



BRISBANE CITY COUNCIL BRISBANE WATER

Australia Trade Coast Sewer Project

SP300

Serpentine Rd Pump Station

Operation & Maintenance Manual

Contract No. BW30137-02/03

Volume No. 1

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Brisbane Water
Serpentine Road P/S SP300 Australia Trade Coast Sewer Project

BW30137-02/03

<u>Volume</u>	<u>Section</u>	<u>Description</u>	<u>Pages</u>
---------------	----------------	--------------------	--------------

		Hyperlink Files SP300\SPSV3.doc Standard Functional Specification SPSV3	57
2	2	Proprietary Equipment Manuals/Maintenance and Service	
	2.1	Weir Services: Hydrostal Pumps	
		Hyperlink Files SP300\Hydrostal Pump I O Instructions - rev A.doc Hydrostal Pump Installation and Operating Instructions. Including the following	63
		1. Introduction and Background Information	
		2. Installation and Commissioning	
		3. Appropriate Records Pump Declaration of Conformity/ Pump Volute Casing Water Pressure Test/Pump Workshop Test Records Q/H & NPSH etc/	
		4. Operation and Maintenance	
		Hyperlink Files SP300\wd8160_1 Layout1 (1).pdf Pump General Arrangement Drg	1
	2.2	SE Power Equipment: Generator Set	
		Hyperlink Files SP300\14860 SP300 Manual Cover Page and Contents.pdf SE Power Equipment: Generator Operation & Maintenance Manuals	4
		Hyperlink Files SP300\Section 2 - Deutz Operation Manual.pdf Diesel Engine Generator Operator's Manual	71
		Hyperlink Files SP300\Section 3 - Deutz Spare Parts Catalogue.pdf Deutz Spare Parts Catalogue	85
		Hyperlink Files SP300\Section 4 - Stamford Installation, Service & Maintenance Man.pdf AC Generator Installation, Service & Maintenance Manual	44
		Hyperlink Files SP300\Section 5 - Part 1 PLC GE Fanuc.pdf GE Fanuc Automation Series 90TM-30 PLCs	2
		Hyperlink Files SP300\Section 5 - Part 2 PLC GE Fanuc.pdf GE Fanuc Automation Programmable Control Products Series 90TM-30 PLC Installation and Hardware Manual	67
		Hyperlink Files SP300\Section 5 - Part 3 PLC GE Fanuc.pdf GE Fanuc Automation Programmable Control Products Series 90TM-30 Programmable Control Troubleshooting Guide	18
		Hyperlink Files SP300\Section 6 - Functional Description.doc Local Control Panel Functional Description	14
		Hyperlink Files SP300\SE Power Equipment Generator Drg.pdf Diesel Engine/Generator Drg	7
		Hyperlink Files SP300\SE Power Works Test ITP Generator.pdf	17

Issue Date: 09 Feb 06

Page 2 of 8

Rev: 0

G:\CNPMSS\Asset Creation Program\STTG -Australia TradeCoast Sewer\2005-2006\COMMISS\MANUALS\OMM SP300
Rev 0\Table of Contents SP300.doc

BRISBANE CITY COUNCIL

BW30137-02/03

Brisbane Water

Serpentine Road P/S SP300 Australia Trade Coast Sewer Project

<u>Volume</u>	<u>Section</u>	<u>Description</u>	<u>Pages</u>
		SE Power Works Test ITP Generator	
2.1	2.3	Common Logic: Main Switchboard & Associated Equipment	
		Hyperlink Files SP300\JH42MC03 Serpentine Rd.pdf Main Switchboard Manual. Including the following.	12
		Section 1.0 General Description of Operation	
		Section 2.0 General Description of System (Componenets)	
		Hyperlink Files SP300\Common Logic.pdf Section 3.0 As Construction Drawings. Including Door Key Allocation	13
		Hyperlink Files SP300\Drawing Transmittal.pdf Section 3.1 Drawing Transmittal	3
		Hyperlink Files SP300\Parts List.pdf Section 4.0 Part List	3
		Hyperlink Files SP300\JH42MCR2 01 Tech data Sheets List.pdf Section 5.0 Technical Manuals and Data Sheets	1
		Hyperlink Files SP300\TDS1804S277.pdf Section 5.0 TDS-DinLine Surge Suppressor. Installation Instructions ECO	32
		Hyperlink Files SP300\TDF10A240V.pdf Section 5.0 Transient Discriminating Filter Model Number TDF-10A-240V. Installation Instructions ECO	2
		Hyperlink Files SP300\DAR275V.pdf Section 5.0 DinLine Alarm Relay (DAR) Model Number DAR275v. Installation Instructions.	2
		Hyperlink Files SP300\3000-000-06.pdf Section 5.0 Rotork Circuit Diagram N0-REV 3000-000-06	1
		Hyperlink Files SP300\Rotork Electric E170E2.pdf Section 5.0 Rotork IQ Range Installation and Maintenance Instructions	86
		Hyperlink Files SP300\RWS300 (IQ IQT Remote Control 24Vdc).pdf Section 5.0 Rotork Standard IQ/IQT Remote Control Circuitry (24V DC)	1
		Hyperlink Files SP300\multitrode_mtr_international-datasheet.pdf Section 5.0 Liquid Level Control Relay	2
		Hyperlink Files SP300\CA10 switches.pdf Section 5.0 Switchboard Accessories/Crompton	56
		Hyperlink Files SP300\analogue244.pdf Section 5.0 Switchboard Accessories/Crompton	21
		Hyperlink Files SP300\din250 trip relay.pdf Section 5.0 Switchboard Accessories/Crompton	8
		Hyperlink Files SP300\MannIndQS_FTXDMV.pdf Section 5.0 Switchboard Accessories/Mann Ind QS	2

Issue Date: 09 Feb 06

Page 3 of 8

Rev: 0

G:\CNPMS\Asset Creation Program\STTG -Australia TradeCoast Sewer\2005-2006\COMMISS\MANUALS\OMM SP300

Rev 0\Table of Contents SP300.doc

BRISBANE CITY COUNCIL
Brisbane Water
Serpentine Road P/S SP300 Australia Trade Coast Sewer Project

BW30137-02/03

<u>Volume</u>	<u>Section</u>	<u>Description</u>	<u>Pages</u>
		Hyperlink Files SP300\3004032[1].pdf Section 5.0 Switchboard Accessories/Phoenix	7
		Hyperlink Files SP300\3004100[1].pdf Section 5.0 Switchboard Accessories/Phoenix	7
		Hyperlink Files SP300\uk5n_en.pdf Section 5.0 Switchboard Accessories/Phoenix	2
		Hyperlink Files SP300\Vegabar27525-EN.pdf Section 5.0 Vegabar 64 Pressure Transmitter 4—20 mA/HART. Operating Instructions	72
		Hyperlink Files SP300\Vegadis20591-EN.pdf Section 5.0 Adjustment Module for Pressure Transmitter. Operating Instructions	16
		Hyperlink Files SP300\Vegawell27630-EN.pdf Section 5.0 Vegawell 72 is a suspension pressure transmitter for level and gauge measurement. Operating Instructions	48
		Hyperlink Files SP300\MagMaster flowmeter.pdf Section 5.0 Instruction Manual	24
		Section 5.1 Contents Sheet	
		Hyperlink Files SP300\mg10p222.pdf Section 6.0 Danfoss VFD Instruction Manual Modbus RTU	33
		Hyperlink Files SP300\SP300 VFD Settings Pump 1 and 2 As Built.pdf Section 6.1 VFD Settings and Parameters	2
		Hyperlink Files SP300\doc_C_1_MG80A802.pdf Section 6.2 Danfoss VFD Operating Instructions VLT 8000 AQUA	197
		Hyperlink Files SP300\Ziehl-ebmFAN.pdf	83
		Hyperlink Files SP300\Switchboard Accessories NHP.pdf	39
		Hyperlink Files SP300\Serpentine Rd ITP.pdf Hyperlink Files SP300\Serpentine Rd FAT.pdf Section 7.0 ITP Procedure, Test Sheets & Factory Acceptance Test	5 11
		Hyperlink Files SP300\BW Factory Acceptance Test Document Switchboard.pdf BW Factory Acceptance Test Document Switchboard	6
2.2	2.4	Hyperlink Files SP300\20650144_050124.pdf DEMAG Crane Operating Instructions	80
		Hyperlink Files SP300\22251644_040526.pdf DEMAG Component Parts	44
		Hyperlink Files SP300\Crane Load Test Report.pdf Quality Assurance Load Test Report	1
	2.5	Hyperlink Files SP300\O & M Manual Odour Scrubber.pdf AIREPURE Odour Control System	63

Issue Date: 09 Feb 06

Page 4 of 8

Rev: 0

G:\CNPMS\Asset Creation Program\STTG -Australia TradeCoast Sewer\2005-2006\COMMISS\MANUALS\OMM SP300

Rev 0\Table of Contents SP300.doc

BRISBANE CITY COUNCIL
Brisbane Water
Serpentine Road P/S SP300 Australia Trade Coast Sewer Project

BW30137-02/03

<u>Volume</u>	<u>Section</u>	<u>Description</u>	<u>Pages</u>
2.6		Hyperlink Files SP300\Serpentine Road Manual.pdf Style Industries Mechanical I & OMM	97
		Part 1 Introduction and Background Information.	
		Part 2 Description of Equipment and Process.	
		Part 3 Appropriate Records.	
		Part 4 Operation and Maintenance.	
		Appendix 1 Pressure Gauge Certificate. Appendix 2 Rilsan Nylon 11 Polymeric Coatings. Appendix 3 Metal Seated Sluice Valves. Appendix 4 Knifegate Valve. Appendix 5 Dismantling Joints. Appendix 6 Reflux Valves. Appendix 7 Sump Pump. Appendix 8 Stainless Steel Ball Vaves. Appendix 9 Ventilation Fan. Appendix 10 Davit Lifting Arms. Appendix 11 Non-Shrink Epoxy Grout.	
3	3	Drawings & Drawing Register	
		Electronic copy of the following drawings on CD. Table of Contents	
3.1		Hyperlink Files SP300\Drawing Register.xls	7
		Hyperlink Files SP300\486 5 7-TR201 001.pdf Locality Keyplan Drawing	1
		Hyperlink Files SP300\OMM SP300 Introduction Description Design and Process Rev0.doc - LINK4 Street Location Map	1
		As Constructed Drawings Rising Mains	
3.2		Hyperlink Files SP300\Rising Main Drg Lytton Rd to Serpentine Rd.pdf Sewer Rising Main Lytton Road Pump Station (SP298) to Serpentine Road Pump Station (SP300)	16
3.3		Hyperlink Files SP300\Incomming rising main from Kingsford Smith Drive.pdf Sewer Rising Main from Kingsford Smith Drive to Serpentine Road Pump Station (SP300)	15
		As Constructed Drawings Pump Station SP300 Mechanical/Electrical/Switchboard/Generator/Pit Covers	
3.4		Hyperlink Files SP300\486 5 7-TR201 000 ACD SP300.pdf As-constructed drawings Serpentine Rd Pump Station SP300. Mechanical/Electrical/Switchboard/Generator/Pit Covers	94

Issue Date: 09 Feb 06

Page 5 of 8

Rev: 0

G:\CNPMS\Asset Creation Program\STTG -Australia TradeCoast Sewer\2005-2006\COMMISS\MANUALS\OMM SP300
Rev 0\Table of Contents SP300.doc

BRISBANE CITY COUNCIL
Brisbane Water
Serpentine Road P/S SP300 Australia Trade Coast Sewer Project

BW30137-02/03

Volume	Section	Description	Pages
		Weir Services: Pump General Arrangement Drawing	
	3.5	Hyperlink Files SP300\wd8160_1 Layout1 (1).pdf	1
4	4	Traning/System Testing/Pre-Commissioning/Installation Method Statement/QA Records	
	4.1	BW Site Based Traning Hyperlink Files SP300\BW Site Based Training.pdf	4
	4.2	BW: System Integration Testing	
		Hyperlink Files SP300\SP298 SP300 System Integration Testing Procedure Rev 1.doc (BW) System Integration Testing Procedure SP 298 Lytton Rd Pump Station & SP 300 Serpentine Rd Pump Station. Including the following	7
		Hyperlink Files SP300\BW ITP 001 Rev0.pdf (BW) ITP: 001 Rev.0 EQUIPMENT: Sewer RM Pritchard St PS to Lytton Rd PS. Sewer RM from connection to Kiawanah Rd PS SP49 RM at Lindum Rd to Lytton Rd PS.	1
		Hyperlink Files SP300\BW ITP 002 Rev0.pdf (BW) ITP: 002 Rev.0 (Separable Portion 2 SP298 Lytton Rd Pump Station) EQUIPMENT: Pumping Station Site System Commissioning	1
		Hyperlink Files SP300\BW ITP 003 Rev0.pdf (BW) ITP: 003 Rev.0 (Separable Portion 2 SP300 Serpentine Rd Pump Station) EQUIPMENT: Pumping Station Site System Commissioning	1
		Hyperlink Files SP300\Check List 1.pdf (BW) Inspection Check List No1 Lytton Rd	1
		Hyperlink Files SP300\Check List 2.pdf (BW) Inspection Check List No 2 Serpentine Rd	1
		Hyperlink Files SP300\SP300 Serpentine Road Functional Spec 1-10.doc	24
		Hyperlink Files SP300\SP300 FS Document Signoff Approval.pdf	1
		Hyperlink Files SP300\SP300 Functional Specification Rev 3.doc Parsons Brinckerhoff Date of Issue: 4 November 2004	26
		Hyperlink Files SP300\SP298 Lytton Road 4 Functional Spec 1-10.doc	18
		Hyperlink Files SP300\SP298 FS Document Signoff Approval.pdf (BW) 1-05. doc	1
		Hyperlink Files SP300\SP298 Functional Specification Rev 4.pdf Parsons Brinckerhoff Date of Issue: 5 November 2004	24
		Hyperlink Files SP300\Trends SP298 13-06-2005 (2-6-24 hours).pdf	3

Issue Date: 09 Feb 06

Page 6 of 8

Rev: 0

G:\CNPMS\Asset Creation Program\STTG -Australia TradeCoast Sewer\2005-2006\COMMISS\MANUALS\OMM SP300
Rev 0\Table of Contents SP300.doc

BRISBANE CITY COUNCIL
Brisbane Water
Serpentine Road P/S SP300 Australia Trade Coast Sewer Project

BW30137-02/03

<u>Volume</u>	<u>Section</u>	<u>Description</u>	<u>Pages</u>
		Lytton Rd P/S SP298 No.4 Pump Trends (2/6/24hours)	
		Hyperlink Files SP300\Trends SP300 - Concrete Main - 06-10-2005 (2-6-24 hours).pdf Serpentine Rd P/S SP300 Pumping into the DN1840 Concrete Rising Main. Eagle Farm at Maximum Flow. Pump Trends (2/6/24hours)	3
		Hyperlink Files SP300\Trends Steel Main SP300 11-06-2005 (2-6-24 hours).pdf Serpentine Rd P/S SP300 Pumping into the DN1370 Steel Rising Main. Pump Trends (2/6/24hours)	3
		Hyperlink Files SP300\Pre-Commissioning Acceptance Test Document.pdf Pre-Commissioning Acceptance Test Document	3
		Hyperlink Files SP300\Site Acceptance Test SAT Test Document On Site.pdf BW Site Acceptance Test Document Switchboard	6
		Hyperlink Files SP300\IDTS Point Commissioning Sheet and Generator Supply Operational Checks.pdf BW IDTS Point Commissioning Sheet Switchboard	5
		Hyperlink Files SP300\BW Site Inspection Report Switchboard 1.pdf BW Site Inspection Report Switchboard	7
4.3		Leighton/Parsons Brinckerhoff: Pre-Commissioning Report	
		Hyperlink Files SP300\Pages from Letter Electrical Installation in accordance with AS3000.pdf Letter from REDILEC (who was working under Leighton direction) to certify that the electrical works is in accordance with AS3000.	1
		Hyperlink Files SP300\RPT021Bvb - Precommissioning Serpentine Rd PS.pdf Pre-commissioning Report Lytton Road Pump Station SP298. Including the following.	37
		Introduction	
		Appendix A: Pre-commissioning plan	
		Appendix B: Temporary pre-commissioning pipework arrangement	
		Appendix C: Manufacturers test data	
		Appendix D: Pre-Commissioning test data	
		Appendix E: Pump data comparison graphs	
		Conclusion	
4.4		Leighton: Work Method Statement	
		Hyperlink Files SP300\Q1112-CS-703 CMS of SP2.doc Leighton Construction Method Statement: Rising mains from Lytton Rd P/S to Serpentine Rd P/S.	8
		Hyperlink Files SP300\Q1112-CS-705 CMS of Serpentine Road pump	10

Issue Date: 09 Feb 06

Page 7 of 8

Rev: 0

G:\CNPMS\Asset Creation Program\STTG -Australia TradeCoast Sewer\2005-2006\COMMISS\MANUALS\OMM SP300

Rev 0\Table of Contents SP300.doc

Australia Trade Coast Sewer Project

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BRISBANE CITY COUNCIL

BW30137-02/03

Brisbane Water

Serpentine Road P/S SP300 Australia Trade Coast Sewer Project

1. Introduction**Serpentine Road P/S SP300 Australia Trade Coast North**

The Serpentine Road P/S SP300 will be located in an existing Brisbane Water pipeline easement at the Western end of Serpentine Road Pinkenba. The pumping station structure will be located on the western side of the existing Eagle Farm to Luggage Point sewage rising mains and will discharge directly into these mains.

Flow will be delivered into the station SP300 from a 450mm diameter rising main from the new **Lytton Road** pumping station SP298. Also delivering into the station SP300 will be the **Pinkenba Sewage System**: Kingsford Smith Drive PS, Hugh Street PS, and McBride Road PS will pump into a new shared rising main from Kingsford Smith Drive PS to Serpentine Road Pump Station. The pump station will be operated in the normal manner and controlled by the sewage levels in the wet well. This configuration overcomes some problems associated with the existing situation where pump stations operate in series and are prone to overloading.

1.1 Description of System and Overview**Locality Keyplan**

The Australia Trade Coast Sewer Project consisting of the following infrastructure.

Refer to Locality Keyplan BW drg [486/5/7-TR201/001](#).

- a) Incoming rising mains from Pritchard Street P/S SP085 (refer to drg [486/5/8-SM20/021](#)) and connection to Kiwanah Road P/S SP49 (refer to drg [486/5/8-SM21/021](#)) rising main at Lindum Road.
- b) Lytton Road No.4 Pumping Station SP298. (refer to drg [486/5/7-WR101/030](#)).
- c) Rising main from Lytton Road P/S SP298 No.4 to Serpentine Road Pump Station SP300. (refer to drg [486/5/8-SM18/021](#)).
- d) Serpentine Road Pumping Station SP300 (refer to drg [486/5/7-TR201/030](#)).
- e) Serpentine Road Pumping Station SP300. Outgoing rising mains to Eagle Farm Rising Mains. (refer to drg [486/5/7-TR201/042 & 044](#)).
- f) Incoming rising main from Kingsford Smith Drive Pumping Station SP146 to Serpentine Road Pump Station SP300. (refer to drg [486/5/8-SM17/021](#)).
- g) Viola Place Pumping Station SP299.
- h) Rising mains from Viola Place Pumping Station SP299 to Eagle Farm Rising Mains.

Issue Date: 07 Feb 06

Page 1 of 6

Rev: 0

G:\CNPMS\Asset Creation Program\STTG -Australia TradeCoast Sewer\2004-2005\COMMISS\Reg McGIRR\OMM SP300 Rev 0\Hyperlink Files SP300\OMM SP300 Introduction Description Design and Process Rev0.doc

BRISBANE CITY COUNCIL
Brisbane Water
Serpentine Road P/S SP300 Australia Trade Coast Sewer Project

BW30137-02/03

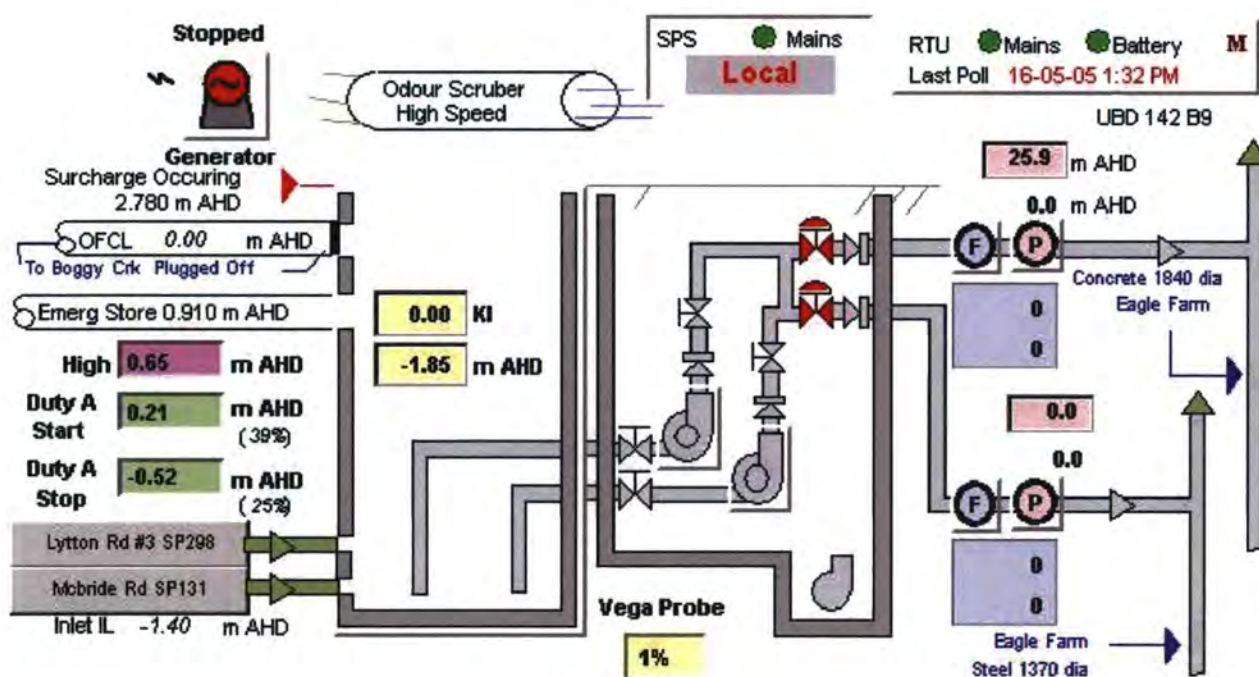
1.2 Design and Process

Serpentine Rd P/S SP300 Overview of Incoming Rising Mains

The incoming sewage flows into Serpentine Rd P/S SP300 are from the following two (2) rising mains.

- Rising main from Lytton Road P/S SP298 No.4 to Serpentine Road Pump Station SP300. (refer to drg [486/5/8-SM18/021](#)).
- Incoming rising main from Kingsford Smith Drive Pumping Station SP146 to Serpentine Road Pump Station SP300. (refer to drg [486/5/8-SM17/021](#)).

Fig. 0
Process and Instrumentation Overview



1.3 Pumping System Operation

General Process Description.

The incoming flow to SP300 comes from SP298 at Lytton Rd Lytton (South side) and a number of other pumping stations (Pinkenba Sewage System) on the north side of the Brisbane River. Sewage is pumped from all locations into the wet well at SP300.

Issue Date: 07 Feb 06

Page 2 of 6

Rev: 0

G:\CNPMS\Asset Creation Program\STTG -Australia TradeCoast Sewer\2004-2005\COMMISS\Reg McGIRR\OMM SP300 Rev 0\Hyperlink Files SP300\OMM SP300 Introduction Description Design and Process Rev0.doc

BRISBANE CITY COUNCIL

BW30137-02/03

Brisbane Water

Serpentine Road P/S SP300 Australia Trade Coast Sewer Project

SP300 is designed to discharge into one of two 'Eagle Farm to Luggage Point' rising mains.

- Low pressure DN1840 concrete rising main .
- High pressure DN1370 steel rising main.

The Eagle Farm Pump Station (EFPS) actually consists of two pump stations:

- EFPS#1, which has three 2000 kW pumps in a two duty/one standby arrangement; and
- EFPS#2, which has two 1850 kW pumps in a duty/standby arrangement.

Both EFPS#1 and EFPS#2 use variable speed pumps and hence the sewage flow in each rising main is variable.

During dry weather, EFPS#1 is normally used in conjunction with the DN1370 main. Under this operating arrangement, EFPS#1 can deliver a maximum of around 4200 L/s through the DN1370 main to the Luggage Point WWTP.

