submersible station with soft starters, but includes a number of enhancements that were recommended in the "Sewage Pumping Station Reliability Improvement" concept design document[ii]. These enhancements include modifications and additions to eliminate single points of failure and to ensure that failures are both detected and alarmed.

Whilst the new standard functional specification will detail the generic requirements, it also includes a range of design options that can be incorporated in the design of each specific site. A separate site-specific functional specification will be developed for each site that will include both standard and non-standard design options. In addition, it will include site specific design requirements such as pump size, flow rates and head pressures as well as specific equipment and instrumentation.

A "standard" pump station has two methods or modes of control; remote and local. In the 'remote' mode, the station runs as a stand-alone unit controlled by a primary controller (RTU) whose control parameters are based on the value of the wet well level probe. The duty pump starts when the wet well level reaches the Top Water Level (TWL) and continues to run until the wet well is emptied to the Bottom Water Level (BWL). Should the duty pump not cope with the inflow, the sewage will reach the standby start level and the second pump starts and runs in tandem to reduce the level in the wet well.

The RTU provides pump protection whilst in the 'remote' mode. In some instances, due to electrical or hydraulic constraints, both pumps are interlocked to prevent them from running simultaneously. For sites with variable speed drives, the 'remote' mode control algorithm will gradually vary the speed of the pump (thereby limiting delivery flow fluctuations), to maintaining the wet well to as constant a level as possible. In effect, the change in speed will control the delivery flow to match the inflow to the station. The inflow varies according to the stations diurnal flow pattern, therefore the station delivery flow will also have a diurnal flow pattern (refer to Figure 1: Typical Diurnal Flow Pattern). For a sudden change in the station's inflow, caused by the on/off cycling of an upstream station, the pumps will vary their speed (and thus the delivery flow) in a controlled manner, using the wet well as a temporary storage buffer.

Once the delivery flow has converged on the inflow, it will slightly over compensate, so that over time, the wet well level will be brought back to the desired level. Thus the change in wet well level is controlled while still minimising delivery flow fluctuations.

Figure 1: Typical Diurnal Flow Pattern.

To provide redundancy for the wet well level probe, a discrete high level probe and a discrete surcharge imminent probe are installed to provide both alarming of abnormal wet well levels and also to act as a backup signal to start the pumps. These two additional probes ensure that the station does not surcharge due to a fault in an individual level sensor or probe. Should the pumps be started using either the high level or surcharge imminent probe, the station is said to be in ‘high level pumping mode’ and ‘emergency backup pumping mode’ respectively.

As stated earlier, the station may be selected to operate under 'local' control, most often used to test the system and to provide station control to an on site operator whilst undertaking maintenance procedures. The primary controller (RTU) controls the pumps in 'local' mode.

In both 'local' and 'remote' modes, the station may also be operated independently of the RTU, via the surcharge imminent probe and an emergency pumping mode start switch. Control of the station is via a secondary control circuit, completely independent of the primary control circuit. This secondary control circuit is hard wired to ensure that the station will operate in the event of a critical fault in the primary control circuit (including complete RTU failure, or RTU power supply failure).

As part of a larger sewer network, the pump station will be pumping to either a downstream pump station or a waste water treatment plant. In the event of a downstream failure, the control room operator can delay and minimise the volume pumped by selecting ‘all pumps inhibited’ mode, which fully utilises the storage capacity of the wet well and the inlet sewer system. This control mode can avoid or minimise the volume surcharged downstream of the station.

The primary controller will only alert the control room operator when an event occurs outside normal operating parameters. This is known as 'reporting by exception'. The operator, via the Queensland Urban Utilities Telemetry System (UUTS), can start, stop, or inhibit an individual pump to respond to any abnormal situation within the station or the overall sewer system. Operator controls from the UUTS will not prevent the station from pumping at maximum available capacity in Emergency Pumping Mode, however an operator inhibit can be used to select an alternate pump on an interlocked site.

Each station includes the optional ‘Controlled Pump Down’ mode. This is designed to reduce the risk of inundating downstream sites by preventing the pump station from automatically operating at maximum station flowrates at high well levels following interruptions to normal pump operation (eg. releasing station inhibit mode, Site power fail restoration, returning the switchboard to remote etc.). While Controlled Pump Down mode decreases the risk of surcharge caused by downstream inundation, it increases the time taken (typically less than 30 minutes) to remove abnormal volume from a catchment and slightly increases the risk of surcharge if a subsequent failure occurs to the site before the well level has restored to normal operational levels. (Refer 2.1.5)

Each station includes the ‘Station Run At Max’ mode designed to allow the station to empty quickly. This will have benefit when a storm cell is approaching to maximise retention volumes and before using a 'station inhibit’ on all upstream stations for planned flow control activity. On fixed speed sites all available pumps will run. On Variable Speed sites the pump speed will be increased. (Refer 2.1.7). This will be applied manually by the Control Room Operator.

Each station includes a 'Time to overflow' mode to allow continuous ON/OFF application of station inhibit for a period of 24 hours at a single sewage pump station. The data gathered (in UUTS trend history) over the 24 hour period will allow Operations to check the accuracy of station time to surcharge graphs at different times of the day. It is anticipated that this will be used once a year (in dry weather only) for each site and will be applied manually by the Control Room Operator.

The station is interrogated at a regular poll interval via the telemetry network, to routinely update the status of the station to the UUTS master station and upload the previous poll period’s historical data. The station also requests an immediate upload when any critical event occurs at the station. The UUTS master station will then alert the control room operator of any abnormal conditions at the station. Calculations are also performed and telemetered to the UUTS master station to aid system planning and fault finding for the station and surrounding sewer network.

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Acronyms

UUTS	Queensland **U**rban **U**tilities **T**elemetry **S**ystem
RTU	**R**emote **T**elemetry **U**nit
SCADA	**S**upervisory **C**ontrol **A**nd **D**ata **A**cquisition
mAHD	**M**etres above **A**ustralia **H**eight **D**atum
TWL	**T**op **W**ater **L**evel
BWL	**B**ottom **W**ater **L**evel

1 INTRODUCTION

This document defines the functional requirements for the control, monitoring, and telemetry of a "standard" sewage pumping station comprising two or three pumps up to 90kW with either fixed speed or variable speed control.

The functional specification of a particular sewage pumping station's operation and control can be determined by the following set of documents;

1. Standard functional specification (this document)
2. Site electrical drawings
3. Site specific functional specification
4. Site information spreadsheet
5. Site change records
6. Site record (on-site maintenance log)
7. UUTS standards documents (Point standard configuration, Site schematic specification)

The standard functional specification details the generic requirements and a range of design options.

The separate site functional specification defines which standard design options apply and details any non-standard design elements. In addition, it will include site specific design requirements such as pump size, flow rates and head pressures as well as specific equipment and instrumentation.

The site electrical drawings are "As constructed" records of the site detailing the control elements, wiring connections and labelling, physical layout of the switchboard, list of installed electrical/control equipment. The site electrical drawings are in general not maintained.

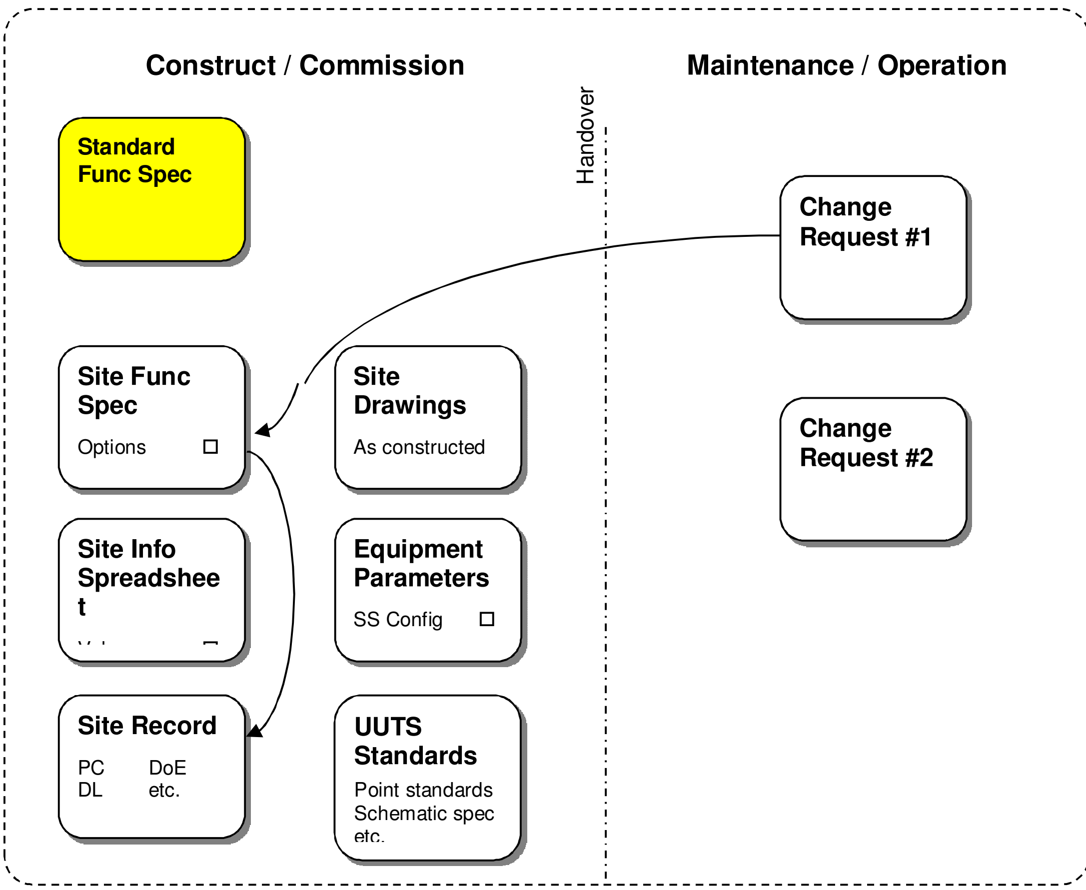


Figure 1: Site Functional Specification Document Set

2 CONTROL PHILOSOPHY

2.1 Overview

The following section outlines the operating philosophy of a high reliability sewerage pump station with stop start control. Normally the size of the sewer pumps is selected so that a single pump will be adequate for ultimate peak wet weather flow. If the electrical and hydraulic restrictions permit, two sewer pumps are allowed to run simultaneously to cope with higher flows.

The pumping station has two main modes of operation, "Local" and "Remote". Selection of the station operating mode is via an on-site "Local/Remote" selector switch.

The station is designed, and is normally selected, to run autonomously in remote. It can also be controlled by an on-site operator via the local mode. The primary control circuit (RTU) controls both the remote and local control modes. The station is also designed to run independently of the primary control circuit, via a secondary control circuit (hardwired) which is activated via the surcharge imminent probe or the emergency pumping mode start switch.

2.1.1 Normal Operation (Remote Mode)

2.1.1.1 Fixed Speed (Standard)

Under normal operation in remote mode the station is controlled using 'dutyA pump start level' and 'dutyA pump stop level'. Once one pump is running, if the level continues to rise above the 'dutyB start level', a second pump will start and run until the level falls to the 'dutyB stop level'. The start and stop levels are measured in mAHD and are site specific (refer to *Figure 4: Wet Well Level Set Points* for a graphical representation of the various wet well level set points).

The duty sequence starts the pumps alternatively to balance run hours. The station will run autonomously until a fault condition occurs at which time the control room operator is required to take appropriate action according to the alarm instruction.

2.1.1.2 Variable Speed (Option W)

For variable speed drive sites, the normal pumping mode shall function as per the following functional requirements:

Under normal operation (in remote mode) the station is controlled using 'dutyA pump stop level' and 'dutyA pump start level'. The lead pump will start at the dutyA start level at minimum speed. If the level continues to rise the pump will increase in speed, as calculated by the control algorithm, up to maximum speed. If the level rises above the 'dutyB start level', a second pump will start and run until the level falls to the 'dutyB stop level'.

The second pump will run at the same speed as the dutyA pump. To achieve a smooth transition between one pump running and two pumps running, when the standby pump is commanded to start, both the duty pump (already running) and standby pump (starting) will be commanded to run at the 'two pump minimum speed' for a period of 30 seconds. The '2 pump minimum speed' is configured during commissioning to deliver the same flow rate as single (duty) pump running at maximum speed.

When two pumps are running together, they are both limited to the '2 pump maximum speed'. This maximum speed may differ from the single pump maximum speed due to hydraulic restrictions in the system – for example:

- to avoid over pressurising the rising main
- to avoid causing overflows at downstream manholes (due to high flow rates).
- To avoid air locking the gravity mains downstream (due to high flow rates).

For three pump stations, the pump station will be interlocked so that only two pumps can operate at any time. The start and stop levels are measured in mAHD and are site specific (refer to *Figure 4: Wet Well Level Set Points* for a graphical representation of the various wet well level set points).

The duty sequence starts the pumps alternatively to balance run hours. The station will run autonomously until a fault condition occurs at which time the control room operator is required to take appropriate action according to the alarm instruction.

As described in the executive summary, under normal operating conditions, the 'remote' mode control algorithm will gradually vary the speed of the pump to control both the wet well level and the flow. Provided the delivery flow meter signal is valid, the pump speed will be controlled by a 'level-flow-speed' cascaded P.I.D.[1] loop. This loop will be 'tuned' to control the wet well level to a constant set point, to minimise the 'bellows' effect, while limiting excessive fluctuations in the delivery flow.

In the event that the delivery flow meter signal is invalid, a basic 'level-speed' P.I.D. loop will be utilised to maintain the desired wet well level. This P.I.D. loop will be 'tuned' to control the wet well level to a constant set point to minimise the 'bellows' effect.

2.1.1.2.1 Cascaded 'Level to Flow to Speed' PID Control

The pump speed will increase, using a cascaded PID loop controlling both wet well level and flow rate, until it reaches its maximum speed. The diagram below shows the PID loop for flow control. (The control algorithm of the PID integration and output values is limited to within minimum and maximum values for flow rates and VSD speed.)

The cascaded PID loop control relies on the wet well level set point. This set point is compared with the actual wet well level. When the wet well level is greater/smaller than the wet well level set point the flow control set point will increase/decrease accordingly. This flow control set point is then compared with the actual flow reading and the speed of the VSD is adjusted to achieve the required flow set point.

The PID loop will be tuned so that as the inflow to the station increases, the outflow increases to match, thereby maintaining the wet well level set point. The secondary PID loop will be tuned so that the rate of change of the flow rate is controlled and undue flow fluctuations are minimised.

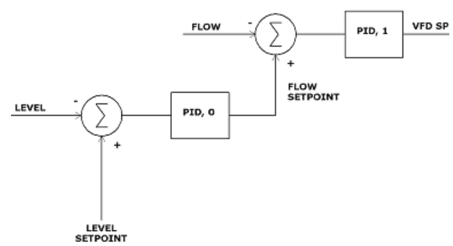


Figure 2 :Cascade Level-Flow Pid Loop Control

2.1.1.2.2 'Level to Speed' PID Control

In the event of a failure of the flow meter, a simple level-speed PID control loop will control the speed of the pumps to maintain a constant level. The diagram below shows the PID loop control for the level/flow control.

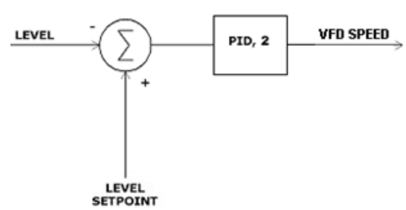


Figure 3: Wet Well Level Pid Loop Control

The value of the VSD speed is adjusted to achieve the required level set point. The PID loop will be tuned so that as the inflow of the station increases, the speed of the variable speed drive will increase to match the flow, thereby maintaining the level set point. The wet well level will only fall below the set point if the inflow to the station is less than the flow rate produced when the VSD is at minimum speed.

[1] A proportional-integral-derivative (PID) controller tracks the error between the process variable and the setpoint, the integral of recent errors, and the rate by which the error has been changing. It computes its next corrective action from a weighted sum of those three terms (or modes), then outputs the results to the process and awaits the next measurement.

2.1.2 High Level Pumping Mode

2.1.2.1 Fixed Speed (Standard)

If the level continues to rise above the Duty B start level then depending on the level reached, 'High', 'Surcharge Imminent' and 'Surcharge Occurring' alarms will be raised and sent back to the control room operator. The control room operator is also alerted to 'Low' and 'Invalid' conditions. The alarm conditions are normally set as follows:

Wet Well Low	200mm (nominal) below 'dutyA pump stop level' set point (BWL)
Wet Well High	400mm (nominal) above 'dutyA pump start level' (TWL)
Surcharge Imminent	300mm below surcharge occurring level
Surcharge Occurring	25mm below actual surcharge level

Apart from the inflow to the station being higher than the pumping capacity of the available pumps (wet weather or degraded pump), the main reasons that a wet well will fill to the high level while the primary control circuit is healthy are listed below.

1. The probe measuring the wet well level is invalid (pumps will not start if the level is not valid).
2. The probe measuring the wet well level is 'frozen' at a valid level but below the start level.
3. The station "all pumps inhibited" mode is selected.
4. The station has a mains power failure (ie Energex and Generator power are both unavailable).
5. A Wet Well Calibration Test or Secondary Control Circuit Test is active.
6. The station is in Local mode and the pumps have not been operated.

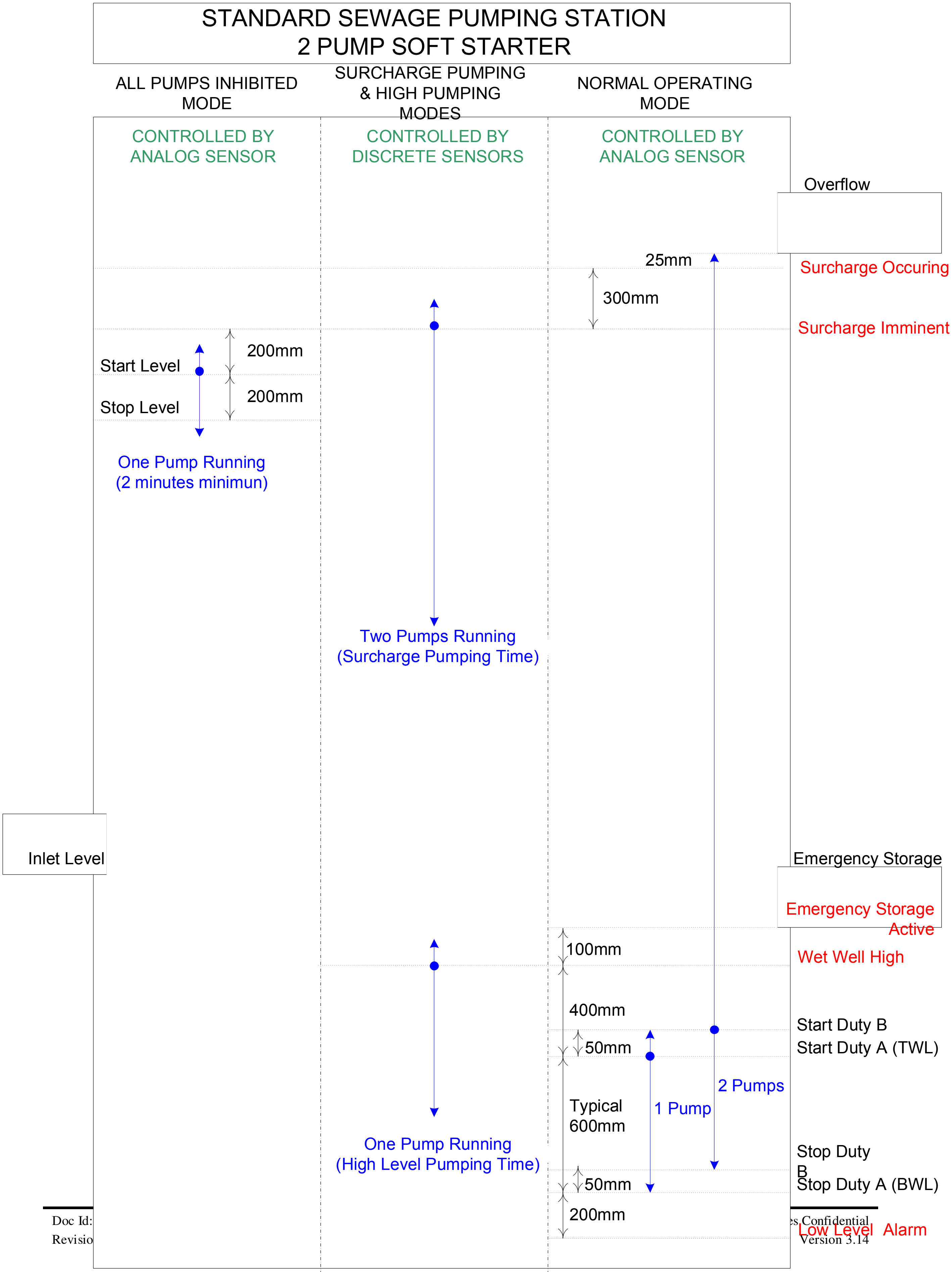
While the station is **not** in "all pumps inhibited" mode and the discrete high level probe is activated and a wet well calibration or secondary control circuit test is not active, and the station is in Remote then the primary controller will initiate the "high level pumping" mode. In "high level pumping" mode, the duty pump will be commanded to run. The high level pumping mode is active while the wet well level is at or above the high level and for a site specific minimum time after the high level probe de-activates. Once "high level pumping" mode is deactivated the station will revert to its normal operation.

NOTE 1 The site specific minimum time is calculated as half the time taken to pump from high level to the dutyA stop level under normal dry weather conditions.

2.1.2.2 Variable Speed (Option W)

For variable speed drive sites, the high level pumping mode shall function as per the above section with the following additional functional requirements:

The station will run the pumps at maximum speed when in high pumping mode. This is achieved by setting the Analog output to the maximum speed AND also by activating the Run at Max digital output.


STANDARD SEWAGE PUMPING STATION
2 PUMP SOFT STARTER
ALL PUMPS INHIBITED MODE
SURCHARGE PUMPING & HIGH PUMPING MODES
NORMAL OPERATING MODE
CONTROLLED BY ANALOG SENSOR
CONTROLLED BY DISCRETE SENSORS
CONTROLLED BY ANALOG SENSOR
Overflow
25mm
Surcharge Occuring
300mm
Surcharge Imminent
200mm
Start Level
200mm
Stop Level
One Pump Running
(2 minutes minimun)
Two Pumps Running
(Surcharge Pumping Time)
Inlet Level
Emergency Storage
Emergency Storage Active
100mm
Wet Well High
400mm
Start Duty B
50mm
Start Duty A (TWL)
2 Pumps
1 Pump
Typical 600mm
One Pump Running
(High Level Pumping Time)
Stop Duty B
50mm
Stop Duty A (BWL)
200mm
Low Level Alarm

2.1.3 Emergency Pumping Mode

2.1.3.1 Fixed Speed (Standard)

Apart from the inflow to the station being higher than the pumping capacity of the available pumps (wet weather or degraded pump). The main reasons a station can reach the surcharge imminent level are listed below.

1. The probe measuring the wet well level has failed (see above) AND
   the high level probe has failed to activate.
2. The probe measuring the wet well is reading low by 200+ mm (calibration error) AND the station "all pumps inhibited" mode is selected.
3. The primary control circuit has failed (RTU or control power supply failure).
4. The station has a mains power failure (ie Energex and Generator power are both unavailable).
5. The onsite Local/Remote selector switch is selected for Local (or failed).

If the level reaches the surcharge imminent level, both the primary control circuit (RTU) if healthy, and the secondary control circuits (hardwired) will initiate the emergency pumping mode. In emergency pumping mode all available pumps will be commanded to run. For environmental reasons, emergency pumping mode has priority and wet well level duty stop set points are ignored. Pump inhibits are also ignored in emergency pumping mode with the exception of interlocked sites. If interlocking - Option O1 is enabled (or if interlocking - Option O2 is enabled, while a generator is supplying the station) an inhibited pump will be interrupted while the alternate pump remains available and not inhibited.

NOTE: The site specific minimum time is calculated as half the time taken to pump from surcharge imminent level to the dutyA stop level under normal dry weather conditions. This time is programmed into the primary control circuit and 80% of this value into the secondary control circuit.

2.1.3.2 Variable Speed Drive (Option W)

In emergency pumping mode two available pumps will be commanded to run at maximum speed. The speed analogue output will be clamped at maximum speed and as a backup, the 'run at maximum' digital output will also be activated. For environmental reasons, emergency pumping mode has priority and all pump inhibits and wet well level duty stop set points are ignored.

2.1.4 Pumps Inhibit

The control room operator can inhibit one or more of the station's pumps. If an individual pump is inhibited, then only that pump is considered inhibited from operating under normal operating conditions. It is effectively removed from the duty cycle. If all pumps are inhibited, then the whole station is considered inhibited and in 'all pumps inhibited mode'.

2.1.4.1 Single Pump Inhibit / Degraded Mode

A single pump can be inhibited manually by the control room operator if it is not operating efficiently, or automatically degraded by the RTU if it exhibits non-critical fault conditions. This will remove it from the duty cycle allowing the more efficient pump to permanently operate as the duty pump until the inhibit / degrade is cleared. This will allow the station to run normally until the inefficient pump can be unblocked or repaired.

If the uninhibited / non-degraded duty pump can not keep up with the inflow and the wet well level rises, as the respective alarm levels are reached, the wet well high alarm will activate as a warning. If the level continues to rise above the surcharge imminent level, then the surcharge imminent alarm will activate and the inhibited / degraded pump, if available, will automatically be commanded to run under emergency pumping mode - effectively ignoring the inhibit / degrade placed upon it by the control room operator or RTU. After the emergency pumping cycle is completed, the pump will remain "inhibited / degraded" and is only uninhibited by a command from the control room operator (operator inhibit) or when the pump becomes fully healthy (degraded).

NOTE for interlocked sites: Because the emergency pumping mode is only able to run one pump (via hard wiring) the RTU will ensure that the uninhibited / non-degraded pump will run (rather than the inhibited / degraded pump) via the "emergency mode interrupt" relay outputs. (ie on an interlocked site the inhibited / degraded pump's "emergency mode interrupt" digital output will be active while **a single** pump is inhibited / degraded). The exception to this rule is if pump 3 reflux valve has failed to close (or pump 2 on a site interlocked to one pump), pump 3 must be one of the pumps used in emergency pumping mode otherwise recirculating pumping occurs through the failed reflux valve.

2.1.4.2 Station Inhibit Mode

2.1.4.2.1 Fixed Speed (Standard)

Station Inhibit mode (previously All pumps inhibited mode) can be utilised to delay the flow of sewerage to downstream sites in an emergency. This will mitigate a surcharge situation at either a failed downstream pump station or a problem in the sewer network downstream from the pump station. There are two ways (dependant on site software versions) to activate 'station inhibited' mode on a station where all pumps are healthy

1. All the pumps are inhibited individually by the control room operator OR
2. The control room operator can select the control 'Station Inhibit' (where configured, this will be a control button on the schematic screen).

When Option 1. is chosen each pumps inhibit feedback will be activated and the Station Inhibit feedback point will not be activated. When Option 2. is chosen each pumps inhibit feedback will not be activated (unless one or more pumps were already inhibited) and the Station Inhibit feedback will be active. Using the Option 2 method the system can remember which pumps were inhibited before Station Inhibit became active and keep these individual pump inhibits following release of the Station Inhibit.

When the station inhibit mode is activated by the operator for the purpose of delaying flow to downstream sites, it is desirable to delay and minimise the volume pumped.

To achieve this the wet well storage capacity above the TWL is utilised to a safe maximum level. Nominally the TWL is raised to 200mm below surcharge imminent. At this level a single pump will run for a minimum of 2 minutes and until the wet well level drops to 400 mm below surcharge imminent (both conditions need to be satisfied before the pump stops. Refer to *Figure 4: Wet Well Level Set Points* for a graphical representation of these new start and stop levels.

If the inflow volume causes the wet well level to rise above the 'all pumps inhibited' start level and reach the surcharge imminent level, the surcharge imminent alarm will activate and command the pumps to follow the emergency pumping mode instead of the 'all pumps inhibited' mode.

Emergency pumping mode is designed to control the well level and will run the pumps for a longer minimum duration than 'station inhibited' mode. Although this is contrary to the purpose of 'station inhibited' mode, which is to minimise the flow to the down stream station, emergency pumping mode takes precedence. The inflow to the station would have to be significantly higher than the dry weather average inflow to cause the level to reach surcharge imminent level set point while there are healthy pumps on site.

Once the emergency pumping mode deactivates, the station will revert back to 'station inhibited' mode. The station will remain in this mode until at least one pump is uninhibited (operator inhibit) or the Station Inhibit control is removed by the control room operator. As a feedback indicator for the control room operator, the sewer pump displayed on the UUTS master station has a yellow (Operator Inhibit) or orange (Auto Inhibit) inner circle if it is inhibited.