During wet weather events, EFPS#1 is normally used in conjunction with the DN1370 main, and EFPS#2 is brought online to assist, in conjunction with the DN1840 main. Under this operating arrangement, the EFPS can deliver a maximum of around 8000 L/s through both mains to the WWTP. If the steel rising main DN1370 is offline (for maintenance) then EFPS#2 is operated in conjunction with the DN1840 main. Under this operating arrangement, the operator at Eagle Farm runs EFPS#2 in manual mode to ensure that the pressure remains within acceptable limits.

As SP300 is required to deliver sewage directly into the existing rising mains, its duty head is a strong function of the residual head in the selected discharge main. The maximum and minimum pump duties for SP300 are presented in the table below.

Main in Use	EFPS Flow (L/s)	SP300 Flow (L/s)	SP300 Head (m)
DN1370	4200	348	40.8
	0	348	8.9
DN1840	3800	348	19.2
	0	348	8.9

SP300 Serpentine Road has been designed to operate predominantly with the steel rising main and the pumps and drives have been sized accordingly. If this steel rising main is not in service (as determined by the Eagle Farm pump station operators), then SP300 can utilise the concrete rising main provided that certain limitations are adhered to.

The main two limitations are limiting the station to only run one pump and to restrict the pump running to a maximum speed of 33Hz (to be confirmed after commissioning when pumps run on 1840mm main). Limiting the speed of the drive limits the flow and head pressure to the figures shown in the table below. The limiting of the speed will limit the flow and the head pressure to the limits listed below. These limits will have alarms configured to alert both the Eagle Farm control room and IDTS master station. The max speed of 52 hz will need to be confirmed after commissioning when pumps run on 1370mm main

Issue Date: 07 Feb 06

Page 3 of 6

Rev: 0

G:\CNPMSS\Asset Creation Program\STTG -Australia TradeCoast Sewer\2004-2005\COMMISS\Reg McGIRR\OMM SP300 Rev 0\Hyperlink Files SP300\OMM SP300 Introduction Description Design and Process Rev0.doc

BRISBANE CITY COUNCIL
Brisbane Water
Serpentine Road P/S SP300 Australia Trade Coast Sewer Project

BW30137-02/03

Main in Use	Maximum Pumps to Run	Maximum Speed (Hz)	Maximum Flow (l/s)	Maximum Head Pressure (m)
DN1370	2	52.0	Unlimited	Unlimited
DN1840	1	33.0	348	10.0

a) Pump Nameplate Data:

Pump Type-----Hidrostal
Pump Code-----H0K-M02R+ETZ4-XMEK+NEE8-16
Pump Motor Power P2-----200Kw.
Pump -----400l/s
Pump Head-----33m
Voltage-----400V
Hz-----50
Current Max-----420A
N.NR-----1380/8
O.NR-----2004/05353
VDE0530-----07/91
Cos-----0.81
RPM-----1490
IP-----68
I.CL-----F

1.4 Locality Plan

Fig.1
New Serpentine Rd Sewage Pumping Station SP300



Issue Date: 07/10/00
Rev: 0
G:\CNPMSS\Asset Creation Program\STTG -Australia TradeCoast Sewer\2004-2005\COMMISS\Reg McGIRR\OMM SP300 Rev 0\Hyperlink Files SP300\OMM SP300 Introduction Description Design and Process Rev0.doc

BRISBANE CITY COUNCIL
Brisbane Water
Serpentine Road P/S SP300 Australia Trade Coast Sewer Project

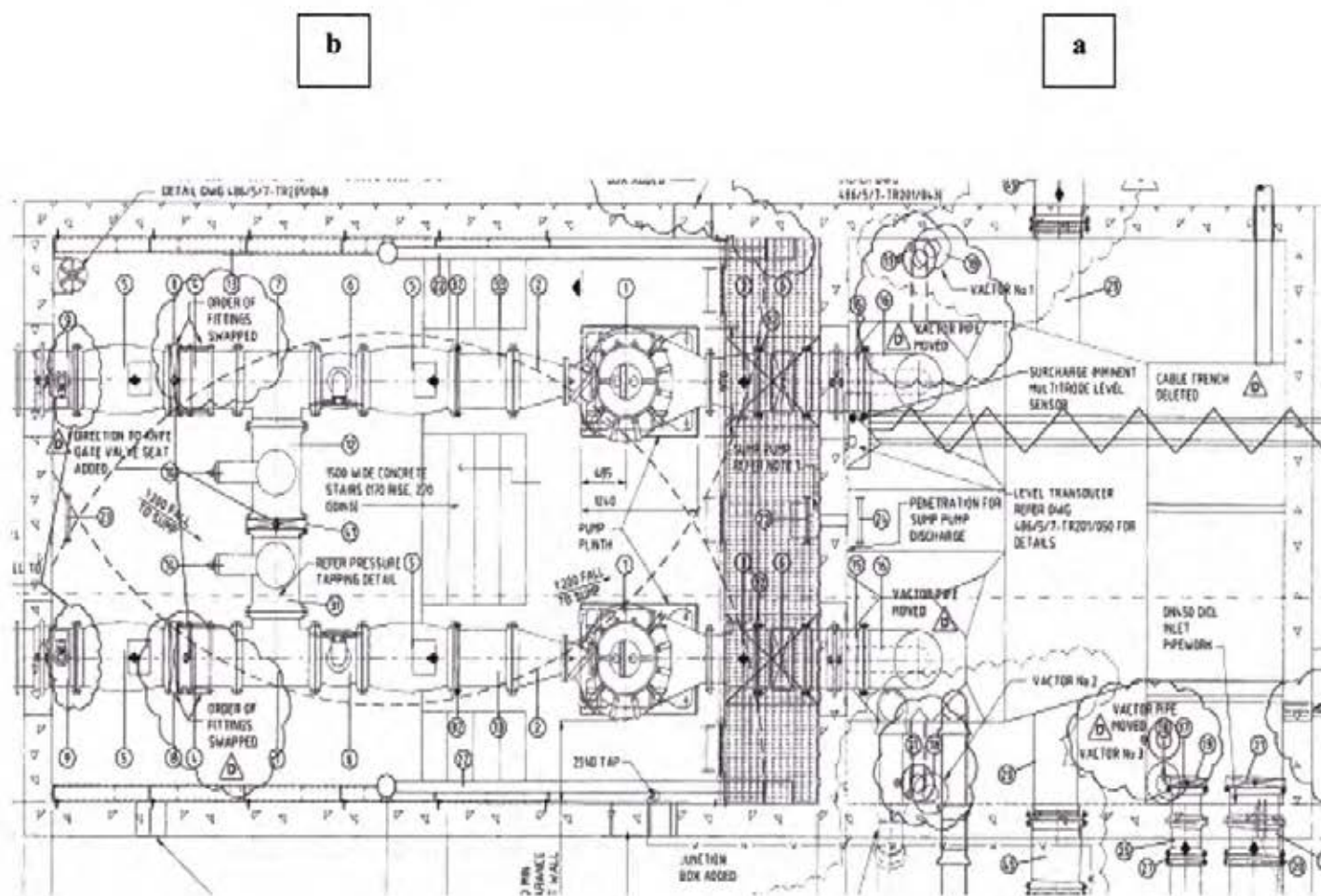
BW30137-02/03

1.5 Pump Station SP300 Layout

The pump station SP298 is made up of the following (Fig.2 & 3):

- a) Wetwell.
- b) Pump Dry-well including Valving.

Fig.2
Pump Station Plan View (refer drg [486/5/7-TR201/030](#))



Issue Date: 07 Feb 06

Page 5 of 6

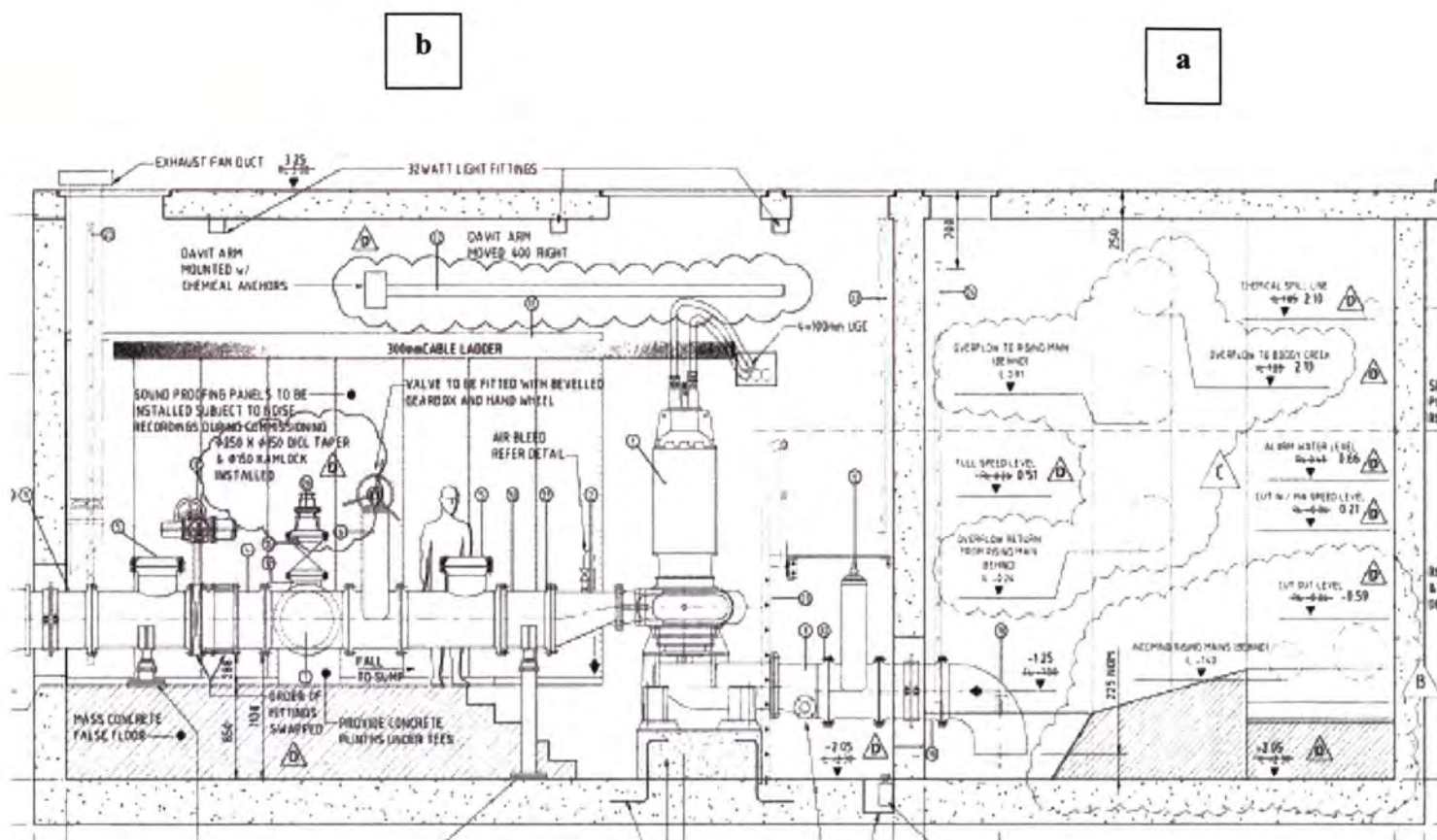
Rev: 0

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Process Rev0.doc

BRISBANE CITY COUNCIL
Brisbane Water
Serpentine Road P/S SP300 Australia Trade Coast Sewer Project

BW30137-02/03

Fig.3
Pump Station Side View (refer to drg [486/5/7-TR201/031](#))



Issue Date: 07 Feb 06

Page 6 of 6

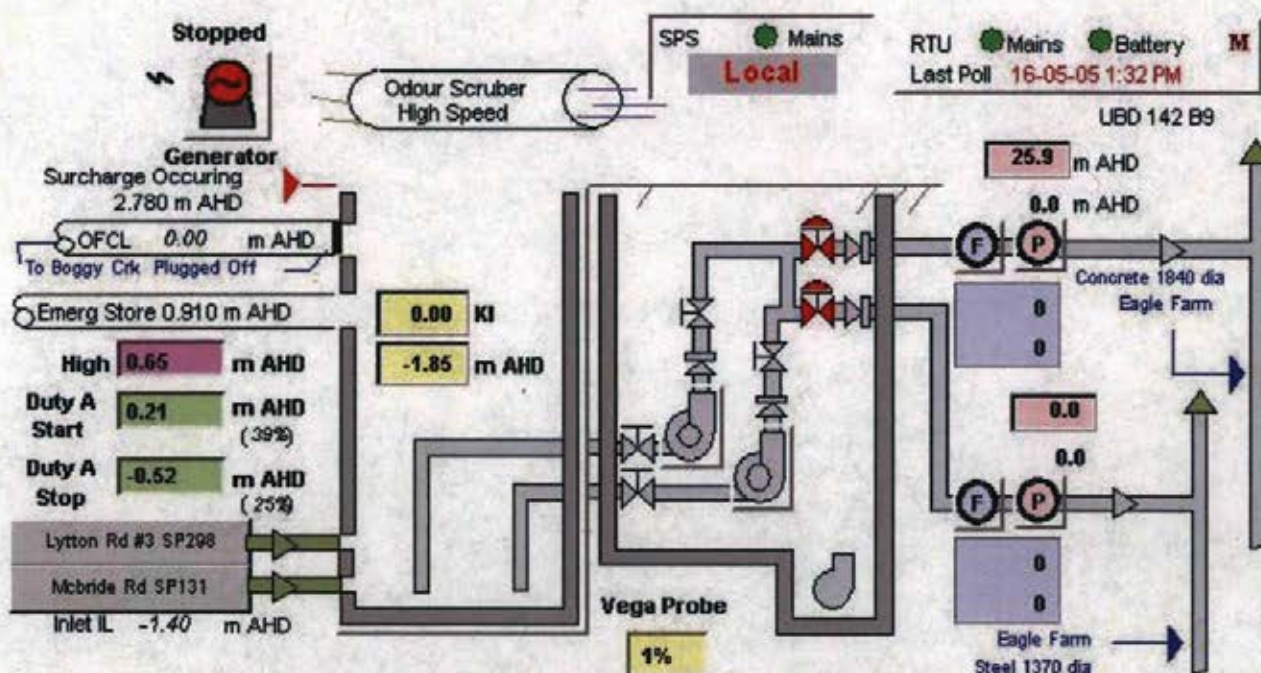
Rev: 0

G:\CNPMS\Asset Creation Program\STTG -Australia TradeCoast Sewer\2004-2005\COMMISS\Reg
McGIRR\OMM SP300 Rev 0\Hyperlink Files SP300\OMM SP300 Introduction Description Design and
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BRISBANE WATER

Network Control Systems



FUNTIONAL SPECIFICATION

SP300 Serpentine Rd

Sewage Pumping Station

Conventional 2 Pumps With VSD and 2 Valves

Document Signoff

Approval

	Name	Role	Signature	Date
Supervising Elec. Eng <i>Engineering Design Services</i>	Alan Mooney	Recommend		
Supervising Elec. Eng <i>Engineering Design Services</i>	Henri Lai	Concur		
Team Leader <i>Network Control Systems</i>	Peter Sherriff	Concur		
Manager <i>System Planning</i>	Peter Casey	Concur		
Manager <i>Water & Sewerage Operations</i>	George Henry	Concur		
Manager <i>Mechanical And Electrical Services</i>	Michael Greene	Concur		
Project Manager	Andrew Bannik	Approve		

Distribution

Name	Role	Section

Revision Control

Revision Number	Date	Amendment Details	Responsible Officer
Version 0.00	11/11/2004	Original Draft – Developed from Leightons SP300 Revised Functional Spec – Version 3	Alex Witthoft
Version 0.03	26/11/2004	Issued for comment	Alex Witthoft
Version 0.04	29/11/2004	Added Comments by Malcolm Barrett	Alex Witthoft
Version 0.05	08/03/2005	Revised the Valve Control Section	Alex Witthoft
Version 0.06	09/03/2005	Finished 3.2.1 Valve Control	Alex Witthoft
Version 0.10	22/03/2005	Added Comments by Reg McGirr Issued to Reg for distribution to Leightons.	Alex Witthoft
Version 0.20	06/04/2005	Modified wet well levels (section 3) Added emergency storage (section 3.2.3 & 3.3.2) Added systemic control (section 3.3.3) Added Non standard picture sections (3.4.3 & 3.4.4)	Alex Witthoft
Version 1.00	16/05/2005	Minor modification from Reg McGirr	Alex Witthoft
Version 1.10	21/11/2005	Levels modified after official NSM surveying	Alex Witthoft

Document Consultation

Please review the attached document and add your comments where necessary. To ensure that the process is kept within reasonable timeframes, it would be appreciated if you could return this document by the **Requested Return Date** listed below.

Project Sponsor: Andrew Bannik

Officer Code: PM13BW

Location: T.C.B. Level 2

Author: Alex Witthoft

Officer Code: CTAMP12

Location: Cullen Ave

Document Administrator: Alan Mooney

Officer Code: SEEPSBW

Location: T.C.B. Level 2

Version Number (1,2,3 etc)	Forwarded To: (Name / Officer Code)	Location (eg,TCB, Cullen Ave)	Date Sent	Requested Return Date	Date Returned	Comments Received (Y / N)	Comments Incorporated (Y / N)
0.03	Malcolm Barrett	Cullen Ave	26/11/04	03/12/04	03/12/04	Y	Y
0.04	Peter Sherriff	Cullen Ave	29/11/04	06/12/04	06/12/04	Y	Y
0.04	George Henry	Cullen Ave	29/11/04	06/12/04	06/12/04	Y	Y
0.04	Alan Mooney	TCB	29/11/04	06/12/04	06/12/04	Y	Y
0.04	Peter Casey	TCB	29/11/04	06/12/04	06/12/04	Y	Y
0.04	Henri Lai	TCB	29/11/04	06/12/04	06/12/04	Y	Y
0.06	Henri Lai	Cullen Ave	09/03/05	14/03/05	-	N	N
0.06	Kerry McGovern	Cullen Ave	09/03/05	14/03/05	-	N	N
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Table of Contents

1	INTRODUCTION	<u>76</u>
1.1	GENERAL PROCESS DESCRIPTION	<u>87</u>
2	EQUIPMENT INSTALLED	<u>109</u>
2.1	STANDARD EQUIPMENT	<u>109</u>
2.2	NON STANDARD EQUIPMENT.....	<u>109</u>
2.2.1	Emergency Generator	<u>109</u>
2.2.2	Activated Carbon Scrubber.....	<u>109</u>
2.2.3	Actuated Valves.....	<u>109</u>
2.3	PROVISION FOR FUTURE NON-STANDARD EQUIPMENT	<u>1140</u>
2.3.1	Dosing Pumps.....	<u>1140</u>
3	CONTROL PHILOSOPHY	<u>1244</u>
3.1	SITE SPECIFIC VALUES.....	<u>1342</u>
3.2	NON STANDARD CONTROL.....	<u>1544</u>
3.2.1	Valve Control.....	<u>1544</u>
	Control Modes	<u>1544</u>
	Sequencing.....	<u>1645</u>
	Failure States.....	<u>1645</u>
3.2.2	Pump Controls.....	<u>1746</u>
	Number of Pumps.....	<u>1746</u>
	Interlocking and Speed Limiting	<u>1746</u>
3.2.3	Emergency Storage	<u>1847</u>
3.2.4	Peer to Peer Comms.....	<u>1948</u>
	To SP298 Lytton Rd #4 - Systemic Control	<u>1948</u>
	From SP010 Eagle Farm ((FUTURE))	<u>1948</u>
3.3	NON STANDARD MONITORING AND ALARMS	<u>2049</u>
3.3.1	Additional Valve Monitoring and Alarms.....	<u>2049</u>
	Available	<u>2049</u>
	Available for Remote.....	<u>2049</u>
	Open.....	<u>2049</u>
	Closed.....	<u>2049</u>
	Fail to Open	<u>2049</u>
	Fail to Close.....	<u>2049</u>
	Valve Station Auto / Manual Control and Feedback.....	<u>2120</u>
	Sewage Pumping Station Mode Control / Selected.....	<u>2120</u>
3.3.2	Additional Wet Well Monitoring and Alarms.....	<u>2120</u>
	Emergency Storage Imminent Alarm.....	<u>2120</u>
	Emergency Storage Active Alarm	<u>2120</u>
3.3.3	Systemic Control	<u>2224</u>
	Systemic Control Enable and Feedback.....	<u>2224</u>
	Systemic Control Active	<u>2224</u>
3.3.4	Additional RTU Monitoring and Alarms	<u>2224</u>
	Remote RTU Comms Fault.....	<u>2224</u>
3.4	NON STANDARD IDTS PICTURE	<u>2322</u>
3.4.1	Additional Valves	<u>2322</u>
3.4.2	Additional Pipe Animation.....	<u>2322</u>
3.4.3	Systemic Control	<u>2322</u>
3.4.4	Emergency Storage	<u>2322</u>
4	REFERENCES.....	<u>2423</u>

Table of Figures

Figure 1: SP300 Location Map	76
Figure 2: SP300 Process and Instrumentation Overview	87
Figure 3: SP300 Station Level Set Points	1244

Table of Tables

Table 1: Site Specific Constants defined in the PLC	1342
Table 2: Site Specific Constants defined in the RTU	1342
Table 3: Site Specific Variable defined in the RTU	1342
Table 4: Wet Well Level vs Volume Data	1443

Definitions

IDTS	Integrated Departmental Telemetry System
RTU	Remote Telemetry Unit
SCADA	Supervisory Control And Data Acquisition
MAHD	Metres above Australia Height Datum

1 INTRODUCTION

This document contains the site specific details and describes the non standard functional requirements for control, monitoring and telemetry at sewage pump station SP300 at Serpentine Road Pinkenba. The functional requirements described in the document are in addition to the standard functionality detailed in “SPSV3 SEWAGE PUMPING STATION SUBMERSIBLE 3 PUMPS WITH VFD”¹.

The standard specification was written for a 3 pump station, of which only 2 pumps are allowed to run at any given time. The functionality for SP300 Serpentine Road is identical, except that SP300 only has 2 pumps, both of which can run simultaneously into the DN1370 main and single pump into the DN1840 main.

The site specific details and the non standard functional requirements in this document were derived from the functional specification written by Leighton Contractors Pty Ltd “SP300 FUNCTIONAL SPECIFICATION REV 3”².

SP300 is a sewage pump station incorporating two variable speed driven 216 kW dry mounted submersible pumps operating in a duty/standby arrangement. SP300 is located in a Brisbane Water pipeline easement at the western end of Serpentine Road Pinkenba.



Figure 1: SP300 Location Map

1.1 General Process Description

The incoming flow to SP300 comes from SP298 at Lytton Rd Lytton (South side) and a number of other pumping stations on the north side of the Brisbane River. Sewage is pumped from all locations into the submerged inlet chamber at SP300. From the inlet chamber, the sewage flows directly into the wet well.

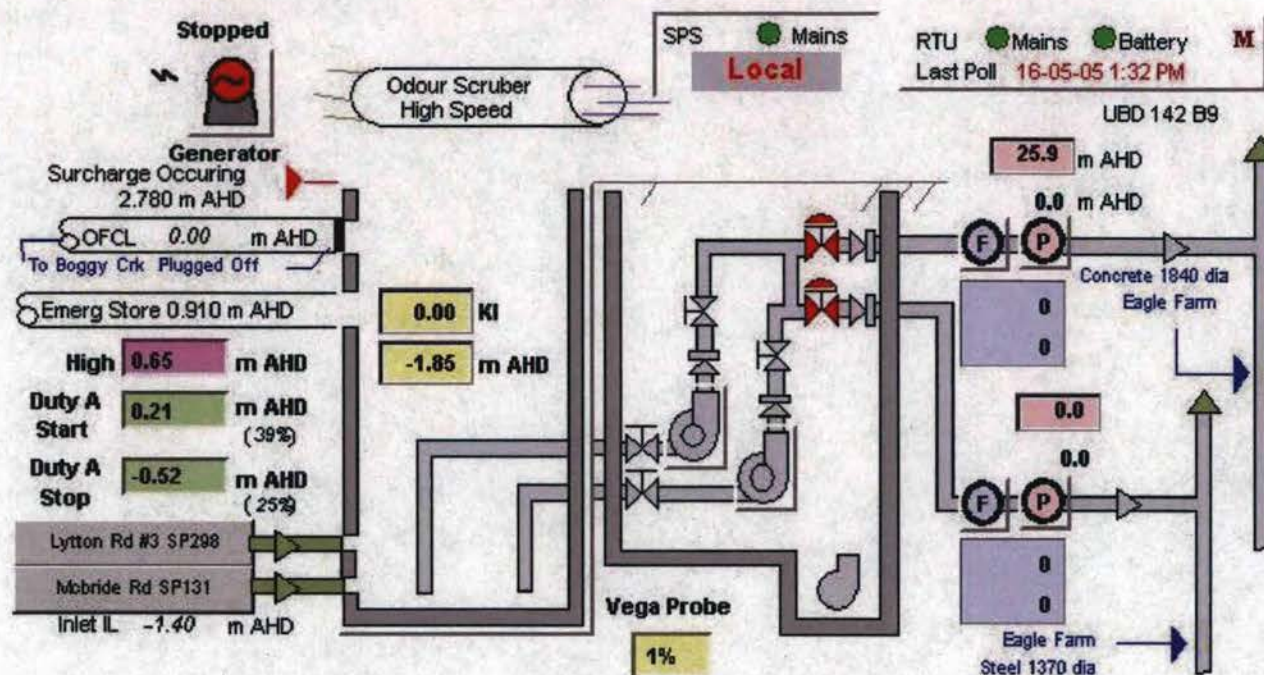


Figure 2: SP300 Process and Instrumentation Overview

SP300 is designed to discharge into one of two 'Eagle Farm to Luggage Point' rising mains

1. Low pressure DN1840 concrete rising main
2. High pressure DN1370 steel rising main.

The Eagle Farm Pump Station (EFPS) actually consists of two pump stations:

1. EFPS#1, which has three 2000 kW pumps in a two duty/one standby arrangement; and
2. EFPS#2, which has two 1850 kW pumps in a duty/standby arrangement.

Both EFPS#1 and EFPS#2 use variable speed pumps and hence the sewage flow in each rising main is variable.

During dry weather, EFPS#1 is normally used in conjunction with the DN1370 main. Under this operating arrangement, EFPS#1 can deliver a maximum of around 4200 L/s through the DN1370 main to the Luggage Point WWTP.

During wet weather events, EFPS#1 is normally used in conjunction with the DN1370 main, and EFPS#2 is brought online to assist, in conjunction with the DN1840 main. Under this operating arrangement, the EFPS can deliver a maximum of around 8000 L/s through both mains to the WWTP.

If the steel rising main DN1370 is offline (for maintenance) then EFPS#2 is operated in conjunction with the DN1840 main. Under this operating arrangement, the operator at Eagle Farm runs EFPS#2 in manual mode to ensure that the pressure remains within acceptable limits.

As SP300 is required to deliver sewage directly into the existing rising mains, its duty head is a strong function of the residual head in the selected discharge main. The maximum and minimum pump duties for SP300 are presented in the table below.

Main in Use	EFPS Flow (L/s)	SP300 Flow (L/s)	SP300 Head (m)
DN1370	4200	348	40.8
	0	348	8.9
DN1840	3800	348	19.2
	0	348	8.9

SP300 Serpentine Road has been designed to operate predominantly with the steel rising main and the pumps and drives have been sized accordingly. If this steel rising main is not in service (as determined by the Eagle Farm pump station operators), then SP300 can utilise the concrete rising main provided that certain limitations are adhered to.

The main two limitations are limiting the station to only run one pump and to restrict the pump running to a maximum speed of 33Hz (to be confirmed after commissioning when pumps run on 1840mm main). Limiting the speed of the drive limits the flow and head pressure to the figures shown in the table below. The limiting of the speed will limit the flow and the head pressure to the limits listed below. These limits will have alarms configured to alert both the Eagle Farm control room and IDTS master station. The max speed of 52 hz will need to be confirmed after commissioning when pumps run on 1370mm main

Main in Use	Maximum Pumps to Run	Maximum Speed (Hz)	Maximum Flow (l/s)	Maximum Head Pressure (m)
DN1370	2	52.0	Unlimited	Unlimited
DN1840	1	33.0	348	10.0

2 EQUIPMENT INSTALLED

2.1 Standard Equipment

SP300 Serpentine Rd pump station has the following standard equipment installed. The functionality for the control, monitoring and alarming for these items is fully described in the standard functional specification.

Pumps	Two Hidrosta I10K submersible pumps with 216 kW four pole electric motors are installed in the dry well. Each pump is fitted with moisture probes in the oil chamber and thermistors in the stator windings.
Pump Starters	Two Danfoss VLT8000 Variable Frequency Drives (VFDs) are installed in the pump station switchboard. The VFDs will also provide soft starting functionality.
Flow meters	Two direct buried DN500 ABB Magmaster electromagnetic flow meters are installed in the DN500 PE100 discharge mains downstream of the valve chamber. The flowmeter will be used in the flow control algorithm (PID Loop) to control the speed of the pumps.
Level Sensors	One Vega hydrostatic level transmitter and one Multitrode level probe are installed in the wet well.
Pressure Transmitters	Two Vega D84 pressure transmitters are installed on the discharge pipe work in the valve chamber.

2.2 Non Standard Equipment

SP300 Serpentine Rd pump station has the following non standard equipment installed. The functionality for the control, monitoring and telemetry for is described in the following sections as these items are NOT described in the standard specification.

Emergency Generator	One SE Power 500 kVA diesel powered backup generator is installed on a slab adjacent to the valve chamber. The generator includes its own GE FANUC PLC mounted in a dedicated control panel inside the generator housing.
Actuated Valves	Two DN450 Keystone Figure 951 knife gate valves with 415 V Rotork actuators are installed in the discharge pipe work in the valve chamber.
Activated Carbon Scrubber	One activated carbon odour scrubber (nominally RKR Engineering Aircenz) to be installed adjacent to the wet well. Provision was made for the starter and controls for the activated carbon unit to be installed in a dedicated control panel adjacent to the scrubber.

2.2.1 Emergency Generator

The emergency generator is designed to the standard functionality as described by “DIESEL STANDBY GENERATOR LOCAL CONTROL PANEL FUNCTIONAL DESCRIPTION”.³ The generator is supplied with the PLC fully configured and loaded with the standard program. The RTU (Logica MD3311) will be programmed with the standard interface program that will provide the monitoring, control and telemetry to the IDTS master station.

2.2.2 Activated Carbon Scrubber

SP300 will have an activated carbon scrubber unit installed to eliminate odours. The functional specification for this equipment has not been finalised and will be provided in a separate document.

2.2.3 Actuated Valves

The two actuated knife gate valves are used to control which rising main the station will pump into. The functionality of these valves is detailed in the Control Philosophy section.

2.3 Provision for Future Non-Standard Equipment

Although the project has made civil provision for the following future equipment, no PLC or RTU code has been developed

- Dosing Pump

Any future project to install the above equipment will provide funding for the functional specification and programming of the control, monitoring and telemetry.

2.3.1 Dosing Pumps

Provision was made for two chemical dosing pumps (nominally Alldos 0.18 kW) to be installed adjacent to the dosing slab. Provision was made for VFDs for these pumps to be installed in a dedicated control panel adjacent to the pumps.

3 CONTROL PHILOSOPHY

The station will operate according to the control philosophy detailed in the standard functional specification (SPSV3). The only modification is to the duty rotation algorithm, which will now control only two pumps instead of three. The number of pumps allowed to run remains the same (2) and the initialisation block will be configured with the site specific set points listed in the tables in the next sections.

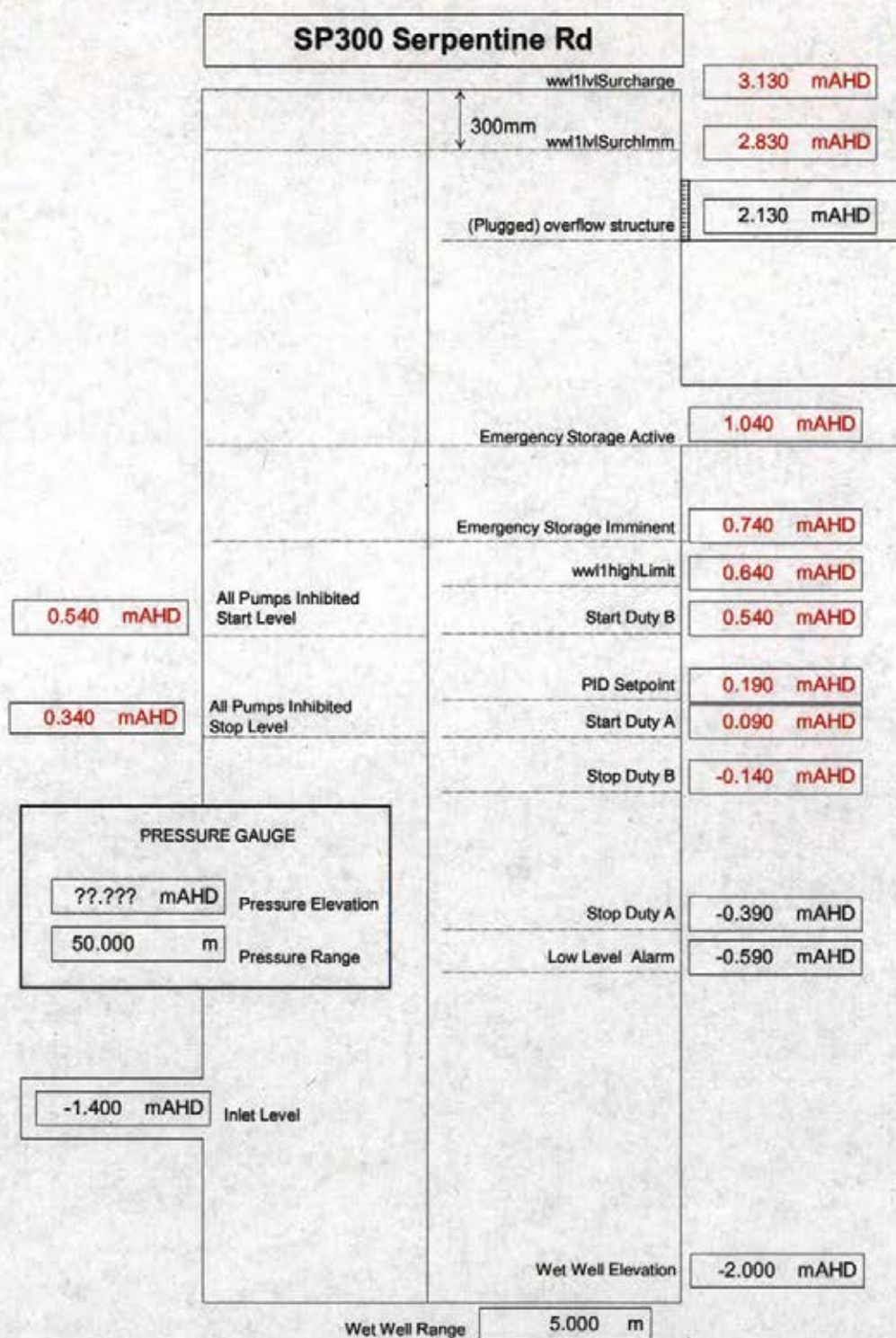


Figure 3: SP300 Station Level Set Points

SOME LEVELS MAY CHANGE ACCORDING TO COMMISSIONING FIGURES

3.1 Site Specific Values

Table 1: Site Specific Constants defined in the PLC

Tag Name	Description	Type	Value	Units
Sewerage Pumping Station				
Stn01grSurchPumpingTime	Surcharge pumping duration ³	Integer	600	Sec
Delivery flow				
Flw0[x]txRange	Delivery flow – Range	Real	7500	l/s
Stn01grMinFlow1Pmp	Delivery flow – Minimum flow	Real	100	l/s
Stn01grMaxFlow1Pmp	Delivery flow – Maximum flow – 1 Pump	Real	348	l/s
Stn01grMaxFlow2Pmp	Delivery flow – Maximum flow – 2 Pumps	Real	700	l/s
Delivery pressure				
Pre01txRange	Delivery pressure - Range	Real	5000	mmAHD
Pre01txZero	Delivery pressure – Elevation of the transducer	Real	T.B.A	mmAHD
Pump Blockage				
Stn01grPmpBlockFlowKneeSP	Flow blocked limit for flow/level PID control (knee)	Integer	T.B.A	l/s x 100
Stn01grPmpBlockSpeedKneeSP	VFD speed blocked limit for flow/level PID control (knee)	Integer	T.B.A	Hz x 100
Stn01grPmpBlockSpeedMinSP	VFD speed blocked limit for minimum flow PID control	Integer	T.B.A	Hz x 100
Wet well level				
Wwl01txRange	Wet well level range	Integer	5500	mmAHD
Wwl01txSurchImmLevelSP	Wet well surcharge imminent level	Integer	2830	mmAHD
Wwl01txEStorImmLevelSP	Wet well surcharge imminent level	Integer	640	mmAHD
Wwl01grInhStartLevelSP	Wet well inhibit mode start level	Integer	540	mmAHD
Wwl01grInhStopLevelSP	Wet well inhibit mode stop level	Integer	340	mmAHD
Wwl01grRunatMaxLvlSP	Wet well run at maximum speed level	Integer		mmAHD
Wwl01txDtyBStartLevelSP	Wet well duty B pump start level	Integer		mmAHD
Wwl01txPIDLevelSP	Wet well PID set point	Integer		mmAHD
Wwl01txDtyAStartLevelSP	Wet well duty A pump start level	Integer		mmAHD
Wwl01txDtyBStopLevelSP	Wet well duty B pump stop level	Integer		mmAHD
Wwl01txDtyAStopLevelSP	Wet well duty A pump stop level	Integer		mmAHD
Wwl01txZero	Wet well empty level (4mA of Probe)	Integer	-1920	mmAHD
Variable Frequency Drive				
Stn01grMinSpeed	Variable Frequency Drive – Minimum Speed (either mode)	Integer	250	Hz x 100
Stn01grMaxSpeed1	Variable Frequency Drive – Maximum Speed (Mode 1)	Integer	500	Hz x 100
Stn01grMaxSpeed2	Variable Frequency Drive – Maximum Speed (Mode 2)	Integer	330	Hz x 100

Table 2: Site Specific Constants defined in the RTU

Tag Name	Description	Type	Value	Units
flw1almInhibitTm	Delivery flow - Alarm inhibit timer	Integer	15	sec
pre1almInhibitTm	Delivery pressure - Alarm inhibit timer	Integer	15	sec
wwl1surchLvlVol	Wet well volume at surcharge level	Real	46.30	kl
wwl1lvlSurcharge	Wet well surcharge occurring level	Real	1.880	mAHD
Pumps 1 & 2				
Pmp[x]almInhPwrTm	Pump [x] - Motor power alarm inhibit timer.	Integer	15	sec
pmp[x]almInhCrntTm	Pump [x] - Motor current alarm inhibit timer.	Integer	15	sec
pmp[x]currRange	Pump [x] - Motor current range	Real		Amps

Table 3: Site Specific Variable defined in the RTU

Wet well level				
wwl1highLimit	Wet well level - High alarm set point	Integer	510	mmAHD
wwl1lowLimit	Wet well level - Low alarm set point	Integer	-970	mmAHD
Delivery flow				
flw1highLimit	Delivery flow - High alarm set point	Integer	7000	ml/s x 10
flw1lowLimit	Delivery flow - Low alarm set point	Integer	700	ml/s x 10
flw2highLimit	Delivery flow - High alarm set point	Integer	7000	ml/s x 10
flw2lowLimit	Delivery flow - Low alarm set point	Integer	700	ml/s x 10
Delivery pressure				
pre1highLimit	Delivery pressure DN1370 – High alarm set point	Integer		mmAHD
pre1lowLimit	Delivery pressure DN1370 – Low alarm set point	Integer		mmAHD
pre2highLimit	Delivery pressure DN1840 – High alarm set point	Integer		mmAHD
pre2lowLimit	Delivery pressure DN1840 - Low alarm set point	Integer		mmAHD
Pumps 1 & 2				
pmp[x]currHiLimit	Pump [x] - Motor current high alarm set point ⁴	Integer		mAmps
pmp[x]currLoLimit	Pump [x] - Motor current low alarm set point ⁵	Integer		mAmps
pmp[x]powHiLimit	Pump [x] - Motor power high alarm set point	Integer		Watts
pmp[x]powLoLimit	Pump [x] - Motor power low alarm set point	Integer		Watts

Table 4: Wet Well Level vs Volume Data

	Height (mAHD)	Volume m ³	Remaining Storage m ³	% Level	% Volume
1	-0.720	0.000	60.430	22%	0%
2	-0.270	7.300	53.130	30%	12%
3	-0.120	9.800	50.630	33%	16%
4	0.210	15.100	45.330	39%	25%
5	0.510	20.000	40.430	44%	33%
6	0.660	22.400	38.030	47%	37%
7	0.760	24.000	36.430	49%	40%
8	1.250	32.000	28.430	58%	53%
9	1.450	35.300	25.130	61%	58%
10	1.650	38.500	21.930	65%	64%
11	2.110	46.000	14.430	73%	76%
12	2.130	46.300	14.130	74%	77%
	3.000	60.430	0.000	89%	100%

THESE FIGURES WILL NEED TO BE UPDATED TO INCLUDE THE EMERGENCY STORAGE VOLUME

(TO BE PROVIDED BY SYSTEM PLANNING)

3.2 Non Standard Control

3.2.1 Valve Control

The two knife gate valve which determine which rising main the station is discharging into are not standard equipment and their functionality are not covered by the standard specification. These valves also effect the pump control functionality however this section only covers the valve control functionality.

The two knife gate valves are the mechanism in which the station switches between 2 modes of operation, controlled by the open and close status of valve 1 and valve 2. These modes are:

Rising Main	Valve 1	Valve 2	Description
1 – DN1370	OPEN	CLOSED	SP300 is discharging into the high pressure steel rising main.
2 – DN1840	CLOSED	OPEN	SP300 is discharging into the low pressure concrete rising main.

The rising main can be selected under the following modes of operation

1. Local
2. Remote – Manual
3. Remote – Auto (**FUTURE**)

Control Modes

Local

The valves can also be controlled locally via hard wiring (independent of the PLC). While in local control, it is the responsibility of the on site technician to ensure the correct rising main is in operation.

Remote – Manual

Under remote-manual mode the valves are controlled by the control room operator via the IDTS master station. The selection of the valve position is done via a selection popup screen in which the operator can choose to select either the DN1370 or the DN1840. The PLC will then operate the valves in the sequence outlined in the following section.

Remote – Auto (**FUTURE**)

The mode which is selected is governed by which rising main(s) is being used by Eagle Farm. The following table details the active mode depending on the status of the two Eagle Farm pumping stations.

The default mode is mode 1 – DN1370. This has SP300 discharging into the high pressure rising main. This is the safest mode as there are no pressure restriction. Eagle Farm pumping station will communicate, via peer to peer communication over the Trio radio network, the status of both of the Eagle Farm pump stations. If the peer to peer communications fail, then SP300 will revert back to remote-manual mode.

Sequencing

The valves can change position while the pumps are off or while they are running. As the wet well has a very small volume compared with the flow rates, there is minimal retention time in the system while the pumps are off. The most likely change over will therefore occur while the pumps are running. At no stage should both valves be open, as this could lead to the high pressure steel main over pressurising the low pressure concrete main. The change over sequence will be as follows.

Mode 1 → Mode 2

1. Starting conditions are valve 1 open, valve 2 closed, 0 to 2 pumps running at up to 52 Hz.
2. Limit the station to only 1 pump.
3. Clamp the speed of the pump to minimum speed (25 Hz).
4. Close Valve 1.
5. When valve 1 is closed, open valve 2.
6. When valve 2 is open, unclamp the speed of the pump (to a maximum of 33Hz)

Mode 2 → Mode 1

1. Starting conditions are valve 1 closed, valve 2 open, 0 or 1 pump running at up to 33 Hz.
2. Clamp the speed of the pump to minimum speed (25 Hz).
3. Close valve 2.
4. When valve 2 is closed, open valve 1.
5. When valve 1 is open, unclamp the speed of the pump and allow 2 pumps to run (if needed).

Failure States

There are three failure modes that will prevent a successful mode change. These failure modes and their respective recovery procedures are as follows.

Failure Mode	Recovery Process for Failed Valve	Recovery Process for Other (Healthy) Valve
Fail to Close	Command to Open. Can not close until failed to close alarm has been reset.	Stays closed
Fail to Open	Command to Close. Can not open until failed to open alarm has been reset.	Once failed valve has re-closed, then healthy valve is commanded to open.
Failed in Transit (Both Failed to Open and Failed to Close are active)	Stays in current (failed position) until faults have been reset.	The healthy valve will stay in its current position.

3.2.2 Pump Controls

The pump control will be based upon the standard pump control philosophy outlined in the standard specification. This included the wet well to flow to speed cascaded P.I.D. which will be tuned maintain the wet well level yet still provide control over the flow rate. The following sections highlight the specific differences between this site and standard functionality.

Number of Pumps

SP300 is designed to normally operate with the DN1370 steel rising main. In this mode, the station acts as per the functionality outlined in the standard Functional Specification. The duty block is modified to only consider 2 pumps (the standard has 3 pumps).

Interlocking and Speed Limiting

As mentioned in the Valve Control section, if the station is operating with the DN1840 concrete rising main, the station will become interlocked, allowing only one pump to operate at any given time. This interlock is both in the hard wiring as well as in the PLC code. Not only is the station interlocked, the variable speed drives are limited to run at a much lower speed (33Hz). All these limitations are imposed to ensure that the low pressure rising main operates acceptable pressures. These limitations are in effect during both local and remote control modes.

3.2.3 Emergency Storage

Instead of the standard overflow structure, this site will 'overflow' into an emergency storage facility (abandoned eagle farm rising main). This inclusion of this extra storage will significantly increase the time to overflow, in the case of complete station failure.

The system was modelled at ultimate PWWF with a total inflow to Serpentine Rd of 252 l/s. Time to full storage has been calculated to be:

With the rising main shut at Eagle Farm	5 hrs 13 minutes.
With a 100mm Scour Valve (46 l/s)	5 hrs 31 minutes.
With a 150mm Scour Valve (97 l/s)	5 hrs 59 minutes.
With a 225mm Scour Valve (187 l/s)	7 hrs 42 minutes.

The Maximum hydraulic gradient line (HGL) in Serpentine Rd pump station wet well is 2.45 mAHD.

NOTE: Once this level is reached if the inflow is not diverted, higher HGL's will occur in the wet well resulting in an overflow.

The emergency storage will be connected to the wet well at 0.910 mAHD. This is 1.22 meters below the original overflow structure that has been constructed.

Modelling of the emergency storage has been performed and it was found that the maximum hydraulic gradient of the emergency storage when it is draining into Eagle Farm pumping station SP010) is **higher** (2.45 mAHD) than the overflow structure (2.13 mAHD) that has been constructed. To avoid unnecessary overflow into the environment (Boggy Creek) the existing overflow structure will be 'sealed'.

NOTE: In the unlikely event that the wet well reaches the sealed overflow structure (because the emergency storage is either shut at the Eagle Farm pump station or is blocked) then the level will rise past the sealed overflow structure. The site will then overflow through the wet well lids, over the site and then into the Boggy Creek. The resultant overflow will be uncontrolled. (As opposed to a controlled overflow through the overflow structure.)

To incorporate this emergency storage into the control philosophy the following changes were made to the standard alarms and controls.

- The surcharge imminent electrode will be utilised as the emergency storage imminent electrode, the surcharge imminent alarm will now be only raised by the wet well level sensor (instead of a level sensor AND an electrode).
- The surcharge occurring alarm will be set at the height of the wet well lids instead of the overflow structure (now sealed) as this is the level at which the sewerage will overflow into the environment.
- The 'new' emergency storage imminent probe will be used to active the emergency sewerage imminent alarm (identical functionality to the surcharge imminent alarm detailed in the standard functional specification (Ref1)).
- Instead of the surcharge pumping mode, the site will have a emergency storage pumping mode (identical to the surcharge pumping mode detailed in the standard functional specification (Ref1)).

3.2.4 Peer to Peer Comms

To SP298 Lytton Rd #4 - Systemic Control

The majority of the inflow to Serpentine Rd comes from Lytton Rd #4. Lytton Rd #4 has the capability to divert all inflow coming to it, from SP049 Kianawah Rd and SP085 Prichard St, to Gibson Island.

Systemic control from SP300 Serpentine Rd to SP298 Lytton Rd #4 will automatically, via peer to peer communications over the Trio radio network, 'inhibit' all pumps at Lytton Rd #4 if any of the following occurs.