The wet well high alarm and high level pumping mode will be suppressed when 'Station inhibited' mode is active as the well level, in 'Station inhibited' mode, could be above the wet well high alarm set point.

2.1.4.2.2 Variable Speed Drive (Option W)

Same functionality as Fixed speed (described above) except for variable speed drive sites, when the station is in Station Inhibit mode and the wet well reaches the Inhibit Start Level then a single pump will run for a minimum of 2 minutes with a PID Setpoint equal to the Inhibit Start Level. Therefore if the level rises above the Inhibit Start level then the speed of the pump will increase. The response times on the PID will be sufficient to allow full speed to be attained before the level reaches Inhibit Start + 100mm. When the level reaches Inhibit Start + 100mm a second pump will be called to start if able to be started. Again the PID setpoint will remain at the Inhibit Start level. Once the 2 minute timer has expired and the wet well level drops to the Inhibit Stop level (normally 400 mm below surcharge imminent) all pumps will stop. Note both conditions need to be satisfied before the pump stops. Refer to Figure 4: Wet Well Level Set Points for a graphical representation of these new start and stop levels. Note the difference between a single pump operation and dual pump operation on VFD sites capable of operating two pumps. The station would start only one pump at the Inhibit Start level and then only start the second if the level rises above Inh Start + 100mm i.e. one pump at full speed cannot meet the flow. Two pumps would then operate until the Inhibit stop conditions are reached or Emergency Pumping mode levels are reached.

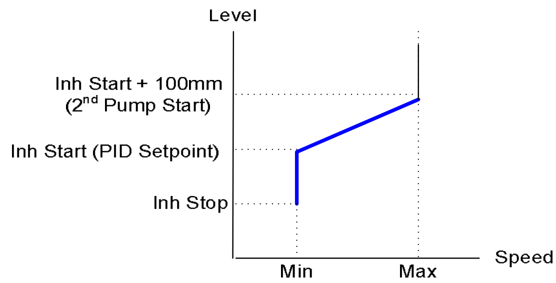


Figure 5: Wet Well Level vs Pump Speed During Inhibit Mode

2.1.5 Controlled Pump Down Mode

'Controlled Pump Down' mode is designed to reduce the risk of inundating downstream sites. This is achieved by preventing the pump station from automatically operating at maximum station flowrates at high well levels during dry weather. Instead the station is operated at lower flowrates to reduce the well level back to normal operating levels within a site specific time period following interruptions to normal pump capacity (eg. releasing station inhibit mode, Site power fail restoration, returning the switchboard to remote etc.).

While Controlled Pump Down mode is active the wet well level rate of change is continuously monitored. If a single pump is not maintaining the required rate of change, a second pump is called to operate (a variable speed site will be speed controlled to match the required rate of change whereas a fixed speed site will operate at maximum station flowrate capacity). If emergency pumping mode becomes active or the Station Run At Max Mode is started then Controlled Pump Down mode will be deactivated and the station operated at maximum flowrate capacity.

It must also be said that while Controlled Pump Down mode decreases the risk of surcharge caused by downstream inundation, it also increases the time taken (typically less than 30 minutes) to remove abnormal excess volume from a catchment and therefore slightly increases the risk of surcharge if a subsequent failure occurs to the site before the well level has restored to normal operational levels.

2.1.6 Time to Overflow Mode

'Time to overflow' mode will allow the continuous ON/OFF application of station inhibit for a period of 24 hours at a single sewage pump station. The data gathered (in UUTS trend history) will allow Operations to check station time to surcharge graphs. It is anticipated that this will be used once a year to assess the accuracy of time to surcharge graphs at each site. When a pump station is sent a control to initiate 'Time to Overflow' mode the station will enter 'Station Inhibit' mode until the Inhibit Start level is reached. The station will then pump down to Duty A Stop level and commence this process all over again (this cycle could take several hours depending on the station catchment size and time of day). At the end of 24 hours (or if the operator clears the control earlier) the station will return to normal operation. Note if the Operator were to place the station into Station inhibit mode during this test then the 'Time to Overflow' mode will be removed.

It is recommended that this mode is only applied to sewage pump stations that have recently had a wet well clean to prevent the likelihood of instrument malfunction.

2.1.7 Station Run At Max Mode

The 'Station Run At Max' mode is designed to allow the station to empty quickly. This will have benefit when a storm cell is approaching to maximise retention volumes and before using a 'station inhibit' on all upstream stations for planned flow control activity. This mode will prevent the current or next High level electrode check from being performed and prepare the site for abnormal flow situations. On fixed speed sites all available pumps will run. On Variable Speed sites the PID setpoint will be lowered to a level just above the Duty A Stop level.

At some stage in the future it is anticipated that this mode could be used as part of a catchment wide application via SCADA scripting.

Note some sites may not have this mode accessible for operational reasons i,e, potential dry weather flooding of treatment works etc. This will be documented in the site specific functional specification for each site.

2.2 Standard Design Options

The standard design for the fixed speed sewerage pumping station is designed for a pump stations with two pumps sized up to 90kW. The standard design incorporates a range of optional design specifications, the inclusion of which is determined by individual site requirements. A dedicated space in the switchboard is allocated for each option. The design will allow the upgrade of a pump stations' pumps, up to 90kW, as well as the replacement of the RTU, without the need to replace the switchboard. The following table is a list of the standard design options available:

Table 1: Standard Options for a Fixed Speed Sewerage Pumping Station

Option	Description
A	Individual pump moisture in oil (MIO) sensor and fault relay
B	Individual pump motor protection fault (moisture in stator and temperature)
C	Individual pump reflux valve micro switch
D1	Upstream manhole surcharge imminent - Float Switch
D2	Upstream manhole surcharge imminent - Electrode
E	Station dry well sump pump and level indication sensors and relays
F	Station permanent generator (ATS and control connections).
G	Emergency Storage Level Sensor & Dewatering Pump
H	Station delivery flow meter
I	Backup communication
J	Pump de-contactors
K	Cathodic protection
L	Motor thermistor
M	Odour Control - Carbon Scrubber
N	Current transformer (CT) metering
O1	Pumps Fully interlocked
O2	Pumps Interlock with Genset Only
P	Wet well washer
Q	Valve Pit Sump Pump and Level
R	Telemetry Radio
S	Wet Well Secondary Level Sensor (Radar)
T	Wet Well Primary Level Sensor (Hydrostatic)
U	Delivery Pressure Transmitter
V	Chemical Dosing
W	Variable Speed Drives
X	Third Pump
Y	Power Meter

Each option has been fully specified in both this functional specification and the detailed design drawings. (refer to Appendix A).

2.2.1 Option A: Moisture in Oil

The moisture in oil signal provides warning that the primary wet end motor seal is failing. The availability of this signal is dependent on the pump design and will be included following the manufacturer's recommendation.

2.2.2 Option B: Motor Protection Fault (Moisture in Stator and Temperature)

The moisture in stator signal provides warning that the IP rating of the motor has deteriorated. The availability of this signal is dependent on the pump design and will be included following the manufacturer's recommendation.

The motor temperature signal provides warning of high bearing temperatures and/or high winding temperature that could be caused by the degradation of the bearing lubrication or due to excessive loading on the pump. The availability of this signal is dependent on the pump design and will be included following the manufacturer's recommendation.

These two signals (individually or combined) are wired in parallel to provide the generic motor protection fault input into the RTU.

2.2.3 Option C: Individual Pump Reflux Valve Micro Switch

For conventional pump stations, a reflux micro switch is added to detect air locking and pump blockage failures as well as the failure of the reflux to close after operation.

2.2.4 Option D1: Upstream Manhole Surcharge Imminent – Float Switch

For sites where the upstream manhole requires overflow monitoring, this option, using a float switch or "bulls ball" will be configure at 300mm below the surcharge occurring point.

This option does NOT allow for the float switch to be tested with the electrode test relay.

2.2.5 Option D2: Upstream Manhole Surcharge Imminent - Electrode

For sites where the upstream manhole requires overflow monitoring, an electrode will be configure at 300mm below the surcharge occurring point.

This option DOES allow for the float switch to be tested with the electrode test relay.

2.2.6 Option E: Station Dry Well Sump Pump and Level Indication

For conventional pump stations, the dry well will be monitored for a high level via a high level electrode. This electrode (set 100mm above lowest floor level), when submerged, will trigger alarm to alert the control room operator that the site is flooding.

An additional trip level electrode is installed as a safety interlock to prevent the pumps from running while the dry well has filled to a level which will render that station electrically unsafe (ie 100mm below electrical connections **not** within an IP68 enclosure).

When both the dry well high and dry well trip electrodes have been activated, the station is locked out and an on-site operator reset from either pump is required (after the operator has checked that the site is safe to run). To prevent false triggering of the trip electrode stopping the station unnecessarily, both the high and trip electrodes must be active for 10 seconds for the lockout to be activated.

When the station is locked out – the RTU will activate the Pump Interrupt commands to prevent the hard wired secondary control circuit from starting the pumps. The only way the pumps can be started if the lock out is active, is via the on-site emergency start switch.

The control room operator will receive an alarm signal at both the high and trip levels as they occur.

A sump pump will be installed to de-water the dry well. This sump pump status will be monitored to detect excessive run and excessive cycling, both of which are the first indicators that the dry well has excessive ingress of water.

The dry well contains a strobe light which will be used to notify M&E personnel working within the dry well of unusual level conditions. The strobe light will operate if either:

- The High Level Alarm from the hydrostatic or electrode is active (suppressed alarm condition eg. no operation if the station inhibit or electrode testing is in progress) while the site is in remote. OR
- The Surcharge Imminent alarm from the hydrostatic or electrode is active.

The sump in which the sump pump is installed may, over time, dry out. To alert the field services maintenance team of the potential 'seizing' of a sump pump, a report in the UUTS is to be developed to identify which sump pumps have not run for the last 30 days.

2.2.7 Option F: Station Permanent Generator (ATS & Control Connections)

This optional upgrade to a pump station is to have a semi-permanently connected generator that automatically runs the station on generator supply following an Energex power failure. This upgrade provides an automatic transfer switch (ATS) to disconnect Energex and connect the generator. Extra physical I/O and UUTS alarms are configured in the RTU to provide full feedback on the status of the semi-permanent generator.

2.2.7.1 Transition from Energex to Generator

When the station loses Energex power, the generator will start automatically after a 30 second delay. Once the generator has been running for a defined period of time (default 2 minutes) then the auto-transfer switch will automatically change from Energex supply to the Generator supply.

The pumps, if running, would have stopped on the loss of Energex Supply, and the station will now resume normal operation, starting the pumps when they reach the start level.

2.2.7.2 Transition from Generator Back to Energex

When stable Energex Power has been restored to the station, defined by a site specific time (default 2 minutes), then the auto-transfer switch will automatically change from Generator supply back to Energex supply.

As the Generator Supply and the Energex Supply will not be synchronised (out of phase), all pumps will be stopped at least 25 seconds before the auto-changeover is expected (which allows for ramp down). This function is implemented to prevent cumulative damage to the starter that would be caused by transferring to an 'out of phase' supply. Additionally, this function will ensure that the pump circuit breaker does not trip due to any back EMF generated. (NOTE – this has occurred previously at sites where the auto-changeover has occurred while the pumps were running, resulting in both pumps being unavailable until the circuit breakers were reset by an on-site operator).

Once the changeover has occurred, the station must be on Energex supply for 30 seconds before the pumps are allowed to start. This also includes inhibiting the backup controller for the pump stopped time period of 30 seconds.

To prevent the station from multiple changeovers in a short time frame (which can be caused by 'noisy' Energex supply), or from unnecessarily stopping the pumps and changing back to Energex whilst the wet well level is above surcharge imminent level, the following delay in changeover is also implemented:

The station will only allow the change back to Energex once every 10 minutes and not within the first 10 minutes of a surcharge imminent alarm activating.

This is achieved by activating the Phase Fail simulation digital output for 10 minutes if:

- Energex Power failure is detected within 10 minutes of the previous changeover OR
- Surcharge imminent alarm is activated whilst the generator is running

The activation of this digital output will ensure that the Energex Power is not detected as healthy for at least 10 minutes since the last changeover or since the surcharge imminent alarm has activated.

This functionality balances the need to not run the generator unnecessarily when the Energex Supply is available (thereby depleting the fuel reserves) with the preference to not stop the pumps when the surcharge imminent alarm is active (which ensures that the brief stoppage of pumps does not in itself cause a surcharge).

Note: If this Option is not enabled then a permanent generator is not implemented and the switchboard will have a generator connection cubicle to provide for quick connection of a mobile generator during extended power outages. The non-permanent generator is manually operated and supplies power via a generator circuit breaker that is mechanically interlocked with the Energex circuit breaker. The pump station will operate normally while the site power is supplied from the generator.

2.2.8 Option G: Emergency Storage Level Sensor & De-watering Pump

For off-line emergency storage (emergency storage that is not hydraulically linked) an additional level probe is required for each storage area that is hydraulically separated from the wet well (multiple if required). This probe will allow the calculation of the current volume (and storage remaining) using a separate level vs volume table which will be provided by system planning for inclusion into the RTU program.

For off-line emergency storage, the schematic will indicate that the chamber is in use and will show the level within the chamber in m AHD. The de watering pump will pump out the storage chamber .

The dewatering pump digital output will be activated when the emergency storage level sensor is above the emergency storage level start level AND the wet well is not in either the high pumping mode OR surcharge pumping modes. It will stop when the level falls below the emergency storage level dewatering stop level.

The dewatering pump will be 'bumped' for 5 seconds every Monday at 7am to avoid seizing up.

2.2.9 Option H1: Station Delivery Flow Meter

A flow meter will be installed on all new site installations to provide the information for the following

- Ability to determine pump complete and partial pump blockages (reduced flow)
- Analysis of the performance of the pump (Flow vs Pressure Pump Curves)
- Analysis of the sewer network – daily, weekly and diurnal flow patterns
- Ability to calibrate system models with accurate flow data

Existing sites which have the switchboard upgraded will have the flow meter requirement assessed on a site by site basis.

A SCADA control named 'Sewage_pumping_station : 1 : Ignore_flowmeters' is included to allow newly installed flow meters to be monitored for stability without causing PID flow control or pump blockage issues. When this control is active (or the flowmeter is invalid) the feedback point 'Sewage_pumping_station : 1 : Flow_control_and_pump_blockage_detection_inactive' is returned to the SCADA system.

2.2.10 Option H2: Dual Station Delivery Flow Meters

This option indicates that two flowmeters have been installed onsite, one for each pump. Note both flowmeters need to be summated for total station flow. Otherwise same as Option H1. If either flowmeter invalid then Flowmeter invalid signal raised. Only summated points are returned to SCADA i.e. points same as single flowmeter site.

2.2.11 Option I: Backup Communication Options

The primary communications link from the site to the UUTS master station will normally be via the Trio Radio network. As the communication link is vital in ensuring a timely response to any critical alarms a secondary communication link is required if any of the following criteria is not met.

- Site must have at least 85 minutes storage above high water level at ultimate peak dry weather flow UPDWF
- Site must have easily accessible communication assets (ie not require a bucket truck to access antenna)
- IF the primary communication medium is the Trio radio network, the signal strength must be greater than –80dB on both the receive and transmit paths

2.2.12 Option J: Motor Connection (Direct / De-contactor / Field Connection)

To allow for easy, quick and safe replacement of pumps, a de-contactor is installed in the disconnection chamber for pumps that are 37.5 kW and under. This disconnection chamber is completely sealed from the rest of the switchboard to prevent any gas ingress to all other section of the switchboard. For pumps over 37.5 kW in size a de-contactor is not viable as the pump cable and plug arrangement become physically too large and unwieldy.

For these larger pumps a separate field disconnection box is installed in an appropriate location near the pumps. Any cabling (both power and control) which originates in the wet well will terminate in this disconnect box before being permanently wired to the switchboard. This provides extra isolation from the wet well to ensure the integrity of the switchboard from possible gas ingress.

2.2.13 Option K: Cathodic Protection (CP)

The current practice for Queensland Urban Utilities is to include Cathodic Protection at submersible sewage pumping station that meets any of the following criteria.

- Any pump 30kW & above will have CP protection
- Stations located in industrial areas which receive trade waste will have CP protection
- CP to be installed where there is a history of corrosion

All new submersible pump switchboards will incorporate a space provision for CP.

2.2.14 Option L: Motor Thermistor

The motor thermistor option is implemented by wiring the thermistor into the soft starter. The thermistor fault is identified by the soft starter which will incorporate it into the starter fault signal to the RTU.

2.2.15 Option M: Odour Control (Carbon Scrubber)

For stations with on-site odour control unit is installed, a 240 VAC feed to the unit is provided from the switchboard plus the following IO:

- Carbon Scrubber High Speed Command (Digital Output from RTU)

The carbon scrubber unit will run at maximum speed when the calculated inflow to the station is higher than the operator adjustable set point AND no pumps are running (ie the wet well level is rising at a fast enough rate to require the higher air flow provided by increasing the speed).

2.2.16 Option N: Current Transformer (CT) metering

CT metering is required for any station that can draw over 100 amps, for this reason any pump station that has pumps sized at 30kW or above will have CT metering installed. For sites that have smaller sized pumps, the CT metering compartment will remain vacant to allow for future pump upgrades without the need to replace the switchboard.

2.2.17 Option O1: Pump Interlocking

For sites that have an electrical or hydraulic requirement for pump interlocking both a hardwired and software interlock will be included in the design. The interlock will prevent both pumps from running in **all** modes of operation including emergency pumping mode.

2.2.18 Option O2: Generator Pump Interlocking

For sites that have an electrical requirement for pump interlocking when the standby generator is online. The interlock will prevent both pumps from running in generator only mode. The switchboard will have hard wired interlocks preventing both pumps from running in generator only mode. If Option O1 Pump Interlocking is true then Option O2 Generator Pump Interlocking is not considered. That is, Option O1 if active dictates that the pumps are always interlocked. Option O2 Generator Pump Interlocking will only be considered if Option O1 Pump Interlocking is false.

2.2.19 Option P: Wet Well Washer

If a wet well washer is required, the wet well washer solenoid is activated when both sewer pumps stop and remains active for a site configurable time period (typically 60 seconds).

2.2.20 Option Q: Valve Pit Sump Pump and Level Probe

This option allows for a single phase sump pump to be installed in the sump of the valve pit for de-watering purposes only. A 24VDC level probe is installed in the valve pit 100mm above the sump level to indicate that the de-watering has not occurred. The only indication to the control room will be a valve pit high alarm which will activate if the high level input is 'high' for 10 seconds and will deactivate if the high level input has been 'not high' for 10 seconds.

2.2.21 Option R: Telemetry Radio

The primary communications link from the site to the UUTS master station will be via the Trio Radio network for all sites that have an adequate signal strength (greater than –95dB) on both the receive and transmit paths. (Refer to Option I for the requirements of a secondary communication link).

2.2.22 Option S: Ultrasonic Level Sensor (Secondary)

An Ultrasonic or Radar secondary Level Sensor shall provide constant method of calibration check for the hydrostatic level sensor and is optional for all new installations. The secondary probe is continuously compared to the primary prove,and if the two differ my more than 100mm for over 60 seconds, then a calibration alarm is activated.

2.2.23 Option T: Hydrostatic Level Sensor (Primary)

The Hydrostatic Level Sensor provides the primary method of measuring the wet well level and is used in all of the control functions of the RTU.

2.2.24 Option U: Delivery Pressure Gauge

All sites that have a rising main shall have a delivery pressure gauge. For lift stations, where the pumps only lift the sewage into a gravity sewer, there is no requirement for a delivery pressure gauge.

2.2.25 Option V: Chemical Dosing

For stations with on-site chemical dosing units installed, a 240 VAC feed to the unit is provided from the switchboard plus the following IO:

- Chemical Dosing Speed Command (Analogue Output from RTU)

The RTU will provide the required dosing rate to the chemical dosing unit via the analogue output. This dosing rate will be proportional to the delivery flow rate.

2.2.26 Option W: Variable Speed Drives

The standard option for a sewage pump station is for fixed speed control achieved with soft starters. For sites where there is a valid engineering reason for variable speed control of the pumps, variable speed drives are incorporated into the integrated design. The following are typical engineering reasons for the need for variable speed control:

- Keeping the wet well level constant: To reduce odour emission (caused by the 'bellows effect' of a continually rising and falling wet well). If site conditions allow, the variable speed is capable of reducing speed so that the delivery flow equals the inflow, thus keeping the wet well constant.
- Flow smoothing function: The variable speed drives can also be used to smooth the flow fluctuations in delivery flow to the downstream sewer network (caused by the diurnal flow pattern). This is particularly important for waste water treatment plants which operate more effectively under constant flow conditions.
- Reduction of Dynamic Losses: For systems where there are large dynamic losses (friction losses) at full speed (Peak Wet Weather Flow) the installation of a VSD can have dramatic effects on the efficiency of the station and help reduce energy costs.

The variable speed drive option will include the following digital and analog outputs from the RTU:

- Pump Speed Control (Analog output for each pump from RTU)
- Pump Run at Max Command (Digital output for each pump from RTU)

NOTE: As per section *6.8.4: Variable Speed Drives* of the *Sewage Pumping Station Code of Australia WSA 04—2005:*

"Variable speed drives are not normally used in submersible type stations and their use should be limited to situations where hydraulic control is required for particular pumping situations e.g. pumping directly to sewage treatment plants or where their application significantly improves the cost of pumping."

2.2.27 Option X: Third Pump

For stations where two pumps are required to achieve the necessary flow range of peak dry weather flow then a third standby pump is required to ensure that the station has at least 50% spare capacity at all times as required by the Sewage Pumping Station Code of Australia WSA 04—2005. This third pump, as a standard, shall be identical to the first two and shall have all the similar associated ancillary pump specific options also enabled (ie reflux valves, moisture in oil/stator and VSD).

NOTE: As per section *6.5 Triple-Pump Pumping Stations* of the *Sewage Pumping Station Code of Australia WSA 04—2005*

"Triple-pump pumping stations are not generally recommended."

2.2.28 Option Y: Power Meter

A power meter is added for sites with high power consumption or with Variable Speed Drives. The power meter allows for the sites harmonics and power factors to be monitored.

2.3 Station Instrumentation

The station has the following instrumentation connected to the primary controller. All I/O must be connected as per the standard site physical I/O connections (Refer to *Appendix B: Standard Physical I/O List*). The I/O has been allocated to provide the best redundancy for the control stations, with each pump IO allocated on separate cards, as well as the separation of the high level and surcharge imminent level probes. For a full equipment list refer to the standard drawing set. (Refer to Appendix A: Drawing List). The items listed in italics text are new features incorporated into the design as recommended by the concept design. Devices labelled with a "Option [X]" are standard design options, the inclusion of which are determined by individual site requirements.

Table 2: Standard Fixed Speed Pumping Station Instrumentation

Station Energex mains power relay	Status of power on the line side of the main incomer
Station mains power relay	Status of power after the main incomer
Pump control power relay	Status of pump control power after the pump circuit breakers
RTU mains power relay	Status of power after the RTU circuit breaker
Main incomer CB status	Status of the Main Incomer CB(used in conjunction with Energex and station mains power relays to determine whether a generator is currently running on site)
Surge diverter	Status of surge diverter
Site door switch status	Combined status of all switchboard door (All closed or not)
Wet Well Hydrostatic Probe	The probe is positioned in the well to cover the operating level of the well in mAHD.
Wet Well Ultrasonic Probe	*The probe is positioned in the well to cover the operating level of the well in mAHD.*
Pressure Gauge	Delivery pressure of the pump station in mAHD
Wet Well High Level Electrode	*Electrode to detect if wet well level has reached high level*
Wet Well Surcharge Imminent Electrode	Electrode to detect if wet well level has reached surcharge imminent level
MH Surcharge Imminent Electrode	Electrode at upstream manhole to detect surcharge imminent (Option D)
Station Local Controls and Indication	Local/remote selector switch (for the station) Start, stop and reset push button for each pump Emergency stop push button for each pump Wet Well level % indicator gauge *Emergency pumping mode selector switch (for each pump)* *Emergency Mode Interrupt Command Relay (for each pump)* *Graphical Display*
Pump Starter	Pump Starter control and display panel Running Feedback Fault Feedback VFD Not Ready (Not in auto or faulty) indication (Option W). VFD Run At Max command (Option W). Run Command Relay Reset Command Relay Modbus link to RTU for pump power and current (and speed *Option W)* Pump Speed Command *(Option W)*
Optional Pump Sensors (Options A-C)	*Moisture in Oil (Option A)* *Moisture in Stator (Option B)* *Motor Temperature Fault (Option B)* *Reflux valve micro switch (Option C)*
Sump Pump Control and Indication (Option E)	*Sump pump start / stop push buttons* *Sump pump running signal* *Sump pump healthy signal* *Dry well flooded high level sensor* *Dry well flooded trip level sensor*
Permanent Generator (Option F)	*Tripped* *Warning* *Low Fuel* *Medium Fuel* *Running* *Security (Door switch)* *Local CB Tripped* *Auto* *On Site* *Exercise Command (to Station mains power relay)*
Emergency Storage Hydrostatic Probe (Option G)	*The probe is positioned in the emergency storage vessel to provide the current level (in mAHD), and thus volume, of the emergency storage area.*
Flow meter (Option H)	*Delivery flow of the station in l/s*
Cathodic Protection (Option K)	*De-energise rectifier (fault reset) command* *Fault Indication* *Local Reset push button* *Current transducer*

2.4 Remote Mode

Remote mode is the normal operating mode of the primary control circuit. In this mode the primary control circuit controls the pumps in a duty/standby configuration, starting and stopping the pumps according to the wet well start and stop set points (as described in the overview and illustrated in *Figure 4: Wet Well Level Set Points*).

The control room operator can issue remote manual commands to the RTU to control the station. The following are the controls available to the control room operator.

- Stop — Stops a specific pump provided that the station is in its 'normal' wet well range (below the Start Duty A level). If the wet well level is abnormal (higher than Start Duty A level), then the "inhibit" can be used to stop a pump (excepting where the pump is required for Emergency Pumping Mode).
- Start — Start a specific pump provided the wet well level is above the pump's stop level. If no pumps are running, the first pump can be started if the wet well level is above the duty A pump stop level. If a pump is already running, the second pump can be started provided the wet well level is above the duty B pump stop level. The 'start command' over rides the pump lockout which restricts the number of starts per hour under autonomous control.

  NOTE: The start command will NOT start an inhibited pump.
- Reset — Allows the operator to remotely reset any latched pump alarms (excepting Emergency Stop) provided the original fault condition has cleared.
- Inhibit — Allows the operator or RTU to inhibit a specific pump from operating under the normal operating mode, effectively removing it from the duty rotation. If all pumps are inhibited the station will operate in 'all pumps inhibited' mode.

  NOTE: By inhibiting the running pump the operator can 'swap duty'. On an interlocked site an inhibited pump will be interrupted while the alternate pump remains available and not degraded/inhibited permitting a duty swap above the surcharge imminent level. To achieve this above the surcharge imminent level the RTU will activate the emergency pumping mode interrupt command relay for the inhibited pump.
- Speed Control — In remote mode the speed is controlled by the RTU and can NOT be adjusted by the control room operator.

The control room operator can also send the following site commands:

- Abnormal Operation Reset — This command reset the abnormal operation alarm which is activated whenever the RTU has an 'abnormal operation' (ie the RTU resets for any reason).
- Alarm limit set points — The operator has the ability to modify the set points for the high and low alarms configured for various Analogue signals except the wet well signals which are hard coded. (eg. pressure).
- Exercise Generator — The operator has the ability to command the generator to exercise (start and changeover to generator supply or back to Energex and stop the generator).

The Control Room Operator can NOT:

- Switch the RTU from local to remote mode (Physical switch on site only)
- Start or Stop the pumps if the station is in local mode.
- Modify operational set points, eg. Start/Stop duty A/B level set points
- Change alarm priority class or alarm triggering configuration on the communications channel
- Change motor current high/low set points

2.5 Local Control

The on-site technician can assume control of the site by switching the site into local mode (via the local/remote selector switch) and manually operating the pumps via the push buttons. Local mode is also controlled by the primary control circuit and is primarily used for testing and maintenance purposes.

NOTE: Once started in local mode the pumps will still stop automatically at the duty A pump stop level to prevent the station from pumping below the 'bottom water level'. To allow the station to be de-watered, the pumps can be run below the bottom water level by holding in the start push button.

The on-site technician has the following local station controls:

- Station Local / Remote — Selector switch to determine operating mode of the station

The on-site technician has the following controls for each pump:

- Start — Push button to start pump.
- Stop — Push button to stop pump (soft stop via pump starter).
- Speed Control (Option W) — The on-site operator can control the speed the pump via a dial (potentiometer) on the pump control panel. The speed will be limited to between the minimum and maximum speeds set in the variable speed drive.
- Emergency Pumping Mode — Selector Switch to activate the emergency pumping mode via secondary control circuit. (Hard Wired). Note: in emergency pumping mode, some of the motor protection devices are disabled, and should not be used for normal pump stop start control.
- Emergency Stop — Latched push button (hard stop via electrical isolation).
- Reset — Push button (reset any latched alarms in RTU related to pump).
- Sump Pump Start / Stop — The station also has start and stop pushbuttons that are hard wired to the control circuit of the sump pump. (Option E).