- Emergency Storage Imminent
- Both pump unavailable (for any reason including power outage)

In this mode, Lytton Rd will divert all inflow (from Prichard and Kianawah) to Gibson Island, instead of pumping it to Serpentine Rd. According to figures provided by Brisbane Water Projects Branch, this will alleviate up to 90% of the flow to Serpentine Rd.

In addition to the Emergency storage imminent (or pumps available) alarm the IDTS master stations will also receive the Pump inhibited alarms for both pumps at Lytton Rd #4. Once the Lytton Rd has been inhibited, it will stay inhibited until the operator manually 'uninhibited' at least one pump at Lytton Rd. The operator will NOT be able to uninhibited the pumps while the conditions at Serpentine Rd that caused the automatic inhibit are still active.

Systemic control can be deactivated by the control room operators via a control button on the IDTS details page for SP300 Serpentine Rd.

An addition alarm will be configured to monitor the status of the communication link between the two RTU's. No systemic control will be possible if the communication link has failed. The control room operator will still be able to manually inhibit both pumps at Lytton Rd #4 at any stage (assuming communications to Lytton Rd #4 are healthy).

From SP010 Eagle Farm ((FUTURE))

To achieve remote-auto mode for the valve control, this site will have to communicate to the Eagle Farm pumping station, to receive the operational status of both the EFPS#1 and EFPS#2. To achieve this, a Logica MD3311 RTU has to be installed at Eagle Farm pumping station to communicate directly via the Trio radio network.

3.3 Non Standard Monitoring and Alarms

3.3.1 Additional Valve Monitoring and Alarms

The following alarms and events are associated with both valves

Plant	Quantity	Priority
Valve	Available	1
Valve	Available_remote	0
Valve	Open	0
Valve	Closed	0
Valve	Fail_open_alarm	1
Valve	Fail_close_alarm	1
Valve_station	Auto_manual	Control
Valve_station	Auto_manual_Fbk	0
Sewage_pumping_station	Mode_control	Control
Sewage_pumping_station	Mode_selected	0

Available

The valve is considered available only when all of the following conditions are present:

- Available for Remote
- Not “Failed to Open”
- Not “Failed to Close”

Available for Remote

The digital input status for “valve available for remote” is transferred directly to the IDTS master station.

Open

The digital input status for “valve open” is transferred directly to the IDTS master station. This is used to animate the valve status on the main IDTS page.

Closed

The digital input status for “valve closed” is transferred directly to the IDTS master station. This is used to animate the valve status on the main IDTS page.

Fail to Open

If the valve is commanded to open and does not reach the open limit within the pre determined time period (set at two times the normal travel time) then the failed to open alarm will be activated. The valve will then revert back to the last healthy position (ie pen). This alarm can be reset locally by pressing either of the pump (1 & 2) reset push buttons or remotely by the IDTS master station.

Fail to Close

If the valve is commanded to close and does not reach the close limit within the pre determined time period (set at two times the normal travel time) then the failed to close alarm will be activated. The valve will then revert back to the last healthy position (ie closed). This alarm can be reset locally by pressing either of the pump (1 & 2) reset push buttons or remotely by the IDTS master station.

Valve Station Auto / Manual Control and Feedback

When the sewage pumping station is in remote mode, the valve station (both valve 1 and 2) can be selected to be in either manual or auto mode. The current mode selected is returned back to the IDTS master station via the feedback variable.

Sewage Pumping Station Mode Control / Selected

If the valve station is selected to be in auto mode, then the control room operator is able to select which rising main is to be operational via the 'mode control' control variable. The current mode selection will be returned back to the IDTS master station via the feedback variable.

3.3.2 Additional Wet Well Monitoring and Alarms

Plant	Quantity	Priority
Sewage_pumping_station	Emergency_storage	1
Sewage_pumping_station	Emergency_storage_imminent	1

Emergency Storage Imminent Alarm

The emergency storage imminent alarm is a final warning to the control room operator that the site is at immediate risk of overflowing into the emergency storage. This serves as a reminder to the control room operator in implementing the contingency plans.

As the emergency storage imminent electrode triggers this alarm, it also provides a redundancy to the wet well high alarm that the Vega probe should activate. The emergency storage imminent alarm is the first alarm that the control room operator receives if the wet well level Vega probe is not functioning correctly.

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

As a backup, a valid wet well level signal exceeding the emergency storage imminent level by 100mm, for 10 seconds, will also trigger the emergency storage imminent alarm while the station is in remote mode. This 100mm is ignored during power outages. The emergency storage imminent electrode is 24VDC and is backed up by the battery system.

Emergency Storage Active Alarm

This alarm is the final alarm that the control room operator will receive as the wet well level rises to the emergency storage level.

When the wet well level is greater than or equal to the surcharge level 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.

3.3.3 Systemic Control

Plant	Quantity	Priority
Sewerage_pumping_station	Systemic_control_enable	Control
Sewerage_pumping_station	Systemic_control_enable_Fbk	0
Sewerage_pumping_station	Systemic_control	0

Systemic Control Enable and Feedback

This control point will enable and disable the systemic control of SP298 Lytton Rd #4. The feedback point will be configured to display the current status of the control point.

Systemic Control Active

This event will be configured to indicate to the control room operator whether the systemic control has been activated. The same point will also be configured on the SP298 Lytton Rd #4 site indicate whether that site has currently received a request from SP300 to activate the systemic control (inhibit both of its pumps). This will be displayed on the SP298 Lytton Rd #4 details page to indicate the inhibit function has been activated by SP300 Serpentine Rd (rather than by an operator).

3.3.4 Additional RTU Monitoring and Alarms

Plant	Quantity	Priority
Remote_rtu	Comms_fault	1

Remote RTU Comms Fault

The station will monitor the peer communications to all the RTU's that it is configured to communicate with. The alarm will activate if the site has not received a peer communication within the specified time period (site specific peer timeout value set in the initial block).

3.4 Non Standard IDTS Picture

3.4.1 Additional Valves

The two valves will be displayed and will be animated to indicate open, closed and faulted conditions. Double clicking on the valve will bring up the valve control page, on which the following operator controls will be available:

- Individual valve remote resets
- Mode selection (manual/auto)
- Rising Main selection (DN1370 / DN1840)

3.4.2 Additional Pipe Animation

The two rising main pipes (which are connected to the DN1370 and the DN1840) will be animated to show a “filled” condition if their respective valve is open.

3.4.3 Systemic Control

To allow the control room operator to enable and disable the systemic control of SP298 Lytton Rd #4, a control pushbutton will be displayed on a popup screen which can be opened from the SP300 Serpentine Rd details page.

The current status of the systemic control will be displayed next to the control button in the form of a text field with ‘On’ or ‘Off’

3.4.4 Emergency Storage

The emergency storage pipe will be displayed and will have the hydraulic gradient level marked to indicate the level at which the sewerage will start to flow into Eagle Farm.

4 REFERENCES

TITLE	SPSV3 Sewage Pumping Station Submersible 3 Pumps With VFD – Functional Specification
DOCUMENT ID	003589
VERSION	0.30
AUTHOR	Alex Witthoft , Brisbane Water – Network Control Systems
DOCUMENT OWNER	Peter Sherriff, Brisbane Water – Network Control Systems

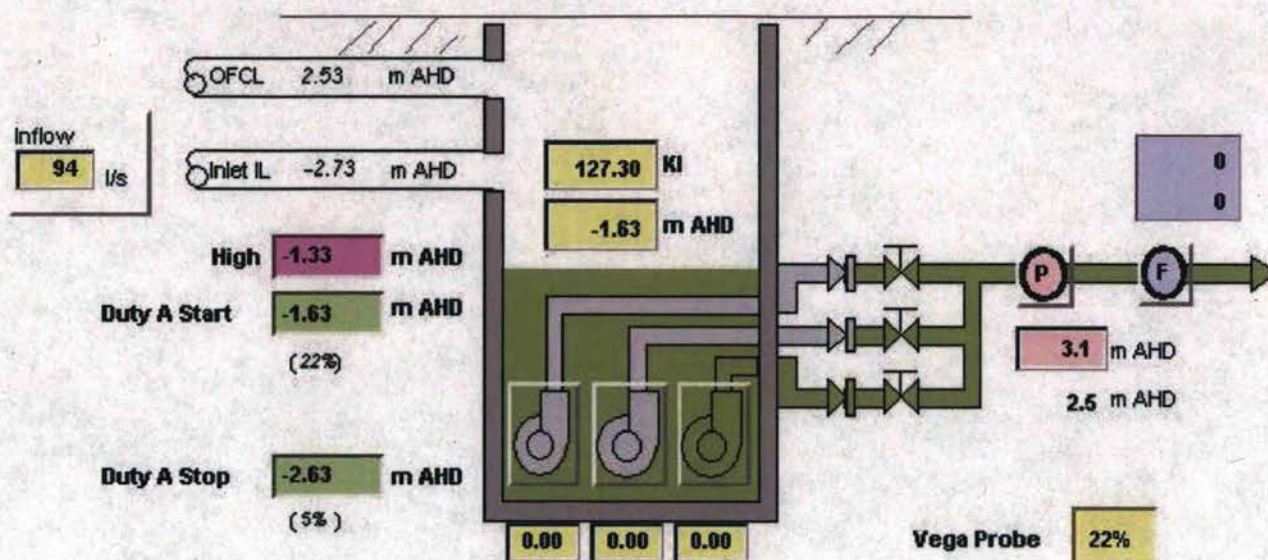
2

TITLE	SP300 Functional Specification
DOCUMENT ID	N/A
VERSION	REVISION 3
AUTHOR	M. BRAND
DOCUMENT OWNER	Leighton Contractors Pty Ltd

3

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

SPSV3 SEWAGE PUMPING STATION SUBMERSIBLE 3 PUMPS WITH VARIABLE FREQUENCY DRIVES



FUNCTIONAL SPECIFICATION

BW NET M&E 04/04
Network Branch

Project Owner:
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Document Signoff

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Revision Control

Revision Number	Date	Amendment Details	Responsible Officer
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Version 0.13	17/09/2004	Comments included from Malcolm Barrett	Alex Witthoft
Version 0.15	29/09/2004	Comments included from George Henry	Alex Witthoft
Version 0.30	26/10/2004	Final draft issued for comments	Alex Witthoft

Document Consultation

Please review the attached document and add your comments where necessary. To ensure that the process is kept within reasonable timeframes, it would be appreciated if you could return this document by the **Requested Return Date** listed below.

Project Sponsor: George Theo

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0.13	George Henry	Cullen Ave	17/09/2004	24/09/2004	24/09/2004	Y	Y
0.15	Paul Daley	Cullen Ave	01/10/2004	22/10/2004	-	N	N
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Version 0.15 superseded – Paul Daley and Alan Mooney issued with later version for review.							
0.30	Paul Daley	Cullen Ave	05/11/2004	12/11/2004			
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0.30	John Titmarsh	Cullen Ave	05/11/2004	12/11/2004			
0.30	Peter Sherriff	Cullen Ave	05/11/2004	12/11/2004			
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Table of Contents

1	EXECUTIVE SUMMARY	6
2	CONTROL PHILOSOPHY.....	8
2.1	OVERVIEW	8
2.1.1	Normal Operation (Remote Mode).....	8
2.1.2	Surcharge Pumping Mode	10
2.1.3	All Pumps Inhibited / Blocked Mode and Individual Pump Inhibit / Blocked.....	10
2.2	STATION INSTRUMENTATION	12
2.2.1	IO Allocation between RTU and PLC.....	12
2.2.2	Modbus Communications	13
2.3	REMOTE MODE	15
2.3.1	Pump Duty Selection	15
2.3.2	Pump Lockout	15
2.3.3	Pump Start Delay.....	16
2.4	LOCAL MODE.....	16
2.5	STATION FAULT CONDITIONS.....	16
2.5.1	Wet Well Level Invalid.....	16
2.5.2	Site Power.....	17
2.5.3	Pump Availability.....	17
3	SITE SPECIFIC VALUES.....	18
3.1	SITE SPECIFIC CONSTANTS DEFINED IN PLC	18
3.2	SITE SPECIFIC CONSTANTS DEFINED IN RTU.....	18
3.3	SITE SPECIFIC VARIABLES DEFINED IN RTU.....	19
4	ALARMS AND EVENTS	20
4.1	INTRODUCTION	20
4.2	ALARM AND EVENT DEFINITIONS.....	20
4.2.1	Alarms	20
4.2.2	Events	21
4.3	ALARM INSTRUCTIONS.....	21
4.4	ALARM SUPPRESSION	22
4.4.1	Local Mode	22
4.4.2	Station Mains Fail.....	22
4.4.3	All Pumps Inhibited.....	22
4.4.4	Wet Well Invalid.....	22
4.4.5	Signal Invalid Alarm	22
	Alarm Suppression Tree.....	22
4.5	ALARM AND EVENT LISTING.....	23
4.6	ALARM AND EVENT DESCRIPTION.....	24
4.6.1	Attention	24
4.6.2	Flow meter.....	24
4.6.3	Pressure Gauge.....	25
4.6.4	Security.....	25
4.6.5	Switchboard Power Monitoring.....	26
4.6.6	Station Mode.....	27
4.6.7	Sewer Pump	28
4.6.8	Wet Well	30
4.6.9	RTU and PLC.....	32
5	CALCULATIONS.....	33
5.1	CALCULATED VALUES.....	33
5.2	FEEDBACK VALUES.....	34
5.3	ANALOG SIGNAL PROCESSING	35
5.3.1	Analog Clamping	35
5.3.2	Analog Filtering.....	35
5.3.3	Analog Conversion to Engineering Unit.....	35
5.4	DELIVERY FLOW RATE KL/DAY.....	35
5.5	DELIVERY FLOW - VOLUME PUMPED (KL).....	35
5.6	DELIVERY PRESSURE MAHD.....	36
5.7	PUMP HRS RUN / DAY.....	36
5.8	PUMP STARTS / DAY	36

5.9	PUMP KL / DAY	36
5.10	PUMP KW HRS / DAY	37
5.11	WET WELL LEVEL MAHD	37
5.12	WET WELL VOLUME	38
5.13	STATION SURCHARGE DURATION	39
5.14	STATION TIME TO SURCHARGE (UNDER DEVELOPMENT)	39
5.15	STATION INFLOW (UNDER DEVELOPMENT)	40
5.15.1	Method A – Time between Start and Stop	40
5.15.2	Method B – Array method	40
5.15.3	Combining Method A and Method B results	40
5.15.4	Total Inflow	40
6	IDTS SCADA CONFIGURATION	41
6.1	IDTS POINTS DATABASE	41
6.2	IDTS SIGNIFICANT POINTS	41
6.3	IDTS HISTORY DATABASE	41
6.4	IDTS SITE RTU DATABASE	41
6.5	IDTS ALARM INSTRUCTIONS	42
6.6	IDTS PICTURES	43
6.6.1	Main Site Detail Screen	43
6.6.2	Popup Controls Screens	44
	APPENDIX A: STANDARD PHYSICAL I/O LIST	45
	APPENDIX B: SPXXX.MAIN FILE	56
	APPENDIX C: DRAWING LIST	57

Table of Figures

Figure 1:	Wet Well Level Set Points	7
Figure 2:	Typical Diurnal Flow Pattern	7
Figure 3 :	Cascade Level-Flow Pid Loop Control	9
Figure 4:	Wet Well Level Pid Loop Control	9
Figure 5:	Modbus RS485 Network Diagram	13
Figure 6	Radio Communication Channel	20
Figure 7:	Alarm Suppression Tree	22
Figure 8:	Example of Switchboard Power Monitoring Diagram	26
Figure 9:	Level vs Volume Chart (SAMPLE)	38
Figure 10:	Wet well diagram	39
Figure 11:	Site Detail Screen	43
Figure 12:	Pump Control Popup	44
Figure 13:	Set Point Control Popup	44
Figure 14:	Control Point Page	44

Table of Tables

Table 1:	Station Instrumentation	12
Table 2:	Modbus Digital Signals to the RTU	13
Table 3:	Modbus Digital Controls to the PLC	14
Table 4:	Modbus Integer Signals to the RTU	14
Table 5:	Priority 1 Alarms	23
Table 6:	Priority 2 Alarms	23
Table 7:	Priority 3 Alarms	23
Table 8:	Events (Priority 0 Alarms)	23
Table 9:	Level vs Volume Lookup Table (SAMPLE)	38

Definitions

IDTS	Integrated Departmental Telemetry System
RTU	Remote Telemetry Unit
SCADA	Supervisory Control And Data Acquisition
MAHD	Metres above Australia Height Datum
TWL	Top Water Level
BWL	Bottom Water Level
PID	Proportional, Integral and Derivative

1 EXECUTIVE SUMMARY

This document outlines the functional requirements for the control, monitoring, and telemetry of a standard three-pump submersible sewerage pump station with variable frequency drive (VFD), controlled by a GE-Fanuc 90-30 PLC which communicates to the IDTS master station via a Logica CMG MD3311 Remote Telemetry Unit (RTU).

The boundary of this functional specification is to form the basis for the PLC and RTU code development. The Summary of IDTS SCADA configuration and control room operator actions are provided for completeness only.

This type of station is equipped with variable frequency drives to reduce odour emission (caused by the 'bellows effect' of a continually rising and falling wet well). The variable frequency drives also enable the smoothing of the fluctuation in delivery flow to the down stream sewer network. This is particularly important for waste water treatment plants which operate more effectively under constant flow conditions.

The station is designed, and is normally selected, to run autonomously under the control of the GE-Fanuc PLC based on the value of the wet well level. This 'remote' mode starts the duty pump when the wet well level reaches the start duty A level (refer to *Figure 1: Wet Well Level Set Points*) and continues to run the pump while the wet well level is above the stop duty A level. A second pump will operate if the wet well rises to the start duty B level (when the inflow into the station is above the flow capacity of one pump). The station will be interlocked (within the code) so that only two pumps can operate at any one time.

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 2: 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.

To provide redundancy for the Vega probe (which measures the wet well level) a surcharge imminent electrode is installed. This electrode not only provides redundancy in the alarming of abnormally high wet well levels, it also serves as a backup signal to start the pumps, ensuring that the station does not surcharge due to a fault in the Vega probe. If the pumps are started using this electrode, the station is said to be in 'surcharge pumping' mode. This mode will start two pumps and command them to run at maximum speed.

The station is also designed, and may be selected, to operate under local control. The primary use of local control is for testing the system during maintenance. The speed of the pumps in local mode is also locally controlled via a dial on the switchboard.

In an emergency situation, if the PLC has failed, a qualified technician is able to start any individual pump via VFD by activating the VFD keypad (changing the VFD from auto to manual (keypad) control). In manual mode, however, the VFD can **not** be controlled by the PLC.

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

The RTU will report by exception (eg alarm) to the IDTS master station if an event occurs outside its normal operating parameters. The control room operator, via the IDTS master station, can modify certain PLC/RTU operating parameters to respond to an abnormal situation, but can not override the PLC/RTU logic.

The program written for the PLC has significant 'intelligence' to be able to cope with any abnormal events and continue to operate the station in a safe manner. The functional specification also describes the control strategies for the majority of failure scenarios, for which the intervention by the control room operator is not relied upon.

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

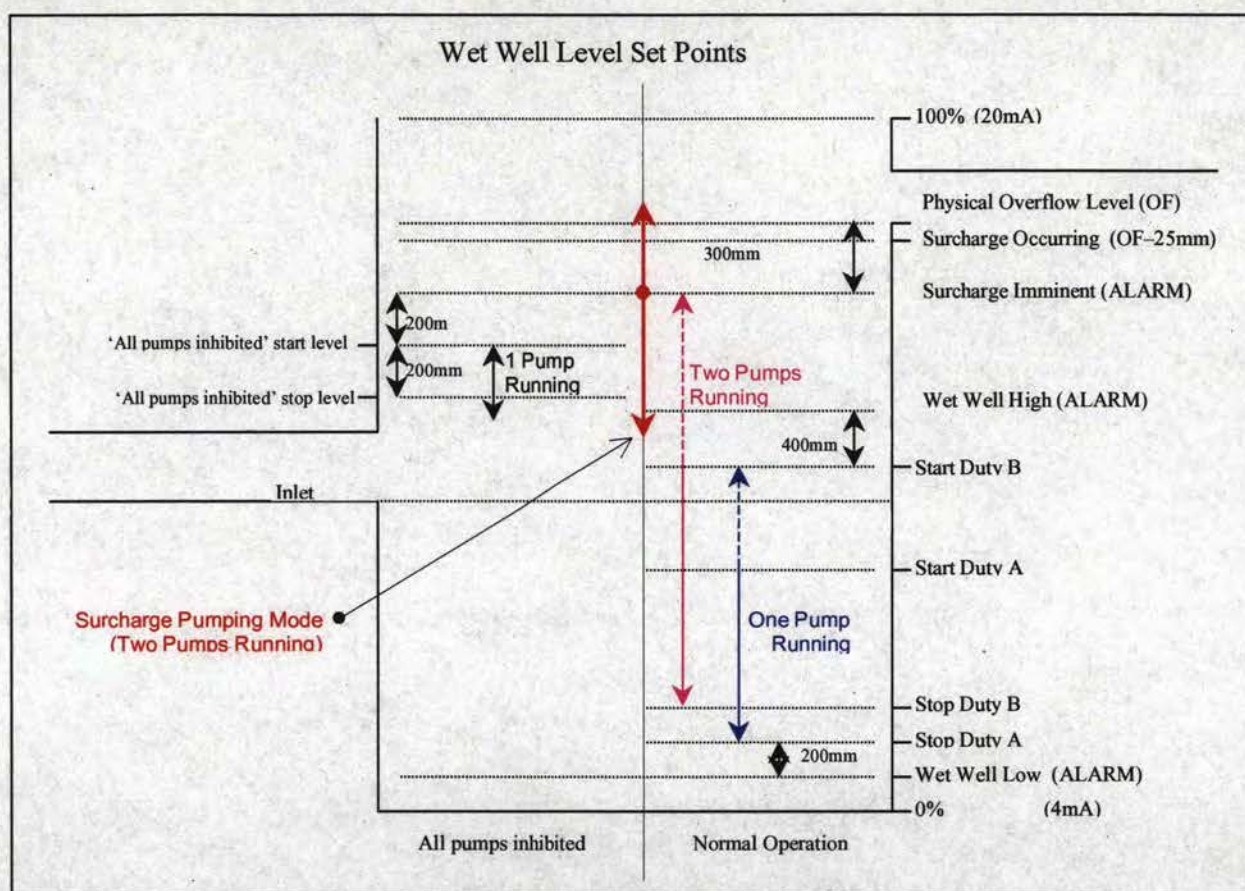


Figure 1: Wet Well Level Set Points

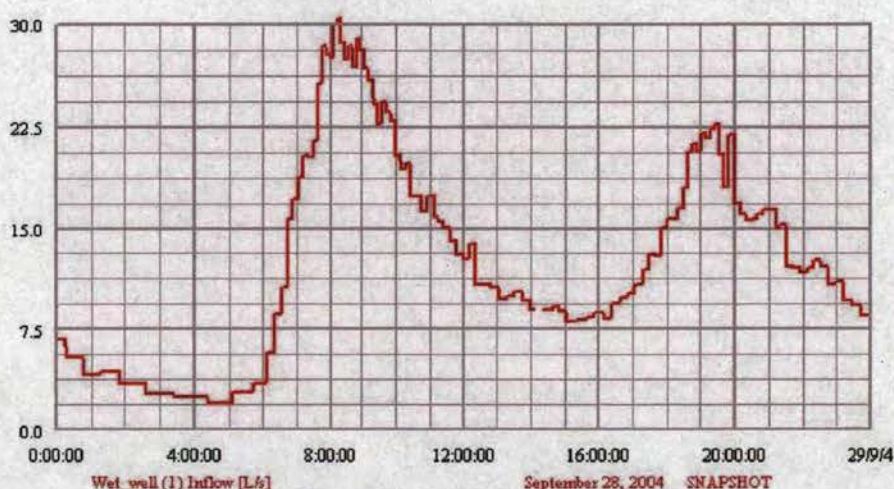


Figure 2: Typical Diurnal Flow Pattern

2 CONTROL PHILOSOPHY

2.1 Overview

The following section outlines the operating philosophy of a standard three-pump submersible sewerage pump station with variable frequency drives. The size of the sewer pumps shall be selected so that one pump will be adequate for normal dry weather flow. Two (only) pumps are allowed to run simultaneously to cope with higher flows during wet weather conditions.

The station can be selected to be in one of the following three modes

- Remote Mode (Normal Operating Mode)
- Local Mode
- Emergency Mode (VFD Keypad control)

All mode selection is done on site by the on site technician via the local/remote selector switch. Both local and remote control are controlled by the GE-Fanuc 90-30 PLC, independently from the MD3311 RTU. The RTU is only required for the monitoring of the station by the IDTS master station.

The station is designed, and is normally selected, to run autonomously under the control of the GE-Fanuc PLC based on the value of the wet well level. The station is also designed, and may be selected to run under local control. Local mode is designed for an on site technician to manually control the pumps. Its primary use is for testing the system during maintenance.

In the event of a complete RTU failure, the PLC will continue to operate in the mode that it is selected. The IDTS master station will alert the control room operator of a communications fault.

In the event of a PLC failure, the RTU will immediately alarm a PLC fault at the IDTS master station and each pump can be individually run via the VFD keypad when a technician arrives on site, completely independent of the PLC. Keypad control is initiated via each pumps individual VFD control keypad.

2.1.1 Normal Operation (Remote Mode)

Under normal operation (in remote mode) the station is controlled using 'dutyA pump stop level' and 'dutyA pump start 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 second pump will run at the same speed as the dutyA pump - as calculated by the control algorithm. 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 1: Wet Well Level Set Points* for a graphical representation of the various wet well level set points).

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.

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.

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 VFD 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 VFD 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.

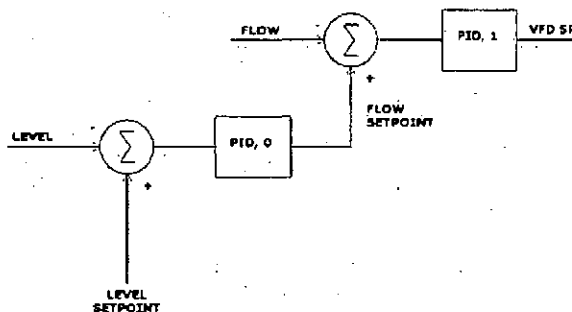


Figure 3 :Cascade Level-Flow Pid Loop Control

'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.

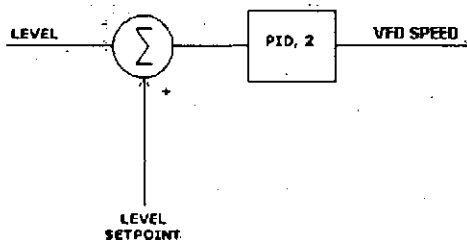


Figure 4: Wet Well Level Pid Loop Control

The value of the VFD 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 frequency 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 VFD is at minimum speed.

2.1.2 Surge Pumping Mode

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 (Refer to 2.5.1 *Wet Well Level Invalid*). 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 'dutyB pump start level' (TWL)
Surcharge Imminent	300mm below actual surcharge level
Surcharge Occurring	25mm below actual surcharge level

When the level reaches the surcharge imminent level (as per the physical surcharge imminent electrode or according to the wet well Vega probe) the station will initiate the surcharge pumping mode. In surcharge pumping mode two available pumps will be commanded to run at maximum speed. The speed analog output will be clamped at maximum speed and as a backup, the 'run at maximum' digital output will also be activated. For environmental reasons, surcharge pumping mode has priority and all pump inhibits and wet well level duty stop set points are ignored.

There are three main reasons that a station will fill to the surcharge imminent level.

1. The Vega probe measuring the wet well level is invalid (pumps will not start if the level is not valid)
2. The Vega probe measuring the wet well level is 'frozen' at a valid level but below the start level.
3. The inflow to the station is higher than the pumping capacity of the available pumps running.

The surcharge pumping mode is active while the wet well level is at or above the surcharge imminent level and for a site specific minimum of time after the level falls below the surcharge imminent condition. Once surcharge pumping mode is deactivated the station will revert to its previous mode of operation (normal operation or all pumps inhibited mode).

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.

2.1.3 All Pumps Inhibited / Blocked Mode and Individual Pump Inhibit / Blocked

The control room operator can inhibit one or more of the station's pumps. If a single pump is inhibited, then that pump is considered inhibited from operating under normal operating conditions. If all pumps are inhibited, then the whole station is considered inhibited and in 'all pumps inhibited mode'

NOTE: If a pump blockage alarm is active for a specific pump then this will have the same effect as if the control room operator has inhibited the pump.

Single Pump Inhibit (Blocked) Mode

A single or pair of pumps can be inhibited if they are not operating efficiently (eg partially or fully blocked). This will remove them from the duty cycle allowing the more efficient pump(s) to permanently operate as the duty pump until the inhibit is removed. This will allow the station to run normally until the inefficient pump(s) can be unblocked or repaired.

If the uninhibited duty pump(s) 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, if less than two pumps are running, one of the inhibited pumps, if available, will automatically be commanded to run to ensure two pumps are running under surcharge pumping mode. They effectively ignore the inhibit placed upon it by the control room operator. After the surcharge pumping cycle is completed, the pump(s) will remain "inhibited" and are only uninhibited by a command from the control room operator.

All Pumps Inhibited Mode

All pumps inhibited mode is 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. To activate 'all pumps inhibited' mode, all the pumps at a site have to be either inhibited individually by the control room operator or have their respective 'pump blockage' alarm active.

When the whole pumping station is in 'all pumps inhibited' mode, it is desirable to minimise the volume pumped. This is achieved by utilising the wet well storage capacity to a safe maximum level. Nominally the duty start level 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 1: Wet Well Level Set Points* for a graphical representation of these new start and stop levels.

NOTE: In the case where some of the pumps are inhibited and some have the pump blockage alarm active, the pumps which are inhibited are started in preference to the pumps that are blocked.

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 surcharge pumping mode instead of the 'all pumps inhibited' mode.

Surcharge pumping mode is designed to control the well level and will run the pumps for a longer minimum duration than 'all pumps inhibited' mode. Although this is contrary to the purpose of 'all pumps inhibited' mode, which is to minimise the flow to the down stream station, surcharge 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.

Once the surcharge pumping mode deactivates, the station will revert back to 'all pumps inhibited' mode. The station will remain in this mode until at least one pump is both uninhibited by the control room operator and is not blocked. As a feedback indicator for the control room operator, the sewer pump displayed on the IDTS master station has a yellow inner circle if it is inhibited. The pump blockage alarm is itself a priority 1 alarm and is not part of the pump availability condition.

The wet well high alarm will be suppressed when 'all pumps inhibited' mode is active as the well level, in 'all pumps inhibited' mode, is above the wet well high alarm set point.

NOTE: As the 'all pumps inhibited' mode is operating within 200mm of the surcharge imminent level set point, a calibration 'drift' in the wet well Vega probe can cause the station to trigger a surcharge imminent alarm during dry weather conditions. This will trigger a 'wet well calibration fault' alarm to the control room operator, instructing him to schedule a calibration of the Vega probe.

2.2 Station Instrumentation

The station has the following instrumentation connected to the MD3311 RTU or GE-Fanuc 90-30 PLC. All I/O must be connected as per the standard site physical I/O connections (Refer to *Appendix A: Standard Physical I/O List*). For a full equipment list refer to the standard drawing set. (Refer to *Appendix C: Drawing List*)

Table 1: Station Instrumentation

Station Energex 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 mains power relay	Status of 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)
Battery system	Status of the battery system
Surge diverter	Status of surge diverter
Site door switch status	Combined status of all switchboard door (All closed or not)
Wet Well Vega 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
Flow Meter	Delivery flow of the pump station in l/s
Wet Well Surge Imminent Electrode	Electrode to detect if wet well level has reached surge imminent level
Station Local Controls and Indication	Site attention reset push button Local/remote selector switch Site attention indication lamp Wet Well level % indicator gauge Battery Check relay
Pump Local Controls and Indication	Start push button Stop push button Emergency stop push button Pump status indication lamp
Pump Variable Frequency Drives (Danfoss)	VFD control and display panel Running Feedback Fault Feedback Run Command Reset Command Local Speed Command (4-20 from Potentiometer) Remote Speed Command (4-20mA from PLC) Speed Feedback (4-20mA to PLC) Modbus link to RTU for pump power and current Moisture in Oil (Optional)

2.2.1 IO Allocation between RTU and PLC

The IO is split into the MD3311 RTU and GE-Fanuc PLC, determined by whether or not the I.O. is required for the control of the pumps.

Signals which are required for monitoring only, or controls not associated with the control of the pumps (ie generator I.O.) are wired directly into the MD3311 RTU. All I.O., which are wired into the MD3311 RTU, are backed up by the battery system and will continue to function even during power outages.

All pump I.O. required for pump control are wired into the GE-Fanuc PLC. All monitoring and controls are communicated via the Modbus link to the MD3311 RTU and then to the IDTS master station. The I.O. wired to the GE-Fanuc PLC are not backed up by the battery system and will fail during power outages. This is not detrimental to the operation of the station as the pumps can not run without 415VAC.

Even though wet well level analog signal is required for the control of the pumps, it is also critical during power outage. Therefore it is wired, in series, to both the RTU and the PLC.

2.2.2 Modbus Communications

The Modbus communications will be configured as over a RS485 link as per the diagram below.

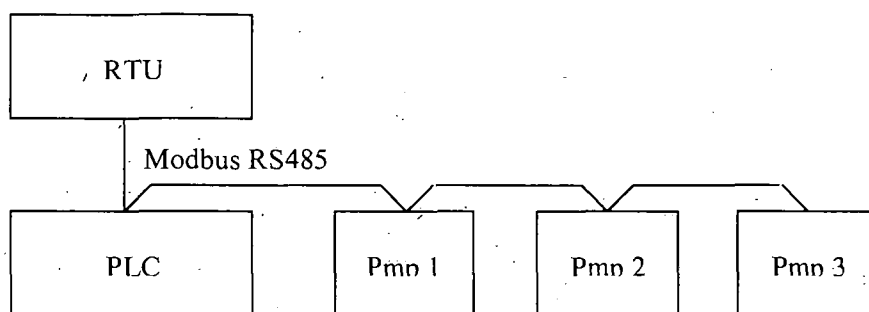


Figure 5: Modbus RS485 Network Diagram

For a full description on how to configure this network, refer to the following range of technical documents found on the Brisbane Water Infonet.

Branch	Section	Document Type	ID	Title
Newtorks	Water &Sewerage Operations	Technical Manual Or Specification	003590	Modbus Md3311 To Ge 90-30
Newtorks	Water &Sewerage Operations	Technical Manual Or Specification	003591	Modbus Ge 90-30 To Danfoss
Newtorks	Water &Sewerage Operations	Technical Manual Or Specification	003592	Modbus Md3311 To Ematron.Doc

The IO that is calculated in the PLC and then transferred from the PLC to the RTU is listed in the tables below.

The Modbus communication fault is determined by a watchdog counter which is passed back and fourth from the RTU and the PLC and incremented on each pass in the PLC. If the RTU does not register an increment in any given 30 second time period, then a communication fault alarm is activated.

Table 2: Modbus Digital Signals to the RTU

GE-Fanuc Tag Name	Description
Pmp[x]dsMainsPower	Pump No.[x] Mains Power IDTS Indication
Pmp[x]dsAvalableIDTS	Pump No.[x] Available IDTS
Pmp[x]dsRunning	Pump No.[x] Running
Pmp[x]dsInhibit	Pump No.[x] Inhibited
Pmp[x]dsEStop	Pump No.[x] Emergency Stop Fault
Pmp[x]dsFault	Pump No.[x] Fault
Pmp[x]dsVFDFlt	Pump No.[x] VFD Fault
Pmp[x]dsVFDAuto	Pump No.[x] VFD Auto
Pmp[x]dsMIO	Pump No.[x] Moisture in Oil
Pmp[x]dsBlockAlm	Pump No.[x] Blockage Alarm
Pmp[x]dsVFDFltExceeded	Pump No.[x] VFD Fault Count Exceeded
Pmp[x]dsVFDFltAutoReset	Pump No.[x] VFD Fault Auto Reset
Pmp[x]dsSpeedInvalid	Pump No.[x] Speed Signal Invalid
Stn01dsSurchImm	Surcharge Imminent
Stn01dsRemote	Station Remote Selected
Wwl01dsInvalid	Wet Well Level Signal Invalid
Pre01dsInvalid	Delivery Pressure Signal Invalid
Flw01dsInvalid	Delivery Flow Signal Invalid
Plc01dsFirstScan	PLC 1 first scan

Table 3: Modbus Digital Controls to the PLC

GE-Fanuc Tag Name	Description
Pmp[x]dcStart	Pump No.[x] Remote Start Command
Pmp[x]dcStop	Pump No.[x] Remote Stop Command
Pmp[x]dcReset	Pump No.[x] Remote Reset
Pmp[x]dcInhibit	Pump No.[x] Remote Inhibit
PLC01dcinitReset	PLC 1 initiate reset

Table 4: Modbus Integer Signals to the RTU

GE-Fanuc Tag Name	Description
Wwl01txSurchImmLevelSP	Surcharge Imminent
Wwl01txDtyBStartLevelSP	Duty B Pump Start Level (mmAHD)
Wwl01txPIDLevelSP	PID Level Setpoint (mmAHD)
Wwl01txDtyAStartLevelSP	Duty A Pump Start Level (mmAHD)
Wwl01txDtyBStopLevelSP	Duty B Pump Stop Level (mmAHD)
Wwl01txDtyAStopLevelSP	Duty A Pump Stop Level (mmAHD)
Wwl01txEGU	Wet Well Level (mmAHD)
Wwl01txRange	Wet Well Level Range (mm)
Wwl01txZero	Wet Well Zero (mmAHD)
Pre01txEGU	Delivery Pressure (mmAHD)x10
Pre01txRange	Delivery Pressure Range (mm)
Pre01txZero	Delivery Pressure Zero (mmAHD)x10
Flw01txEGU	Delivery Flow (l/s) x 10
Flw01txRange	Delivery Flow Range (l/s) x 10
Pmp01txSpeedEGU	Pump 1 Speed (%) x 10
Pmp02txSpeedEGU	Pump 2 Speed (%) x 10
Pmp03txSpeedEGU	Pump 3 Speed (%) x 10

2.3 Remote Mode

Remote mode is the normal operating mode of the station. In this mode the PLC program 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 1: Wet Well Level Set Points*)

The control room operator can issue remote manual commands to the PLC, via the RTU, to control the station outside the normal set point parameters. 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 but below surcharge imminent level), then the "inhibit" can be used to stop a pump.
- **Start** Start a specific pump provided the wet well level is above the 'bottom water level' (duty A pump stop level). The 'start command' over rides the pump lockout which restricts the number of starts per hour under autonomous control.
- **Reset** Allows the operator to remotely reset any latched pump alarms provided the original fault condition has cleared.
- **Inhibit** Allows the operator 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 operator has 'inhibited' the station causing the station to run under 'all pumps inhibited' mode.

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

- **Attention Activate** By sending this control the operator activates a site attention indicator requesting the on site technician to contact the control room.
- **Abnormal Operation Reset** This command reset the abnormal operation alarm which is activated whenever the RTU or PLC has an 'abnormal operation' (ie the RTU or PLC resets by itself).
- **Alarm limit set points** The operator has the ability to modify the set points for the high and low alarms configured for various signals (eg. pressure, motor current and motor power and wet well).

The Control Room Operator can NOT:

- Switch the station 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.
- Control the speed of the pumps. The PLC automatically determines the speed of the pumps using the PID control algorithms

2.3.1 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 normal duty standby operation. If a pump is unavailable, inhibited, blocked or locked out then that pump will not be set as duty A or duty B. 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.

2.3.2 Pump Lockout

In remote mode, under normal operating conditions (the station is not in either surcharge 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 IDTS master station.

2.5.2 Site Power

The site requires 3 phase mains power (Energex) to operate the sewer pumps. The RTU requires DC power and is equipped with a backup battery supply that lasts for approximately 2 hours. These batteries also supply standby power to the communications device (eg Trio radio), the wet well level Vega probe and surcharge imminent electrode. The PLC is **NOT** backed up by the Battery as it requires 240VAC.

The control room operator is alerted of a site power outage. Any consequential alarms resulting from the power outage are suppressed as described in the section 4.4.6 Alarm Suppression Tree. The control room operator is able to monitor the wet well level and is alerted to a wet well high condition and eventually a surcharge imminent condition during the power outage (until the battery goes flat).

The station switchboard has a generator connection cubicle allowing a mobile generator to be connected under extended power outages. The generator is manually operated and can supply power via a generator circuit breaker which is mechanically interlocked with the mains circuit breaker. The pump station will operate normally (with at least one pump) while the site power is supplied from the generator. Depending on the capacity of the generator the station may have to be further interlocked to a limit of one pump.

NOTE: The on site technician is required to remain on site while the generator is connected and running, to ensure the safety of the public as the generator connection are temporary and are not secured.

An optional upgrade to a pump station is to have a semi-permanently connected generator which 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 IDTS alarms are configured in the RTU to provide full feedback on the status of the semi-permanent generator.

2.5.3 Pump Availability

All electrical fault and interlock 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 PLC 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.

- | | |
|-------------------------------------|---|
| • Site mains power fail | - Switchboard does not have 415V mains power supplied |
| • Pump well flooded trip | - The pump dry well has flooded above the trip level |
| • Pump mains power fail | - Pump does not have 240V control power supplied |
| • Pump fail | - Pump has failed to start |
| • Pump VFD not in Auto | - Pump is in Keypad control |
| • Pump VFD fault | - Pump VFD motor protection has activated |
| • Pump VFD fault Count Exceeded | - Three or more faults in the last 8 hours |
| • Pump emergency stop input faulted | - Push button has been pressed |
| • Pump emergency stop fault latched | - Emergency fault has not been reset |

The functional descriptions of these conditions are described under section 4.6 Alarm and Event Description

To ensure that there is redundancy in the number of pumps available, each pump station is designed to require only one pump to run under dry weather conditions. If one pump becomes unavailable, the another pump will become the duty pump 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 IDTS 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.

3 SITE SPECIFIC VALUES

Although each pump station is built according to a standard, there are variables which are site specific and must be programmed directly into the PLC code. This is achieved by an initialisation block in which all the site specific values are loaded with an initial value. The code for each site is identical except for this initialisation block. This initialisation block is divided into two distinct sections:

1. Site specific Constants
2. Site specific Variables

The site specific constants are internal parameters of the code and can be directly written to by a move command. The site specific variables are also adjustable by the control room operator, an operate block is used to 'load' a default value into these pseudo inputs. Most constant values are listed as 'site specific', but where a default value is commonly used its value is listed in the table below.

3.1 Site Specific Constants defined in PLC

Description	Type	Value	Units
Sewerage Pumping Station			
Minimum time between starts for each pump	Integer	300	Sec
Fail to start/stop timer	Integer	30	Sec
Minimum time 'all pumps inhibited' run is active.	Integer	120	Sec
Surcharge pumping duration ³	Integer	Site Spec	Sec
Delivery flow			
Delivery flow - Range	Real	Site Spec	l/s x 100
Delivery flow - Minimum flow	Real	Site Spec	l/s x 100
Delivery pressure			
Delivery pressure - Range	Real	Site Spec	mmAHD
Delivery pressure - Elevation of the transducer	Real	Site Spec	mmAHD
Pump Blockage			
Flow blocked limit for flow/level PID control (knee)	Integer	Site Spec	l/s x 100
VFD speed blocked limit for flow/level PID control (knee)	Integer	Site Spec	Hz x 100
VFD speed blocked limit for minimum flow PID control (min)	Integer	Site Spec	Hz x 100
Wet well level			
Wet well level range	Integer	Site Spec	mmAHD
Wet well surcharge occurring level	Integer	Site Spec	mmAHD
Wet well surcharge imminent level	Integer	Site Spec	mmAHD
Wet well inhibit mode start level	Integer	Site Spec	mmAHD
Wet well inhibit mode stop level	Integer	Site Spec	mmAHD
Wet well duty B pump start level	Integer	Site Spec	mmAHD
Wet well duty A pump start level	Integer	Site Spec	mmAHD
Wet well duty A pump stop level	Integer	Site Spec	mmAHD
Wet well duty B pump stop level	Integer	Site Spec	mmAHD
Wet well empty level (4mA of Probe)	Integer	Site Spec	mmAHD
Variable Frequency Drive			
Variable Frequency Drive - Minimum Speed	Integer	Site Spec	Hz x 100
Variable Frequency Drive - Maximum Speed	Integer	Site Spec	Hz x 100

3.2 Site Specific Constants defined in RTU

Tag Name	Description	Type	Value	Units
Sewerage Pumping Station				
atn1duration	Attention alarm duration	Integer	15	min
stn1calFltDelay	Delay wet well calibration fault on start up ¹	Integer	3600	sec
rtu1BattChkDur	Battery check test duration ²	Integer	600	sec
stel percent	Percentage value of analog alarm hysteresis	Real	1.0	%
Delivery flow				
flw1almInhibitTm	Delivery flow - Alarm inhibit timer	Integer	15	sec
Delivery pressure				
pre1almInhibitTm	Delivery pressure - Alarm inhibit timer	Integer	15	sec
Wet well level				
ww1surchLvlVol	Wet well volume at surcharge level	Real	Site Spec	kl
Pumps 1 - 3				
pmp[x]almInhPwrTm	Pump [x] - Motor power alarm inhibit timer.	Integer	15	sec
pmp[x]almInhCrntTm	Pump [x] - Motor current alarm inhibit timer.	Integer	15	sec
pmp[x]currRange	Pump [x] - Motor current range	Real	Site Spec	Amps

3.3 Site Specific Variables defined in RTU

Tag Name	Description	Type	Value	Units
Wet well level				
wwlhighLimit	Wet well level - High alarm set point	Integer	Site Spec.	mmAHD
wwllowLimit	Wet well level - Low alarm set point	Integer	Site Spec.	mmAHD
Delivery flow				
flwhighLimit	Delivery flow - High alarm set point	Integer	Site Spec.	ml/s
flwlowLimit	Delivery flow - Low alarm set point	Integer	Site Spec.	ml/s
Delivery pressure				
prehighLimit	Delivery pressure - High alarm set point	Integer	Site Spec.	mmAHD
prelowLimit	Delivery pressure - Low alarm set point	Integer	Site Spec.	mmAHD
Pumps 1 - 3				
pmp[x]currHiLimit	Pump [x] - Motor current high alarm set point ⁴	Integer	Site Spec.	mAmps
pmp[x]currLoLimit	Pump [x] - Motor current low alarm set point ⁵	Integer	Site Spec.	mAmps
pmp[x]powHiLimit	Pump [x] - Motor power high alarm set point	Integer	Site Spec.	Watts
pmp[x]powLoLimit	Pump [x] - Motor power low alarm set point	Integer	Site Spec.	Watts

Notes

1. Upon start-up a delay of 1 hour ensures that, if PLC/RTU initialises while the level is above the surcharge imminent level, the station has adequate time to pump the level back to within normal operating levels. This prevents invalid 'calibration fault' alarms from being triggered.
2. The battery test checks that the battery is able to provide backup power long enough (ten minutes) after a station mains fail to send the station mains fail alarm back to the IDTS master station.
3. The surcharge pumping duration is calculated as half the time taken to pump from surcharge imminent level to the dutyA stop level under normal dry weather conditions.
4. The current high alarm set point is configured to detect high current reading which is a symptom of a jammed pump.
5. The current low alarm set point is configured to detect a low current reading which is a symptom of an air locked, a worn pump or a blocked pump.

4 ALARMS AND EVENTS

4.1 Introduction

Acquisition of data from the site is performed by the IDTS master station regularly “polling” the RTU once every hour. When this poll occurs the current status of all digital and analog values are transmitted to the IDTS master station. Additionally, time stamped historical values for selected points may also be uploaded. (This information is used for trending purposes).

The regular polling routine is overridden by an “Alarm call” message generated by the RTU if a “significant” point changes state at the site. An “Alarm call” is a short message sent to the IDTS Master station requesting an immediate communication with the site. The master station then schedules a “poll”

1. Significant : Alarm call the master station on change of state or prescribed deviation
2. History : Time stamp events in the RTU at the prescribed frequency and deviation

The RTU communicates to the IDTS master station via a communication channel, typically the Trio radio network. To conserve the radio channel bandwidth the RTU only priority 1 alarms are set up to be significant points.