The on-site technician has the following indication for the station:

- Graphical Display — Pump Status including all alarms status
Station Wet well level (current and recent trend)
Station Delivery Pressure (current and recent trend)
Station Delivery Flow (current and recent trend) (Option H)
History of recent alarms
Full I.O. Status of RTU
- Wet well level — Wet well level indication in % (independent of RTU and Display) including a red line to indicate the surcharge imminent level.
- Pump Starter — Control panel to configure the parameters of the pump starter and also to display motor status (ie motor current). The pump control panel will be able to provide a drive reset function.

2.6 Station Secondary Control Circuit and Emergency Pumping Mode Switches

In both local and remote mode, if the primary control circuit fails the station will fall under the control of the secondary control circuit. The secondary control circuit controls the station in the emergency backup pumping mode and is completely independent from the RTU and the RTU power supply.

The secondary control circuit is initiated via the surcharge imminent electrode regardless of which mode (local or remote) is selected for the station. When the secondary control circuit is activated the station will run the maximum number of allowed pumps (at maximum speed for variable speed drive sites (Option W)) for the surcharge pumping duration.

An on-site technician is also able to start each pump via the secondary control circuit via each pumps “Emergency Pumping Mode Start” selector switch. This switch will allow the operation of the site by an on-site operator while the stations primary controller has failed, assuming the person has a “C” class key to access the switchboard.

WARNING. As the secondary control circuit is completely independent of the RTU, there are no controls based on the level of the well. Once the pumps have been started via the surcharge imminent probe, they will run for surcharge pumping time (hardwired timer in the emergency control circuit) after the surcharge imminent input is no longer active.

If they are being run using the emergency pumping mode selector switch for each pump, they will “run to destruction”. The pumps will **not** switch off automatically when the wet well level reaches the ‘stop duty A level’ set point. The only protection provided by the switchboard is from the soft starter itself (including thermistor fault), see the next section for pump availability conditions.

If the on-site technician does not stop the pump before the wet well level falls below the pump intake, then the pump will ‘suck’ air and will ‘air lock’ making the pump inoperable until it is either ‘bled’ or ‘re-primed’. It is up to the on-site technician to ensure the pump only runs while the level is above the stop level.

2.7 Pump Fault and Control Conditions

2.7.1 Pump Availability

All electrical and mechanical fault conditions pertaining to a particular pump must be healthy before that pump can be run. A pump is considered 'available' if all these conditions are met. The RTU will only command a pump to run if it is available. If a pump becomes unavailable at any time while the pump is running, it will stop immediately.

Any one of the following on site fault conditions will make the pump unavailable under the primary and secondary control circuits.

- Station mains power fail - Switchboard does not have 415V mains power supplied
- Pump control power fail - Pump does not have 240V control power supplied
- Pump emergency stop input faulted - Push button currently depressed
- Pump starter fault - Motor protection has activated
- Dry Well Flooded Trip Alarm active - Pump electrical connections near submersion. (RTU interrupts Secondary Controller so pumps able to operate if RTU not active). (Option E)

Any one of the following on site fault conditions, which are calculated in the RTU, will make the pump unavailable in the primary control circuit.

- Pump emergency stop fault latched - Emergency stop fault (in the RTU) has not been reset
- Pump starter fault count exceeded - Three or more faults in the last 8 hours
- Pump fail to start - Pump has failed to start
- Pump fail to stop - Pump has failed to stop
- Pump motor protection fault - Pump moisture in stator fault and/or Pump temperature fault (Option B)
- Pump reflux fail to open - The pumps reflux valve has failed to open (Option C)
- Pump reflux fail to open count exceeded - Reflux fail to open fault has occurred more than 3 times in 8 hours (Option D)

The functional descriptions of these conditions are described under section *4.4 Alarm and Event Description*

To ensure that there is redundancy in the number of pumps available, each pump station is designed to have at least 50% spare capacity which translates into at least one spare pump during dry weather conditions. If one pump becomes unavailable, the other pump(s) will become and remain the duty pump(s) until such time as the unavailable pump is once again available for duty rotation.

As a feedback indicator for the control room operator, the sewer pump displayed on the UUTS master station has a red inner circle if it is unavailable.

If all pumps become unavailable, then the station will not run any pumps and contingency measures are initiated by the control room operator to ensure that no surcharge occurs.

2.7.2 Pump Available for Duty Sequence

A pump that is available (as defined above) can be removed from the duty cycle for any of the following conditions

- Pump has been inhibited by the control room operator
- Pump has been degraded by the RTU due to;
  - Moisture in Oil (Option A)
  - Pump blockage (via flow) alarm is active (Option H)
  - Pump current high or low

The functional descriptions of these conditions are described under section 4.4 Alarm and Event Description

If a pump is not available for duty sequence, the other pump(s) will become and remain duty until such time as either the unavailable for duty pump is once again available or the other pump becomes as equal or less available. The unavailable for duty does **not** prevent a pump from running in emergency pumping mode.

A degraded pump due to opposing reflux-fail-to-close should be able to run as a Duty B (eg. second best) pump to cater for sites where dry weather inflow can exceed one pump capacity. Aside from pump degradation, this would only normally occur on a minority of three pump sites.

2.7.3 Pump Duty Selection

The duty rotation is based on a simple rotational basis. When the duty pump stops running, the duty is rotated to the next pump available for duty sequence (as per previous section). If no pumps are running and the control room operator issues the command for a specific pump to run then that pump is assigned to be the duty A pump.

One potential reason that a sewage pumping station reaches the wet well high level during normal dry weather conditions is that the duty pump is under performing or is partially or even fully blocked. This is particularly problematic for interlocked sites as no other pumps can start. To ensure that in these situations the station does not keep running the potentially blocked pump, the duty will be rotated for interlocked site, when the high alarm is activated. This will result in the running pump stoping and the newly assigned duty pump starting.

2.7.4 Pump Lockout

In remote mode, under normal operating conditions (the station is not in either high level pumping mode, emergency pumping or ‘all pumps inhibited’ mode) a pump is locked out from starting for 5 minutes since its last start. This is to protect the motor and starting equipment from thermal failure due to too many starts per hour. The lockout is bypassed by the remote start command sent from the UUTS master station.

2.7.5 Pump Interlock (Option O)

For sites that have an electrical or hydraulic requirement for the pumps to be interlocked, the program will only be able to request one pump to run at any given time. Hard wiring will ensure that this will be enforced during emergency pumping mode. The interlock option will also affect the pump duty selection functionality (refer to Section 1.7.3).

2.7.6 Pump Start Delay

While under the control of the primary control circuit, the stations pumps are prevented from starting simultaneously by a pump start delay of 10 seconds commencing from the last time a pump has started. This will minimise any inrush current to the station and also minimise water hammer effects.

2.7.7 Pump Emergency Mode Interrupt

The secondary controller interrupt command for each pump will enable the RTU to interrupt the secondary control circuit. Each pumps secondary controller interrupt will be active under the following conditions regardless of whether the station is in local or remote.

1. During the Secondary Controller Pumping Mode Self Diagnostic Test (see next section)
2. For an interlocked site, if the pump is inhibited and the other pump is not inhibited (To ensure the non-inhibited pump runs during emergency pumping mode).
3. For a conventional site, when the dry well high **and** dry well trip electrodes are active for 10 seconds (station locked out) then secondary controller mode interrupt for each pump will be active to ensure the pumps do not run automatically. (The pump can only be run via the emergency start switch under these conditions).

2.7.8 Pump Run at Max (Option W)

For variable speed drive sites, the run at max digital output command provides a backup control of the speed of the pumps in the event that the Analogue speed control signal is not operating correctly. The run at max command will activate under the following conditions:

1. High level pumping mode is active
2. Surcharge Pumping Mode is active

2.8 Self-Diagnostics

2.8.1 Electrode Test

To ensure that each of the following level relays and electrodes are operational, they are tested via the electrode test relay for 2 seconds every 6 hours, with the first test performed at midnight.

- Surcharge Imminent
- Wet Well High
- Dry Well Flooded High
- Dry Well Flooded Trip
- Upstream Manhole Surcharge Imminent
- Valve Pit High

The test relay contacts provide a path to ground for each electrode, thereby activating the level relay for 2 seconds. If the individual signal for each electrode is not received within 2 seconds, the sensor fault for that electrode is activated.

All alarms off these electrodes have a 10 second delay time and this will prevent any alarms from activating during this test.

In addition to the individual electrode sensor fault, if all installed electrodes remain active for longer than 5 seconds, a test relay failed alarm is activated. This priority 1 alarm will also inhibit all alarms that are activated from these electrodes, but alarms that were already active before the electrode test relay was activated will remain active.

To ensure the pumps do not run via the secondary controller circuit due to the test relay failure, each pumps 'interrupt' relay will be activated.

The electrode test duration is to be configurable (between 2 - 5 secs) to allow for damped multitrode relays on noisy VFD sites.

2.8.1.1 Entry Conditions

The electrode test will be prevented from occurring when a secondary control or wet well calibration test is in progress, if the station mains power has failed, if the surcharge imminent electrode is active or if the high alarm electrode is active or if the Electrode Test is already active.

2.8.2 Wet Well Calibration Test

To ensure the accuracy and reliability of the wet well level sensor and the wet well high alarm electrode, a daily calibration test is performed during a peak inflow period (nominally at 7:30 am). During wet well calibration mode the station will prevent the pumps from running until the wet well reaches the wet well high alarm level.

Both the level sensor and high level electrode signals are then compared to ensure that both sensors are within 100mm of each other (the exact calibration value is captured and stored so that it can be trended over time in the UUTS master station). Once the calibration has been completed, the duty pump will be requested to run. When the level reaches the top water level (TWL) or 10 minutes (site configurable) have elapsed, the duty pump will continue to run and the station will return to normal operating mode. (NOTE if the level is above start duty B level after 10 minutes, the standby pumps will start).

To provide the station with the ability to run both pumps once a day to provide slime stripping velocity, the station will have the option of immediately returning to normal operation when the high alarm level is reached, thereby starting both pumps until the station level falls to stop duty B level.

This option will be controlled via a UUTS Master station and will be default to OFF. IT will NOT be activated unless specifically requested by Sewer Operations.

The calibration error value will not be updated if the electrode test is active as the electrode has been activated by the test relay, not the actual wet well level making contact with the wet well high electrode.

2.8.2.1 Entry Conditions

The wet well calibration test will only be activated if all of the following conditions are true at the time of the test (at 7:30 am). If these conditions are not true at 7:30 then the test will not activate until the next day.

1. At most one pump is unavailable
2. Wet well level is below top water level for Soft Starter sites OR Wet well level is below high level for VSD sites (Many VFD sites spend a majority of the time at, or above, PID setpoint - normally 50 mm above TWL).

2.8.3 Secondary Control Circuit Test

To ensure that the secondary control circuit is operational, once a day (usually at 7:30 am) the station will activate the secondary controller via the Electrode Test relay in the following sequence. If any of the steps in the sequence fail – the secondary control circuit failure alarm is triggered.

For the standard two pump station (without interlocking) both pumps are tested during each secondary control circuit test.

For interlocked two pump stations, only one pump is to be tested during each secondary control circuit test and the RTU will rotate which pump will be tested, The RTU will use the pump inhibit digital output to ensure that the desired pump starts during the test.

For three pump stations, the RTU will ensure that two pumps are tested each secondary control circuit test and will rotate which pump does NOT get tested. Again, the RTU will use the pump inhibit digital outputs to ensure the desired pumps start during the test.

For VFD Installations, the RTU will conform that the VFD speed does reach 100% speed (with error allowance)

Below is the typical example of a test sequence time line:

1. t = 0 Activate Electrode Test Relay for 25 seconds (inhibit all electrode alarms while the test relay is active.

   For interlocked sites, determine which pump is to be tested today.
2. t = 20 The secondary control circuit will detect a surcharge imminent and start the first pump and activate the "Emergency Pumping Mode Active" digital input.
3. t = 25 Ensure the "Emergency Pumping Mode Active" digital input is active - otherwise trigger alarm. Deactivate the Electrode Test relay.
   Ensure that the first pump has started – otherwise trigger alarm.
4. t = 40 After the pump start delay (10 seconds) second pump should start.
5. t = 45 Ensure that the second pump (if required) has started – otherwise trigger alarm.
6. t = 45 + Fail to Start Timer (site specific)

   Once two pumps have started, for VSD starters validate both pumps have reached maximum speed via modbus based only on the digital "run at maximum" signal within this time. This is to ensure when the RTU fails the pumps will run at maximum during emergency pumping mode. Activate each pumps interrupt, thereby stopping both pumps, to ensure the station does not run dry.
7. t = 50 + Fail to Stop Timer (site specific)

   Ensure that all pumps have stopped.
8. t = 20 + 75% x Surcharge Pumping Time (site specific)
9. Ensure the "Emergency Pumping Mode Active" digital input is still active - otherwise trigger alarm
10. = 20 + Surcharge Pumping Time (site specific)

    Ensure the "Emergency Pumping Mode Active" deactivates - otherwise trigger alarm.

    Once "Emergency Pumping Mode Active" deactivated, then deactivate each pump interrupt

2.9 Ancillary Controls

2.9.1 Generator Exercise (Option F)

For semi-permanent generator connection, the control room operator can test the generator by sending an 'exercise generator' command. This command will activate the generator test sequence which will energise the exercise command relay to simulate an Energex failure. The test will ensure that the generator will start , the ATS will switch and the generator is capable of running a pump. There are numerous checks during the sequence to ensure the correct operation. The failure of any of these checks will raise the generator test fail alarm.

2.9.1.1 Test Sequence

1. t = 0 (sec) Control room operator starts the test by sending the "Exercise Generator" start command.
2. t = 0 If the high level alarm is not active, the RTU will activate the 'exercise generator' command relay.

   If the station is in station inhibit mode or all pumps are unavailable, the test is aborted and the test fail alarm is raised.
3. t = 0 The RTU will stop all pumps prior to generator transfer and will keep pumps off until 2 minutes following generator start unless Wet Well High alarm is active.
4. t = 5 An Energex power failure will be detected by the control system AND initiate the generator start.
5. t = 30 Generator will start.
6. t = 45 If the generator running signal is not received 45 seconds after the start, the test is aborted and the test fail alarm (last test failed fault 1) is raised.
7. t = 65 The ATS will switch to generator power.
8. t = 65 After the ATS has switched to generator the RTU will start the duty pump. If the station loses power during the pump start up or the pumps become unavailable due to pump control power loss, the test is aborted and the generator test fail alarm is raised and the station is reverted back to Energex Power.
9. t = 65 RTU will wait for generator running signal to confirm the generator has started. If the generator running signal is not received 65 seconds after the start, the test is aborted and the test fail alarm (last test failed fault 2) is raised.
10. t = 90 If the generator CB status does not change to 'closed' within 75 seconds from the start of the test, the test is aborted and an alarm is raised.
11. t = x The station will run under generator for 60 minutes unless the control room operator stops the test by sending the "Exercise Generator" stop control.

    When either condition occurs the RTU will then stop the test and de-activate the exercise generator command relay.
12. t= x + 135 After 135 seconds the ATS controller will transfer back to Energex power. If the ATS generator CB status does not change to 'open' within 180 seconds of the test being stopped, the test fail alarm (last test failed fault 3) is raised.
13. t= x + 125 25 seconds prior to when the ATS is expected to transfer back to Energex power the RTU will issue a stop all pumps command for 30 seconds.
14. t= x + 330 Once the ATS has switched back to Energex, the generator will continue to run for 5 minutes. If generator running signal (to the RTU) does not deactivate within 330 seconds then the generator test fail alarm (last test failed fault 4) is raised.

2.9.2 Cathodic Protection De-energise Rectifier Relay (Option K)

The cathodic protection rectifier is de-energised if the rectifier current is invalid, high or low.

3 CONTROL SYSTEM CONSTANTS AND VARIABLES

Although each pump station is built according to a standard, each site has site specific requirements that must be programmed directly into the RTU code. To achieve this, the program utilises an initialisation block in which all the site specific constants and variables are loaded with the desired value. The RTU code for each site is identical and the initialisation block will load the site specific data from a site configuration file. This allows for standard code to be loaded into each site and still allow for each sites' specific requirements.

1. Site specific Constants
2. Site specific Variables

The site specific constants are internal parameters only and site specific variables are adjustable by the control room operator. Most constant values are listed as 'site specific', but where a default value is commonly used its' value is listed in the tables below.

Table 3: Site Specific Constants

Tag Name	Description	Type	Value	Units
Cathodic Protection (Option K)				
cat1grAlmDurnTm	Cathodic protection - Alarm duration timer	Integer	2	sec
cat1grAlmInhTm	Cathodic protection - Alarm inhibit timer	Integer	10	sec
cat1grCurrOffset	CP Rectifier current - Offset (4mA value)	Real	Site Spec	mAHD
cat1grCurrRange	CP Rectifier current - Range	Real	Site Spec	mAHD
Delivery pressure				
pre1grAlmDurnTm	Delivery pressure - Alarm duration timer	Integer	30	sec
pre1grAlmInhTm	Delivery pressure - Alarm inhibit timer	Integer	30	sec
pre1grElevation	Delivery pressure - Elevation of the transducer	Real	Site Spec	mAHD
pre1grPreRange	Delivery pressure - Range	Real	Site Spec	mAHD
Emergency Storage (Option G)				
stn1grEStAlDurTm	Emergency storage - Alarm duration timer	Integer	30	sec
stn1grEStoragRng	Emergency storage - Level range	Real	Site Spec	m
stn1grEStorgElev	Emergency storage - Empty level (4mA of Probe)	Real	Site Spec	mAHD
wwl1grEStgLim	Emergency storage - Overflow level	Real	Site Spec	mAHD
Flow meter (Option H)				
flw1grAlmDurnTm	Flowmeter - Alarm duration timer	Integer	30	sec
flw1grAlmInhTmr	Flowmeter - Alarm inhibit timer	Integer	30	sec
flw1grFlowRange	Flowmeter - Range	Real	Site Spec	l/s
flw1grFlowRteMin	Flowmeter - Minimum (4mA value)	Real	Site Spec	l/s
Generator (Option F)				
gen1grAlmDurnTm	Generator - Alarm duration timer	Integer	30	sec
gen1tmEnergTraTm	Generator - Transfer to Energex time	Integer	180	sec
gen1tmExercRunTm	Generator - Exercise/Test Duration	Integer	1800	sec
gen1tmGenTraTm	Generator - Transfer to Generator time (Exercise)	Integer	75	sec
Pump 1 & 2 (& Pump 3 Option X)				
pmp[x]asCurrHiLim	Pump [x] - Motor current high alarm set point	Real	Site Spec	Amps
pmp[x]asCurrLoLim	Pump [x] - Motor current low alarm set point	Real	Site Spec	Amps
pmp[x]grAInhCurrTm	Pump [x] - Motor current alarm inhibit timer.	Integer	15	sec
pmp[x]grBlkFlwLim	Pump [x] - Blocked flow limit	Real	Site Spec	l/s
pmp[x]grBlockageTm	Pump [x] - Blockage time	Integer	Site Spec	sec
pmp[x]grCurDurnTm	Pump [x] - Motor current alarm duration timer	Integer	15	sec
pmp[x]grCurrRange	Pump [x] - Motor current range	Real	Site Spec	Amps
pmp[x]grFailTime	Pump [x] - Fail to start/stop timer	Integer	20	sec
pmp[x]grLockoutTm	Pump [x] - Minimum time between complete starts	Integer	120	sec
pmp[x]grPwrRange	Pump [x] - Motor power range	Real	Site Spec	kW
pmp[x]grSSRstDly	Pump [x] - Soft starter auto reset delay	Integer	20	min
Pump Reflux Valve 1 & 2 (Option C and Valve 3 for Option X + C)				
pmp[x]grRflxClDly	Pump Reflux Valve [x] - close delay	Integer	60	sec
pmp[x]grRflxOpDly	Pump Reflux Valve [x] - open delay	Integer	60	sec
pmp[x]grRflxRstDly	Pump Reflux Valve [x] - auto reset delay	Integer	20	sec
Remote Telemetry Unit				
rtu1asDBVersion	RTU database / config file version (YYMMDD)	Integer	Site Spec	Units
rtu1grRtuDBAddr	RTU address	Integer	Site Spec	Units

Tag Name	Description	Type	Value	Units
Secondary Control Circuit				
scc1grRiseTout	Secondary control circuit test sequence timeout	Integer	Site Spec	sec
scc1grFallTout	Secondary control circuit test sequence fall stage	Integer	900	sec
scc1grStHHMMTmr	Sec Controller Test Start Time	Integer	730	HHMM
Sewerage Pumping Station				
stn1grInhibitTime	Minimum time 'all pumps inhibited' run is active.	Integer	120	sec
stn1grWwlWashTmr	Station - Wet well wash cycle duration	Integer	50	sec
xxg1grAlmHystPC	Station - Analog alarm hysteresis	Real	1.0	%
xxg1grInvHystPC	Station - Analog invalid hysteresis	Real	1.0	%
xxg1grElctTstDur	Station - Electrode Test Duration	Integer	2	sec
stn1gbOptAMIO	Site Option A Pump Moisture In Oil Fault	Boolean	Site Spec	Off / On
stn1gbOptBMtProt	Site Option B Pump Motor Protection Fault	Boolean	Site Spec	Off / On
stn1gbOptCPmpRfx	Site Option C Individual Pump Reflux Valve micro switch	Boolean	Site Spec	Off / On
stn1gbOptDMnHoSI	Site Option D Upstream Manhole Surcharge Imminent	Boolean	Site Spec	Off / On
stn1gbOptEDryWel	Site Option E Station Dry Well	Boolean	Site Spec	Off / On
stn1gbOptFGenATS	Site Option F Station Perm Generator with ATS	Boolean	Site Spec	Off / On
stn1gbOptGEmStor	Site Option G Station E Storage Level Sensor	Boolean	Site Spec	Off / On
stn1gbOptHFlowMt	Site Option H Station Delivery Flow Meter	Boolean	Site Spec	Off / On
stn1gbOptIBackCom	Site Option I Station Backup Communications	Boolean	Site Spec	Off / On
stn1gbOptJDeCon	Site Option I Pump De-Contactors	Boolean	Site Spec	Off / On
stn1gbOptKCaProt	Site Option K Cathodic Protection	Boolean	Site Spec	Off / On
stn1gbOptMOdoCtl	Site Option M Odour Control (Carbon Scrubber)	Boolean	Site Spec	Off / On
stn1gbOptO1Intlk	Site Option O1 Pump Interlocking	Boolean	Site Spec	Off / On
stn1gbOptO2Intlk	Site Option O2 Pump Interlocking - Generator Only	Boolean	Site Spec	Off / On
stn1gbOptPWasher	Site Option P Wet Well Washer	Boolean	Site Spec	Off / On
stn1gbOptQVlvPit	Site Option Q Valve Pit	Boolean	Site Spec	Off / On
stn1gbOptSSecLev	Site Option S Secondary Level Sensor (Ultrasonic)	Boolean	Site Spec	Off / On
stn1gbOptTPriLev	Site Option T Primary Level Sensor (Hydrostatic)	Boolean	Site Spec	Off / On
stn1gbOptUPresG	Site Option U - Delivery Pressure Gauge	Boolean	Site Spec	Off / On
stn1gbOptVChemD	Site Option V - Chemical Dosing	Boolean	Site Spec	Off / On
stn1gbOptWVSD	Site Option W - VSD	Boolean	Site Spec	Off / On
stn1gbOptX3rdPmp	Site Option X - Third Pump	Boolean	Site Spec	Off / On
Wet well level				
wwl1grCaliVar	Wet well - Calibration error allowance	Real	0.1	M
wwl1grDtyBStrLvl	Wet well - duty B pump start level	Real	Site Spec	mAHD
wwl1grDtyAStrLvl	Wet well - duty A pump start level	Real	Site Spec	mAHD
wwl1grDtyAStpLvl	Wet well - duty A pump stop level	Real	Site Spec	mAHD
wwl1grDtyBStpLvl	Wet well - duty B pump stop level	Real	Site Spec	mAHD
wwl1grHiElHgLth	Wet well - High level electrode hanging length	Real	Site Spec	M
wwl1grLevelRange	Wet well - Range	Real	Site Spec	mAHD
wwl1grLevelHgLth	Wet well - level probe hanging length	Real	Site Spec	M
wwl1acLvlLoLim	Wet well - Low alarm set point	Real	Site Spec	mAHD
wwl1grSImmEHgLth	Wet well - Surcharge imminent electrode hanging length	Real	Site Spec	M
wwl1grSrchPmpTime	Wet well - Surcharge pumping duration	Integer	Site Spec	Sec
wwl1grSrchImmLvl	Wet well - Surcharge imminent level	Real	Site Spec	mAHD
wwl1grSurchLvl	Wet well - Surcharge occurring level	Real	Site Spec	mAHD
wwl1grInhStrtLvl	Wet well - inhibit mode start level	Real	Site Spec	mAHD
wwl1grInhStopLvl	Wet well - inhibit mode stop level	Real	Site Spec	mAHD
wwl1grHiLimit	Wet well - High alarm set point	Real	Site Spec	mAHD
wwl1grHiPmpTime	Wet well - High level pumping duration	Real	Site Spec	mAHD
wwl1grWwlElev	Wet well - Empty level (4mA of Probe)	Real	Site Spec	mAHD
Ultrasonic level (Option K)				
ult1grLevelRange	Ultrasonic level - Range	Real	Site Spec	mAHD
ult1grWwlElev	Ultrasonic level - Offset (4mA value)	Real	Site Spec	mAHD
Variable Speed Drive (Option W)				
VSD[x]grSpeedMin	Variable Speed Drive Speed Minimum	Real	Site Spec	Hz
VSD[x]grSpeedMax	Variable Speed Drive Speed Maximum	Real	Site Spec	Hz

Table 4: Site Specific Variables

Tag Name	Description	Type	Value	Units
Cathodic Protection (Option K)				
cat1grCurrHiLim	CP Rectifier current - High alarm set point	Real	Site Spec.	Amps
cat1grCurrLoLim	CP Rectifier current - Low alarm set point	Real	Site Spec.	Amps
Delivery pressure				
pre1acPresHiLim	Delivery pressure - High alarm set point	Real	Site Spec.	mAHD
pre1acPreLoLim	Delivery pressure - Low alarm set point	Real	Site Spec.	mAHD
Emergency Storage (Option G)				
stn1acEStgLoLim	Emergency Storage - Low alarm set point	Real	Site Spec.	mAHD
stn1acEStgHiLim	Emergency Storage - High alarm set point	Real	Site Spec.	mAHD
Station Odour Scrubber (Option M)				
stn1acOdoInHiLim	Carbon Scrubber - High speed inflow high limit	Real	Site Spec.	l/s
Flow meter (OptionF)				
flw1acFlowHiLim	Delivery flow rate - High alarm set point	Real	Site Spec.	l/s
flw1acFlowLoLim	Delivery flow rate - Low alarm set point	Real	Site Spec.	l/s

4 ALARMS AND EVENTS

4.1 Alarm and Event Definitions

Discrete signals sent back to the UUTS master station can be configured to be triggered events. A triggered event will initiate a transmission to the master station upon entering the abnormal state. A non-triggered event will only record any change of state and transmit during the regular history updates.

4.2 Alarm Instructions

Each event or alarm that requires an action from the control room operator is provided with an 'Alarm Instruction'. This 'alarm instruction' is in the form of a text file that is associated with all alarms and events. A typical action may be to send an electrician to the site or to order a sewerage tanker. Refer to Section *7.5 UUTS Alarm Instructions* for an example of an alarm instruction file.

4.3 Alarm Suppression

An alarm's primary function is to notify the control room operator that an abnormal situation exists at a sewerage pump station. The Queensland Urban Utilities operational instructions for each sewerage site determine the action the control room operator takes in response to an alarm. To avoid consequential alarming (one fault condition triggering multiple alarms at the UUTS SCADA system) alarm suppression is used on secondary alarms. All alarm suppression is performed in the RTU therefore modification to the RTU code is required to alter the suppression of any alarms.

4.3.1 Station Mains Fail

The main consequential alarm condition is Site Power Fail. If site power fails the following secondary alarms are suppressed if not active before the power failure:

- RTU Mains Fail
- Sewer pump not available
- Sewer pump motor power and current low alarms
- Delivery Pressure Invalid
- Delivery Flow Invalid

4.3.2 All Pumps Inhibited

When the 'all pumps inhibited' mode is active, the wet well high alarm is suppressed, since the normal wet well level in inhibit mode could be above the wet well high point.

4.3.3 Wet Well Invalid

If the wet well level becomes invalid, the wet well low alarm, surcharge occurring alarm and high and surcharge imminent alarms based on wet well level are suppressed.

NOTE: As the wet well level is backed up by the battery – the site power does **not** suppress the wet well level invalid alarm.