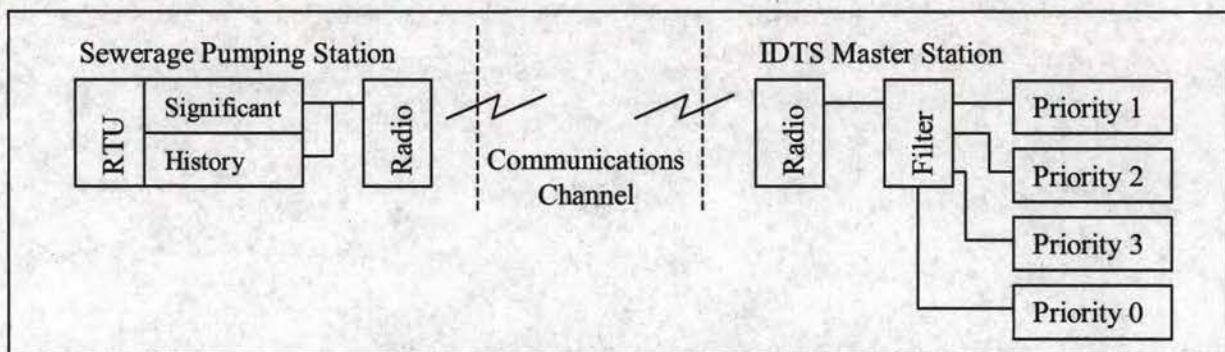


Figure 6 Radio Communication Channel

4.2 Alarm and Event Definitions

All Boolean signals sent back to the IDTS master station are given an alarm priority classification which will determine whether they are alarms or events. These priorities are as follows:

Priority 1	Alarm	Immediate action
Priority 2	Alarm	Action next calendar day
Priority 3	Alarm	Action next working day
Priority 0	Event	No Action required

4.2.1 Alarms

As the definition of a Priority 1 alarm is that immediate action is required. All Priority 1 alarms are classified as significant. Any change of state triggers an alarm call from the RTU to the IDTS master station requesting an immediately poll of the RTU. All other non-significant alarms/events which are configured for history are time stamped and placed in the RTU history to be uploaded when:

- the RTU is polled by the IDTS or
- the buffer becomes full or
- a priority 1 alarm occurs causing all the buffer contents to be sent.

NOTE: The MITS MD3311 RTU's synchronise their time with the master station using a UNIX time routine.

The alarm priority class is shown by colour in the control room operator's alarm page picture on the IDTS. The IDTS SCADA alarms are filtered by priority class, then by the time stamp. A log file records the time and date of the activation and deactivation of alarms at the RTU.

NOTE: Alarms which have an initial state of 'TRUE' (i.e. Available) should be initialised as TRUE in the point configuration of ISaGRAF to avoid erroneous alarm on the first scan of the RTU.

4.2.2 Events

Events are actions recorded by the RTU, which are not in an alarm category, for example pump running (start/ stop action). The events are stored in the RTU history with a time and date stamp and are transmitted to the IDTS master station with the priority 2 and 3 alarms. To avoid multiple alarms for a single pump fault, all pump faults have been classified as events. They all trigger the pump available alarm, which is a priority 1 alarm.

4.3 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 6.5 *IDTS Alarm Instructions* for an example of an alarm instruction file.

4.4 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 Brisbane Water 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 IDTS 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.

4.4.1 Local Mode

When the station is switched to local mode, the site is under control of the on site technician. An alarm is triggered at the IDTS SCADA system to indicate the station is in local control. All pump alarms are suppressed as the on site technician has assumed responsibility for the station. Surge imminent, based on the wet well level, is also suppressed to avoid triggering Surge pumping mode during the maintenance of the Vega probe. The wet well level alarms of wet well high, surge imminent (triggered by the surge imminent electrode), and surge occurring are not suppressed in local mode.

4.4.2 Station Mains Fail

The main consequential alarm condition is Site Power Fail. If site power fails the following secondary alarms are suppressed:

- RTU Mains Fail
- Sewer pump not available
- Sewer pump motor power
- Current Invalid
- Delivery pressure Invalid
- Flow Invalid

4.4.3 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 is above the wet well high point.

4.4.4 Wet Well Invalid

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

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

4.4.5 Signal Invalid Alarm

Any analog signal (delivery pressure) 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 suppressed by both the signal invalid alarm and the station mains power input.

4.4.6 Alarm Suppression Tree

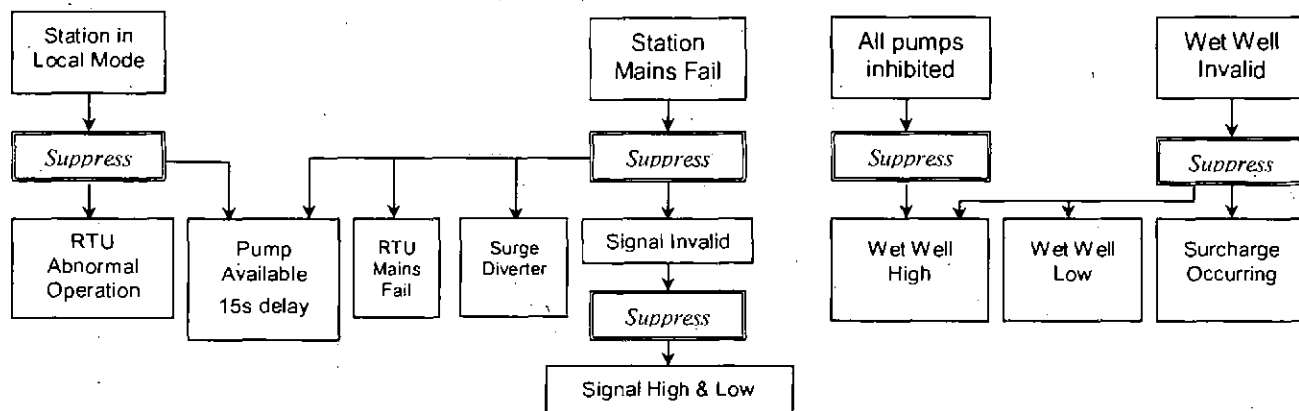


Figure 7: Alarm Suppression Tree

4.5 Alarm and Event Listing

Table 5: Priority 1 Alarms

Plant	Quantity	Desig	Alarm Description
Plc	Abnormal operation	1	Abnormal operation of PLC
Plc	Comms fault	1	Modbus communications to PLC has failed
Rtu	Abnormal operation	1	Abnormal operation of RTU
Rtu	Battery	1	RTU power failure (battery)
Rtu	Heartbeat	1	RTU heartbeat to IDTS has failed
Rtu	Mains fail	1	RTU power failure (mains)
Power supply	Surge diverter fault	1	Surge Diverter fault
Sewage pumping station	Local remote	1	Station in local mode
Sewage pumping station	Mains fail	1	Site main power fails
Sewer pump	Available	1-3	Pump unavailable
Sewer pump	Blocked	1-3	Pump blocked
Wet well	Level invalid	1	Wet well measuring instrument faulted
Wet well	High	1	Wet well level rises above a high alarm level
Wet well	Surcharge imminent	1	Wet well level reaches the surcharge imminent level
Wet well	Surcharge occurring	1	Wet well level reaches the surcharge occurring level

Table 6: Priority 2 Alarms

Plant	Quantity	Desig	Alarm Description
Sewer pump	Inhibit Fbk	1-3	Pump 1 inhibited by control room operator
Security	Door limit switch	1	One or more of the switchboard doors is open

Table 7: Priority 3 Alarms

Plant	Quantity	Desig	Alarm Description
Wet well	Low	1	Wet well level is low
Wet well	Calibration fault	1	Wet well level calibration fault
Pressure gauge	High	1	Delivery pressure high
Pressure gauge	Low	1	Delivery pressure low
Pressure gauge	Invalid	1	Delivery pressure invalid
Flow meter	High	1	Delivery flow high
Flow meter	Low	1	Delivery flow low
Flow meter	Invalid	1	Delivery flow invalid
Variable speed drive	Automatic reset	1-3	VFD starter fault has reset automatically
Variable speed drive	Speed invalid	1-3	VFD speed feedback is invalid

Table 8: Events (Priority 0 Alarms)

Plant	Quantity	Desig	Alarm Description	Alarm
Attention	Automatic reset	1	Site attention indication has automatically reset	N/A
Rtu	Battery test failed	1	Battery test has failed	N/A
Rtu	Battery test inprogress	1	Battery test is in progress	N/A
Power supply	Generator online	1	Generator is Running	N/A
Power supply	Main incomer CB closed	1	Main Incomer CB is closed	N/A
Sewer pump	Emergency stop fault	1-3	Pump Emergency stop active	Pump Avail
Sewer pump	Fault	1-3	Pump Failed to start or stop	Pump Avail
Sewer pump	Mains power	1-3	Pump Mains power fault	Pump Avail
Sewer pump	Moisture in oil fault	1-3	Pump Moisture in oil fault	Pump Avail
Sewer pump	Motor power high	1-3	Pump motor power high	N/A
Sewer pump	Motor power low	1-3	Pump motor power low	N/A
Sewer pump	Motor current high	1-3	Pump motor current high	N/A
Sewer pump	Motor current low	1-3	Pump motor current low	N/A
Sewer pump	Running	1-3	Pump Running	N/A
Variable speed drive	Auto	1-3	VFD starter not in keypad mode	Pump Avail
Variable speed drive	Count exceeded	1-3	VFD starter faults exceeds maximum allowed	Pump Avail
Variable speed drive	Fault	1-3	VFD starter fault	Pump Avail

4.6 Alarm and Event Description

4.6.1 Attention

The following alarms and events are associated with the Attention Command

Plant	Quantity	Priority
Attention	Automatic_reset	0

Automatic Reset

The site attention control controls a indication lamp or strobe light at the RTU site. The control room operator is able to initiate and cancel the "attention indication" from the work stations. The on site technician will be required to contact the control room operator by radio or telephone when they see the alarm lamp/strobe.

Once activated, the attention alarm shall remain on for a period of 15 minutes. If it is not acknowledged it is then reset automatically. The attention indication can be acknowledged by the on site technician pushing the local 'attention acknowledge' pushbutton. An alarm flag is returned to the IDTS master station if the site attention was reset automatically.

4.6.2 Flow meter

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

Plant	Quantity	Priority
Flow_meter	High	3
Flow_meter	Low	3
Flow_meter	Invalid	3

The delivery flow meter low alarm is only checked when station power and the invalid alarms are healthy. It will be active at all times but when a pump starts the alarms will be inhibited for a period determined by the flow meter alarm inhibit time (default 15 seconds). This ensures that any instability caused by the pump starting has dissipated.

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 and less than 20mA for 30 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.

Low Alarm

If all the alarm conditions are satisfied then the flow low alarm is activated if the signal is less than the low limit set point. It is deactivated if any of the above conditions become false or the signal is greater than the low limit set point plus the dead band. The dead band is calculated using the alarm hysteresis value multiplied by the range.

High Alarm

If all the alarm conditions are satisfied then the flow high alarm is activated if the signal is greater than the high limit set point. It is deactivated if any of the above conditions become false or the signal is less than the high limit set point minus the dead band. The dead band is calculated using the alarm hysteresis value multiplied by the range.

4.6.3 Pressure Gauge

The following alarms and events are associated with the delivery pressure gauge.

Plant	Quantity	Priority
Pressure_gauge	High	3
Pressure_gauge	Low	3
Pressure_gauge	Invalid	3

The high and low alarms are only checked when station power and the invalid alarms are healthy and a pump has been running for the pressure alarm inhibit time (default 15 seconds). This ensures that any instability caused by the pump starting has dissipated.

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 and less than 20mA 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.

Low Alarm

If all the alarm conditions are satisfied then the pressure low alarm is activated if the signal is less than the low limit set point. It is deactivated if any of the above conditions become false or the signal is greater than the low limit set point plus the dead band. The dead band is calculated using the alarm hysteresis value multiplied by the range.

High Alarm

If all the alarm conditions are satisfied then the pressure high alarm is activated if the signal is greater than the high limit set point. It is deactivated if any of the above conditions become false or the signal is less than the high limit set point minus the dead band. The dead band is calculated using the alarm hysteresis value multiplied by the range.

4.6.4 Security

The following alarms and events are associated with the Security.

Plant	Quantity	Priority
Security	Door_limit_switch	2

Door Limit Switch

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 of these limit switches are wired in series to give a combined signal which 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.

4.6.5 Switchboard Power Monitoring

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 power alarms associated with the switchboard (refer to Figure 8: Example of Switchboard Power Monitoring Diagram, to locate the point of failure for the switchboard).

Drawing ID	Plant	Quantity	Priority
1	Sewage_pumping_station	Energex_power	1
2	Power_supply	Main_incomer_CB_closed	0
1&2	Power_supply	Generator_online	0
3	Sewage_pumping_station	Mains_fail	1
4	Power_supply	Surge_diverter_fault	1
5	Rtu	Battery	1
6	Rtu	Mains_fail	1
7 & 8	Sewer_pump	Mains_fail	0

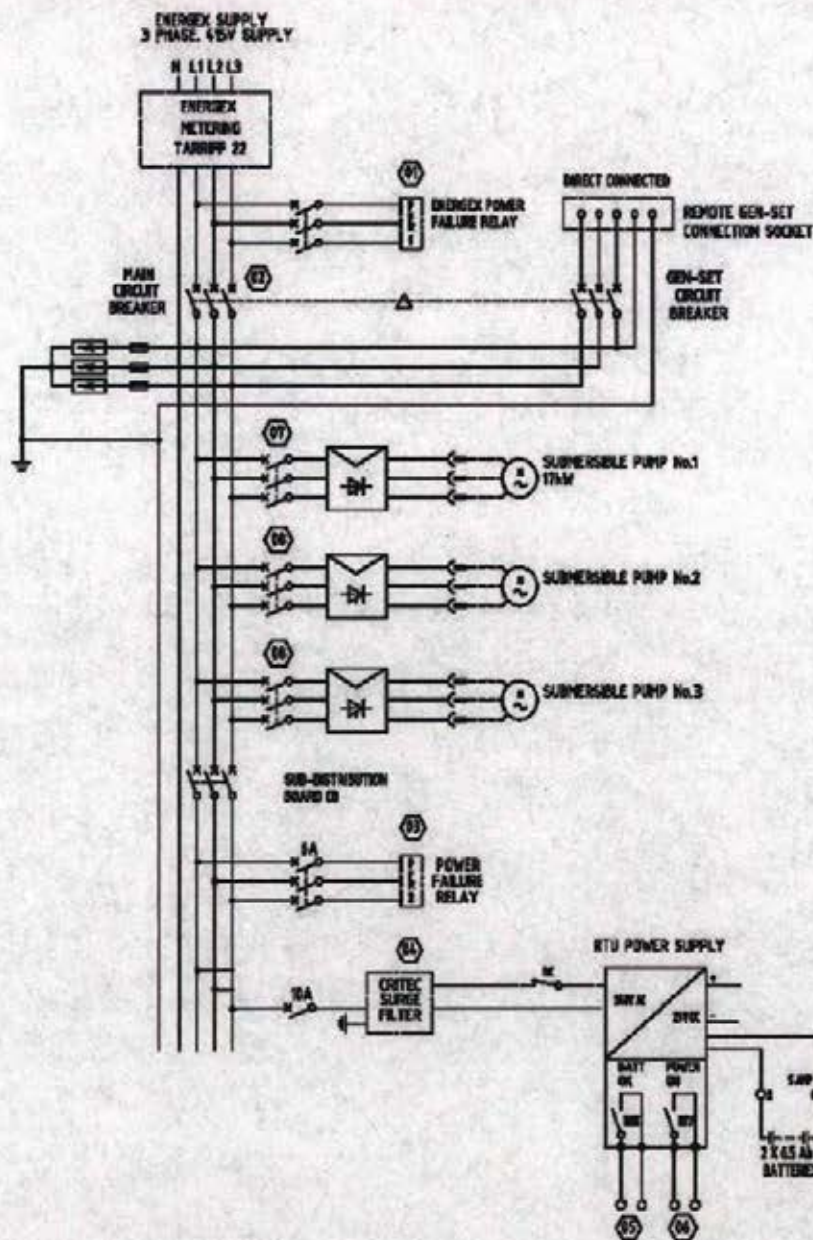


Figure 8: Example of Switchboard Power Monitoring Diagram

Energex Power

If the power monitoring relay on the Energex side of the main incomer is indicating a fault then after a 120 seconds 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 120 second delay is used to eliminate alarms due to brown outs and momentary losses of power.

Main Incomer Circuit Breaker Closed

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

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.

Station Mains Fail

If the power monitoring relay on the station side of the main incomer is indicating a fault then after a 15 seconds delay, the Mains fail signal will activated. This signal is used to determine if station has power, from either the line side of the main incomer or from the generator. The 15 second delay is to eliminate alarms due to brown outs and momentary losses of power.

Surge Diverter Fault

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

RTU 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.

Pump Mains power

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.

Battery (Fault)

This alarm indicates whether the power supply has a healthy battery system connected and that the batteries are adequately charged. If the battery system signal is in the fault state (and the battery check is not in progress) then the RTU Battery signal becomes faulty after a 20 second delay.

4.6.6 Station Mode

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

Plant	Quantity	Priority
Sewage_pumping_station	Local_remote	1

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.

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.

4.6.7 Sewer Pump

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

Plant	Quantity	Priority
Sewer pump	Available	1
Sewer pump	Blocked	1
Sewer pump	Emergency stop fault	0
Sewer pump	Fault	0
Sewer pump	Inhibit Fbk	2
Sewer pump	Mains power	0
Sewer pump	Moisture in oil fault (optional)	0
Sewer pump	Motor power high	3
Sewer pump	Motor power low	3
Sewer pump	Motor current high	3
Sewer pump	Motor current low	3
Sewer pump	Running	0
Variable speed drive	Auto	0
Variable speed drive	Automatic reset	3
Variable speed drive	Count exceeded	0
Variable speed drive	Fault	0
Variable speed drive	Speed invalid	0

Available

The pump considered available only when all of the following conditions are not present:

- Site mains power fail
- Pump mains power fail
- Pump fail
- Pump VFD not in Auto
- Pump VFD fault
- Pump VFD fault Count Exceeded
- Pump emergency stop input faulted
- Pump emergency stop fault latched
- Switchboard does not have 415V mains power supplied
- Pump does not have 240V control power supplied
- Pump has failed to start
- Pump is in Keypad control
- Pump VFD motor protection has activated
- Three or more faults in the last 8 hours
- Push button has been pressed
- Emergency fault has not been reset

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 availability alarm is suppressed by the station mains power fault condition and the station being in local mode. The pump must also be unavailable for 15 seconds before the alarm is sent to the IDTS master station. All the conditions which make the pump unavailable are event and can be easily identified by the control room operator by listing the abnormal points for the station.

Running

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

Emergency Stop Fault

If the emergency stop input becomes faulty and the station mains power is still healthy then, after a 2 second delay, 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.

Fault

The sewer pump fault flag is activated by the pump failing to start or failing to stop. If the pump is commanded to start or stop and the running indication does not match the running command, then after a site specific time period, the pump fault will become active. The time period is dependant on the ramp up and ramp down period of the VFD. (Default 30 seconds).

Moisture in Oil (Optional)

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. The moisture in oil relay is only installed on pump motors which are 22kW or greater in size.

Pump Blockage

Pump Blockage is designed to identify a possible blockage in an individual pump.

The pump blockage alarm is set if the pump is running individually in remote and for longer than a certain time period either:

1. The speed is too high for producing the minimum flow or
2. The flow is lower than the 'blocked flow rate limit' while the pump speed is greater than the 'blocked speed limit'.

The first condition will ensure that the pump does not speed up continuously to meet the minimum required flow rate. The second condition has site specific set points, which ensure that, while flow rate is above the minimum required, the speed to achieve this is not excessive. Two conditions are required so that the pump blockage can be determined in both low flow and peak flow conditions.

Once the pump blockage alarm is set for a pump it can be reset by the on site technician pressing the local reset button or the control room operator sending a remote reset (if the station is in remote mode).

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 effectively 'inhibits' the blocked pump from running. (refer to section 2.1.3 All Pumps Inhibited / Blocked Mode and Individual Pump Inhibit / Blocked). If all the pumps are either blocked or inhibited, then the inhibited pumps will be given preference to run.

Motor Current High and Low Alarms

The pump current high and low alarms are only checked when station power is healthy and the pump has been running for the pump alarm inhibit time (default 15 seconds). This ensures that any instability caused by the pump starting has dissipated.

If all the above conditions are satisfied then the high alarm is activated if the signal is greater than the high limit set point. It is deactivated if any of the above conditions become false or the signal is less than the high limit set point minus the dead band. The dead band is calculated using the alarm hysteresis value multiplied by the range. A high alarm is indicative of a jammed pump or a pump motor fault.

If all the above conditions are satisfied then the low alarm is activated if the signal is less than the low limit set point. It is deactivated if any of the above conditions become false or the signal is greater than the low limit set point plus the dead band. The dead band is calculated using the alarm hysteresis value multiplied by the range. A low alarm is indicative of an air locked pump or a blocked pump.

Motor Power High and Low Alarms

The pump power high and low alarms are only checked when station power is healthy and the pump has been running for the pump alarm inhibit time (default 15 seconds). This ensures that any instability caused by the pump starting has dissipated.

If all the above conditions are satisfied then the high alarm is activated if the signal is greater than the high limit set point. It is deactivated if any of the above conditions become false or the signal is less than the high limit set point minus the dead band. The dead band is calculated using the alarm hysteresis value multiplied by the range.

If all the above conditions are satisfied then the low alarm is activated if the signal is less than the low limit set point. It is deactivated if any of the above conditions become false or the signal is greater than the low limit set point plus the dead band. The dead band is calculated using the alarm hysteresis value multiplied by the range.

Variable Frequency Drive Auto

Direct feedback of the digital input status to indicate whether the VFD is on auto or keypad control.

Variable Frequency Drive Fault

If the variable frequency drive fault input becomes active and the station mains power is healthy and the emergency stop button has not been pressed, then after a 2 second delay, the variable frequency drive fault signal is activated. Once activated, the variable frequency drive fault input must clear before the fault signal can be reset.

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 by an automatic reset. All these three resets will activate the reset relay for 2 seconds, which sends a physical reset command to the variable frequency drive.

Variable Frequency Drive Fault Automatic Reset

Once the variable frequency drive fault input becomes healthy, to avoid the unnecessary unavailability of the sewer pump, the latched variable frequency drive fault signal will be reset automatically after the variable frequency drive fault reset delay time (default 20 minutes).

Variable Frequency Drive Fault Count Exceeded

The purpose of the fault count exceeded alarm is to prevent a reoccurring variable frequency drive 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).

Variable Frequency Drive Speed 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 and less than 20mA 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.

4.6.8 Wet Well

Plant	Quantity	Priority
Wet_well	Level_invalid	1
Wet_well	Low	3
Wet_well	High	1
Wet_well	Surcharge_imminent	1
Wet_well	Surcharge_occuring	1
Wet_well	Calibration_fault	3

As the Vega 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

Invalid

The signal is deemed invalid if it is

Less than (4mA – dead band) or greater than (20mA + dead band) for 1 second.

Once the invalid alarm has been activated it can only be reset when the signal is both greater than 4mA and less than 20mA 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.

Low Alarm

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. An air locked pump must be primed by an on site technician to make it available to run.

If the signal is valid and the start up delay has expired then the low alarm is activated if the signal is less than the low limit set point. It is deactivated if any of the above conditions become false or the signal is greater than the low limit set point plus the dead band. The dead band is calculated using the alarm hysteresis value multiplied by the range.

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.

If the signal is valid and the start up delay has expired then the high alarm is activated if the signal is greater than the high limit set point. It is deactivated if any of the above conditions become false or the signal is less than the high limit set point minus the dead band. The dead band is calculated using the alarm hysteresis value multiplied by the range.

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.

As this alarm is triggered by the surcharge imminent electrode, it also provides a redundancy to the wet well high alarm that the Vega probe should activate. The surcharge imminent alarm is the first alarm that the control room operator receives if the wet well level Vega probe is not functioning correctly.

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. This 100mm is ignored during power outages.

The surcharge imminent electrode is 24VDC and is backed up by the battery system. On all previous installations for HWT sites the surcharge imminent electrode has been powered by mains power and was not backed up by the battery.

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.

Wet Well Calibration Fault

The wet well calibration fault is activated one of two ways. The first is if the surcharge imminent electrode is activated while the wet well level (reading on the Vega probe) is more than 100mm below the surcharge imminent level. The second is if the wet well level (reading on the Vega probe) reaches 100mm above the surcharge imminent level without the surcharge imminent electrode being activated.

Both of these methods are inhibited for 1 hour after the RTU initialises. This prevents the alarm raised if on power up the wet well level is already above the surcharge imminent level. To reset the calibration fault signal the control room operator sends a calibration fault reset command from the IDTS master station.

4.6.9 RTU and PLC

The following alarms and events are associated with the RTU.

Plant	Quantity	Priority
Rtu / Plc	Abnormal operation	1
Rtu	Heartbeat failed	1
Plc	Comms fault	1
Rtu	Battery test failed	3
Rtu	Battery test inprogress	0

Abnormal Operation

An abnormal operation alarm identifies when the RTU or PLC operating system program has restarted. 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 IDTS master station.

Heartbeat failed

A counter increments every 1 minute and is sent to the IDTS master station. The IDTS master stations then checks that this 'heartbeat' figure has incremented every time the site has polled. If it has not, then a heartbeat failed alarm is by the IDTS master station to alert the control room operator that the RTU has stopped operating.

PLC Comms Fault

The Modbus communication fault is determined by a watchdog counter which is passed back and fourth from the RTU and the PLC and incremented on each pass in the PLC. If the RTU does not register an increment in any given 30 second time period, then a communication fault alarm is activated.

Battery Test in Progress

The battery test is used to check the state of the battery system. When a battery test is initiated, the battery test output relay is driven to disconnect the RTU power supply from mains power for 10 minutes. During this test, and while the station and RTU mains power signals are healthy and the battery system signal is healthy, the battery test in progress signal is active.

Battery Test Failed

A battery test failed alarm indicates that the batteries have failed their test and need to be replaced. The battery test failed signal is activated if the battery test in progress is deactivated because the battery system signal is in the fault state. This alarm is latched until a new battery test is activated or a battery test failed reset signal is sent by the control room operator.

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 IDTS 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 IDTS SCADA system as feedback points to allow the control room operator to view the current control parameters.

5.1 Calculated Values

Plant	Quantity	Desig	Alarm Description
Flow meter	Flow rate	1	Delivery flow rate in l/s
Flow meter	Volume	1	Daily volume in kL
Flow meter	Volume yesterday	1	Daily volume for past 24 hrs in kL
Pressure gauge	Pressure mahd	1	Delivery Pressure in mAHD
Pressure gauge	Pressure kpa	1	Delivery Pressure in kpa
Rtu	Battery discharge time	1	Time taken for Battery to discharge during test
Rtu	Site id	1	Network Address of RTU
Sewer pump	Hours run	1-3	Hours run for pump running by itself since midnight
Sewer pump	Hours run yesterday	1-3	Hours run for pump by itself yesterday
Sewer pump	Hours run 12	1	Run hours of pumps 1&2 operating since midnight
Sewer pump	Hours run 12 yesterday	1	Run hours of pumps 1&2 operating yesterday
Sewer pump	Hours run 13	1	Run hours of pumps 1&3 operating since midnight
Sewer pump	Hours run 13 yesterday	1	Run hours of pumps 1&3 operating yesterday
Sewer pump	Hours run 23	1	Run hours of pumps 2&3 operating since midnight
Sewer pump	Hours run 23 yesterday	1	Run hours of pumps 2&3 operating yesterday
Sewer pump	Motor current	1-3	Motor current
Sewer pump	Motor power	1-3	Motor power
Sewer pump	Number of starts	1-3	Number of starts for pump since midnight
Sewer pump	Number of starts yesterday	1-3	Number of starts for pump yesterday
Sewer pump	Total kWhrs	1-3	Total kWhrs for pump since midnight
Sewer pump	Total kWhrs yesterday	1-3	Total kWhrs for pump yesterday
Sewer pump	Total outflow	1-3	Total outflow for pump since midnight
Sewer pump	Total outflow yesterday	1-3	Total outflow for pump yesterday
Variable speed drive	Speed Fbk	1-3	Variable frequency drive operating speed
Wet well	Inflow	1	Average inflow to the station
Wet well	Level	1	Level of the wet well in mAHD
Wet well	Surcharge duration	1	Duration of last surcharge event
Wet well	Surcharge time remaining	1	Estimated time until surcharge if pumps do not run
Wet well	Total inflow	1	Total inflow to the station since midnight
Wet well	Total inflow yesterday	1	Total inflow to the station yesterday
Wet well	Volume	1	Current Volume in the wet well

5.2 Feedback Values

Plant	Quantity	Desig	Alarm Description
Flow meter	High limit Fbk	1	Delivery flow High alarm set point
Flow meter	Low limit Fbk	1	Delivery flow Low alarm set point
Pressure gauge	Elevation Rtu	1	Static elevation of the pressure gauge in mAHD
Pressure gauge	High limit Fbk	1	High alarm set point
Pressure gauge	Low limit Fbk	1	Low alarm set point
Pressure gauge	Pressure range Fbk	1	Range of the pressure gauge in meters
Sewer pump	Motor current high limit Fbk	1-3	High alarm set point
Sewer pump	Motor current low limit Fbk	1-3	Low alarm set point
Sewer pump	Motor power high limit Fbk	1-3	High alarm set point
Sewer pump	Motor power low limit Fbk	1-3	Low alarm set point
Sewerage pumping station	Blockage flw SP knee Fbk	1	Blockage flow setpoint at the 'knee' of the curve
Sewerage pumping station	Blockage spd SP knee Fbk	1	Blockage speed setpoint at the 'knee' of the curve
Sewerage pumping station	Blockage spd SP min Fbk	1	Blockage speed setpoint for the minimum flow
Wet well	Duty A start setpoint Fbk	1	Start duty pump set point
Wet well	Duty A stop setpoint Fbk	1	Stop duty pump set point
Wet well	Duty B start setpoint Fbk	1	Start standby pump set point
Wet well	Duty B stop setpoint Fbk	1	Stop standby pump set point
Wet well	High limit Fbk	1	High alarm set point
Wet well	Level range Fbk	1	Range of Vega Instrument measuring wet well level
Wet well	Low limit Fbk	1	Low alarm set point
Wet well	Zero MAHD Fbk	1	Bottom of wet well Vega Probe in mAHD

5.3 Analog Signal Processing

5.3.1 Analog Clamping

Before it is used to calculate the engineering value of the signal the raw analog input signal is clamped to the 4-20mA limits if the value is above or below these values plus and minus the flux value respectively. Flux value is the range of the signal multiplied by the site percent variable which represents the acceptable error percent.

5.3.2 Analog 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.

5.3.3 Analog Conversion to Engineering Unit

The analog input card converts the 4-20mA signals received to a raw count of 800 to 4000 for the RTU and 6400 to 32000 in the GE Fanuc PLC. This raw count is converted in the code to engineering units using the following formula. This is to be done in the code using the site specific values (conversion tables are not to be used).

$$\begin{aligned}\text{Engineering Unit (RTU)} &= (\text{Raw signal} - 800)/3200 \times \text{Engineering Range.} \\ \text{Engineering Unit (PLC)} &= (\text{Raw signal} - 6400)/32000 \times \text{Engineering Range.}\end{aligned}$$

The following are the signals received by the RTU.

Signal	Engineering Units
Flow Meter	Litres per second
Delivery Pressure	meters
Wet Well Level	meters
Flow Meter	Litres per second
Motor Power	kW
Motor Current	Amps
VFD Speed	Hz

5.4 Delivery Flow Rate kl/day

The flow is measured in litres per second. For every sewerage flow meter a flow rate conversion is performed to get the equivalent flow rate in kilolitres per day (kl/day) and sent back to the IDTS SCADA system.

$$\begin{aligned}\text{Flow (kl/day)} &= \text{Flow (l/s)} * K \\ k &= 86.4 \quad (\text{converts l/s to kl/day})\end{aligned}$$

IDTS Database Record Name		
Plant	Quantity	Description
Flow meter	Flow kl	Flow rate in l/s converted to kl/day value

5.5 Delivery Flow - Volume Pumped (kl)

The total volume pumped for the station is calculated using the flow rate (l/s) integrated over time, while the any pump is running. A snapshot of this figure is recorded at midnight to give the previous days volume pumped and this integral is reset.

IDTS Database Record Name		
Plant	Quantity	Description
Flow meter	Volume	Total volume pumped since midnight
Flow meter	Volume yesterday	Total volume pumped yesterday

5.6 Delivery Pressure mAHD

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

$$\begin{aligned} \text{Pressure (mAHD)} &= \text{Pressure (kPa)} / k + \text{Pres Elev (mAHD)} \\ k &= 9.803 \quad (\text{Pressure constant to convert from kPa to metres}) \\ \text{Pres Elev (mAHD)} &= \text{Site specific pressure elevation of pressure gauge} \end{aligned}$$

IDTS Database Record Name		
Plant	Quantity	Description
Pressure gauge	Pressure kpa	Delivery pressure (if gauge operating) of pumps - kpa units
Pressure gauge	Pressure mahd	Delivery pressure (if gauge operating) of pumps - MAHD units

5.7 Pump Hrs Run / day

The hours a pump runs individually are accumulated. The hours when both pumps run together are also accumulated. These integrals are reset at midnight

NOTE: To calculate the total hours run for a pump for one day the individual pump run hours are added to the both pumps running together run hours.

IDTS Database Record Name		
Plant	Quantity	Description
Sewer pump	Hours run	Pump only run hours since midnight
Sewer pump	Hours run yesterday	Pump only run hours yesterday
Sewer pump	Hours run 12	Run hours of pumps 1&2 operating simultaneously since midnight
Sewer pump	Hours run 12 yesterday	Run hours of pumps 1&2 operating simultaneously yesterday
Sewer pump	Hours run 13	Run hours of pumps 1&3 operating simultaneously since midnight
Sewer pump	Hours run 13 yesterday	Run hours of pumps 1&3 operating simultaneously yesterday
Sewer pump	Hours run 23	Run hours of pumps 2&3 operating simultaneously since midnight
Sewer pump	Hours run 23 yesterday	Run hours of pumps 2&3 operating simultaneously yesterday

5.8 Pump Starts / day

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

IDTS Database Record Name		
Plant	Quantity	Description
Sewer pump	Number of starts	Starts of Pump since midnight
Sewer pump	Number of starts yesterday	Starts of Pump yesterday

5.9 Pump kl / day

The volume that an individual pump delivers is calculated by integrating the flow rate over time while that pump is running by itself. This integral is reset at midnight

NOTE: outflow, while a pump is running in tandem with the other pump, is ignored.

IDTS Database Record Name		
Plant	Quantity	Description
Sewer pump	Total outflow	Volume pumped by Pump running by itself
Sewer pump	Total outflow yesterday	Volume pumped yesterday by Pump running by itself

5.10 Pump kW hrs / day

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

NOTE: kilowatts while a pump is running in tandem with the other pump are ignored.

IDTS Database Record Name		
Plant	Quantity	Description
Sewer pump	Total KWHrs	Pump power consumption
Sewer pump	Total KWHrs yesterday	Pump power consumption yesterday

5.11 Wet Well Level mAHD

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.

$$\text{WWL (mAHD)} = \text{WWL (meters)} + \text{WWL Zero Level (mAHD)}$$

IDTS Database Record Name		
Plant	Quantity	Description
Wet well	Level	Level of wet well

5.12 Wet Well 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'. Volume in 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 9: Level vs Volume Lookup Table) which also provides a graphical representation of all the sample points (Figure 9: Level vs Volume Chart).

Table 9: Level vs Volume Lookup Table (SAMPLE)

	Excel Data		RTU Data
	Wet Level[AHD]	Well Remaining Capacity [m ³]	Current 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
	2.790	4.968	4.251
	2.849	4.130	5.089
	2.924	3.005	6.213
High Alarm Level	3.000	2.139	7.079
	3.076	1.417	7.802
	3.151	0.709	8.510
	3.227	0.000	9.219
Surcharge Level			

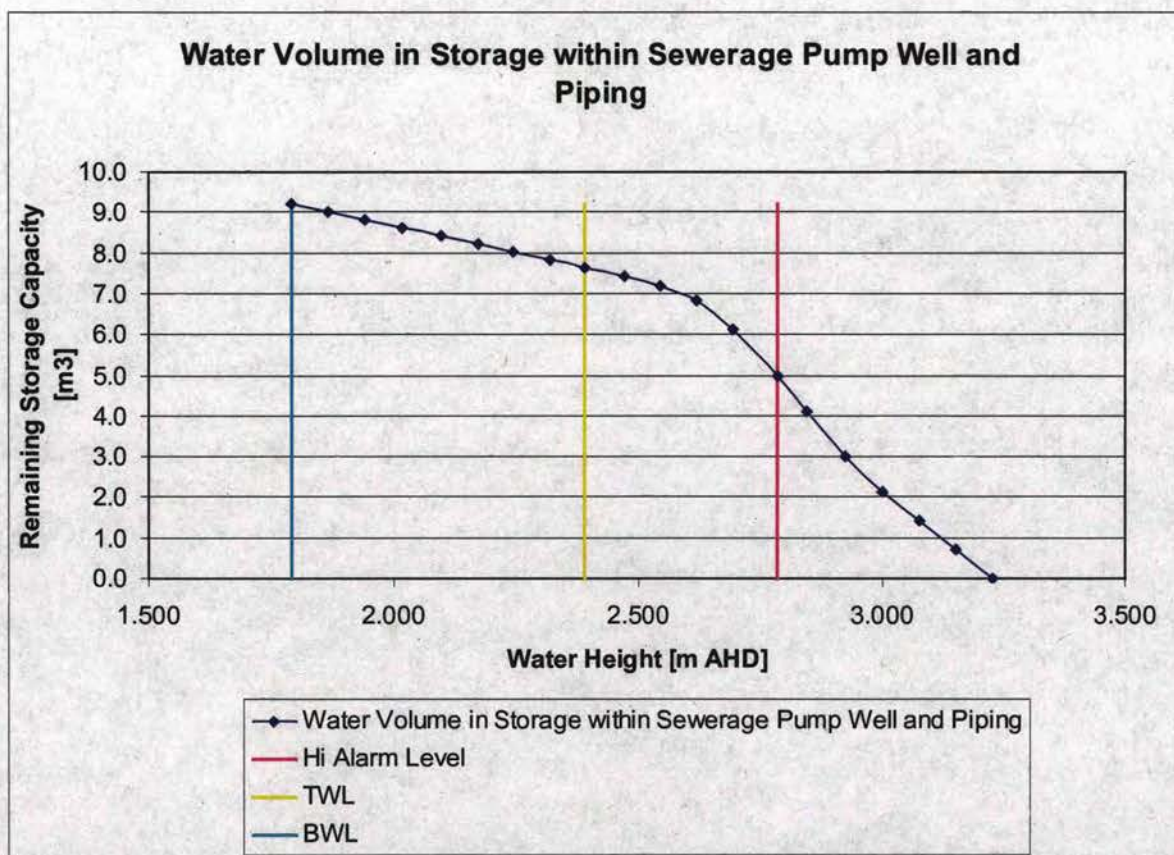


Figure 9: Level vs Volume Chart (SAMPLE)

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 10: Wet well diagram*

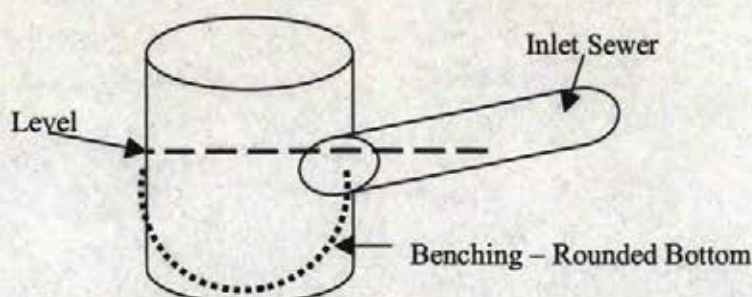


Figure 10: Wet well diagram

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 IDTS server and can download directly to the RTU from the server. (Refer to *Appendix B: Spxxx.main File* for an example of a site *.main file).

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 Brisbane Water.

In *Figure 9: Level vs Volume Chart*, the 'Top Water Level' (TWL) is the Duty A Start, and the 'Bottom Water Level' (BWL) is Duty A Stop.

IDTS Database Record Name		
Plant	Quantity	Description
Wet well	Volume	Volume of sewerage in wet well calculated from using the level in the lookup table

5.13 Station Surge Duration

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

IDTS Database Record Name		
Plant	Quantity	Description
Wet well	Surge duration	Time duration of surge

5.14 Station Time to Surge (**UNDER DEVELOPMENT**)

When both pumps are stopped, the Station Inflow is used to calculate the time it would take to fill the remaining storage capacity (wet well capacity - current Wet Well Volume). The time (in minutes) to surge is only displayed on the station MITS GUI picture after the wet well high alarm is raised.

IDTS Database Record Name		
Plant	Quantity	Description
Wet well	Surge time remaining	Estimated time in minutes until surge when both pumps are NOT running

5.15 Station Inflow (**UNDER DEVELOPMENT**)

The simplified formula for calculating the inflow over a period of time is

$$\begin{aligned} \text{Inflow (l/s)} &= \text{Volume Difference (litres)} / \Delta t \text{ (s)} + \text{Outflow (l/s)} \\ \text{Volume Difference (l)} &= \text{difference in volume over the sample period} \\ \Delta t \text{ (s)} &= \text{sample period} \\ \text{Outflow (l/s)} &= \text{Integral of the flow meter for the sampling period} \end{aligned}$$

5.15.1 Method A – Time between Start and Stop

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.

5.15.2 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 (cleared) 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.

5.15.3 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.

5.15.4 Total Inflow

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

$$\text{Total Inflow (kl)} = \text{Total Inflow (kl)} + [\text{Inflow (l/s)} \times 15 \text{ (s)} / 1000]$$

IDTS Database Record Name		
Plant	Quantity	Description
Wet well	Inflow	Instantaneous inflow to the wet well when pumps are NOT running
Wet well	Total inflow	Total inflow to the wet well since midnight when pumps are NOT running

6 IDTS SCADA CONFIGURATION

Every site on the IDTS 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

6.1 IDTS Points Database

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

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

These points are detailed on the 'IDTS spreadsheet' which is created for each site. This spreadsheet details each point's corresponding address in the RTU, sets up any alarm priority and all other point attributes. The site 'IDTS spreadsheet' is used by the IDTS system administrator to populate the online database with the site points required.

6.2 IDTS Significant Points

All points which are classified as priority 1 alarms are configured as 'significant' points. This is done on the online IDTS database and is then downloaded to the RTU. Any alarm configured to be significant will cause the RTU to immediately transmit to the IDTS master station.

6.3 IDTS History Database

All digital and analog 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 IDTS SCADA system. The history database is configured by the IDTS system administrator.

6.4 IDTS Site RTU database

Each MD3311 or MD1000 RTU commissioned in the field has a RTU database generated from in the IDTS 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 using by the IDTS master station using the IO configuration, history configuration, significant points configuration as well as the *.main file in the IDTS server. (Refer to *Appendix B: Spxxx.main File* for an example of a site *.main file).

6.5 IDTS Alarm Instructions

The IDTS administrator installs the alarm instruction list onto the IDTS master station. Each file is linked to its associated alarm and provided 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 for each alarm plant and quantity. The IDTS administrator can generate a site specific instruction file if the site needs a unique instruction. It is preferable, however, to expand on the generic alarm instruction where possible as this reduces the amount of deviation from the standard. (Easier to maintain the current set of alarm instruction list)

6.6 IDTS Pictures

6.6.1 Main Site Detail Screen

Each 3 pump submersible pump station has as a detail screen as shown below:

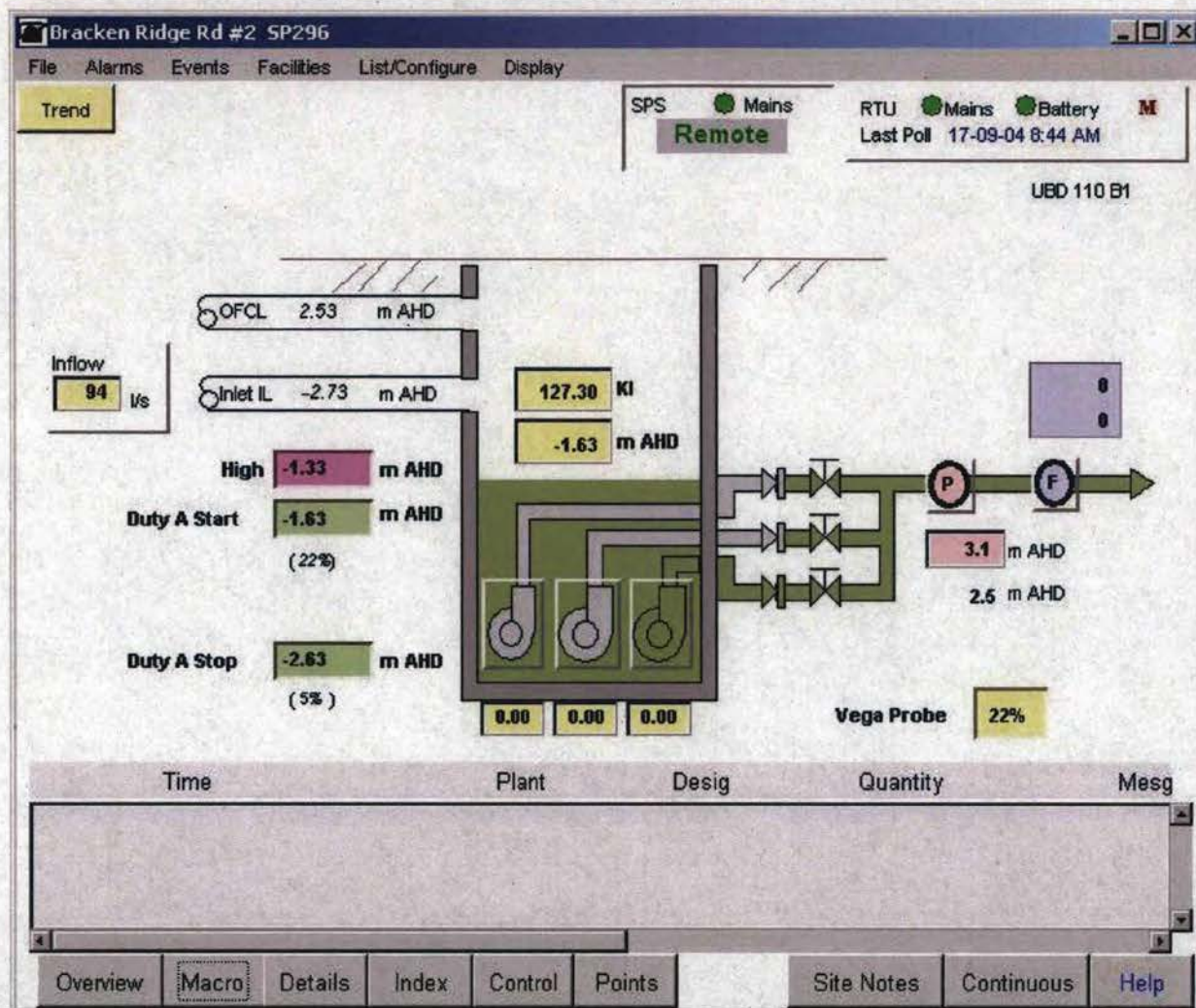


Figure 11: Site Detail Screen

Live points from RTU fed back to picture:

- ☐ Wet well level in metres AHD and % full.
- ☐ Pump duty A start level (in metres AHD and percentage), pump duty A stop level, and wet well high level
- ☐ Status of each pump (available, running, inhibited status shown by colour)
- ☐ Speed of each pump
- ☐ Delivery pressure in metres AHD
- ☐ Delivery flow in l/s (and volume for the day)
- ☐ Site power status
- ☐ Local/ remote control status
- ☐ Station inflow (when pumps are not running)
- ☐ Wet well volume
- ☐ Time (in minutes) to surcharge (when pumps are unavailable and wet well high alarm is active)

IDTS database points in the picture are stored in the IDTS database and not in the RTU. These values are displayed in the main station picture:

- ☐ The Inlet level (metres AHD)
- ☐ Overflow Control Level (metres AHD)
- ☐ Site Level (metres AHD)

6.6.2 Popup Controls Screens

Pump Control Popup

Each pump can be controlled by the following popup. Clicking on the pump icon on the main operator screen activates the individual pump control screens.