4.3.4 Signal Invalid Alarm

Any Analogue signal (delivery pressure and delivery flow) not backed up by the RTU battery has its invalid alarm suppressed by the station mains power input. The signal high and low alarms are both suppressed by the signal invalid alarm, and the signal low alarm only is suppressed by the station mains power input.

4.4 Alarm and Event Description

4.4.1 Standard Analogue Alarms

Unless stated otherwise, all analogue signals detailed in section 5.1 Analogue Signal Processing will have the following standard alarms configured.

4.4.1.1 Invalid

The signal is deemed invalid if it is less than (4mA – dead band) or greater than (20mA + dead band) for 2 seconds.

Once the invalid alarm has been activated it can only be reset when the signal is both greater than (4mA – dead band / 2) and less than (20mA + dead band / 2) for 20 seconds. The time delays ensure that a signal is truly invalid before an alarm is set and that it is stable before it is reset. The dead band is calculated using the site invalid hysteresis value multiplied by the range.

4.4.1.2 Low Alarm

The low alarm is generated if the analogue signal is not invalid and remains less than the low limit set point for the duration of the alarm low delay on time (default 5 seconds). It is deactivated when the signal is greater than the low limit set point plus the dead band for the duration of alarm low delay off time (default 5 seconds)..

The dead band is calculated using the alarm hysteresis value multiplied by the range.

4.4.1.3 High Alarm

The high alarm is generated if the analogue signal is not invalid and remains greater than the high limit set point for the duration of the alarm high delay on time (default 5 seconds). It is deactivated when the signal is less than the high limit set point minus the dead band for the duration of alarm high delay off time (default 5 seconds)..

The dead band is calculated using the alarm hysteresis value multiplied by the range.

4.4.2 Cathodic Protection (Option K)

The following alarms and events are associated with cathodic protection.

UUTS Database Record Name			
Plant	**Quantity**	**Desig**	**Triggered**
Cathodic_protection	Rectifier_current_high	1	No
Cathodic_protection	Rectifier_current_invalid	1	No
Cathodic_protection	Rectifier_current_low	1	No
Cathodic_protection	Rectifier_fault	1	No

4.4.2.1 Rectifier Current High Alarm

The rectifier current high alarm is standard as per Section 4.4.1 Standard Analogue Alarms with the following additional conditions.

The high alarm is suppressed unless station power and the signal invalid alarms are healthy and the cathodic protection circuit interrupt has been clear longer than the cathodic protection alarm inhibit time (default 10 seconds). This ensures that any instability caused by the cathodic protection circuit energising has dissipated.

The high alarm is generated if the signal is greater than the high limit set point for the duration of the cathodic protection alarm duration time (default 2 seconds). It is deactivated when the signal is less than the high limit set point less the dead band.

4.4.2.2 Rectifier Current Invalid Alarm

The rectifier current invalid alarm standard as per Section 4.4.1 Standard Analogue Alarms.

4.4.2.3 Rectifier Current Low Alarm

The rectifier current low alarm is standard as per Section 4.4.1 Standard Analogue Alarms with the following additional conditions.

The low alarm is suppressed unless station power and the signal invalid alarms are healthy and the cathodic protection circuit interrupt has been clear longer than the cathodic protection alarm inhibit time (default 10 seconds). This ensures that any instability caused by the cathodic protection circuit energising has dissipated.

The low alarm is generated if the signal is less than the low limit set point for the duration of the cathodic protection alarm duration time (default 2 seconds). It is deactivated when the signal is greater than the low limit set point plus the dead band.

4.4.2.4 Rectifier Fault Alarm

The rectifier fault alarm is a common latched fault indication asserted when any of the following points are active;

- Rectifier current invalid
- Rectifier current low
- Rectifier current high

The rectifier fault alarm is reset either by the cathodic protection local reset button or remotely by a control room operator sending a cathodic protection remote reset control. The reset is active for a minimum of ten seconds to ensure that the cathodic protection rectified interrupt has a chance to be deactivated.

When the rectifier fault alarm is active and a reset isn't active the cathodic protection interrupt is activated which will de-energise the cathodic protection circuit

4.4.3 Emergency Storage (Option G)

The following alarms and events and points are associated with the emergency storage.

UUTS Database Record Name			
Plant	**Quantity**	**Desig**	**Triggered**
Emergency_storage	High- Fail to pump down Alarm	1	Yes
Emergency_storage	Level_invalid	1	Yes
Dewatering_pump	Running	1	0
Dewatering pump	Level		

4.4.3.1 High Alarm

The high alarm is standard as per Section 4.4.1 Standard Analogue Alarms.

The high alarm (EStorage) is generated if the signal is greater than the high limit set point (stop / start level for the Emergency Storage alarm duration time (default 1 hour). It is deactivated when the signal is less than the stop / start level set point minus the dead band. The Storage alarm is alarmed if the dewatering pump is requested to run (level above start level and pump station well is below high) and site specific dewatering pump down time is exceeded . (can be up to 10 hour to pump down)Level Invalid – not used

The invalid alarm is standard as per Section 4.4.1 Standard Analogue Alarms.

4.4.3.2 Low Alarm– not used

The low alarm is standard as per Section 4.4.1 Standard Analogue Alarms.

4.4.3.3 Excessive Cycling– not used

If the dewatering pump starts within 5 minutes of its last start the sump pump excessive cycling fault is activated. This alarm is active until the dewatering pump is not running and has not run for at least 5 minutes. This alarm can also be reset remotely from the UUTS master station via the dewatering pump reset command.

4.4.3.4 Excessive Run– not used

If the dewatering pump has been running for longer than [x] hours the sump pump excessive run fault is activated. This alarm is active until the dewatering pump stops. The time in hours is determined by the following formula which represents 25% extra time than it should take for the pump to dewater the emergency storage chamber:

Time [hrs] = (Volume @ Start Level (L) – Volume @ Stop Level (L) / Duty Point (L/s) x 3600 x 1.25

4.4.3.5 Running

The de-watering pump running. Note: there is no feedback from pump running – Derived from output DI contact to run dewatering pump

Flow Meter (Option H)

The following alarms and events are associated with the flow meter.

UUTS Database Record Name			
Plant	**Quantity**	**Desig**	**Triggered**
Flow_meter	Invalid	1	No
Flow_meter	Volume_invalid	1	No

4.4.3.6 Invalid Alarm

The invalid alarm standard as per Section 4.4.1 Standard Analogue Alarms.

4.4.3.7 Volume Invalid

When the invalid alarm is active the volume invalid is also set until midnight. At midnight the accumulated volume and the volume invalid values are reset.

4.4.4 Generator Monitoring (Option F)

The emergency generator is designed to the standard functionality as described by "DIESEL STANDBY GENERATOR LOCAL CONTROL PANEL FUNCTIONAL DESCRIPTION". [iii] The generator is supplied with a PLC fully configured and programmed with the UUTS standard generator monitoring and control program.

This description is independent of the type of generator used onsite. At the time of writing there are two types of Generators in use within QUU (Cummins and SE Power).

UUTS Database Record Name			
Plant	**Quantity**	**Desig**	**Triggered**
Generator	Automatic	1	Yes
Generator	CB_tripped	1	Yes
Generator	Common_fault	1	Yes
Generator	Door_status	1	No
Generator	Last_test_aborted	1	No
Generator	Last_test_failed	1	No
Generator	Last_test_failed_fault_1	1	No
Generator	Last_test_failed_fault_2	1	No
Generator	Last_test_failed_fault_3	1	No
Generator	Last_test_failed_fault_4	1	No
Generator	Last_test_failed_fault_5	1	No
Generator	Last_test_failed_fault_6	1	No
Generator	Last_test_passed	1	Yes
Generator	Low_fuel	1	Yes
Generator	Mid_fuel	1	No
Generator	Offsite	1	Yes
Generator	Online	1	No
Generator	Running	1	No
Generator	Test_sequence_active	1	No
Generator	Transfer_expected	1	Yes
Generator	Warning	1	No

4.4.4.1 Automatic

The generator auto (into the RTU) is an indication of the auto/manual switch in the generator. When the generator is switched to manual mode the generator auto indication on the UUTS master station is deactivated and triggered to alert the operator that the generator will no longer start automatically.

4.4.4.2 Circuit Breakers Tripped

The generator local CB healthy signal (into the RTU) is a direct indication of the generator Circuit Breaker status (open/closed). This signal is a combination of the circuit breakers required to be healthy for the generator to power the pump station including the circuit breaker on the generator itself (GCBT) and also the Auto Transfer Switch generator mains CB in the pump station switchboard (ATSG). A CB tripped position (digital input is off) activates the generator CB tripped indication on the UUTS master station.

4.4.4.3 Common Fault

The generator common fault signal (into the RTU) is active when anyone of a range of critical faults occurs.

The generator common fault status input is directly fed back to the generator common fault indication on the UUTS master station. As the RTU also receives some of the individual alarms that make up this common fault the common fault signal to the UUTS master station is suppressed if any of the following signals are also received by the RTU.

- Generator CB tripped

4.4.4.4 Door Status

When the generator canopy door is open the generator door status indication on the UUTS master station is activated as open and alarmed to alert the operator that the generator has been accessed. This alarm is suppressed if the generator is not on site.

4.4.4.5 Last Test Failed

For semi-permanent generator connection, the control room operator can test the generator by sending an ‘exercise generator’ command. The test will simulate an Energex failure. If anything in the sequence does not operate as scheduled the generator test fail alarm is raised. For a full description of the generator test fail alarm and the associated test sequence fault indicators refer to section 2.9.1 Generator Exercise (Option F).

4.4.4.6 Low Fuel

The generator low fuel alarm is directly fed to the generator low fuel indication on the UUTS master station.

4.4.4.7 Mid Fuel

The generator medium fuel status input is directly fed to the generator medium fuel indication on the UUTS master station.

4.4.4.8 Offsite

The generator on site signal (into the RTU) is a simple bridged connection in the disconnect plug on the generator to indicate that the generator control cable is connected to a generator. This signal is inverted and fed back as the generator off site indication on the UUTS master station.

4.4.4.9 Running

The generator running signal (into the RTU) is directly fed to the generator run indication on the UUTS master station.

4.4.4.10 Transfer Expected

If the Station is running under Generator Power (Transfer Switch is not in the ‘Normal’ state) and Energex Power is available (PFRE Relay is active) for 5 minutes, then the generator transfer expected alarm will be activated.

4.4.4.11 Warning

The generator warning signal is active when anyone of a range of warning signals is present on the generator. .The generator warning signal is directly fed back to the generator warning fault indication on the UUTS master station.

4.4.5 Odour control station

The following alarms and events are associated with the power supply.

UUTS Database Record Name			
Plant	**Quantity**	**Desig**	**Triggered**
Odour_control_station	High_speed_active	1	No

4.4.6 Power Supply

The switchboard at a sewerage pumping station has multiple points of isolation and failure. There are various monitoring relays and circuit breaker status inputs to determine the power status for the entire switchboard.

The following alarms and events are associated with the power supply.

UUTS Database Record Name			
Plant	**Quantity**	**Desig**	**Triggered**
Power_supply	Main_incomer_CB_closed	1	No

UUTS Database Record Name			
Plant	**Quantity**	**Desig**	**Triggered**
Power_supply	Surge_diverter_fault	1	Yes

4.4.6.1 Main Incomer Circuit Breaker Closed

This event is a direct feedback of the digital input indicating the status of the main incomer circuit breaker.

4.4.6.2 Surge Diverter Fault

The surge diverter has a healthy status fed back to the RTU. If this signal indicates a fault, and the station mains power is still active, then after a 2 second delay the surge diverter fault is activated.

4.4.7 Pressure Gauge

The following Analogue alarms are associated with the delivery pressure gauge.

UUTS Database Record Name			
Plant	**Quantity**	**Desig**	**Triggered**
Pressure_gauge	High	1	No
Pressure_gauge	Invalid	1	No
Pressure_gauge	Low	1	No

4.4.7.1 High Alarm

The high alarm is standard as per Section 4.4.1 Standard Analogue Alarms with the following additional conditions.

The high alarm is suppressed when the signal invalid alarm is healthy and a pump has been running for less than the pressure alarm inhibit time (default 15 seconds). This ensures that any instability caused by the pump starting has dissipated.

The high pressure alarm is generated if the signal is greater than the high limit set point for the duration of the pressure alarm duration time (default 15 seconds). It is deactivated when the signal is less than the high limit set point minus the dead band.

4.4.7.2 Invalid Alarm

The invalid alarm is standard as per Section 4.4.1 Standard Analogue Alarms with the following additional condition.

The invalid alarm is suppressed for the alarm inhibit time (default 15 seconds) after a pump has stopped. This ensures that any effects of negative pressure caused by the pump stopping have dissipated.

4.4.7.3 Low Alarm

The low alarm is standard as per Section 4.4.1 Standard Analogue Alarms with the following additional conditions.

The low alarm is suppressed when station power and the signal invalid alarm is healthy and a pump has been running for less than the pressure alarm inhibit time (default 15 seconds). This ensures that any instability caused by the pump starting has dissipated.

The low pressure alarm is generated if the signal is less than the low limit set point for the duration of the pressure alarm duration time (default 15 seconds). It is deactivated when the signal is greater than the low limit set point plus the dead band.

4.4.8 Reflux Valve (Option C)

UUTS Database Record Name			
Plant	**Quantity**	**Desig**	**Triggered**
Reflux_valve	Close_fault	1,2 & 3	No
Reflux_valve	Open_auto_fault_reset	1,2 & 3	No
Reflux_valve	Open_count_check	1,2 & 3	No
Reflux_valve	Open_fault	1,2 & 3	No

4.4.8.1 Close Fault

The reflux valve close fault is latched when pump mains power is healthy, the pump is not running and the reflux valve microswitch is in the “not closed” position for the pump reflux close delay time (site specific, default 60 seconds). The fault signal can be reset by the on site technician pressing the local reset button or by the control room operator sending a remote reset (if the station is in remote mode).

4.4.8.2 Open Auto Fault Reset

Once the reflux valve fail to open fault is activated, the pump will become unavailable and stop. To avoid the unnecessary unavailability of the sewer pump, this alarm will be reset automatically after the fault reset delay time (default 20 minutes).

4.4.8.3 Open Count Check

The purpose of the open fault count exceeded alarm is to prevent the re-occurring reflux fail to open fault being continuously reset automatically.

The fault count exceed signal is activated if 3 automatic resets have occurred in the last 8 hours. This signal can only be reset by the on-site technician pressing the local reset button or by the control room operator sending a remote reset (if the station is in remote mode).

4.4.8.4 Open Fault

The reflux fail to open fault is latched when pump mains power is healthy, the pump is running and the reflux valve microswitch is in the "closed" position for the pump reflux open delay time (site specific, default 60 seconds). The fault signal can be reset by the on-site technician pressing the local reset button, the control room operator sending a remote reset (if the station is in remote mode) or an automatic reset.

4.4.9 RTU

The following alarms and events are associated with the RTU.

UUTS Database Record Name			
Plant	**Quantity**	**Desig**	**Triggered**
Rtu	Abnormal_operation	1	Yes
Rtu	Battery	1	No
Rtu	Heartbeat_failed	1	n/a
Rtu	Initialisation_error	1	Yes
Rtu	Mains_fail	1	Yes

4.4.9.1 Abnormal Operation

An abnormal operation alarm identifies when the RTU operating system or code has restarted while in remote mode. This restart is determined by the presence of the 'first scan' flag. A first scan can occur when the RTU has reset itself due to a fault condition. Any abnormal operation should be investigated by a technical officer from the Networks Control Systems (NCS).

As downloading the code by a technical officer also causes a first scan, the technical officer can turn the station to local to suppress and/or reset this alarm. The alarm can also be reset by control room operator using the RTU abnormal operation reset command from the UUTS master station.

4.4.9.2 Battery

If the battery connected to the 24VDC power supply has failed then after a 15 seconds delay, the RTU Battery fail alarm is activated. The 24VDC power supply normally has a Battery OK indication which checks for low voltage on the battery and should also check for battery open circuit. When the Battery OK indication has turned off then a Battery Fail alarm is generated. The Battery OK indication on the current 24VDC power supply (Powerbox 250) does not check for battery open circuit / disconnected.

4.4.9.3 Heartbeat Failed

A counter increments every 5 seconds and is sent to the UUTS master station. The UUTS master station periodically, 'Heartbeat Period', (nominally 15 minutes) checks that the 'Heartbeat' figure has incremented. If the 'Heartbeat' value has not updated after a number, 'Heartbeat Count', (nominally 3) of periods then a Heartbeat Failed alarm is generated by the IDTS master station to alert the control room operator.

The Heartbeat Failed alarm is not generated while a RTU Device Alarm is active or the RTU has been put 'out of service'. The conditions that usually result in a Heartbeat Failed alarm are;

- the RTU has stopped operating
- the RTU is not being actively polled by the UUTS master station

4.4.9.4 Initialisation Error

This alarm will activate if any of the RTU database values failed to load into the Code variables in the Initialisation block during the first scan. The initialisation failure alarm will also activate if the RTU Md3 address does not match the RTU address indicating the incorrect database (including site specific values) has been loaded to the RTU. Forfull details of the RTU database file, refer to Appendix F.

4.4.9.5 Mains Fail

If the circuit breaker feeding the 240VAC to 24VDC power supply is tripped, and the station mains power is healthy, then after a 15 seconds delay, the RTU mains fail alarm is activated.

4.4.10 Security

The following alarms and events are associated with the Security.

UUTS Database Record Name			
Plant	**Quantity**	**Desig**	**Triggered**
Security	Door_status	1	No
Security	Intruder	1	Yes

4.4.10.1 Door Status

This alarm indicates that someone authorised or not, has opened a switchboard door. All the doors of the switchboard have a limit switch to indicate the status of that door. All these limit switches are wired in series to give a combined signal that indicates whether all the doors are closed or at least one door is open. This signal is fed back directly to give a status indication of all the doors on the switchboard to the control room operator.

4.4.10.2 Intruder

The intruder alarm will activate 5 minutes after the door limit switch has been activated unless the Control Room operator logs an on-site operator into a site and disables the intruder alarm. This will be done via the maintenance mode (refer to Appendix E: Maintenance Mode).

4.4.11 Sewage Pumping Station

The following alarms and events are associated with the mode of the switchboard

UUTS Database Record Name			
Plant	**Quantity**	**Desig**	**Triggered**
Sewage_pumping_station	Dry_well_elect_alarm_test_failed	1	Yes
Sewage_pumping_station	Dry_well_elect_trip_test_failed	1	Yes
Sewage_pumping_station	Dry_well_flooded_alarm	1	Yes
Sewage_pumping_station	Dry_well_flooded_trip	1	Yes
Sewage_pumping_station	Electrode Test Active	1	No
Sewage_pumping_station	Electrode Test Failed	1	Yes
Sewage_pumping_station	Emergency_pumping_mode_active	1	No
Sewage_pumping_station	Emergency_pumping_test_aborted	1	No
Sewage_pumping_station	Emergency_pumping_test_active	1	No
Sewage_pumping_station	Emergency_pumping_test_fail	1	Yes
Sewage_pumping_station	Emergency_pumping_test_fault_1	1	No
Sewage_pumping_station	Emergency_pumping_test_fault_2	1	No
Sewage_pumping_station	Emergency_pumping_test_fault_3	1	No
Sewage_pumping_station	Emergency_pumping_test_fault_4	1	No
Sewage_pumping_station	Emergency_pumping_test_fault_5	1	No
Sewage_pumping_station	Local_remote	1	Yes
Sewage_pumping_station	Mains_fail	1	Yes
Sewage_pumping_station	Upstream_manhole_surcharge_imm	1	Yes
Sewage_pumping_station	Water_spray	1	No

4.4.11.1 Dry Well Flooded - Alarm Electrode Test Failed

The circuit is tested every 6 hours for a 2 second period. If the signal is not received within the 2 second period, the electrode probe fault alarm is latched. The alarm is reset by the control room operator sending the probe test reset command.

4.4.11.2 Dry Well Flooded - Trip Electrode Test Failed

The circuit is tested every 6 hours for a 2 second period. If the signal is not received within the 2 second period, the electrode probe fault alarm is latched. The alarm is reset by the control room operator sending the probe test reset command.

4.4.11.3 Dry Well Flooded Alarm

The dry well flooded alarm is the warning, to the control room operator, that the site dry well has flooded and is at risk of reaching the trip level (which will then cause all pumps at the site to stop).

The dry well flooded alarm is activated by an electrode input. When this signal is active for 10 seconds then the dry well flooded alarm is activated. Once activated the alarm is active until an on-site operator has inspected the site and presses any of the sewer pump reset push buttons.

NOTE: During the secondary control circuit test the flooded alarm will be suppressed.

4.4.11.4 Dry Well Flooded Trip

The dry well flooded trip is a safety interlock to all pumps making all pumps unavailable. The dry well flooded trip is activated by the trip electrode input. When the signal is active for 10 seconds then the dry well flooded trip is activated. Once activated the trip is active until an on-site operator has inspected the site and presses any of the sewer pump reset push button.

If both the Dry well flooded alarm and trip are active then the Dry Well Interlock will prevent the pumps from being available.

NOTE: During the secondary control circuit test the flooded trip alarm will be suppressed.

4.4.11.5 Emergency Pumping Mode Active

If the surcharge imminent electrode is activated for 20 seconds the station secondary control circuit (hardwired) will activate in emergency pumping mode. The status of the this secondary control circuit emergency pumping mode will be provided to the UUTS master station as the sewerage pumping station emergency pumping mode active signal.

4.4.11.6 Electrode Test Active

This event is a direct feedback of the digital output that closes the loop of the test electrodes to ground as part of the electrode test.

4.4.11.7 Electrode Test Failed

If all test electrodes remain active for longer than 5 seconds, a test relay failed alarm is activated. This priority 1 alarm will also inhibit all alarms that are activated from these electrodes. Also, each pumps ‘interrupt’ relay will be activated to ensure the pumps do not run via the secondary controller circuit due to the test relay failure.

4.4.11.8 Local Remote

When the station is turned into local mode it ceases to be autonomous and can no longer be controlled by the control room operator. The pumps can only be started and stopped locally by the on site technician or if the emergency pumping mode becomes active.

The status of the local remote switch is sent back directly to the control room operator. This signal is a priority one alarm to immediately inform the control room operator that the station is no longer running under automatic control.

4.4.11.9 Mains Fail

If the power monitoring relay on the station side of the main incomer is indicating a fault then after a 75 seconds delay, the Station mains fail signal will activate. This signal is used to determine if the station has power, from either the line side of the main incomer or from the generator. The 75 second delay is to eliminate alarms due to brown outs and momentary losses of power. If the site has a permanent generator (Option F) then the 75 seconds provides enough time for the generator to start and connect.

4.4.11.10 Upstream Manhole Surcharge Imminent

The upstream manhole surcharge imminent alarm is a warning to the control room operator that the site is at immediate risk of surcharging upstream of the station.

The surcharge imminent alarm is activated by the surcharge imminent electrode input. When this signal is active for 10 seconds then the surcharge imminent alarm is activated. To prevent repetitious alarms due to wave action the signal is kept active for 1 minute after the surcharge imminent electrode deactivates.

NOTE: During the secondary control circuit test the surcharge imminent alarm will be suppressed.

4.4.12 Sewer Pump (Including Options A & B)

The following alarms and events are associated with the sewage pump.

UUTS Database Record Name			
Plant	**Quantity**	**Desig**	**Triggered**
Sewer_pump	Available	1,2 & 3	Yes
Sewer_pump	Best_pump_status	1,2 & 3	No
Sewer_pump	Blocked	1,2 & 3	No
Sewer_pump	Degraded	1,2 & 3	Yes
Sewer_pump	Emergency_stop_fault	1,2 & 3	No

UUTS Database Record Name			
Sewer_pump	Fail_to_run	1,2 & 3	No
Sewer_pump	Fail_to_stop	1,2 & 3	No
Sewer_pump	Inhibit_Fbk	1,2 & 3	No
Sewer_pump	Interrupt_relay	1,2 & 3	No
Sewer_pump	Mains_fail	1,2 & 3	No
Sewer_pump	Modbus_fault	1,2 & 3	No
Sewer_pump	Moisture_in_oil_fault (Option A)	1,2 & 3	No
Sewer_pump	Motor_current_high	1,2 & 3	No
Sewer_pump	Motor_current_low	1,2 & 3	No
Sewer_pump	Motor_protection_fault (Option B)	1,2 & 3	No
Sewer_pump	Running	1,2 & 3	No

4.4.12.1 Available

The pump considered available only when all of the following conditions are met:

- Site power available
- Pump mains power available
- Pump emergency stop input is healthy
- Pump emergency stop fault alarm is healthy
- Pump fail to start/stop alarms are healthy
- Pump starter fault alarm is healthy
- Pump starter fault count exceeded alarm is healthy
- Motor protection fault is healthy (Option B)
- Pump reflux fail to open alarm is healthy (Option C)
- Pump reflux fail to open count exceeded alarm is healthy (Option C)
- Dry Well Interlock is clear (healthy) (Option E)

The Dry Well Interlock is active (unhealthy) when both the following conditions are met:

- Dry Well Trip fault alarm is active (Option E)
- Dry Well High fault alarm is active (Option E)

As the emergency stop fault is latched and has a 2 second delay, both the emergency stop input and the emergency stop fault are needed to ensure the pump becomes unavailable and stops immediately when the emergency stop button is pressed. It also ensures that although the emergency stop button may be unlatched, the emergency stop fault must be reset by the on-site technician before the pump can start.

The pump must also be unavailable for 15 seconds before the alarm is sent to the UUTS master station. All the conditions which make the pump unavailable are events and can be easily identified by the control room operator by listing the abnormal points for the station.

4.4.12.2 Blocked Alarm

The Blocked alarm is designed to identify a possible blockage in an individual pump.

It is not desirable to run a blocked pump as it may damage the pump. To ensure that a pump which has a potential blockage does not run unnecessarily, the pump blockage alarm ‘degrades’ the blocked pump which effectively prevents it from running. If all the pumps are either degraded or operator inhibited, then the degraded pumps will be given preference to run.

The pump blockage alarm is set if any of the following conditions are active;

- (Option H active) the pump is running individually in remote and for longer than a certain time period and the flow is lower than the ‘blocked flow rate limit’. This condition is a site specific and determined by referring to the individual pump curve.

- (Option H not active or flow meter is invalid) The motor current low alarm is active for a period of 15 seconds.

The pump blockage alarm can be reset when the above conditions are no longer active by either a local or remote pump reset.

4.4.12.3 Degraded

The pump will be marked as degraded when it has been detected that its operation has been impaired. When a pump is degraded its level of availability will be decreased such that if the other pump is available and not degraded then the other pump will be selected as the duty pump. If both pumps are degraded then they will swap duty as normal.

The pump degraded condition will be set if the pump is available and any of the following conditions are active;

- Pump moisture in oil
- Pump blocked (either flow or current – refer Section 4.4.4 Motor Current)
- Other pump reflux fail to close
- Motor current high of Low

4.4.12.4 Emergency Stop Fault

If the emergency stop input becomes faulty and the station mains power is still healthy then, after a 2 second delay (to avoid race conditions on power up), the emergency stop fault is activated. Once activated, the emergency stop button must be unlatched and then the on-site technician must press the local reset button.

4.4.12.5 Fail to Run Fault

If the pump is commanded to start and the running indication does not activate, then after a site specific time period, the pump fail to run alarm will become active. As the pumps are controlled by hard wiring in emergency pumping mode (independent of the RTU) this alarm can only be set while the station is under the control of the RTU. The time period is dependent on the ramp up period of the soft starter. (Default 20 seconds).

4.4.12.6 Fail to Stop Fault

If the pump is commanded to stop and the running indication does not deactivate, then after a site specific time period, the pump fail to stop alarm will become active. As the pumps are controlled by hard wiring in emergency pumping mode (independent of the RTU) this alarm will be inhibited when the emergency pumping mode is active. The time period is dependent on the ramp down period of the soft starter. (Default 20 seconds).

NOTE: This alarm will activate when the emergency start switch runs the pump as there is no input into the RTU to indicate the status of this switch.

4.4.12.7 Mains Fail

If the pump control power is faulted and the station mains fail is healthy, then after a 2 second delay, the pump mains power is set to the fault condition.

4.4.12.8 Moisture in Oil (Option A)

If the moisture in oil relay is in the fault condition and the station mains fail is healthy, then after a 2 second delay, the pump moisture in oil fault is activated. This fault will **not** cause the pump to be unavailable This signal can only be reset by the on-site technician pressing the local reset button or by the control room operator sending a remote reset (if the station is in remote mode).

NOTE: The moisture in oil option is dependent on the specific pump that is selected for each site.

4.4.12.9 Motor Current Low Alarm

The low alarm is standard as per Section 4.4.1 Standard Analogue Alarms with the following additional conditions.

The low alarm is suppressed when station power and the signal invalid alarms are healthy and a pump has been running for less than the motor current alarm inhibit time (default 15 seconds). This ensures that any instability caused by the pump starting has dissipated.

The low alarm (motor current) is generated if the signal is less than the low limit set point for the duration of the motor current alarm duration time (default 15 seconds). It is deactivated when the signal is greater than the low limit set point plus the dead band.

4.4.12.10 Motor Current High Alarm

The high alarm is standard as per Section 4.4.1 Standard Analogue Alarms with the following additional conditions.

The high alarm is suppressed when station power and the signal invalid alarms are healthy and a pump has been running for less than the motor current alarm inhibit time (default 15 seconds). This ensures that any instability caused by the pump starting has dissipated.

The high alarm (motor current) is generated if the signal is greater than the high limit set point for the duration of the motor current alarm duration time (default 15 seconds). It is deactivated when the signal is less than the high limit set point minus the dead band.

4.4.12.11 Motor Protection Fault (Option B)

If the moisture in stator relay is in the fault condition and/or the motor temperature is in the fault condition and the pump mains power is healthy, then after a 2 second delay, the pump motor protection fault is activated. This fault will cause the pump to be unavailable. This fault is not latched so the pump can return to service once the temperature input becomes healthy again.

NOTE: The moisture in stator option is dependent on the specific pump that is selected for each site.

NOTE: The motor temperature option is dependent on the specific pump that is selected for each site.

4.4.12.12 Running

The pump running status input is directly fed back via the sewer pump running indication signal to the UUTS master station.

4.4.13 Site

The following alarms and events are associated with the site.

UUTS Database Record Name			
Plant	**Quantity**	**Desig**	**Triggered**
Site	Energex_power	1	Yes
Site	Mobile_generator_online	1	No

4.4.13.1 Energex Power

If the power monitoring relay on the Energex side of the main incomer is indicating a fault then after a 15 second delay, the Energex power signal will be set to the fault state. This signal is used to determine if the Energex power is healthy while the station is running on a generator. The 15 second delay is used to eliminate alarms due to brown outs and momentary losses of power.

4.4.13.2 Mobile Generator Online

The main incomer circuit breaker is interlocked with the generator circuit breaker, only one can be closed at any given time. If the main incomer circuit breaker is not closed and the station still has mains power then, the station must be powered by the generator. Therefore after a 5 second delay, the generator online status is activated.

4.4.14 Soft Starter (Not Option W)

The following alarms and events are associated with the soft starter.

UUTS Database Record Name			
Plant	**Quantity**	**Desig**	**Triggered**
Soft_starter	Auto_ fault_reset	1,2 & 3	No
Soft_starter	Count_check	1,2 & 3	No
Soft_starter	Fault	1,2 & 3	No

4.4.14.1 Auto Fault Reset

A faulted soft starter will be automatically reset by the RTU after a site specific delay (typically 20 minutes). This event is raised to indicate an automatic reset by the RTU.

4.4.14.2 Count Check

The RTU is permitted to automatically reset a soft starter fault a maximum of three times in an 8 hour period. This alarm is raised to indicate a pump has been automatically reset three times in the previous 8 hours and no further automatic fault resets are permissible by the RTU.

This signal can only be reset by the on-site technician pressing the local reset button or by the control room operator sending a remote reset (if the station is in remote mode).

4.4.14.3 Fault

Indicates the soft starter is faulty so the pump is unavailable for operation.

4.4.15 Sump Pump

The following alarms and events are associated with the sump pump.

UUTS Database Record Name			
Plant	**Quantity**	**Desig**	**Triggered**
Sump_pump	Available	1	1
Sump_pump	Excessive_run	1	1
Sump_pump	Excessive_cycle	1	1
Sump_pump	Running	1	0

4.4.15.1 Available

The sump pump healthy signal (into the RTU) provides the sump pump available indication. If the sump pump is not healthy for 5 seconds then the sump pump available is deactivated until the healthy signal is restored.

4.4.15.2 Excessive Cycling

If the sump pump starts within 5 minutes of its last start the sump pump excessive cycling fault is activated. This alarm is active until the sump pump is not running and has not run for at least 5 minutes. This alarm can also be reset remotely from the UUTS master station via the sump pump reset command.

4.4.15.3 Excessive Run

If the sump pump has been running for longer than 10 minutes the sump pump excessive run fault is activated. This alarm is active until the sump pump stops.

4.4.15.4 Running

The sump pump running status input is directly fed back to the sump pump running indication signal to the UUTS master station.

4.4.16 Valve Pit

The following alarms and events are associated with the valve pit.

UUTS Database Record Name			
Plant	**Quantity**	**Desig**	**Triggered**
Valve	Pit_flooded_electrode_test_fail	1	Yes
Valve	Pit_flooded_high	1	Yes

4.4.16.1 Pit Flooded Electrode Test Fail

The circuit is tested every 6 hours for a 2 second period. If the signal is not received within the 2 second period, the electrode probe fault alarm is latched. The alarm is reset by the control room operator sending the probe test reset command.

4.4.17 Variable Speed Drive (Option W)

The following alarms and events are associated with the soft starter.

UUTS Database Record Name			
Plant	**Quantity**	**Desig**	**Triggered**
VSD	Auto_ fault_reset	1,2 & 3	No
VSD	Count_check	1,2 & 3	No
VSD	Fault	1,2 & 3	No

4.4.17.1 Auto Fault Reset

A faulted VSD will be automatically reset by the RTU after a site specific delay (typically 20 minutes). This event is raised to indicate an automatic reset by the RTU.

4.4.17.2 Count Check

The RTU is permitted to automatically reset a VSD fault a maximum of three times in an 8 hour period. This alarm is raised to indicate a pump has been automatically reset three times in the previous 8 hours and no further automatic fault resets are permissible by the RTU.

This signal can only be reset by the on-site technician pressing the local reset button or by the control room operator sending a remote reset (if the station is in remote mode).

4.4.17.3 Fault

Indicates the VSD is faulty so the pump is unavailable for operation.

4.4.18 Wet Well

The following standard Analogue alarms are associated with the wet well.

UUTS Database Record Name			
Plant	**Quantity**	**Desig**	**Triggered**
Wet_well	Calibration_fault	1	Yes
Wet_well	High	1	Yes
Wet_well	High_electrode	1	No
Wet_well	High_electrode_test_fail	1	Yes
Wet_well	Level_invalid	1	Yes
Wet_well	Low	1	No
Wet_well	Slime_strip_mode_active	1	No
Wet_well	Surcharge_elect_test_fail	1	Yes
Wet_well	Surcharge_imminent	1	Yes
Wet_well	Surcharge_occuring	1	Yes
Wet_well	Ultrasonic_level_invalid	1	No
Wet_well	Volume_invalid	1	No

As the wet well probe takes a few seconds to initialise, all the wet well alarms except for invalid, are suppressed for 10 seconds upon RTU start up.

4.4.18.1 Calibration Fault

The calibration will be checked once a day during wet well calibration mode. The wet well calibration fault is activated one of two ways.

1. The high level electrode is activated while the wet well level probe is reading more than 100mm below the high alarm level.
2. The wet well level probe is reading 100mm above the high level without the high level electrode being activated.

To reset the calibration fault signal the control room operator sends a calibration fault reset command from the UUTS master station.

For sites with a secondary probe, the calibration fault is also activated if the seconday probe and the primary prove differ by more than 100mm for more than 60 seconds.

4.4.18.2 High Alarm

A high alarm indicates that the wet well level is above the normal operating range of the pump station and that the inflow is higher than the current pumping capacity of the station. The control room operator must now initiate contingency plans to minimise the possibility of a surcharge.

The high alarm is triggered by either the high level electrode or by the wet well level probe. The high alarm is the first alarm that the control room operator receives if the wet well level probe is not functioning correctly.

The high alarm is primarily activated by the high level electrode input. When this signal is active for 10 seconds then the high level alarm is activated. To prevent repetitious alarms due to wave action the signal is kept active for 1 minute after the high level electrode deactivates.

As a backup, a valid wet well level signal exceeding the high alarm level by 100mm, for 10 seconds, will also trigger the high level alarm while the station is in remote mode. (This will also trigger a wet well calibration fault if the high level electrode is not active).

NOTE: During the wet well calibration and secondary control circuit tests the high level alarm will be suppressed.

4.4.18.3 High Electrode Test Fail

The circuit is tested every 6 hours for a 2 second period. If the signal is not received within the 2 second period, the electrode probe fault alarm is latched. The alarm is reset by the control room operator sending the probe test reset command.

4.4.18.4 Level Invalid

The level invalid alarm is standard as per Section 4.4.1 Standard Analogue Alarms, with the exception that the delay is 1 second instead of 2 seconds.

4.4.18.5 Low Alarm

The low alarm is standard as per Section 4.4.1 Standard Analogue Alarms.

A low alarm indicates that the wet well level may be lower than the intake for the pump. This puts the pump at risk of air locking. A conventional air locked pump must be primed by an on-site technician to make it available to run.

4.4.18.6 Surcharge Imminent Alarm

The surcharge imminent alarm is a final warning to the control room operator that the site is at immediate risk of surcharging. This serves as a reminder to the control room operator in implementing the contingency plans. It also provides a statistical count of all sites that came close to surcharging.

The surcharge imminent alarm is primarily activated by the surcharge imminent electrode input. When this signal is active for 10 seconds then the surcharge imminent alarm is activated. To prevent repetitious alarms due to wave action the signal is kept active for 1 minute after the surcharge imminent electrode deactivates.

As a backup, a valid wet well level signal exceeding the surcharge imminent level by 100mm, for 10 seconds, will also trigger the surcharge imminent alarm while the station is in remote mode. As the surcharge imminent probe is powered by 240VAC and will not be operating during a station mains power failure the surcharge imminent alarm will be activated when the wet well level probe reaches the surcharge imminent alarm level. (i.e. the 100mm is removed from the backup alarm triggering during a station mains power fail).

NOTE: During the secondary control circuit test the surcharge imminent alarm will be suppressed.

4.4.18.7 Surcharge Imminent Sensor Fail Alarm

The surcharge imminent sensor fail alarm is activated if the sensor healthy digital input from the surcharge imminent fail safe relay is not active for 30 seconds. It is deactivated when the signal has been healthy for 5 seconds.

4.4.18.8 Surcharge Occurring Alarm

This alarm is the final alarm that the control room operator will receive as the wet well level rises until it overflows. This alarm is used to calculate the duration of the surcharge event (surcharge duration).

When the wet well level is greater than or equal to the surcharge level minus 25 mm the surcharge occurring signal is activated. To prevent repetitious alarms due to wave action the signal is kept active for 1 minute after the wet well level falls below the surcharge occurring level.

5 CALCULATIONS

The RTU performs calculations for both the controls of the station and for analytical analysis of the station's performance. The calculated values are stored in ordinary RTU memory and are lost when the RTU restarts. The calculated values are sent back periodically to the UUTS SCADA system and stored in the history database. Access to this information is via the operators control station or a casual use work station. All the control variables are also sent back to the UUTS SCADA system as feedback points to allow the control room operator to view the current control parameters.

5.1 Analogue Signal Processing

5.1.1 Analogue Clamping

Before it is used to calculate the engineering value of the signal the raw Analogue input signal is clamped to the 4-20mA limits if the value is within the invalid hysteresis value of the respective limit. The invalid hysteresis value is the range of the signal multiplied by the site invalid hysteresis percentage.

5.1.2 Analogue Conversion to Engineering Unit

The Analogue input card converts the 4-20mA signals received to a raw count of 800 to 4000. This raw count is converted in the code to engineering units using the following formula. This is to be done in the RTU code using the site specific values (conversion tables are not to be used).

Engineering Unit = (Raw signal – 800)/3200 x Engineering Range.

The following are the signals received by the RTU.

Signal	Engineering Units		
Delivery Pressure	meters	(m)	
Wet Well Level	meters	(m)	
Motor Power	kilowatts	(kW)	
Motor Current	Amps	(A)	
Emergency Storage Level	meters	(m)	(Option G)
Delivery Flow	litres per second	(l/s)	(Option H)

5.1.3 Analogue Filtering

The engineering values are filtered using a five element FIFO (first in, first out) stack sampled every 1 second to produce a rolling average. The average is reset when a signal becomes valid after a period of invalidity.

5.2 Calculated and Feedback Values

For a full list of all calculated and feedback values refer to Appendix D: Standard UUTS Alarms Events and Variable List.

5.2.1 Cathodic Protection

The following calculated and feedback points are associated with cathodic protection.

UUTS Database Record Name				
Plant	Quantity	Desig	Units	RTU History
Cathodic_protection	Rectifier_current	1	Amps	Yes
Cathodic_protection	Rectifier_current_high_limit_Fbk	1	Amps	No
Cathodic_protection	Rectifier_current_low_limit_Fbk	1	Amps	No
Cathodic_protection	Rectifier_current_range_Fbk	1	Amps	No

5.2.1.1 Rectifier Current

The cathodic protection rectifier current engineering units will be determined as per the standard Analogue signal processing described in section 5.1.

5.2.2 Emergency Storage

The following calculated and feedback points are associated with the emergency storage.

UUTS Database Record Name				
Plant	**Quantity**	**Desig**	**Units**	**RTU History**
Emergency_storage	Stop level_Fbk	1	MAHD	No
Emergency_storage	Start level_Fbk	1	MAHD	No
Emergency_storage	Level	1	MAHD	Yes
Emergency_storage	Level_range_Fbk	1	Metres	No
Emergency_storage	Overflow level into storage tank_level_Fbk	1	MAHD	No
Emergency_storage	Zero_MAHD_Fbk	1	MAHD	No

5.2.3 Flow meter (Option H)

The following calculated and feedback points are associated with the delivery flow meter.

UUTS Database Record Name				
Plant	**Quantity**	**Desig**	**Units**	**RTU History**
Flow_meter	Flow_rate	1	L/s	Yes
Flow_meter	Flow_rate_Range_Fbk	1	L/s	No
Flow_meter	Volume	1	kL	Yes
Flow_meter	Volume_2_pumps	1	kL	Yes
Flow_meter	Volume_2_pumps_yesterday	1	kL	Yes
Flow_meter	Volume_yesterday	1	kL	Yes

5.2.3.1 Flow rate

The delivery flow rate is measure in l/s. The engineering units will be determined as per the standard Analogue signal processing described in section 5.1.

5.2.3.2 Volume

The volume pumped for the station is calculated using the delivery flow (l/s) integrated over time and reset to 0 at midnight.

5.2.3.3 Volume 2 Pumps

The volume pumped for the station for two pumps running at the same time is calculated using the delivery flow (l/s) integrated while both pumps are running and reset to 0 at midnight.

5.2.3.4 Volume Yesterday

The volume yesterday value is the previous day’s volume pumped and is a record of the volume at midnight prior to the volume value being reset.

5.2.3.5 Volume 2 Pumps Yesterday

The volume 2 pumps yesterday value is the previous day’s volume 2 pumps value and is a record of the volume 2 pumps at midnight prior to the volume 2 pumps value being reset.

5.2.4 Odour control station

The following calculated and feedback points are associated with the odour control station.

UUTS Database Record Name				
Plant	**Quantity**	**Desig**	**Units**	**RTU History**
Odour_control_station	High_speed_inflow_rate_Fbk	1	L/s	Yes

5.2.5 Power Meter

The following power meter parameters are associated with the power meter (derived via the Modbus Link).

UUTS Database Record Name				
Plant	**Quantity**	**Desig**	**Units**	**RTU History**
Site	Voltage	L1/L12	V	Yes
Site	Voltage	L2/L23	V	Yes
Site	Voltage	L3/L31	V	Yes
Site	Current	L1	A	Yes
Site	Current	L2	A	Yes
Site	Current	L3	A	Yes
Site	Current	N	A	Yes
Site	Voltage THD	L1/L12	%	Yes
Site	Voltage THD	L2/L23	%	Yes
Site	Voltage THD	L3/L31	%	Yes
Site	Current THD	L1	%	Yes
Site	Current THD	L2	%	Yes
Site	Current THD	L3	%	Yes
Site	Total power factor	1	-	Yes
Site	Total kW	1	kW	Yes
Site	Total kvar	1	kvar	Yes
Site	Total kVA	1	kVa	Yes

5.2.6 Pressure Gauge

The following calculated and feedback points are associated with the delivery pressure gauge.

UUTS Database Record Name				
Plant	**Quantity**	**Desig**	**Units**	**RTU History**
Pressure_gauge	Elevation_Rtu	1	MAHD	No
Pressure_gauge	High_limit_Fbk	1	MAHD	No
Pressure_gauge	Low_limit_Fbk	1	MAHD	No
Pressure_gauge	Pressure_kpa	1	kPa	Yes
Pressure_gauge	Pressure_mahd	1	MAHD	Yes
Pressure_gauge	Pressure_range_Fbk	1	Metres	No

5.2.6.1 Pressure mAHD

Delivery pressure (if gauge operating) of pumps in measured in mAHD.

The pressure probe measures the pressure in meters. So that the control room operators can compare different sewerage sites successfully, the Pressure in mAHD is calculated and sent back to the UUTS SCADA system.

Pressure (mAHD) = Pressure (meters) + Pres Elev (mAHD)

5.2.7 RTU

The following calculated and feedback points are associated with the RTU.

UUTS Database Record Name				
Plant	**Quantity**	**Desig**	**Units**	**RTU History**
Rtu	Control_id_Fbk	1	Units	No
Rtu	Database_version	1		No
Rtu	Heartbeat	1	Counts	No
Rtu	RTU_address	1	Units	No

5.2.7.1 Control Identifier Feedback

The control feedback variable indicated the current control schedule that has been downloaded from the master station. In general, control schedules are not used for sewage pump stations and a value of -1 indicating no control schedule is loaded is expected to be returned.

5.2.7.2 Heartbeat

The heartbeat value increments by 1 count every 5 seconds. The master station will compare this value between successive polls, and if the number has not incremented since the last poll and alarm will generate in the master station.

5.2.8 Sewer Pump

The following calculated and feedback points are associated with the sewer pumps.

UUTS Database Record Name				
Plant	**Quantity**	**Desig**	**Units**	**RTU History**
Sewer_pump	Blockage_setpoint_Fbk	1,2 & 3		No
Sewer_pump	Hours_run	1,2 & 3	Hours	Yes
Sewer_pump	Hours_run_12	1	Hours	Yes
Sewer_pump	Hours_run_12_yesterday	1	Hours	Yes
Sewer_pump	Hours_run_yesterday	1,2 & 3	Hours	Yes
Sewer_pump	Motor_current	1,2 & 3	Amps	Yes
Sewer_pump	Motor_current_high_limit_Fbk	1,2 & 3	Amps	No
Sewer_pump	Motor_current_low_limit_Fbk	1,2 & 3	Amps	No
Sewer_pump	Motor_power	1,2 & 3	kW	Yes
Sewer_pump	Number_of_starts	1,2 & 3	Counts	Yes
Sewer_pump	Number_of_starts_yesterday	1,2 & 3	Counts	Yes
Sewer_pump	Total_KWHrs	1,2 & 3	kWh	Yes
Sewer_pump	Total_KWHrs_2_pumps	1	kWh	Yes
Sewer_pump	Total_KWHrs_2_pumps_yesterday	1	kWh	Yes
Sewer_pump	Total_KWHrs_yesterday	1,2 & 3	kWh	Yes

5.2.8.1 Hours run

The hours run value is the accumulated hours that a pump runs during the day regardless of the other pump operation. The accumulated value is reset to 0 at midnight.

5.2.8.2 Hours run 12

The hours run 12 value is the accumulated hours that both pumps run together for the current day. The accumulated value is reset to 0 at midnight.

5.2.8.3 Number of Starts

The number for starts per day counter is incremented every time a pump starts. This counter is reset at midnight.

5.2.8.4 Total kW hrs

The kilowatt-hours that an individual pump consumes are calculated by integrating the power over time while that pump is running. This integral is reset at midnight.

5.2.9 Variable Speed Drive (Option W)

The following calculated and feedback points are associated with the variable speed drives

UUTS Database Record Name				
Plant	**Quantity**	**Desig**	**Units**	**RTU History**
VSD	Speed_command	1,2 & 3	Speed % based on VFD max speed	Yes
VSD	Speed_feedback	1,2 & 3	Speed %	Yes
VSD	Speed_max_feedback	1,2 & 3	Hz of max speed	Yes
VSD	Speed_min - not used	1,2 & 3	Hz	Yes

5.2.9.1 Speed Command

The current speed command (% of max speed) being transmitted to the variable speed drive (via the analog output)

5.2.9.2 Speed Feedback

The current speed (Hz) being received from the variable speed drive (via Modbus).

5.2.9.2.1 Speed Min

The minimum speed (Hz) that the drive is configured to run in the variable speed drive (via Modbus).

5.2.9.2.2 Speed Max

The maximum speed (Hz) that the drive is configured to run in the variable speed drive (via Modbus).

5.2.10 Wet Well

The following calculated and feedback points are associated with the wet well.

UUTS Database Record Name				
Plant	**Quantity**	**Desig**	**Units**	**RTU History**
Wet_well	Duty_A_start_setpoint_Fbk	1	MAHD	No
Wet_well	Duty_A_stop_setpoint_Fbk	1	MAHD	No
Wet_well	Duty_B_start_setpoint_Fbk	1	MAHD	No
Wet_well	Duty_B_stop_setpoint_Fbk	1	MAHD	No
Wet_well	High_limit_Fbk	1	MAHD	No
Wet_well	Inflow	1	L/s	Yes
Wet_well	Inhibit_mode_start_level_Fbk	1	MAHD	No
Wet_well	Inhibit_mode_stop_level_Fbk	1	MAHD	No
Wet_well	Level	1	MAHD	Yes
Wet_well	Level_range_Fbk	1	Metres	No
Wet_well	Low_limit_Fbk	1	MAHD	No
Wet_well	Outflow	1	L/s	Yes
Wet_well	Probe_calibration_error	1	Metres	Yes
Wet_well	Surcharge_duration	1	Seconds	Yes
Wet_well	Surcharge_imminent_level_Fbk	1	MAHD	No
Wet_well	Surcharge_imminent_level_Fbk	1	MAHD	No
Wet_well	Surcharge_time_remaining	1	Minutes	Yes
Wet_well	Total_inflow	1	kL	Yes
Wet_well	Total_inflow_yesterday	1	kL	Yes
Wet_well	Total_outflow	1	kL	Yes
Wet_well	Total_outflow_yesterday	1	kL	Yes
Wet_well	Ultrasonic_level	1	MAHD	Yes
Wet_well	Ultrasonic_level_range_Fbk	1	Metres	No
Wet_well	Ultrasonic_zero_MAHD_Fbk	1	MAHD	No
Wet_well	Volume	1	kL	Yes
Wet_well	Zero_MAHD_Fbk	1	MAHD	No

5.2.10.1 Level

The on-site indication on the switchboard is in level % of full range. This value is also sent back to the control room so that the on-site technician and control room operator can compare values in the same units. The Control room operator also requires the wet well level in mAHD to be able to do a meaningful comparison between different sites. The following formulas are used to calculate these values.

WWL (mAHD) = WWL (meters) + WWL Zero Level (mAHD)

5.2.10.2 Volume

The wet well volume is calculated using a 'wet well levels vs volume' look up table stored in the RTU database (.main file). The look up table has a maximum 32 point specification of the non-linear relationship of the wells 'Level vs Volume'. The volume in the wet well is an interpolation of the well vs volume lookup table values. The site specific data is obtained from a table in an Excel spreadsheet (Table 5: Level vs Volume Lookup Table) which also provides a graphical representation of all the sample points (Figure 6: Level vs Volume Chart).

Table 5: Level vs Volume Lookup Table (SAMPLE)

	Excel Data		RTU Data
	Wet Well Level mAHD]	**Remaining Storage Capacity [m^3]**	**Current Storage Volume [m^3]**
BWL of PS	1.790	9.219	0.000
	1.866	9.020	0.199
	1.941	8.821	0.398
	2.017	8.622	0.597
	2.093	8.423	0.796
	2.168	8.224	0.995
	2.244	8.025	1.194
	2.319	7.826	1.392
TWL of PS	2.390	7.641	1.578
	2.471	7.429	1.790
	2.546	7.207	2.012
	2.622	6.832	2.387
	2.698	6.139	3.080
High Alarm Level	2.790	4.968	4.251
	2.849	4.130	5.089
	2.924	3.005	6.213
	3.000	2.139	7.079
	3.076	1.417	7.802
	3.151	0.709	8.510
Surcharge Level	3.227	0.000	9.219

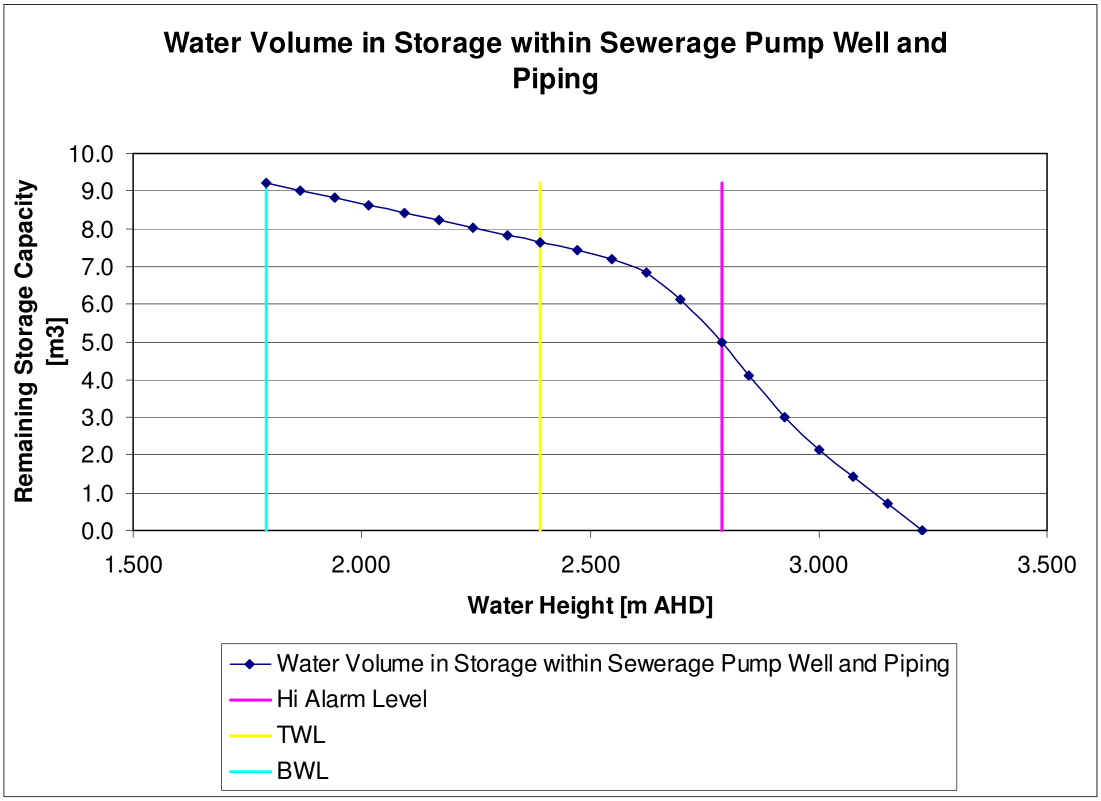
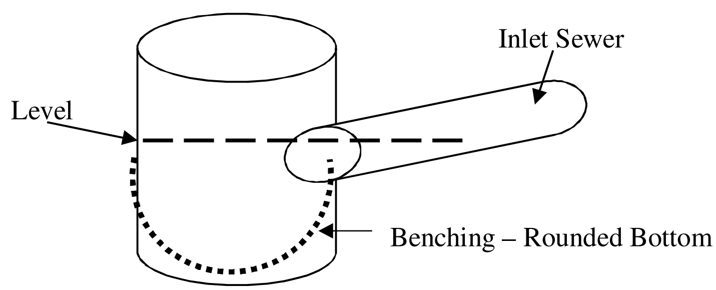


Figure 6: Level vs Volume Chart (SAMPLE)

The non-linearity of the curve level vs volume curve is caused by non-cylindrical shape of the wet well, the displacement of volume caused by object inside the well (pumps and pipe work) and the additional capacity provided by the inlet pipes that feed the wet well. Refer to *Figure 7: Wet well diagram.*

Figure 7: Wet well diagram



The data in the RTU database is stored in an array of 32 'segments'. Each segment has the volume of that segment and the height of that segment. (Not a cumulative height and volume as per the table shown). The site specific RTU database includes the 'SPxxx.main' file is stored on the UUTS server and can download directly to the RTU from the server.

The wet well vs volume table is derived from the 'As Constructed' civil drawings of the station and are provided by the System Planning section of Queensland Urban Utilities.

In *Figure 6: Level vs Volume Chart,* the 'Top Water Level' (TWL) is the Duty A Start, and the 'Bottom Water Level' (BWL) is Duty A Stop.

5.2.10.3 Inflow

The Inflow value is the calculated instantaneous inflow to the wet well when pumps are not running.