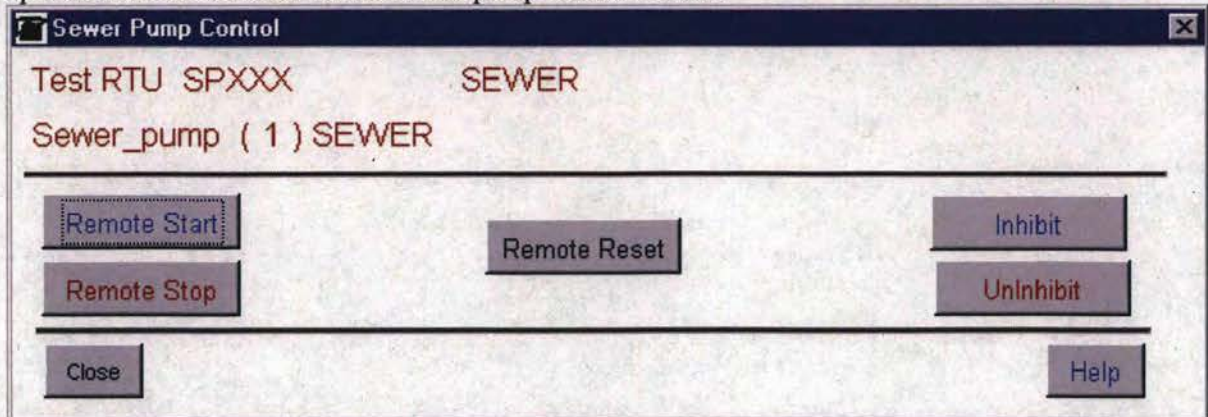


Figure 12: Pump Control Popup

Attention Alarm button

The Site Attention Control Popup is activated by pressing the "Attention" button of the main control page (bottom LHS of screen).

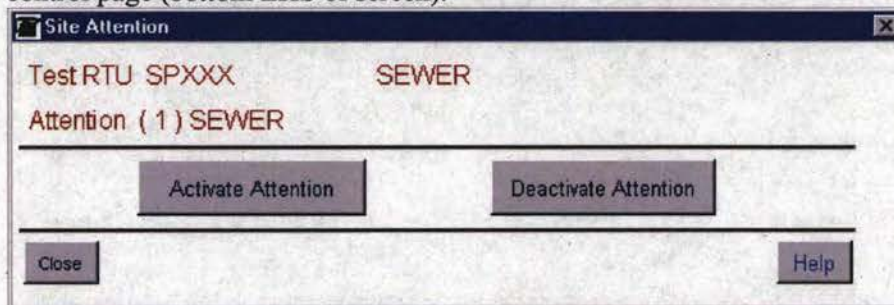


Figure 13: Set Point Control Popup

Set point adjustment - alarm limits

Clicking on a set point will give you the set point control popup.

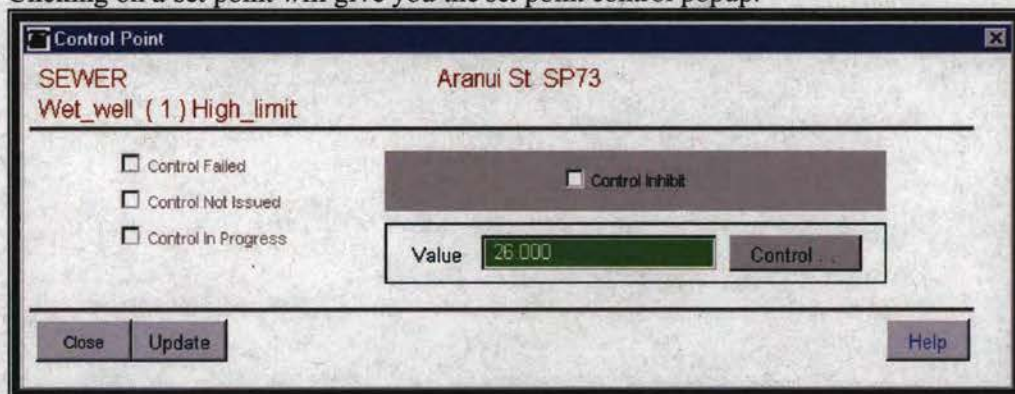



Figure 14: Control Point Page

Appendix A: STANDARD PHYSICAL I/O LIST

The Physical IO Spreadsheet will be created for each site, identifying not only the standard IO, but the Drawing Numbers which are unique to each site. This Physical IO Spreadsheet becomes part of the On-site documentation, providing a quick reference guide of the Physical IO to the on site technician.

		MITS MD3311 EA (Extended I-O) DIGITAL INPUTS (0-15)		SP103 Heroes Ave Sewage Pumping Station			
I/O #	Description	MITS Tag	Off State	On State	Term. #	Wire #	Drawing #
0	Spare	-	-	-		DI00	
1	Spare	-	-	-		DI01	
2	Spare	-	-	-		DI02	
3	Spare	-	-	-		DI03	
4	Spare	-	-	-		DI04	
5	Spare	-	-	-		DI05	
6	Spare	-	-	-		DI06	
7	Spare	-	-	-		DI07	
8	Spare	-	-	-		DI08	
9	Spare	-	-	-		DI09	
10	Spare	-	-	-		DI10	
11	Spare	-	-	-		DI11	
12	Site attention alarm reset pushbutton	atnlacknowledge	Not Pressed	Pressed		DI12	
13	Spare	-	-	-		DI13	
14	Spare	-	-	-		DI14	
15	Site Power	stnlisitePower	Fault	Healthy		DI15	



MITS MD3311 EA (Extended I-O)

DIGITAL INPUTS (16-31)

SP103 Heroes Ave Sewage Pumping S

I/O #	Description	MITS Tag	Off State	On State	Term. #	Wire #	Drawing #
16	Spare	-	-	-		DI16	
17	Spare	-	-	-		DI17	
18	Spare	-	-	-		DI18	
19	Spare	-	-	-		DI19	
20	Spare	-	-	-		DI20	
21	Spare	-	-	-		DI21	
22	Spare	-	-	-		DI22	
23	Spare	-	-	-		DI23	
24	Spare	-	-	-		DI24	
25	Spare	-	-	-		DI25	
26	Spare	-	-	-		DI26	
27	Spare	-	-	-		DI27	
28	RTU Power	RTUpower	Off	On		DI28	
29	Surge Diverter Alarm	StnlSurgeDivAlm	Healthy	Fault		DI29	
30	Spare	-	-	-		DI30	
31	Spare	-	-	-		DI31	



MITS MD3311 EA (Extended I-O)

DIGITAL INPUTS (32-47)

SP103 Heroes Ave Sewage Pumping S

I/O #	Description	MITS Tag	Off State	On State	Term. #	Wire #	Drawing #
32	Generator Fault	genltripped	Ok	Tripped		DI32	
33	Generator Warning	genlwarning	Ok	Alarm		DI33	
34	Generator Low Fuel	genllowFuel	Ok	Low		DI34	
35	Generator Running	genlrunning	Stopped	Running		DI35	
36	Generator Connected	genlconnected	Energex	Generator		DI36	
37	Energex Power	energexPower	Available	Not Available		DI37	
38	Generator Security	genlsecurity	Unsecured	Secured		DI38	
39	Generator CB Status	genllocCBTripped	Closed	Tripped		DI39	
40	Generator Mode	genlauto	Auto	Not Auto		DI40	
41	Generator On Site	genlonSite	False	True		DI41	
42	Spare	-	-	-		DI42	
43	Security Alarm	???	Alarm	Healthy		DI43	
44	Main Incomer CB Closed	???	Open	Closed		DI44	
45	Battery System OK	???	Fault	Healthy		DI45	
46	Cathodic Protection Alarm Reset	???	Not Pressed	Pressed		DI46	
47	Cathodic Protection Power	???	Off	On		DI47	



MITS MD3311 EA (Extended I-O)

DIGITAL OUTPUTS (0-15)

I/O #	Description	MITS Tag	Off State	On State	Term. #	Wire #	Drawing #
0	Spare	-	-	-		DO00	
1	Spare	-	-	-		DO01	
2	Spare	-	-	-		DO02	
3	Spare	-	-	-		DO03	
4	Spare	-	-	-		DO04	
5	Spare	-	-	-		DO05	
6	Spare	-	-	-		DO06	
7	Spare	-	-	-		DO07	
8	Generator Remote Start	gen1start	Off	On		DO08	
9	Generator Remote Stop	gen1stop	Off	On		DO09	
10	Spare	-	-	-		DO10	
11	Wet Well Washer Solenoid	ww1Washer	Off	On		DO11	
12	Attention alarm Indicator	atn1indicator	Off	Alarm		DO12	
13	Battery Check	BattCycRelay	Off	On		DO13	
14	Cathodic Protection Alarm Indicator	cp1Alarm	Off	Alarm		DO14	
15	Cathodic Protection De-energise Rectifier Unit	cp1DeEnergise	Energise	De-Energise		DO15	



MITS MD3311 EA (Extended I-O)

ANALOG INPUTS (0-7)

SP103 Heroes Ave Sewage Pumping S

I/O #	Description	MITS Tag	4mA	20mA	Term. #	Wire #	Drawing #
0	Cathodic Protection Rectifier Current	cplRectCurrent	Site Specific	Site Specific		AI00 +/-	
1	Wet Well Level	wwllevel	0.000 m	??.000 m		AI01 +/-	
2		-	-	-		AI02 +/-	
3		-	-	-		AI03 +/-	
4		-	-	-		AI04 +/-	
5		-	-	-		AI05 +/-	
6		-	-	-		AI06 +/-	
7		-	-	-		AI07 +/-	



GE FANUC

RACK: 0

Slot: 3

Card Type: IC693MDL645

Description: 16 Point Digital Input 24VDC

SP103 Heroes Ave Sewage Pumping Station

GE-Fanuc 90-30 PACK 0

I/O #	Term. #	Description	GE Tag	Address	Off State	On State	Term. #	Wire #	Drawing #
1	2	Station Local remote switch.	Str01dlRemote	%I0001	Local	Remote		DI1-01	
2	3	Station Surcharge Imminent level	Str01dlSurchImm	%I0002	Healthy	Surcharge Imm		DI1-02	
3	4	Spare	%I0003	%I0003	-	-		DI1-03	
4	5	Spare	%I0004	%I0004	-	-		DI1-04	
5	6	Spare	%I0005	%I0005	-	-		DI1-05	
6	7	Spare	%I0006	%I0006	-	-		DI1-06	
7	8	Spare	%I0007	%I0007	-	-		DI1-07	
8	9	Spare	%I0008	%I0008	-	-		DI1-08	
9	10	Spare	%I0009	%I0009	-	-		DI1-09	
10	11	Spare	%I0010	%I0010	-	-		DI1-10	
11	12	Spare	%I0011	%I0011	-	-		DI1-11	
12	13	Spare	%I0012	%I0012	-	-		DI1-12	
13	14	Spare	%I0013	%I0013	-	-		DI1-13	
14	15	Spare	%I0014	%I0014	-	-		DI1-14	
15	16	Spare	%I0015	%I0015	-	-		DI1-15	
16	17	Spare	%I0016	%I0016	-	-		DI1-16	

Doc Id: 003589

Active Date: 1 July 2004

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Printed: 21/02/2006

Owner: Peter Sherriff

Page 50

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Three Pump Submersible Sewerage Pump Station with VFD

Brisbane Water - Network Control Systems



GE FANUC

RACK: 0

Slot: 4

Card Type: IC693MDL645

Description: 16 Point Digital Input 24VDC

SP103 Heroes Ave Sewage Pumping Station

GE-Fanuc 90-30 PACK 0

I/O #	Term. #	Description	GE Tag	Address	Off State	On State	Term. #	Wire #	Drawing #
1	2	Pump 1 Pump power on	Pmp01diPower	%I0017	Off	On		DI2-01	
2	3	Pump 1 Reflux Valve Open	Pmp01diRefluxOpen	%I0018	Not Open	Open		DI2-02	
3	4	Pump 1 Local start pushbutton	Pmp01diLocalStartPB	%I0019	Not Pressed	Pressed		DI2-03	
4	5	Pump 1 Local stop pushbutton	Pmp01diLocalStopPB	%I0020	Not Pressed	Pressed		DI2-04	
5	6	Pump 1 Emergency Stop	Pmp01diESstop	%I0021	Fault	Healthy		DI2-05	
6	7	Pump 1 VFD Auto	Pmp01diVFDAuto	%I0022	Manual	Auto		DI2-06	
7	8	Pump 1 VFD Ready	Pmp01diVFDReady	%I0023	Fault	Ready		DI2-07	
8	9	Pump 1 local reset pushbutton	Pmp01diLocalReset	%I0024	Not Pressed	Pressed		DI2-08	
9	10	Pump 1 Running	Pmp01diRunning	%I0025	Not Running	Running		DI2-09	
10	11	Pump 1 Moisture in Oil	Pmp01diMIO	%I0026	Healthy	Fault		DI2-10	
11	12	Pump 1 Thermistor Fault	Pmp01diTermistor	%I0027	???	???		DI2-11	
12	13	Pump 1 Bearing Temperature	Pmp01diBearingTemp	%I0028	???	???		DI2-12	
13	14	Spare	%I0029	%I0029	-	-		DI2-13	
14	15	Spare	%I0030	%I0030	-	-		DI2-14	
15	16	Spare	%I0031	%I0031	-	-		DI2-15	
16	17	Spare	%I0032	%I0032	-	-		DI2-16	

Doc Id: 003589

Active Date: 1 July 2004

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Printed: 21/02/2006

Owner: Peter Sherriff

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GE FANUC

RACK: 0

Slot: 5

Card Type: IC693MDL645

Description: 16 Point Digital Input 24VDC

SP103 Heroes Ave Sewage Pumping Station

GE-Fanuc 90-30 PACK 0

I/O #	Term. #	Description	GE Tag	Address	Off State	On State	Term. #	Wire #	Drawing #
1	2	Pump 2 Pump power on	Pmp02diPower	%I0033	Off	On		DI3-01	
2	3	Pump 2 Reflux Valve Open	Pmp02diRefluxOpen	%I0034	Not Open	Open		DI3-02	
3	4	Pump 2 Local start pushbutton	Pmp02diLocalStartPB	%I0035	Not Pressed	Pressed		DI3-03	
4	5	Pump 2 Local-stop pushbutton	Pmp02diLocalStopPB	%I0036	Not Pressed	Pressed		DI3-04	
5	6	Pump 2 Emergency Stop	Pmp02diEStop	%I0037	Fault	Healthy		DI3-05	
6	7	Pump 2 VFD Auto	Pmp02diVFDAuto	%I0038	Manual	Auto		DI3-06	
7	8	Pump 2 VFD Ready	Pmp02diVFDReady	%I0039	Fault	Ready		DI3-07	
8	9	Pump 2 local reset pushbutton	Pmp02diLocalReset	%I0040	Not Pressed	Pressed		DI3-08	
9	10	Pump 2 Running	Pmp02diRunning	%I0041	Not Running	Running		DI3-09	
10	11	Pump 2 Moisture in Oil	Pmp02diMIO	%I0042	Healthy	Fault		DI3-10	
11	12	Pump 2 Thermistor Fault	Pmp02diTermistor	%I0043	???	???		DI3-11	
12	13	Pump 2 Bearing Temperature	Pmp02diBearingTemp	%I0044	???	???		DI3-12	
13	14	Spare	%I0045	%I0045	-	-		DI3-13	
14	15	Spare	%I0046	%I0046	-	-		DI3-14	
15	16	Spare	%I0047	%I0047	-	-		DI3-15	
16	17	Spare	%I0048	%I0048	-	-		DI3-16	



GE FANUC

RACK: 0

Slot: 6

Card Type: IC693MDL645

Description: 16 Point Digital Input 24VDC

SP103 Heroes Ave Sewage Pumping Station

GE-Fanuc 90-30 PACK 0

I/O #	Term. #	Description	GE Tag	Address	Off State	On State	Term. #	Wire #	Drawing #
1	2	Pump 3 Pump power on	Pmp03diPower	%I0049	Off	On		DI4-01	
2	3	Pump 3 Reflux Valve Open	Pmp03diRefluxOpen	%I0050	Not Open	Open		DI4-02	
3	4	Pump 3 Local start pushbutton	Pmp03diLocalStartPB	%I0051	Not Pressed	Pressed		DI4-03	
4	5	Pump 3 Local stop pushbutton	Pmp03diLocalStopPB	%I0052	Not Pressed	Pressed		DI4-04	
5	6	Pump 3 Emergency Stop	Pmp03diEStop	%I0053	Fault	Healthy		DI4-05	
6	7	Pump 3 VFD Auto	Pmp03diVFDAuto	%I0054	Manual	Auto		DI4-06	
7	8	Pump 3 VFD Ready	Pmp03diVFDReady	%I0055	Fault	Ready		DI4-07	
8	9	Pump 3 local reset pushbutton	Pmp03diLocalReset	%I0056	Not Pressed	Pressed		DI4-08	
9	10	Pump 3 Running	Pmp03diRunning	%I0057	Not Running	Running		DI4-09	
10	11	Pump 3 Moisture in Oil	Pmp03diMIO	%I0058	Healthy	Fault		DI4-10	
11	12	Pump 3 Thermistor Fault	Pmp03diTermistor	%I0059	???	???		DI4-11	
12	13	Pump 3 Bearing Temperature	Pmp03diBearingTemp	%I0060	???	???		DI4-12	
13	14	Spare	%I0045	%I0061	-	-		DI4-13	
14	15	Spare	%I0046	%I0062	-	-		DI4-14	
15	16	Spare	%I0047	%I0063	-	-		DI4-15	
16	17	Spare	%I0048	%I0064	-	-		DI4-16	

Three Pump Submersible Sewerage Pump Station with VFD

Brisbane Water - Network Control Systems



GE FANUC

RACK: 0

Slot: 7

Card Type: IC693MLD940

Description: 16 Point Digital relay Output 2A

SP103 Heroes Ave Sewage Pumping Station

GE-Fanuc 90-30 PACK 0

I/O #	Term. #	Description	GE Tag	Address	Off State	On State	Term. #	Wire #	Drawing #
1	2	Pump 1 Status Indicator	Pmp01dqLamp	%Q0001	Off	On		DO1-01	
2	3	Pump 1 Run Command	Pmp01dqGo	%Q0002	Off	Run		DO1-02	
3	4	Pump 1 Fault Reset	Pmp01dqReset	%Q0003	Off	Reset		DO1-03	
4	5	Pump 1 Run at Maximum Speed	Pmp01dqRunMax	%Q0004	Off	Maximum Speed		DO1-04	
5	7	Pump 2 Status Indicator	Pmp02dqLamp	%Q0005	Off	On		DO1-05	
6	8	Pump 2 Run Command	Pmp02dqGo	%Q0006	Off	Run		DO1-06	
7	9	Pump 2 Fault Reset	Pmp02dqReset	%Q0007	Off	Reset		DO1-07	
8	10	Pump 2 Run at Maximum Speed	Pmp02dqRunMax	%Q0008	Off	Maximum Speed		DO1-08	
9	12	Pump 3 Status Indicator	Pmp03dqLamp	%Q0009	Off	On		DO1-09	
10	13	Pump 3 Run Command	Pmp03dqGo	%Q0010	Off	Run		DO1-10	
11	14	Pump 3 Fault Reset	Pmp03dqReset	%Q0011	Off	Reset		DO1-11	
12	15	Pump 3 Run at Maximum Speed	Pmp03dqRunMax	%Q0012	Off	Maximum Speed		DO1-12	
13	17	Spare	%Q0013	%Q0013	-	-		DO1-13	
14	18	Spare	%Q0014	%Q0014	-	-		DO1-14	
15	19	Spare	%Q0015	%Q0015	-	-		DO1-15	
16	20	Spare	%Q0016	%Q0016	-	-		DO1-16	



GE FANUC

RACK: 0

Slot: 8

Card Type: IC693ALG221

Description: 4 Channel Analog Input Current (Isolated)

SP103 Heroes Ave Sewage Pumping Station

GE-Fanuc 90-30 PACK 0

I/O #	Term. #	Description	GE Tag	Address	4mA	20mA	Term. #	Wire #	Drawing #
1	3,5	Wet Well Level	Wwl01aiRaw	%AI001	0.000 m	???.000 m		AI1-01P	
2	4,6	Delivery Pressure	Pre01aiRaw	%AI002	0.00 m	????.00 m		AI1-02P	
3	13,15	Delivery Flow	Flw01aiRaw	%AI003	0.0 l/s	????.00 l/s		AI1-03P	
4	14,16	Spare	%AI004	%AI004	-	-		AI1-04P	

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Active Date: 1 July 2004

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Printed: 21/02/2006

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Page 54

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Three Pump Submersible Sewerage Pump Station with VFD

Brisbane Water - Network Control Systems



GE FANUC

RACK: 0

Slot: 9

Card Type: IC693ALG221

Description: 4 Channel Analog Input Current (Isolated)

SP103 Heroes Ave Sewage Pumping Station

GE-Fanuc 90-30 PACK 0

I/O #	Term. #	Description	GE Tag	Address	4mA	20mA	Term. #	Wire #	Drawing #
1	3,5	Pump 1 VFD Running Speed	Pmp01SpeedFbk	%AI005	0.0%	100%		AI2-01P	
2	4,6	Pump 2 VFD Running Speed	Pmp02SpeedFbk	%AI006	0.0%	100%		AI2-02P	
3	13,15	Pump 3 VFD Running Speed	Pmp03SpeedFbk	%AI007	0.0%	100%		AI2-03P	
4	14,16			%AI008				AI2-04P	



GE FANUC

RACK: 0

Slot: 10

Card Type: IC693ALG392

Description: 8 Channel Analog Output Current

SP103 Heroes Ave Sewage Pumping Station

GE-Fanuc 90-30 PACK 0

I/O #	Term. #	Description	GE Tag	Address	4mA	20mA	Term. #	Wire #	Drawing #
1		Pump No.1 Speed Command	Pmp01aqControlSpeed	%AQ001	0%	100%		AO1-01P	
2		Pump No.2 Speed Command	Pmp02aqControlSpeed	%AQ002	0%	100%		AO1-02P	
3		Pump No.3 Speed Command	Pmp03aqControlSpeed	%AQ003	0%	100%		AO1-03P	
4				%AQ004				AO1-04P	
5				%AQ005				AO1-05P	
6				%AQ006				AO1-06P	
7				%AQ007				AO1-07P	
8				%AQ008				AO1-08P	

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Page 55

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Appendix B: SPXXX.MAIN FILE

```

/*
 * SP285 - Aringa Cres
 */
#include "../include/rtudata.h"
#include "../include/md3scanlist.h"
#include "../include/ctrlschl.h"
#include "../include/grfb0002.h"
#include "../include/grfb0006.h"
#include "../include/db_constants.h"

#ifndef PERMANENT

#defineclass remote_rtu REMOTE_RTU_CLASS

/* Master station dial-in radio numbers */

record 1
    trio_ipad      0xc0a82346      /* Trio Alarmcall */
    ipad           0xc0a82301      /* Source IP Address (RTU) */
                                /* Destination IP Address (CSU) */

#defineclass rtu_rtu RTU_RTU_CLASS
/*
 * Vaga Probe length = ?m
 * Diameter = ????m
 * the volume value is derived from the formula  $\pi \cdot (r^2) \cdot h$ , where
 *  $r = d/2$ ,  $h = \text{level}$  and  $\pi = 3.1415927$ . the volume value represents
 * the volume of the segment defined by the level associated with
 * the volume value and the previous level/volume record. If the
 * current record is the first of the list then the segment is defined
 * by the level associated with the volume value and the level of 0.0.
 *
 * level values are entered as millimetres.
 * volume values are entered as  $m^3$  (or kL).
 */

#defineclass wetwell WETWELL_CLASS

/* wet well level to volume lookup table - based on vega probe 0 level */
record 1
    { level 88      volume 0.000 }
    { level 207     volume 0.653 }
    { level 308     volume 0.552 }
    { level 445     volume 0.753 }
    { level 564     volume 0.653 }
    { level 708     volume 0.784 }
    { level 803     volume 0.521 }
    { level 922     volume 0.653 }
    { level 1041    volume 0.728 }
    { level 1160    volume 1.026 }
    { level 1280    volume 1.108 }
    { level 1399    volume 1.331 }
    { level 1518    volume 1.320 }
    { level 1637    volume 1.233 }
    { level 1756    volume 1.170 }
    { level 1876    volume 1.208 }
    { level 1995    volume 1.392 }
    { level 2114    volume 1.342 }
    { level 2233    volume 1.470 }
    { level 2353    volume 1.436 }
    { }

/* wet well surcharge outflow per second lookup table - based on lip of surcharge */
record 2
    { level 0250    volume 1.000 }
    { level 0500    volume 1.000 }
    { level 0750    volume 1.000 }
    { level 1000    volume 1.000 }
    { level 2000    volume 4.000 }
    { }

/*
 * Automatically Generated Database files
 */
#include "SP285.scanlist"
#endif
#include "SP285.reset_fm"

```

Appendix C: DRAWING LIST

TO BE COMPLETED ONCE THE STANDARD DRAWINGS HAVE BEEN CREATED

Electrical Drawing List			
Sheet #	Drawing #	Rev.	Title