As there is no flow meter in the inlet to a standard submersible sewerage station, the instantaneous inflow is calculated using a change in volume, integrated over time, calculations. To negate the outflow of the pump station from the equation, the inflow is only calculated when the **pumps are not running**. The simplified formula for calculating the inflow over a period of time is

Inflow (l/s)	=	Volume Difference (litres) / Δt (s)
Volume Difference	=	difference in volume over the sample period
Δt (s)	=	sample period

Method A – Time between Stop and Start

To ensure a change in volume large enough to make the inherent errors in the volume calculations negligible, method A takes the time to fill the well between the pump stop and start levels as the sampling time and the difference as the change in volume between the duty A stop and duty A start levels. This produced an average inflow over the sample period.

Method B – Array method

To remove the errors inherent in calculating small changes of wet well level, method B applies a 17 element FIFO (first in, first out) stack sampled every 15 second to produce a rolling average filter of the well level. The filter is reset (set to current level) when a pump stops.

To calculate the instantaneous inflow, the volume calculated using the filtered wet well level is recorded every 2 minutes (every 8 samples of the wet well level). The volume difference is the change in volume over a sample period of 2 minutes. To further stabilise the calculated instantaneous inflow calculation, the calculated inflow value itself is passed through a 7 element moving average filter. This filter is not reset between pump running transitions.

Combining Method A and Method B results

Due to the moving average filter and sample intervals used by method B, the first raw inflow value can not be calculated until 6 ¼ minutes after the pumps stopped. If the pumps are stopped long enough for method B to calculate a new inflow value then this new value is loaded into the inflow filter. The average of the last 7 values calculated is the new calculated average inflow figure.

Method A is used to calculate the inflow during high inflows (Off time is less than 6 ¼ minutes). When the flow is high enough that the off time is less than 6 ¼ minutes then the value calculated is 'flooded' into all elements of the inflow filter to make the average inflow value equal to newly calculated inflow value derived by method A.

5.2.10.4 Total Inflow

The total inflow value is the calculated inflow to the wet well since midnight while pumps are not running

The total inflow for each day is the integration of the calculated average inflow value using 15 second sample rate.

Total Inflow (kl) = Total Inflow (kl) + [Inflow (l/s) x 15 (s)/1000]

5.2.10.5 Surcharge Duration

While the surcharge occurring alarm is active, a timer is accumulated to measure the duration of the surcharge event. This figure is stored until a new surcharge occurring alarm is triggered, at which time the timer is reset to zero.

5.2.10.6 Calibration Error

The calibration error is recorded each time the wet well high level switch changes state as long as the electrode test is not active and the wet well level invalid alarm is not active.

6 On Site Graphical Display Configuration

The graphical display on the switchboard provides the on site operator with screens which summarise the status as well as the recent history of the site. This will aid maintenance staff and response crews to quickly determine the current status of the station and highlight any possible faults at the site. The main screens available to the on site operator are

- Main Display
- Wet Well Display
- Pump Status Display
- Alarm History Display
- IO Status Display
- Trend Display

All alarm and event status data sent to the redlion should not be subjected to top-end alarm suppression. This includes suppression due to mains power failure, station local and generator canopy door open.

All displayed names should match as close, as possible, the corresponding name on the electrical drawings.

6.1 Screens

6.1.1 Main Display

The main display screen will have the following information available for the on site operator

- Wet well level in meters, mAHD and %
- Wet well control and alarm levels %
- Current control mode
- Pump mimic (indication of running, fault, speed, 3rd pump, etc).
- Pressure reading in meters and mAHD.
- Flow rate in litres /sec and volume for the day (Option H)
- Calibration Test in Progress
- Maintenance Mode Active and Time Remaining until surcharge

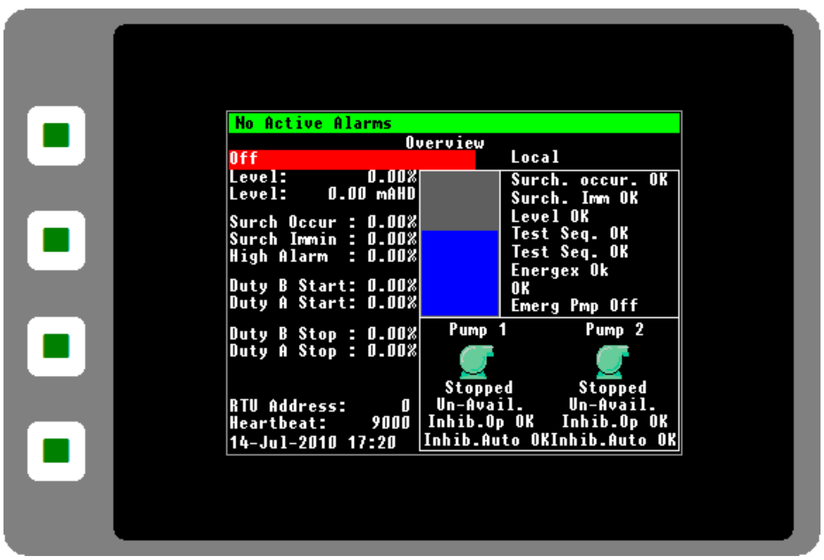


Figure 8: Graphical Display – Main Page

6.1.2 Wet Well Display

The wet well display screen will have the following information available for the on site operator

- Wet well level in meters, mAHD and %
- Wet well control and alarm levels in mAHD
- Wet well probe hanging lengths in meters (showing 3 decimal places)
- Wet well active alarms
- Surcharge imminent time and time remaining
- Wet Well high pumping time and time remaining.

Figure 9: Graphical Display – Wet Well Display

6.1.3 Pump Status Display

The pump status screen will have the following information available for the on-site operator

- All alarm and events
- Run Hours
- Hours Run Yesterday
- Current
- Voltage
- Speed
- Starts today
- Starts Yesterday

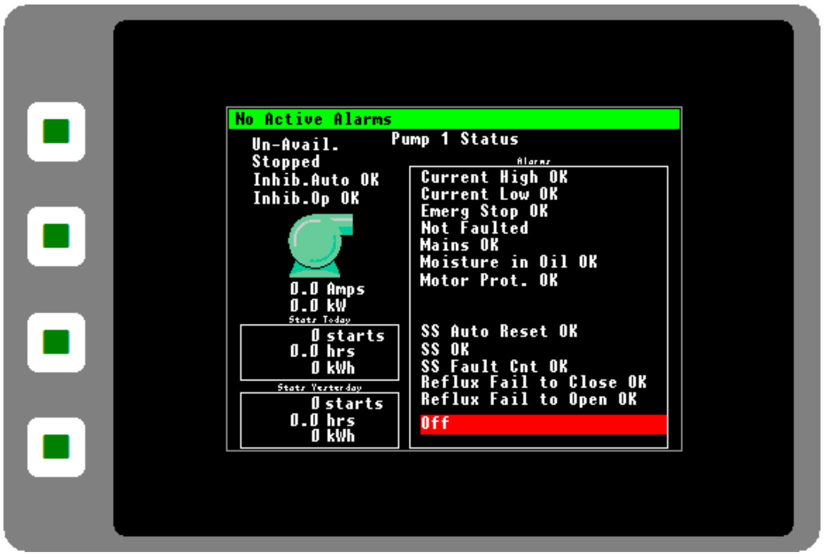


Figure 10: Graphical Display – Pump Status Display

6.1.4 Alarm History Display

The alarm history display will show previous history and sequence of alarms and events. This will assist in fault finding and decrease rectification times.

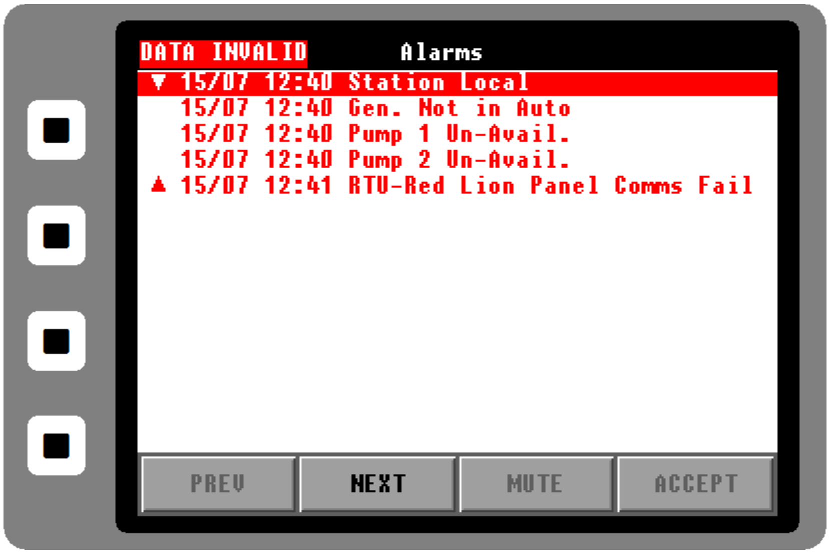


Figure 11: Graphical Display – Alarm History Display

6.1.5 IO Status Display

The IO Status display shows the current status of the RTU IO. This will assist the on site operator to diagnose hardware and software failures.

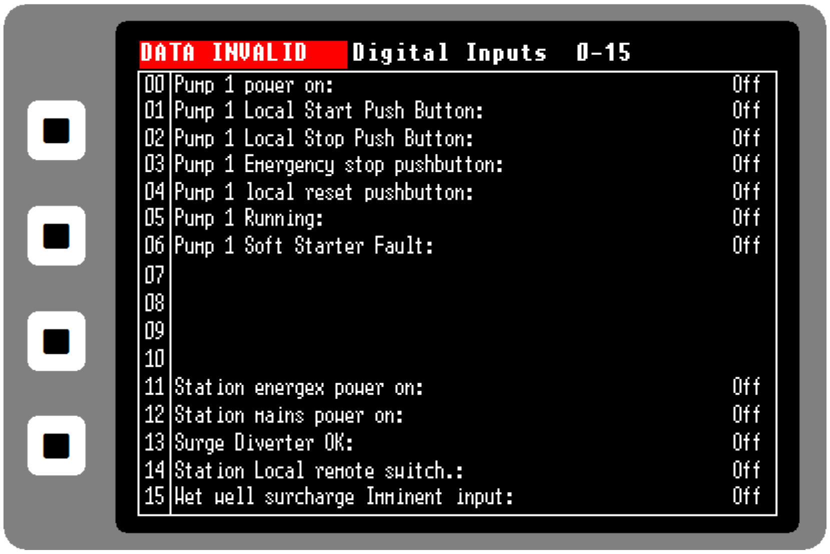


Figure 12: Graphical Display – IO Status Display

6.1.6 Trend Display

The Trend display will trend the wet well level, delivery flow and delivery pressure of the station. This will assist in the testing of pump performance (pump curves). The trend display will also trend the pump current (Amps) for each pump.

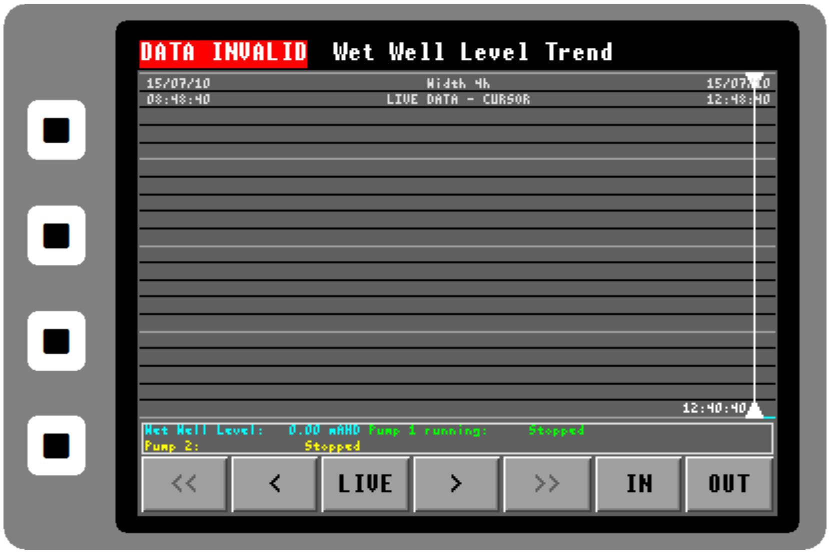


Figure 13: Graphical Display – Trend Display

6.2 Data Communications

The onsite graphical display receives all the displayed data values from the RTU using the Modbus telemetry protocol. The RTU will act as the Modbus master periodically performing Modbus block writes to the graphical display unit acting as the Modbus slave. The Modbus communication medium is usually RS485 serial however, if supported by both devices, Ethernet may be used. In this instance the Modbus/TCP telemetry protocol is used.

6.2.1 Data format

Data is transferred as 16-bit signed integers or 16 Boolean values packed as a single 16-bit integer. The range of the transferred integer values is -32768 to 32767 and as such an appropriate scaling factor should be applied to floating point values.

7 UUTS SCADA CONFIGURATION

Every site on the UUTS SCADA system has to be configured individually. To make each site the following data must be released into the online database.

- Points Database
- Significant/Trigger Points
- History Database
- Site RTU database
- Alarm Instructions
- Site Picture

7.1 UUTS Points Database

The points database consists of all the points configured for communication with the site RTU. They fall under one of three categories

- Digital Alarms and Events (Boolean)
- Control Points (Boolean, Real and Integer)
- Analogue Status (Integer and Real)

These points are detailed on UUTS spreadsheet (Refer to Appendix D). This spreadsheet details each point's corresponding address in the RTU, sets up any alarm priority and all other point attributes. This spreadsheet can be used by the UUTS system administrator to populate the online database with the site points required.

7.2 UUTS History Database

All digital and Analogue points, for which trend data is to be stored, must be populated in the history database and have their parameter (such as sample granularity) configured. Only points configured in the history database can be trended on the UUTS SCADA system. The history database is configured by the UUTS system administrator.

7.3 UUTS Significant Points (MD3311 RTU Only)

For an MD3311 RTU, all points which are classified as priority 1 alarms are configured as 'significant' points. This is done on the online UUTS database and is then downloaded to the RTU. Any alarm configured to be significant will cause the RTU to immediately transmit to the UUTS master station. Any other type or RTU will need to have a method of determining which alarms and events will trigger an immediate transmission to the UUTS master station.

7.4 UUTS Site RTU database (MD3311 RTU Only)

Each MD3311 or MD1000 RTU commissioned in the field has a RTU database generated from in the UUTS master station. This database stores all I/O (physical and pseudo) and also stores the wet well level vs volume data. This database can be used to re-configure the RTU CPU in case of failure. The RTU database is created from the UUTS master station using the IO configuration, history configuration, significant points configuration as well as the *.main file (configuration setting such as site specific variables and constants (including the wet well vs volume lookup table) as well as communication configuration.

7.5 UUTS Alarm Instructions

The UUTS administrator installs the alarm instruction list onto the UUTS master station. Each file is linked to its associated alarm and provides the control room operator the actions required if that alarm is triggered. Below is an example of an alarm instruction file for the "Sewerage_pumping_station – Mains_fail alarm".

```
Contact Energex
If Energex are aware of the problem.
Request an estimate of when power will be restored.
If Energex are unaware of any problem.
An urgent inspection is required.
     Obtain estimate from contingency data as to likelihood of times station will
     overflow.

Normal hours:
Notify Field Services to attend.
Notify Field Services Duty Officer.
Inhibit flow from pumping stations upstream of station outage if possible.
Monitor & check regularly with Energex.

After hours:
Notify Field Services Duty Officer.
Inhibit flow from pumping stations upstream of station outage if possible.
If Energex are unaware of any problem.
An urgent inspection is required.
```

The alarm instructions are generic across sites for each alarm plant and quantity. The UUTS administrator can generate a site specific instruction file if the site needs a unique instruction

7.6 UUTS Site Schematic

The site schematic on the UUTS SCADA system is defined in the "UUTS Functional Requirements Specification – Template Schematics"[iv] document. Further, all sites that are covered by this document should use either the "Sewage Pump Station – Conventional" or "Sewage Pump Station – Submersible" schematic template as the site schematic depending on the individual site type.

Example screen shots of the schematic templates in the operational and development mode are provided below. Schematic elements are made visible according to whether the relating points are defined, the full set of animation and action rules are defined for each template in the functional specification document.

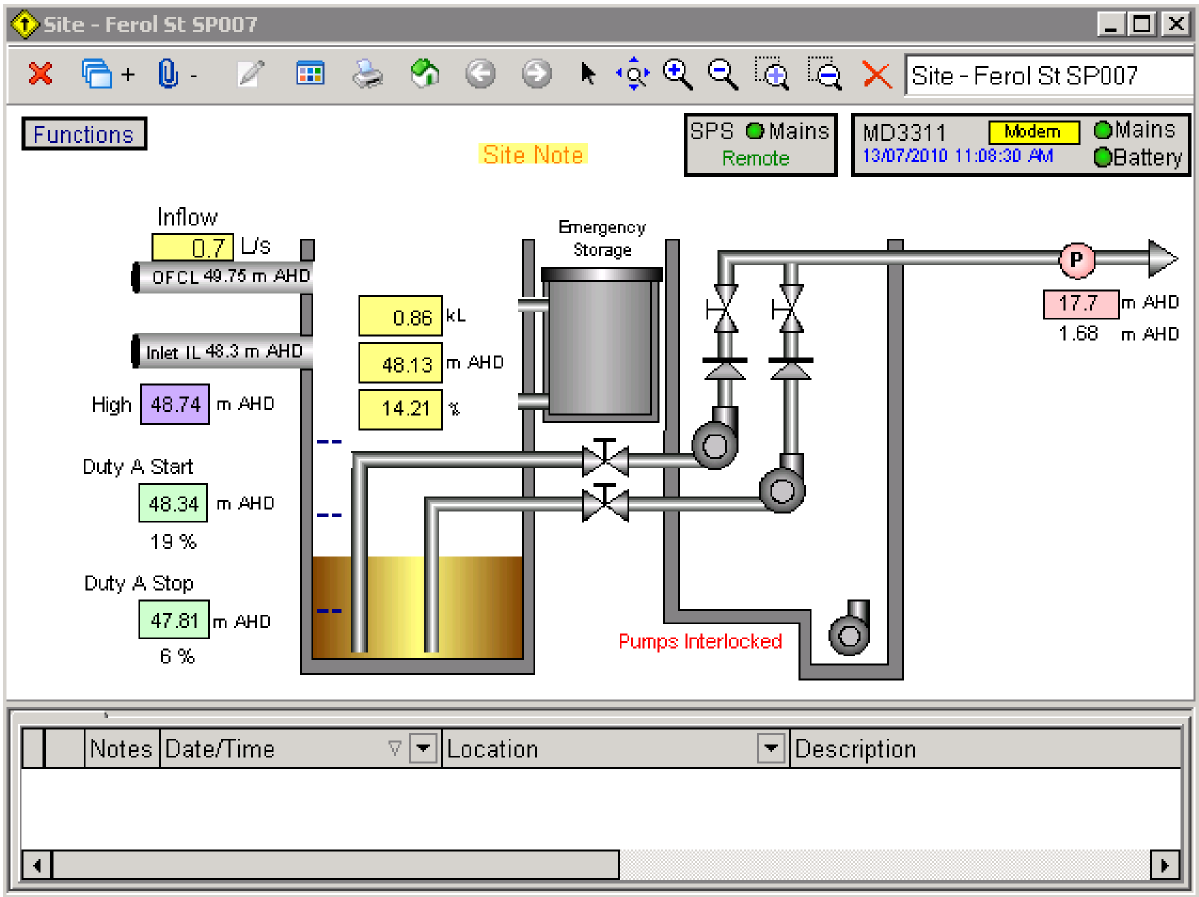


Figure 14: Typical Conventional Site Schematic

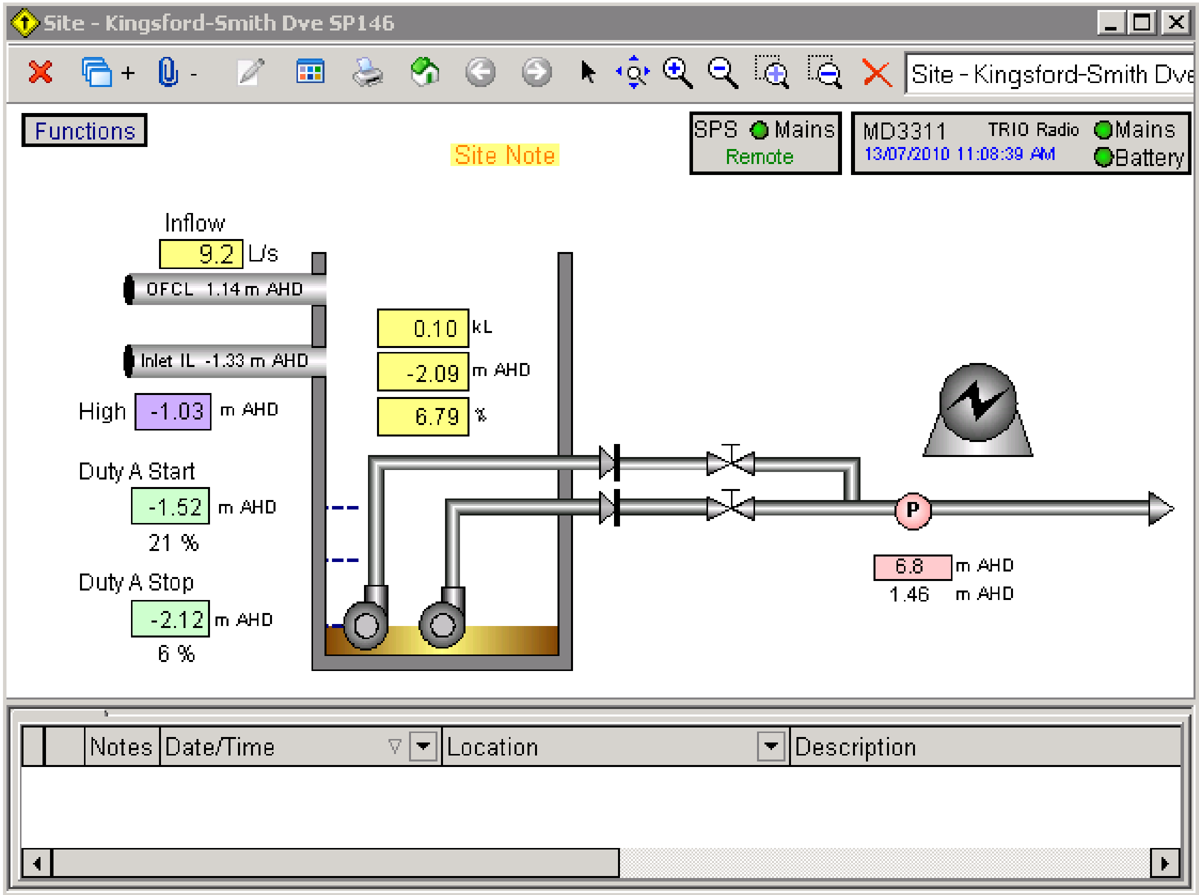


Figure 15: Typical Submersible Site Schematic

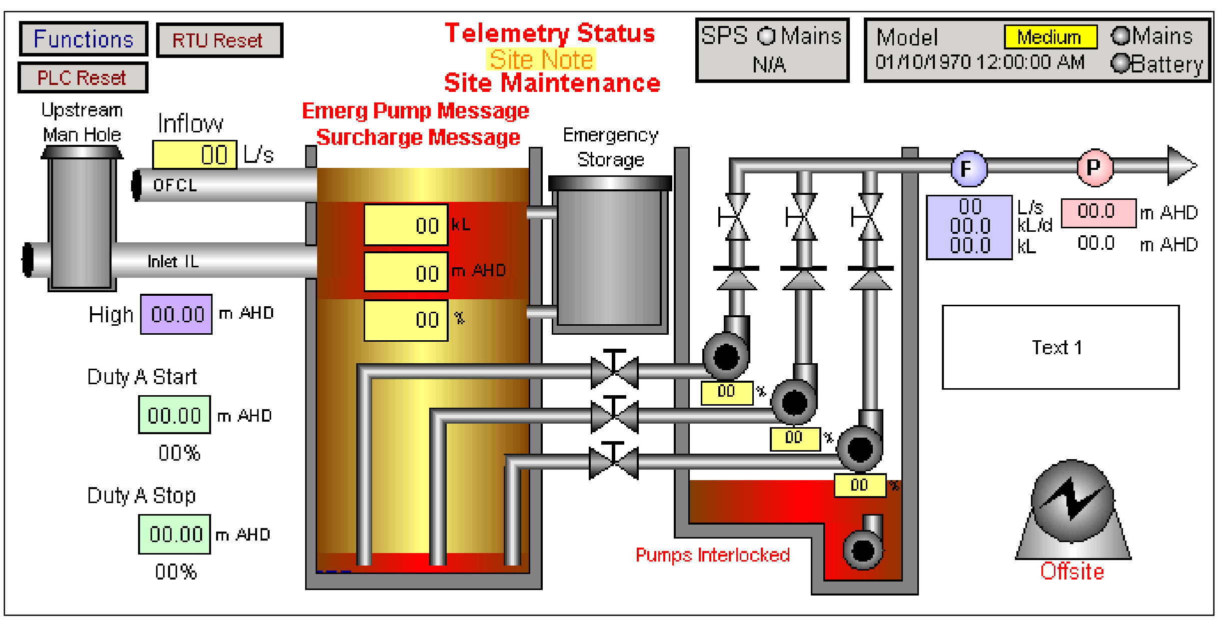


Figure 16: Conventional Site Template Schematic

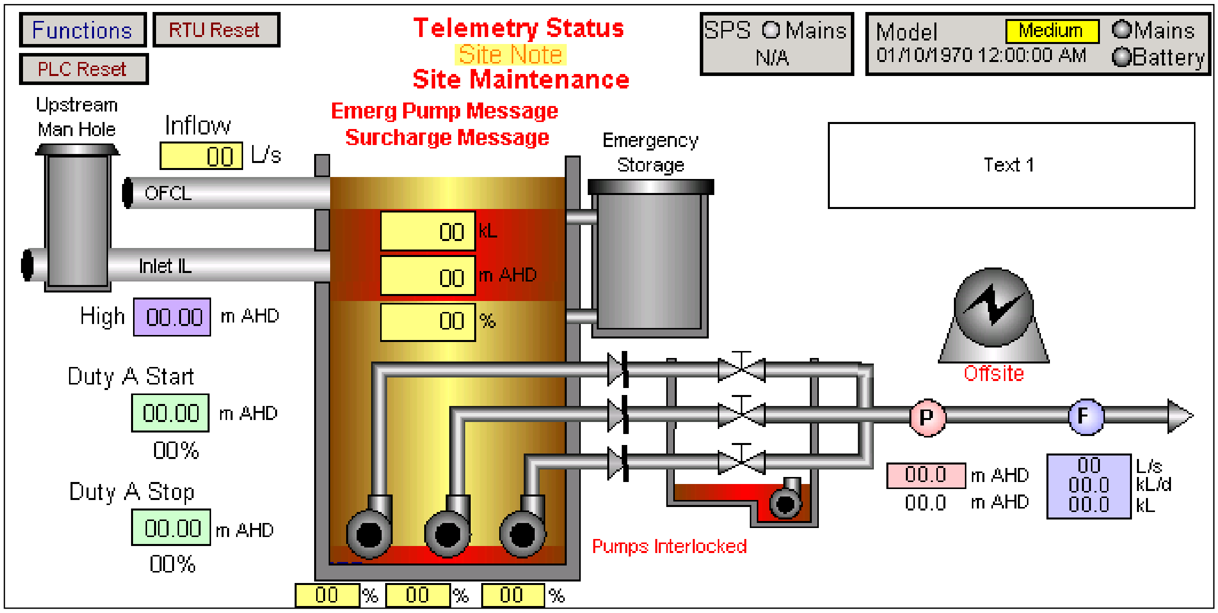


Figure 17: Submersible Site Template Schematic

8 APPENDICES

Appendix A: DRAWING LIST

To determine the latest revision of each drawing, refer to the drawing index – SHEET 00.

Electrical Drawing List		
Sheet #	**Drawing #**	**Title**
0	486/5/7-xxxx-001	Site Cover Sheet
1	486/5/7-xxxx-001	Power Distribution Schematic Diagram
2	486/5/7-xxxx-001	Pump 01 Schematic Diagram
3	486/5/7-xxxx-001	Pump 02 Schematic Diagram
04#	486/5/7-xxxx-001	RESERVED FOR Pump 03 Schematic Diagram
5	486/5/7-xxxx-001	Dry Well Sump & Em. Storage Dewatering Pump
06#	486/5/7-xxxx-001	RESERVED FOR Generator Control
7	486/5/7-xxxx-001	Common Control Schematic Diagram
8	486/5/7-xxxx-001	Common RTU I/O Schematic Diagram
9	486/5/7-xxxx-001	RTU Power Distribution Schematic Diagram
10	486/5/7-xxxx-001	RTU Digital Inputs Termination Diagram - Sheet 1 of 3
11	486/5/7-xxxx-001	RTU Digital Inputs Termination Diagram - Sheet 2 of 3
12	486/5/7-xxxx-001	RTU Digital Inputs Termination Diagram - Sheet 3 of 3
13	486/5/7-xxxx-001	RTU Digital Outputs Termination Diagram - Sheet 1 of 2
14	486/5/7-xxxx-001	RTU Digital Outputs Termination Diagram - Sheet 2 of 2
15	486/5/7-xxxx-001	RTU Analog Inputs Termination Diagram
16	486/5/7-xxxx-001	RTU Analog Outputs Termination Diagram
17	486/5/7-xxxx-001	Common Controls Termination Diagram
18	486/5/7-xxxx-001	Equipment List
19	486/5/7-xxxx-001	Cable Schedule
20	486/5/7-xxxx-001	Switchboard Label Schedule
21	486/5/7-xxxx-001	Switchboard Construction Details - Sheet 1 of 3
22	486/5/7-xxxx-001	Switchboard Construction Details - Sheet 2 of 3
23	486/5/7-xxxx-001	Switchboard Construction Details - Sheet 3 of 3
24	486/5/7-xxxx-001	Field Instrumentation - Installation Details
25#	486/5/7-xxxx-001	RESERVED FOR Cathodic Protection Unit
26#	486/5/7-xxxx-001	RESERVED FOR Field Disconnection Box
27	486/5/7-xxxx-001	SWBD General Arrangement Elevations
28	486/5/7-xxxx-001	SWBD General Arrangement Sections
29#	486/5/7-xxxx-001	RESERVED FOR Generator External Connection Box
30	486/5/7-xxxx-001	Switchboard Slab - Locality and Site Plans
31	486/5/7-xxxx-001	Switchboard Slab and Conduit Details
32	486/5/7-xxxx-001	Switchboard Slab and Electrical Conduit Layout

Appendix B: STANDARD PHYSICAL I/O LIST

SP[xxx] [SITE NAME]

8 I/O slots - PS , CPU and 8 I/O modules, wall mount or 19" rack, Dimensions (WxHxD*): 435 x 244 x 198 mm (17" x 9.61" x 7.80"), Weight: approx. 3.3 Kg (7.3 lb)

RACK - 8 I/O Slot - V108

Slot 00	Slot 01	Slot 02	Slot 03	Slot 04	Slot 05	Slot 06	Slot 07	Slot 08	Slot 09
V251	V446	V265	V265	V265	V265	V616	V616	V318	V118
ACE 3600 POWER SUPPLY	ACE 3640 CPU CARD	Digital Input 16 Channel	Digital Input 16 Channel	Digital Input 16 Channel	Digital Input 16 Channel	Digital Output 16 Channel	Digital Output 16 Channel	Analog Input 8 Channel	Analog Output 4 Channel
(18-72 VDC)		16 DI Fast 24V	16 DI Fast 24V	16 DI Fast 24V	16 DI Fast 24V	16 DO EE Relay 2A	16 DO EE Relay 2A	8 AI, ±20 mA	4 AO, 0-20 mA
		I0.0 - I3.7	I4.0 - I7.7	I8.0 - I11.7	I12.0 - I15.7	Q0.0 - Q1.7	Q2.0 - Q3.7	AI0 - AI7	AO0-AO3

Motorola ACE Parts List

Qty	Item	Descriptions
1	V108	8 I/O slots - PS , CPU and 8 I/O modules, wall mount or 19" rack
1	V367	DC PS 18-72V with Battery charger
1	V328	10 Ah Backup Battery
1	V446	ACE CPU3640
1	V447	Plug-in SRAM
1	VA00362	Plug-in Radio Port
1	V283	Software License (RTU Options) - DNP3+ License
3 (4)	V265	Digital Input Modules - 16 DI FAST 24V DC (Onoy 3 when 3rd pump option is not needed)
1 (0)	V20	Blank I/O module (For Slot 04 when 3rd pump option is not needed).
2	V616	Relay Output Modules -16 DO EE relay 2A
1	V318	Analog Input Modules - 8 AI, ±20 mA
1	V118	Analog Output Modules - 4 AO, ±20 mA

QUEENSLAND UrbanUtilities

SP[xxx] [SITE NAME]

Physical I.O. Spreadsheet **Digital Input Card 1**

I/O #	Term	Tag	Description	Off State	On State	Term. #	Wire #	Schem	Term	O	Comment	FAT	SAT
DI01	1	pmp1mainsPower	Pump control power available	Off	On		DI01			-		☐	
DI02	2	pmp1localStart	Pump local start pushbutton	Not Pressed	Pressed		DI02			-		☐	
DI03	3	pmp1localStop	Pump local stop pushbutton	Not Pressed	Pressed		DI03			-		☐	
DI04	4	pmp1eStop	Pump emergency stop pushbutton	Fault	Healthy		DI04			-		☐	
DI05	5	pmp1localReset	Pump local reset pushbutton	Not Pressed	Pressed		DI05			-		☐	
DI06	6	pmp1running	Pump running	Not Running	Running		DI06			-		☐	
DI07	7	pmp1fault	Pump starter fault	Healthy	Fault		DI07			-	Either SS or VFD	☐	
DI08	8	pmp1MIOFault	Pump moisture in oil	Healthy	Fault		DI08			A		☐	☐
DI09	9	pmp1motorProtFlt	Pump motor protection fault	Healthy	Fault		DI09			B		☐	☐
DI10	10	pmp1reflux	Pump reflux valve microswitch	Not Closed (Flow)	Closed (No Flow)		DI10			C		☐	☐
DI11	11	stn1MHsurchImm	Station manhole surcharge imminent	Healthy	Surcharge Imm		DI11			D		☐	☐
DI12	12	stn1energexPower	Station energex mains power	Off	On		DI12			-		☐	
DI13	13	stn1mainsPower	Station mains power	Off	On		DI13			-		☐	
DI14	14	stn1surgeDivOK	Station surge diverter heatlhy	Fault	Healthy		DI14			-		☐	
DI15	15	stn1localRemote	Station local remote switch	Local	Remote		DI15			-		☐	
DI16	16	wwl1surchImm	Wet well surcharge imminent	Healthy	Surcharge Imm		DI16			-		☐	☐

FACTORY ACCEPTANCE TESTED BY: Date / /

SITE ACCEPTANCE TESTED BY: Date / /

SP[xxx] [SITE NAME]

Physical I.O. Spreadsheet   Digital Input Card 2

I/O #	Term	Tag	Description	Off State	On State	Term. #	Wire #	Schem	Term	O	Comment	FAT	SAT
DI01	1	pmp2mainsPower	Pump control power available	Off	On		DI17			-		□	
DI02	2	pmp2localStart	Pump local start pushbutton	Not Pressed	Pressed		DI18			-		□	
DI03	3	pmp2localStop	Pump local stop pushbutton	Not Pressed	Pressed		DI19			-		□	
DI04	4	pmp2eStop	Pump emergency stop pushbutton	Fault	Healthy		DI20			-		□	
DI05	5	pmp2localReset	Pump local reset pushbutton	Not Pressed	Pressed		DI21			-		□	
DI06	6	pmp2running	Pump running	Not Running	Running		DI22			-		□	
DI07	7	pmp2fault	Pump starter fault	Healthy	Fault		DI23			-	Either SS or VFD	□	
DI08	8	pmp2MIOFault	Pump moisture in oil	Healthy	Fault		DI24			A		□	□
DI09	9	pmp2motorProtFlt	Pump motor protection fault	Healthy	Fault		DI25			B		□	□
DI10	10	pmp2reflux	Pump reflux valve microswitch	Not Closed (Flow)	Closed (No Flow)		DI26			C		□	□
DI11	11	wwl1surchImmOK	Wet well surcharge imminent signal healthy	Fault	Healthy		DI27			-	Added in version 3-10	□	□
DI12	12	rtu1BattSystem	RTU battery system OK	Fault	Healthy		DI28			-		□	
DI13	13	rtu1mainsPower	RTU control power	Off	On		DI29			-		□	
DI14	14	stn1emergPmpMode	Station emergency pumping mode	Not Active	Active		DI30			-		□	
DI15	15	wwl1high	Wet well high level	Healthy	High		DI31			-		□	□
DI16	16	stn1DoorStatus	Station security alarm (Doorswitch)	Alarm	Healthy		DI32			-		□	□

FACTORY ACCEPTANCE TESTED BY: ____________________ Date / /

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SP[xxx] [SITE NAME]

Physical I.O. Spreadsheet **Digital Input Card 3**

I/O #	Term	Tag	Description	Off State	On State	Term. #	Wire #	Schem	Term	O	Comment	FAT	SAT
DI01	1	stn1TSGstatus	Station transfer switch - generator status	Not Generator	Generator		DI49			-		☐	
DI02	2	gen1fault	Generator fault	Ok	Alarm		DI50			F		☐	☐
DI03	3	gen1warning	Generator warning	Ok	Alarm		DI51			F		☐	☐
DI04	4	gen1lowFuel	Generator low fuel	Ok	Low		DI52			F		☐	☐
DI05	5	gen1medFuel	Generator medium fuel	Ok	Medium		DI53			F		☐	☐
DI06	6	gen1running	Generator running	Stopped	Running		DI54			F		☐	☐
DI07	7	gen1canpoyDoors	Generator security	Unsecured	Secured		DI55			F		☐	☐
DI08	8	gen1locCBTripped	Generator CB status	Closed	Tripped		DI56			F		☐	☐
DI09	9	gen1auto	Generator mode	Auto	Not Auto		DI57			F		☐	☐
DI10	10	gen1onSite	Generator on site	False	True		DI58			F		☐	☐
DI11	11	pit1flooded	Valve pit flooded	Not Flooded	Flooded		DI59			Q		☐	☐
DI12	12	cpr1localReset	Cathodic protection local reset	Not Pressed	Pressed		DI60			K		☐	
DI13	13	smp1running	Sump pump running	Healthy	Fault		DI61			E		☐	☐
DI14	14	smp1healthy	Sump pump healthy	Not Running	Running		DI62			E		☐	☐
DI15	15	stn1floodHigh	Dry well flooded high alarm level	Healthy	High		DI63			E		☐	☐
DI16	16	stn1floodTrip	Dry well flooded trip level	Healthy	Trip		DI64			E		☐	☐

FACTORY ACCEPTANCE TESTED BY: Date / /

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Queensland Urban Utilities

SP[xxx] [SITE NAME]

Physical I.O. Spreadsheet Digital Input Card 4

I/O #	Term	Tag	Description	Off State	On State	Term. #	Wire #	Schem	Term	O	Comment	FAT	SAT
DI01	1	pmp3mainsPower	Pump control power available	Off	On		DI65			X		☐	
DI02	2	pmp3localStart	Pump local start pushbutton	Not Pressed	Pressed		DI66			X		☐	
DI03	3	pmp3localStop	Pump local stop pushbutton	Not Pressed	Pressed		DI67			X		☐	
DI04	4	pmp3eStop	Pump emergency stop pushbutton	Fault	Healthy		DI68			X		☐	
DI05	5	pmp3localReset	Pump local reset pushbutton	Not Pressed	Pressed		DI69			X		☐	
DI06	6	pmp3running	Pump running	Not Running	Running		DI70			X		☐	
DI07	7	pmp3fault	Pump starter fault	Healthy	Fault		DI71			X	Either SS or VFD	☐	
DI08	8	pmp3MIOFault	Pump moisture in oil	Healthy	Fault		DI72			XA		☐	☐
DI09	9	pmp3motorProtFlt	Pump motor protection fault	Healthy	Fault		DI73			XB		☐	☐
DI10	10	pmp3reflux	Pump reflux valve microswitch	Not Closed (Flow)	Closed (No Flow)		DI74			XC		☐	☐
DI11	11	#	spare	-	-		DI75			-			
DI12	12	#	spare	-	-		DI76			-			
DI13	13	#	spare	-	-		DI77			-			
DI14	14	#	spare	-	-		DI78			-			
DI15	15	#	spare	-	-		DI79			-			
DI16	16	#	spare	-	-		DI80			-			

FACTORY ACCEPTANCE TESTED BY: Date / /

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Physical I.O. Spreadsheet Digital Output Card 1

I/O #	Term	Tag	Description	Off State	On State	Term. #	Wire #	Schem	Term	O	Comment	FAT	SAT
DO01	1 & 2	pmp1operate	Pump run command	Off	Run		DO01			-		☐	
DO02	3 & 4	pmp1resetCmd	Pump fault reset	Off	Reset		DO02			-		☐	
DO03	5 & 6	pmp1interupt	Pump emergency mode interrupt	Off	Interupt		DO03			-		☐	
DO04	7 & 8	pmp1runAtMax	Pump run at max command	Off	Run at Max		DO04			W		☐	
DO05	9 & 10	wwl1signalTest	Wet well signal test	Off	On		DO05			-		☐	☐
DO06	11 & 12	wwl1washer	Wet well washer solenoid	Off	On		DO06			P		☐	☐
DO07	14 & 15	wwl1strobe	Station strobe light	Off	On		DO07			E		☐	☐
DO08	17 & 18	stn1odourControl	Station Odour Control	Off	On		DO08			M		☐	☐
DO09	21 & 22	pmp3operate	Pump run command	Off	Run		DO09			X		☐	
DO10	23 & 24	pmp3resetCmd	Pump fault reset	Off	Reset		DO10			X		☐	
DO11	25 & 26	pmp3interupt	Pump emergency mode interrupt	Off	Interupt		DO11			X		☐	
DO12	27 & 28	pmp3runAtMax	Pump run at max command	Off	Run at Max		DO12			XW		☐	
DO13	29 & 30	#	spare	-	-		DO13			-			
DO14	31 & 32	#	spare	-	-		DO14			-			
DO15	34 & 35	#	spare	-	-		DO15			-			
DO16	37 & 38	#	spare	-	-		DO16			-			

FACTORY ACCEPTANCE TESTED BY: Date / /

SITE ACCEPTANCE TESTED BY: Date / /

SP[xxx] [SITE NAME]

Physical I.O. Spreadsheet **Digital Output Card 2**

I/O #	Term	Tag	Description	Off State	On State	Term. #	Wire #	Schem	Term	O	Comment	FAT	SAT
DO17	1 & 2	pmp2operate	Pump run command	Off	Run	123 & 124	DO17		11	-		☐	
DO18	3 & 4	pmp2resetCmd	Pump fault reset	Off	Reset	125 & 126	DO18		11	-		☐	
DO19	5 & 6	pmp2interupt	Pump emergency mode interrupt	Off	Interupt	127 & 128	DO19		11	-		☐	
DO20	7 & 8	pmp2runAtMax	Pump run at max command	Off	Run at Max	129 & 130	DO20		11	W		☐	
DO21	9 & 10	gen1start	Generator remote start	Off	On	131 & 132	DO21		11	F		☐	☐
DO22	11 & 12	cpr1deenergise	Cathodic protection de-energise rectifier	Off	On	133 & 134	DO22		11	K		☐	
DO23	14 & 15	cpr1faultInd	Cathodic protection fault indication	Off	On	135 & 136	DO23		11	K		☐	
DO24	17 & 18	est1dewater	Emergency Storage Dewater	Off	On	137 & 138	DO24		11	G			
DO25	21 & 22	#	SPARE	-	-		DO25			-			
DO26	23 & 24	#	SPARE	-	-		DO26			-			
DO27	25 & 26	#	SPARE	-	-		DO27			-			
DO28	27 & 28	#	SPARE	-	-		DO28			-			
DO29	29 & 30	#	SPARE	-	-		DO29			-			
DO30	31 & 32	#	SPARE	-	-		DO30			-			
DO31	34 & 35	#	SPARE	-	-		DO31			-			
DO32	37 & 38	#	SPARE	-	-		DO32			-			

FACTORY ACCEPTANCE TESTED BY: Date / /

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SP[xxx] [SITE NAME]

Physical I.O. Spreadsheet Analog Input Card 1

I/O #	Term	Tag	Description	4mA	20mA	Term. #	Wire #	Schem	Term	O	Comment	FAT	SAT
AI01	1 & 2	wwl1rawSignal	Primary Wet well level raw signal				AI01+,AI01-			-		☐	☐
AI02	3 & 4	pre1rawSignal	Delivery pressure raw signal				AI02+,AI02-			U		☐	☐
AI03	5 & 6	est1rawSignal	Emergency storage level raw signal				AI03+,AI03-			G		☐	☐
AI04	7 & 8	#	Spare				AI04+,AI04-			-			
AI05	11 & 12	gen1rawSignal	Generator Fuel Level	0%	100%		AI05+,AI05-			F		☐	☐
AI06	13 & 14	wwl2rawSignal	Secondary Wet well level raw signal				AI06+,AI06-			S		☐	☐
AI07	15 & 16	cpr1current	Cathodic protection rectifier current				AI07+,AI07-			K		☐	☐
AI08	17 & 18	flw1rawSignal	Delivery flow raw signal				AI08+,AI08-			H		☐	☐

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Urban Utilities

SP[xxx] [SITE NAME]

Physical I.O. Spreadsheet **Analog Output Card 1**

I/O #	Term	Tag	Description	4mA	20mA	Term. #	Wire #	Schem	Term	O	Comment	FAT	SAT
0	2 & 3	pump1Speed	Pump 1 Speed Command	0.0%	100.0%		AO01+,AO01-			W		☐	☐
1	7 & 8	pump2Speed	Pump 2 Speed Command	0.0%	100.0%		AO02+,AO02-			W		☐	☐
2	12 & 13	pump3Speed	Pump 3 Speed Command	0.0%	100.0%		AO03+,AO03-			XW		☐	☐
3	17 & 18	stn1chemDoseRate	Station Chemical Dosing Rate	0.0%	100.0%		AO04+,AO04-			V		☐	☐

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Appendix C: STANDARD UUTS POINT LIST

8.1.1.1 Analog Inputs

ISaGRAF variable	Point Description	Units	Opt
cat1asCurrent	Cathodic_protection : 1 : Rectifier_current :	Amps	K
cat1asCurrHiLimF	Cathodic_protection : 1 : Rectifier_current_high_limit_Fbk :	Amps	K
cat1asCurrLoLimF	Cathodic_protection : 1 : Rectifier_current_low_limit_Fbk :	Amps	K
cat1asCurrRangeF	Cathodic_protection : 1 : Rectifier_current_range_Fbk :	Amps	K
stn1asEStgLoLimF	Emergency_storage : 1 : Empty_limit_Fbk :	MAHD	G
stn1asEStgHiLimF	Emergency_storage : 1 : High_limit_Fbk :	MAHD	G
stn1asEStoragLvl	Emergency_storage : 1 : Level :	MAHD	G
stn1asEStorgRngF	Emergency_storage : 1 : Level_range_Fbk :	Metres	G
wwl1asEStgLimF	Emergency_storage : 1 : Surcharge_level_Fbk :	MAHD	G
stn1asEStrgElevF	Emergency_storage : 1 : Zero_MAHD_Fbk :	MAHD	G
flw1asFlowRate	Flow_meter : 1 : Flow_rate :	L/s	H
flw1asFlowRangeF	Flow_meter : 1 : Flow_rate_Range_Fbk :	L/s	H
flw1asTotOutflw	Flow_meter : 1 : Volume :	kL	H
flw1asPmp12Vol	Flow_meter : 1 : Volume_2_pumps :	kL	H
flw1asPmp12VolY	Flow_meter : 1 : Volume_2_pumps_yesterday :	kL	H
flw1asTotOutflwY	Flow_meter : 1 : Volume_yesterday :	kL	H
not telemetered	Flow_meter : 1 : Constant average		
not telemetered	Flow_meter : 1 : Constant flow		
not telemetered	Flow_meter : 1 : Constant high limit		
not telemetered	Flow_meter : 1 : Constant low limit		
not telemetered	Flow_meter : 1 : Daily average		
not telemetered	Flow_meter : 1 : Daily high limit		
not telemetered	Flow_meter : 1 : Daily low limit		
stn1asOdoInHiLmF	Odour_control_station : 1 : High_speed_inflow_rate_Fbk :	L/s	M
pre1asElevationF	Pressure_gauge : 1 : Elevation_Rtu :	MAHD	U
pre1asPresHiLimF	Pressure_gauge : 1 : High_limit_Fbk :	MAHD	U
pre1asPreLoLimF	Pressure_gauge : 1 : Low_limit_Fbk :	MAHD	U
pre1asPresskPa	Pressure_gauge : 1 : Pressure_kpa :	kPa	U
pre1asPressmAHD	Pressure_gauge : 1 : Pressure_mahd :	MAHD	U
pre1asPreRangeF	Pressure_gauge : 1 : Pressure_range_Fbk :	Metres	U
rtu1asCtrlSchID	Rtu : 1 : Control_id_Fbk :	Units	
rtu1asDBVersion	Rtu : 1 : Database_version :	Units	
rtu1asHeartbeat	Rtu : 1 : Heartbeat :	Counts	
rtu1asAddressFbk	Rtu : 1 : RTU_address :	Units	
not telemetered	Sewage_pumping_station : 1 : Constant average		
not telemetered	Sewage_pumping_station : 1 : Constant high limit		
not telemetered	Sewage_pumping_station : 1 : Constant low limit		
not telemetered	Sewage_pumping_station : 1 : Daily average		
not telemetered	Sewage_pumping_station : 1 : Daily high limit		
not telemetered	Sewage_pumping_station : 1 : Daily low limit		
	Sewage_pumping_station : 1 : Flow_ctrl_min_flw_SP_Fbk		
pmpXasBlkFlwLimF	Sewer_pump : X : Blockage_setpoint_Fbk :	L/s	
not telemetered	Sewer_pump : X : Constant average :	%	
not telemetered	Sewer_pump : X : Constant high limit :	%	
not telemetered	Sewer_pump : X : Constant low limit :	%	
not telemetered	Sewer_pump : X : Constant running :	%	
not telemetered	Sewer_pump : X : Daily average :	Hours	
not telemetered	Sewer_pump : X : Daily high limit :	Hours	
not telemetered	Sewer_pump : X : Daily low limit :	Hours	
pmpXasHoursRun	Sewer_pump : X : Hours_run :	Hours	

ISaGRAF variable	Point Description	Units	Opt
pmpX2asHrsRun	Sewer_pump : X : Hours_run_X2 :	Hours	
pmpX2asHrsRunY	Sewer_pump : X : Hours_run_X2_yesterday :	Hours	
pmpXasHoursRunY	Sewer_pump : X : Hours_run_yesterday :	Hours	
pmpXasMotorCurr	Sewer_pump : X : Motor_current :	Amps	
pmpXasCurrHiLim	Sewer_pump : X : Motor_current_high_limit_Fbk :	Amps	
pmpXasCurrLoLim	Sewer_pump : X : Motor_current_low_limit_Fbk :	Amps	
pmpXasMotorPwr	Sewer_pump : X : Motor_power :	kW	B
pmpXasStartCnt	Sewer_pump : X : Number_of_starts :	Counts	
pmpXasStartCntY	Sewer_pump : X : Number_of_starts_yesterday :	Counts	
pmpXaskWh	Sewer_pump : X : Total_KWHrs :	kWh	
pmpX2askWh	Sewer_pump : X : Total_KWHrs_2_pumps :	kWh	
pmpX2askWhY	Sewer_pump : X : Total_KWHrs_2_pumps_yesterday :	kWh	
pmpXaskWhY	Sewer_pump : X : Total_KWHrs_yesterday :	kWh	
	Variable_speed_drive : x : Frequency_Fbk	Hz	W
	Variable_speed_drive : x : Speed_Fbk	%	W
wwl1asDtyAStrFbk	Wet_well : 1 : Duty_A_start_setpoint_Fbk :	MAHD	
wwl1asDtyAStpFbk	Wet_well : 1 : Duty_A_stop_setpoint_Fbk :	MAHD	
wwl1asDtyBStrFbk	Wet_well : 1 : Duty_B_start_setpoint_Fbk :	MAHD	
wwl1asDtyBStpFbk	Wet_well : 1 : Duty_B_stop_setpoint_Fbk :	MAHD	
wwl1asHiLimitFbk	Wet_well : 1 : High_limit_Fbk :	MAHD	
wwl1asInflow	Wet_well : 1 : Inflow :	L/s	
wwl1asInhStrLvlF	Wet_well : 1 : Inhibit_mode_start_level_Fbk :	MAHD	
wwl1asInhStpLvlF	Wet_well : 1 : Inhibit_mode_stop_level_Fbk :	MAHD	
wwl1asLevel	Wet_well : 1 : Level :	MAHD	
wwl1asLvlRangFbk	Wet_well : 1 : Level_range_Fbk :	Metres	
wwl1asLvlLoLimF	Wet_well : 1 : Low_limit_Fbk :	MAHD	
wwl1asflowRate	Wet_well : 1 : Outflow :	L/s	
	Wet_well : 1 : PID_setpoint_Fbk		
wwl1asCalError	Wet_well : 1 : Probe_calibration_error :	Metres	
wwl1asSurchElp	Wet_well : 1 : Surcharge_duration :	Seconds	
wwl1asSrchImLvlF	Wet_well : 1 : Surcharge_imminent_level_Fbk :	MAHD	
wwl1asSurchLvlF	Wet_well : 1 : Surcharge_occuring_level_Fbk :	MAHD	
wwl1asUntilSurch	Wet_well : 1 : Surcharge_time_remaining :	Minutes	
wwl1asTotInflow	Wet_well : 1 : Total_inflow :	kL	
wwl1asTotInflowY	Wet_well : 1 : Total_inflow_yesterday :	kL	

ISaGRAF variable	Point Description	Units	Opt
wwl1asTotOutflw	Wet_well : 1 : Total_outflow :	kL	
wwl1asTotOutflwY	Wet_well : 1 : Total_outflow_yesterday :	kL	
ult1asLevel	Wet_well : 1 : Ultrasonic_level :	MAHD	S
ult1asLvlRangFbk	Wet_well : 1 : Ultrasonic_level_range_Fbk :	Metres	S
ult1asWwlElevF	Wet_well : 1 : Ultrasonic_zero_MAHD_Fbk :	MAHD	S
wwl1asVolume	Wet_well : 1 : Volume :	kL	
wwl1asWwlElevF	Wet_well : 1 : Zero_MAHD_Fbk :	MAHD	

8.1.1.2 Digital Inputs

ISaGRAF variable	Point Description	State 0	State 1	Opt
cat1dsCurrHigh	Cathodic_protection : 1 : Rectifier_current_high :	Ok	Fault	K
cat1dsCurrInval	Cathodic_protection : 1 : Rectifier_current_invalid :	Ok	Fault	K
cat1dsCurrLow	Cathodic_protection : 1 : Rectifier_current_low :	Ok	Fault	K
cat1dsFault	Cathodic_protection : 1 : Rectifier_fault :	Ok	Fault	K
	Dry_well : 1 : High_electrode_test_fail			
	Dry_well : 1 : Trip_electrode_test_fail			
	Dry_well : 1 : Flooded_high			
	Dry_well : 1 : Flooded_trip			
	Dry_well : 1 : High_electrode			
	Dry_well : 1 : Trip_electrode			
stn1dsEStgLvlHi	Emergency_storage : 1 : High :	Ok	Fault	G
stn1dsEStoragAct	Emergency_storage : 1 : In_use :	No	Yes	G
stn1dsEStgLvlInv	Emergency_storage : 1 : Level_invalid :	Ok	Fault	G
stn1dsEStgLvlLow	Emergency_storage : 1 : Low :	Ok	Fault	G
not telemetered	Flow_meter : 1 : Constant status			H
not telemetered	Flow_meter : 1 : Constant high flow			H
not telemetered	Flow_meter : 1 : Constant low flow			H
not telemetered	Flow_meter : 1 : Daily status			H
not telemetered	Flow_meter : 1 : Daily high flow			H
not telemetered	Flow_meter : 1 : Daily low flow			H
flw1dsFlowInval	Flow_meter : 1 : Invalid :	Ok	Fault	H
flw1dsVolInval	Flow_meter : 1 : Volume_invalid :	No	Yes	H
gen1dsAuto	Generator : 1 : Automatic :	No	Yes	F
gen1dsCBTrip	Generator : 1 : CB_tripped :	No	Yes	F
gen1dsCommonFlt	Generator : 1 : Common_fault :	Ok	Fault	F
gen1dsUnsecured	Generator : 1 : Door_status :	Closed	Open	F
gen1dsSeqAbort	Generator : 1 : Last_test_aborted :	No	Yes	F
gen1dsTestSeqFlt	Generator : 1 : Last_test_failed :	No	Yes	F
gen1dsTestSeqFt1	Generator : 1 : Last_test_failed_fault_1 :	No	Yes	F
gen1dsTestSeqFt2	Generator : 1 : Last_test_failed_fault_2 :	No	Yes	F
gen1dsTestSeqFt3	Generator : 1 : Last_test_failed_fault_3 :	No	Yes	F
gen1dsTestSeqFt4	Generator : 1 : Last_test_failed_fault_4 :	No	Yes	F
gen1dsTestSeqFt5	Generator : 1 : Last_test_failed_fault_5 :	No	Yes	F
gen1dsTestSeqFt6	Generator : 1 : Last_test_failed_fault_6 :	No	Yes	F
gen1dsTestSucc	Generator : 1 : Last_test_passed :	No	Yes	F
gen1dsLowFuel	Generator : 1 : Low_fuel :	No	Yes	F
gen1dsMedFuel	Generator : 1 : Mid_fuel :	No	Yes	F
gen1dsOffSite	Generator : 1 : Offsite :	No	Yes	F
gen1dsPermOnline	Generator : 1 : Online :	No	Yes	F
gen1dsRunning	Generator : 1 : Running :	No	Yes	F
gen1dsTestSeqAct	Generator : 1 : Test_sequence_active :	No	Yes	F
gen1dsTransExpct	Generator : 1 : Transfer_expected :	Ok	Fault	F
gen1dsWarning	Generator : 1 : Warning :	Ok	Fault	F
stn1dsOdourContr	Odour_control_station : 1 : High_speed_active :	No	Yes	M
stn1dsMainCBClsd	Power_supply : 1 : Main_incomer_CB_closed :	No	Yes	
stn1dsSurgeDvFlt	Power_supply : 1 : Surge_diverter_fault :	Ok	Fault	
pre1dsPressHigh	Pressure_gauge : 1 : High :	Ok	Fault	U
pre1dsPressInval	Pressure_gauge : 1 : Invalid :	Ok	Fault	U
pre1dsPressLow	Pressure_gauge : 1 : Low :	Ok	Fault	U
pmpXdsRflxClFlt	Reflux_valve : X : Close_fault :	Ok	Fault	C
pmpXdsRflxOpRst	Reflux_valve : X : Open_auto_fault_reset :	Off	On	C
pmpXdsRflxOpExcd	Reflux_valve : X : Open_count_check :	Off	On	C
pmpXdsRflxOpFlt	Reflux_valve : X : Open_fault :	Ok	Fault	C

ISaGRAF variable	Point Description	State 0	State 1	Opt
rtu1dsFirstScan	Rtu : 1 : Abnormal_operation :	No	Yes	
rtu1dsBatFail	Rtu : 1 : Battery :	Ok	Fault	
not telemetered	Rtu : 1 : Heartbeat_failed :	Ok	Fault	
rtu1dsInitError	Rtu : 1 : Initialisation_error :	No	Yes	
rtu1dsMainsFail	Rtu : 1 : Mains_fail :	Ok	Fault	
stn1dsDoorOpen	Security : 1 : Door_status :	Closed	Open	
stn1dsIntruder	Security : 1 : Intruder :	Ok	Alert	
	Sewage_pumping_station : 1 : Constant running			
	Sewage_pumping_station : 1 : Constant status			
	Sewage_pumping_station : 1 : Constant high run			
	Sewage_pumping_station : 1 : Constant low run			
	Sewage_pumping_station : 1 : Daily status			
	Sewage_pumping_station : 1 : Daily high run			
	Sewage_pumping_station : 1 : Daily low run			
stn1dsElecTstAct	Sewage_pumping_station : 1 : Electrode Test Active :	No	Yes	
stn1dsElecTstRFt	Sewage_pumping_station : 1 : Electrode Test Failed :	No	Yes	
stn1dsEmgPmpAct	Sewage_pumping_station : 1 : Emergency_pumping_mode_active :	No	Yes	
scc1dsTstSqAbort	Sewage_pumping_station : 1 : Emergency_pumping_test_aborted :	No	Yes	
scc1dsTestSeqAct	Sewage_pumping_station : 1 : Emergency_pumping_test_active :	No	Yes	
stn1dsSecCtrlFlt	Sewage_pumping_station : 1 : Emergency_pumping_test_fail :	No	Yes	
scc1dsFaultActv1	Sewage_pumping_station : 1 : Emergency_pumping_test_fail_fault_1 :	No	Yes	
scc1dsFaultActv2	Sewage_pumping_station : 1 : Emergency_pumping_test_fail_fault_2 :	No	Yes	
	Sewage_pumping_station : 1 : Emergency_pumping_test_fail_fault_2A			
scc1dsFaultActv3	Sewage_pumping_station : 1 : Emergency_pumping_test_fail_fault_3 :	No	Yes	
scc1dsFaultActv4	Sewage_pumping_station : 1 : Emergency_pumping_test_fail_fault_4 :	No	Yes	
	Sewage_pumping_station : 1 : Emergency_pumping_test_fail_fault_4A			
scc1dsFaultActv5	Sewage_pumping_station : 1 : Emergency_pumping_test_fail_fault_5 :	No	Yes	
stn1dsRemote	Sewage_pumping_station : 1 : Local_remote :	Local	Remote	
stn1dsMainsFail	Sewage_pumping_station : 1 : Mains_fail :	Ok	Fault	
stn1dsMHSurchImm	Sewage_pumping_station : 1 : Upstream_manhole_surcharge_imm :	No	Yes	D
stn1dsWellWasher	Sewage_pumping_station : 1 : Water_spray :	Off	On	P
pmp1dsAvailable	Sewer_pump : 1 : Available :	No	Yes	
pmp1dsBestEqual	Sewer_pump : 1 : Best_pump_status :	Off	On	
pmp1dsBlocked	Sewer_pump : 1 : Blocked :	No	Yes	
not telemetered	Sewer_pump : 1 : Constant high run :	Ok	Fault	
not telemetered	Sewer_pump : 1 : Constant low run :	Ok	Fault	
not telemetered	Sewer_pump : 1 : Constant status :	Ok	Fault	
not telemetered	Sewer_pump : 1 : Daily high run :	Ok	Fault	
not telemetered	Sewer_pump : 1 : Daily low run :	Ok	Fault	
not telemetered	Sewer_pump : 1 : Daily status :	Ok	Fault	
pmp1dsAutoInh	Sewer_pump : 1 : Degraded :	Ok	Fault	
pmp1dsEStop	Sewer_pump : 1 : Emergency_stop :	Ok	Fault	
pmp1dsFailtoStrt	Sewer_pump : 1 : Fail_to_run :	Ok	Fault	
pmp1dsFailtoStop	Sewer_pump : 1 : Fail_to_stop :	Ok	Fault	
pmp1dsOperInhF	Sewer_pump : 1 : Inhibit_Fbk :	Off	On	
pmp1dsIntruptRly	Sewer_pump : 1 : Interrupt_relay :	Off	On	
pmp1dsMainsFail	Sewer_pump : 1 : Mains_fail :	Ok	Fault	
pmp1dsModbusFlt	Sewer_pump : 1 : Modbus_fault :	Clear	Active	
pmp1dsMstOilFlt	Sewer_pump : 1 : Moisture_in_oil_fault :	Ok	Fault	A
pmp1dsMotProtFlt	Sewer_pump : 1 : Motor_Protection_fault :	Ok	Fault	

ISaGRAF variable	Point Description	State 0	State 1	Opt
pmp1dsCurrHigh	Sewer_pump : 1 : Motor_current_high :	Ok	Fault	
pmp1dsCurrLow	Sewer_pump : 1 : Motor_current_low :	Ok	Fault	
pmp1dsRunning	Sewer_pump : 1 : Running :	Off	On	
pmp2dsAvailable	Sewer_pump : 2 : Available :	No	Yes	
pmp2dsBestEqual	Sewer_pump : 2 : Best_pump_status :	Off	On	
pmp2dsBlocked	Sewer_pump : 2 : Blocked :	No	Yes	
not telemetered	Sewer_pump : 2 : Constant high run :	Ok	Fault	
not telemetered	Sewer_pump : 2 : Constant low run :	Ok	Fault	
not telemetered	Sewer_pump : 2 : Constant status :	Ok	Fault	
not telemetered	Sewer_pump : 2 : Daily high run :	Ok	Fault	
not telemetered	Sewer_pump : 2 : Daily low run :	Ok	Fault	
not telemetered	Sewer_pump : 2 : Daily status :	Ok	Fault	
pmp2dsAutoInh	Sewer_pump : 2 : Degraded :	Ok	Fault	
pmp2dsEStop	Sewer_pump : 2 : Emergency_stop :	Ok	Fault	
pmp2dsFailtoStrt	Sewer_pump : 2 : Fail_to_run :	Ok	Fault	
pmp2dsFailtoStop	Sewer_pump : 2 : Fail_to_stop :	Ok	Fault	
pmp2dsOperInhF	Sewer_pump : 2 : Inhibit_Fbk :	Off	On	
pmp2dsIntruptRly	Sewer_pump : 2 : Interrupt_relay :	Off	On	
pmp2dsMainsFail	Sewer_pump : 2 : Mains_fail :	Ok	Fault	
pmp2dsModbusFlt	Sewer_pump : 2 : Modbus_fault :	Clear	Active	
pmp2dsMstOilFlt	Sewer_pump : 2 : Moisture_in_oil_fault :	Ok	Fault	A
pmp2dsMotProtFlt	Sewer_pump : 2 : Motor_Protection_fault :	Ok	Fault	
pmp2dsCurrHigh	Sewer_pump : 2 : Motor_current_high :	Ok	Fault	
pmp2dsCurrLow	Sewer_pump : 2 : Motor_current_low :	Ok	Fault	
pmp2dsRunning	Sewer_pump : 2 : Running :	Off	On	
stn1dsOptKCaPrtF	Site : 1 : Cathodic_protection_opt_installed :	No	Yes	
stn1dsOptEDryWeF	Site : 1 : Dry_well_flood_opt_installed :	No	Yes	
stn1dsOptGEmStoF	Site : 1 : Emerg_store_level_sensor_opt_installed :	No	Yes	
stn1dsEnergxFail	Site : 1 : Energex_power :	Ok	Fault	
stn1dsOptHFlwMtF	Site : 1 : Flowmeter_opt_installed :	No	Yes	
not telemetered	Site : 1 : Maintenance_mode :	Clear	Active	
gen1dsMobOnline	Site : 1 : Mobile_generator_online :	No	Yes	
stn1dsOptBMtPrtF	Site : 1 : Motor_Protection_opt_installed(MIS&BT) :	No	Yes	
stn1dsOptMOdoCtF	Site : 1 : Odour_Control_opt_installed :	No	Yes	
stn1dsOptFGeATSF	Site : 1 : Perm_generator_opt_installed :	No	Yes	
stn1dsOptO2IntlF	Site : 1 : Pmp_interlock_gen_only_opt_inst :	No	Yes	
stn1dsOptO1IntlF	Site : 1 : Pump_interlock_opt_installed :	No	Yes	
stn1dsOptAMIOF	Site : 1 : Pump_oil_moisture_opt_installed :	No	Yes	
stn1dsOptCPmRfxF	Site : 1 : Reflux_valve_opt_installed :	No	Yes	
stn1dsOptSUltSoF	Site : 1 : Ultrasonic_level_opt_installed :	No	Yes	
stn1dsOptDMHoSIF	Site : 1 : Upstream_manhole_SI_opt_install :	No	Yes	
stn1dsOptQVvPitF	Site : 1 : Valve_pit_opt_installed :	No	Yes	
not telemetered	Site : 1 : Visitation_mode :	Clear	Active	
stn1dsOptPWashF	Site : 1 : Wet_well_washer_opt_installed :	No	Yes	
pmp1dsSSAutoRst	Soft_starter : 1 : Auto_fault_reset :	Off	On	
pmp1dsSSFltExcd	Soft_starter : 1 : Count_check :	Off	On	
pmp1dsSSFault	Soft_starter : 1 : Fault :	Ok	Fault	
pmp2dsSSAutoRst	Soft_starter : 2 : Auto_fault_reset :	Off	On	
pmp2dsSSFltExcd	Soft_starter : 2 : Count_check :	Off	On	
pmp2dsSSFault	Soft_starter : 2 : Fault :	Ok	Fault	
smp1dsFault	Sump_pump : 1 : Available :	No	Yes	E
smp1dsExcCyc	Sump_pump : 1 : Excessive_cycling :	Ok	Fault	E
smp1dsExcRun	Sump_pump : 1 : Excessive_run :	Ok	Fault	E
smp1dsRunning	Sump_pump : 1 : Running :	Off	On	E

ISaGRAF variable	Point Description	State 0	State 1	Opt
vlv1dsVlvPitTFlt	Valve : 1 : Pit_flooded_electrode_test_fail :	No	Yes	Q
vlv1dsLevelHigh	Valve : 1 : Pit_flooded_high :	No	Yes	Q
	Variable_speed_drive : x : Auto_fault_reset			W
	Variable_speed_drive : x : Count_check			W
	Variable_speed_drive : x : Fault			W
wwl1dsCaliFault	Wet_well : 1 : Calibration_fault :	Ok	Fault	
wwl1dsLevelHigh	Wet_well : 1 : High :	Ok	Fault	
wwl1dsHighLS	Wet_well : 1 : High_electrode :	Off	On	
wwl1dsHiLvlTFlt	Wet_well : 1 : High_electrode_test_fail :	Off	On	
wwl1dsLevelInval	Wet_well : 1 : Level_invalid :	No	Yes	
wwl1dsLevelLow	Wet_well : 1 : Low :	Ok	Fault	
wwl1dsSlimeStrpF	Wet_well : 1 : Slime_strip_mode_active :	No	Yes	
wwl1dsSrchImTFlt	Wet_well : 1 : Surcharge_elect_test_fail :	Off	On	
wwl1dsSurchImm	Wet_well : 1 : Surcharge_imminent :	Ok	Fault	
wwl1dsSurchOccur	Wet_well : 1 : Surcharge_occuring :	Ok	Fault	
ult1dsLevelInval	Wet_well : 1 : Ultrasonic_level_invalid :	Ok	Fault	S
wwl1dsVolInval	Wet_well : 1 : Volume_invalid :	Ok	Fault	

8.1.1.3 Analog Controls

ISaGRAF variable	Point Description	Units	Opt
stn1acEStgLoLim	Emergency_storage : 1 : Empty_limit :	MAHD	G
stn1acEStgHiLim	Emergency_storage : 1 : High_limit :	MAHD	G
stn1acOdoInHiLim	Odour_control_station : 1 : High_speed_inflow_rate :	L/s	M
pre1acPresHiLim	Pressure_gauge : 1 : High_limit :	MAHD	U
pre1acPreLoLim	Pressure_gauge : 1 : Low_limit :	MAHD	U

8.1.1.4 Digital Controls

ISaGRAF variable	Point Description	State 0	State 1	Opt
cat1dcRemReset	Cathodic_protection : 1 : Remote_reset :	n/a	Reset	K
	Dry_well : 1 : Electrode_test_fault_reset			
stn1dcEStgReset	Emergency_storage : 1 : Emptied_remote_reset :	n/a	Reset	G
gen1dcGenExerc	Generator : 1 : Remote_exercise :	Stop	Start	F
gen1dcFaultReset	Generator : 1 : Remote_reset :	n/a	Reset	F
rtu1dcInitReset	Rtu : 1 : Abnormal_operation_reset :	n/a	Reset	
scc1dcFaultReset	Sewage_pumping_station : 1 : Emergency_pumping_test_fault_reset :	n/a	Reset	
pmp1dcOperInh	Sewer_pump : 1 : Inhibit :	Clear	Inhibit	
pmp1dcRemReset	Sewer_pump : 1 : Remote_reset :	n/a	Reset	
pmp1dcRemStart	Sewer_pump : 1 : Remote_start :	n/a	Start	
pmp1dcRemStop	Sewer_pump : 1 : Remote_stop :	n/a	Stop	
pmp2dcOperInh	Sewer_pump : 2 : Inhibit :	Clear	Inhibit	
pmp2dcRemReset	Sewer_pump : 2 : Remote_reset :	n/a	Reset	
pmp2dcRemStart	Sewer_pump : 2 : Remote_start :	n/a	Start	
pmp2dcRemStop	Sewer_pump : 2 : Remote_stop :	n/a	Stop	
smp1dcRemReset	Sump_pump : 1 : Remote_reset :	n/a	Reset	E
wwl1dcCaliFltRst	Wet_well : 1 : Calibration_fault_reset :	n/a	Reset	
stn1dcElctTstRst	Wet_well : 1 : Electrode_test_fault_reset :	n/a	Reset	
wwl1dcSlimeStrip	Wet_well : 1 : Slime_strip_mode_enable :	Disable	Enable	

Appendix D: MAINTENANCE MODE

Maintenance Mode functionality has been developed for the Master Station as a separate function to the RTU. The following is an overview of the maintenance mode functionality, refer to the functional specification[v] for further details.

Maintenance mode will be activated by the Control Room operator by using a popup screen which will have the following control features.

1. On-site personal check-in or check-out (Visitor or Maintenance mode)
2. Ability to set on-site duration (20 mins to 4 hours)
3. Current Status (Off/On)
4. Warning alarm 10 minutes prior to on-site duration expiring

The main screen of the site will also indicate that the site is in maintenance mode. The operator will initiate maintenance mode when an on-site operator calls in from site. The duration is to be determined in consultation with the on-site operator. When the on-site operator calls in to leave site - the control room operator will deactivate the maintenance mode and ensure there are no alarms.

The maintenance mode will alarm inhibit all alarms for the location with the following exceptions for a sewage pumping station;

- Wet well high
- Wet well surcharge imminent
- Wet well surcharge occurring
- Site maintenance mode

All points that are not affected by maintenance mode have the Disable Alarm Inhibit (DAI) point attribute.

Appendix E: RTU DATABASE

```
/*
 * Setup the records for the site specific variables (Note: Three decimal places maximum for real values) * Setup the records for the site specific variables (Note: Three decimal places maximum for real values)
*/

/*
 * Setup the records for the site specific variables (Note: Three decimal places maximum for real values) * Setup the records for the site specific variables (Note: Three decimal places maximum for real values)
 * All timer values in the CONSTANT_ANA_CLASS below are in seconds.      * All timer values in the CONSTANT_ANA_CLASS below are in seconds.
*/

defineclass    constant_ana    CONSTANT_ANA_CLASS              defineclass constant_ana CONSTANT_ANA_CLASS
record  1      value   1234    /* Address of RTU from site specific constants */
record  2      value   1234    /* Secondary control circuit test sequence timeout */
record  3      value   1234    /* Secondary control circuit test sequence fall stage */
record  4      value   1234    /* Minimum time the station inhibit run is active */
record  5      value   1234    /* Station wet well wash cycle duration */
record  6      value   1234    /* Electrode Test Duration */
record  7      value   1234    /* Sec Controller Test Start Time in HHMM (NB if 0 then off) */
record  8      value   1234    /* Pump Station ID (SPxxx) (Used to alarm PLC/RTU incompatibility) */
record  100    value   1234    /* Hi level pumping mode duration */
record  101    value   1234    /* Surcharge pumping duration (seconds) */
record  102    value   1234    /* Wet well level high alarm delay timer */
record  103    value   1234    /* Wet well level low alarm delay timer */
record  200    value   1234    /* Delivery Pressure Meter alarm inhibit timer */
record  201    value   1234    /* Delivery Pressure Meter high alarm delay timer */
record  202    value   1234    /* Delivery Pressure Meter low alarm delay timer */
record  300    value   1234    /* Flow Meter No.1 alarm inhibit timer */
record  301    value   1234    /* Flow Meter No.1 high alarm delay timer */
record  302    value   1234    /* Flow Meter No.1 low alarm delay timer */
record  310    value   1234    /* Flow Meter No.2 alarm inhibit timer */
record  311    value   1234    /* Flow Meter No.2 high alarm delay timer */
record  312    value   1234    /* Flow Meter No.2 low alarm delay timer */
record  501    value   1234    /* Station emergency storage level high alarm delay timer */
record  502    value   1234    /* Station emergency storage level low alarm delay timer */
record  800    value   1234    /* Generator Test Duration timer (seconds) */
record  801    value   1234    /* Generator to Energex changeover time (in Genset PLC) */
record  1100   value   1234    /* Pump 1 Motor Current alarm inhibit timer. */
record  1101   value   1234    /* Pump 1 Motor Power alarm inhibit timer. */    To be removed after V7 produced
record  1102   value   1234    /* Pump 1 blockage time (site specific) */
record  1103   value   1234    /* Pump 1 fail to start/stop delay */
record  1104   value   1234    /* Pump 1 minimum time between complete starts */
record  1105   value   1234    /* Pump 1 reflux valve close delay */
record  1106   value   1234    /* Pump 1 reflux valve open delay */
record  1107   value   1234    /* Pump 1 Delay for Auto Reset */
record  1108   value   1234    /* Pump 1 Soft Starter auto reset delay */
record  1109   value   1234    /* Pump 1 Motor Current high alarm delay timer. */
record  1110   value   1234    /* Pump 1 Motor Current low alarm delay timer. */
record  1200   value   1234    /* Pump 2 Motor Current alarm inhibit timer. */
record  1201   value   1234    /* Pump 2 Motor Power alarm inhibit timer. */    To be removed after V7 produced
record  1202   value   1234    /* Pump 2 blockage time (site specific) */
record  1203   value   1234    /* Pump 2 fail to start/stop delay */
record  1204   value   1234    /* Pump 2 minimum time between complete starts */
record  1205   value   1234    /* Pump 2 reflux valve close delay */
record  1206   value   1234    /* Pump 2 reflux valve open delay */
record  1207   value   1234    /* Pump 2 Delay for Auto Reset */
record  1208   value   1234    /* Pump 2 Soft Starter auto reset delay */
record  1209   value   1234    /* Pump 2 Motor Current high alarm delay timer. */
record  1210   value   1234    /* Pump 2 Motor Current low alarm delay timer. */

defineclass    constant_boo    CONSTANT_BOO_CLASS              defineclass constant_boo CONSTANT_BOO_CLASS
record  1      value   0       /* Site Option K Cathodic Protection Selected */
record  2      value   0       /* Site Option E Station Dry Well Selected */
record  3      value   0       /* Site Option G Station E Storage Level Sensor Select */
record  4      value   0       /* Site Option M Odour Control (Carbon Scrubber) */
record  5      value   0       /* Site Option H Station Delivery Flow Meter Selected */
record  6      value   0       /* Site Option F Station Perm Generator with ATS Selec */
record  7      value   0       /* Site Option O1 Pump Interlocking Selected */
record  8      value   0       /* Site Option A Pump Moisture In Oil Fault Selected */
record  9      value   0       /* Site Option B Pump Motor Protection Fault Selecte */
record  10     value   0       /* Site Option D Upstream Manhole Surcharge Imm Selected */
record  11     value   0       /* Site Option C Indiv Pump Reflux Valve Micro Sw Sele */
```

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record  12      value   0          /* Site Option P Wet Well Washer Selected */
record  13      value   0          /* Site Option Q Valve Pit Selected */
record  14      value   0          /* Site Option S Ultrasonic Level Sensor Selected */
record  15      value   0          /* Site Option O2 Pump Interlocking on Generator Selected */
record  16      value   0          /* Site Option XXX Spare 1 */
record  17      value   0          /* Site Option XXX Spare 2 */
record  18      value   0          /* Site Option XXX Spare 3 */
record  19      value   0          /* Site Option XXX Spare 4 */
record  100     value   0          /* Site Option - Disable door switch alarm


defineclass     constant_rea    CONSTANT_REA_CLASS          defineclass constant_rea CONSTANT_REA_CLASS
record  1       value   123.456    /* Percentage value of analog alarm hysteresis */
record  2       value   123.456    /* Percentage value of analog invalid alarm hysteresis */
record  99      value   20091234   /* RTU Database Version - YYYYMMDD */
record  100     value   123.456    /* Calibration error allowance (M) */
record  101     value   123.456    /* Duty A pump stop level (MAHD) */
record  102     value   123.456    /* Duty A pump start level (MAHD) */
record  103     value   123.456    /* Duty B pump stop level (MAHD) */
record  104     value   123.456    /* Duty B pump start level (MAHD) */
record  105     value   123.456    /* Inhibit Mode Stop Level (MAHD) */
record  106     value   123.456    /* Inhibit Mode Start Level (MAHD) */
record  107     value   123.456    /* Wet Well level probe Range (M) */
record  108     value   123.456    /* Surcharge Imminent Level (MAHD) */
record  109     value   123.456    /* Wet well surcharge occuring level (MAHD) */
record  110     value   123.456    /* Wet well empty level (Zero MAHD of tip of level probe) */
record  111     value   123.456    /* Wet well low level alarm point (MAHD) */
record  112     value   123.456    /* Wet well high level alarm point (MAHD) */
record  113     value   124.456    /* Wet well  level probe hanging length (m) */
record  114     value   125.456    /* Wet Well high level electrode hanging length (M) */
record  115     value   126.456    /* Wet Well surcharge imminent electrode hanging length (M) */
record  151     value   127.456    /* Variable speed Drive Minimum Speed (%) */
record  152     value   128.456    /* Variable speed Drive Maximum Speed (%) */
record  153     value   129.456    /* Wet well PID setpoint level (MAHD) */
record  154     value   130.456    /* Wet well PID maximum speed level (MAHD) */
record  200     value   123.456    /* Delivery Pressure elevation of the pressure transdu (MAHD)*/
record  201     value   123.456    /* Delivery Pressure range (M) */
record  202     value   123.456    /* Delivery Pressure low alarm point (MAHD) */
record  203     value   123.456    /* Delivery Pressure high alarm point (MAHD) */
record  300     value   123.456    /* Site specific Flow meter No.1 range (L/Sec) */
record  301     value   123.456    /* Delivery flowrate No.1, Minimum value (4 mA) */
record  302     value   123.456    /* High flow No.1 alarm point (L/Sec) */
record  303     value   123.456    /* Low flow No.1 alarm point (L/Sec) */
record  310     value   123.456    /* Site specific Flow meter No.2 range (L/Sec) */
record  311     value   123.456    /* Delivery flowrate No.2, Minimum value (4 mA) */
record  312     value   123.456    /* High flow No.2 alarm point (L/Sec) */
record  313     value   123.456    /* Low flow No.2 alarm point (L/Sec) */
record  400     value   123.456    /* Cathodic protection unit rectifier current high lim*/
record  401     value   123.456    /* Cathodic protection unit rectifier current low limi*/
record  402     value   123.456    /* Cathodic protection unit rectifier current offset */
record  403     value   123.456    /* Cathodic protection unitr ectifier current range */
record  500     value   123.456    /* Station emergency storage level range (M) */
record  501     value   123.456    /* Station emergency storage elevation (MAHD) */
record  502     value   123.456    /* Station emergency storage overflow level (MAHD) */
record  503     value   123.456    /* Station emergency storage level high limit (MAHD) */
record  504     value   123.456    /* Station emergency storage level low limit (MAHD) */
record  600     value   123.456    /* Stat Odour Contr(Carbon Scrub)Hi Speed Inflow Hi limit */
record  700     value   123.456    /* Ultrasonic Level probe Range (M) */
record  701     value   123.456    /* Ultrasonic empty level (Zero MAHD) */
record  1100    value   123.456    /* Pump 1 Blocked Flow Limit */
record  1101    value   123.456    /* Pump 1 Motor current range (Amps) */
record  1102    value   123.456    /* Pump 1 power range (kW) */
record  1103    value   123.456    /* Pump 1 high current alarm point */
record  1104    value   123.456    /* Pump 1 low current alarm point */
record  1105    value   123.456    /* Pump 1 Motor power high alarm set point */
record  1106    value   123.456    /* Pump 1 Motor power low alarm set point */
record  1200    value   123.456    /* Pump 2 Blocked Flow Limit */
record  1201    value   123.456    /* Pump 2 Motor current range (Amps) */
record  1202    value   123.456    /* Pump 2 power range (kW) */
record  1203    value   123.456    /* Pump 2 high current alarm point */
record  1204    value   123.456    /* Pump 2 low current alarm point */
record  1205    value   123.456    /* Pump 2 Motor power high alarm set point */
record  1206    value   123.456    /* Pump 2 Motor power low alarm set point */
```

9 REFERENCES

i

TITLE	SPSS2 SEWAGE PUMPING STATION SUBMERSIBLE 2 PUMPS WITH SOFT STARTERS
DOCUMENT ID	003501
VERSION	1-20
AUTHOR	ALEX WITTHOFT
DOCUMENT OWNER	PETER SHERRIFF

ii

TITLE	New Switchboards Concept Design
DOCUMENT ID	N/A
VERSION	4-4 (NEW SWITCHBOARDS CONCEPT DESIGN REV. 4-4.DOC)
AUTHOR	ALEX WITTHOFT
DOCUMENT OWNER	ALEX WITTHOFT

iii

TITLE	Diesel Standby Generator - Local Control Panel - Functional Description
DOCUMENT ID	N/A
VERSION	02
AUTHOR	SOUTH EAST POWER GENERATION
DOCUMENT OWNER	

iv

TITLE	UUTS FUNCTIONAL REQUIREMENTS SPECIFICATION – TEMPLATE SCHEMATICS
DOCUMENT ID	N/A
VERSION	TBC
AUTHOR	LOGICA
DOCUMENT OWNER	PETER SHERRIFF

v

TITLE	UUTS Maintenance Mode Functional Requirements Specification
DOCUMENT ID	N/A
VERSION	TBC
AUTHOR	LOGICA
DOCUMENT OWNER	PETER SHERRIFF