BRISBANE CITY COUNCIL
BRISBANE WATER

Australia Trade Coast Sewer Project

SP298

Lytton Rd No. 4 Pump Station

Operation & Maintenance Manual

Contract No. BW30137-02/03

Volume No. 5

BRISBANE CITY COUNCIL BW30137-02/03
Brisbane Water
Lytton Road P/S SP298 Australia Trade Coast Sewer Project

Volume	Section	Description	Pages
1	1	**Table of Contents**	7
		Electronic copy of complete Operation & Maintenance Manual on CD.	
		Hyperlink Files\Title Page Volume 1.doc Hyperlink Files\Title Page Volume 2.doc Hyperlink Files\Title Page Volume 2.1.doc Hyperlink Files\Title Page Volume 3.doc Hyperlink Files\Binder Labels.doc Hyperlink Files\Title Page Volume 4.doc Hyperlink Files\Title Page Volume 5.doc Volume/Title Pages & Binder Labels	
		Hyperlink Files\Revisions Page.xls Revisions	1
	1.1	**Introduction and System Overview Lytton Road No.4 P/S SP298**	
		Hyperlink Files\OMM SP298 Introduction Description Design and Process RevA.doc Subsection 1	6
		Description of System and Overview Locality Keyplan Subsection 1.1	
		Design and Process Subsection 1.2	
		Pumping System Operation Subsection 1.3	
		Inlet Valve Pit at SP298 No.4 Interconnected Rising Mains Subsection 1.4	
		Interconnected Rising Mains Manual Operated Valves Subsection 1.5	
		Flow Diverted from SP298 No.4 to Gibson Island WWTP Subsection 1.6	
		Pump Station SP298 No.4 Layout Subsection 1.7	
	1.2	**Pump Station Equipment Operation**	
		Functional Specification SP298 Lytton Rd 4 described in this document are in addition to the standard functionality detailed in SPSV3 57pages. 1.1 General Process Description 2.1 Standard Equipment 2.2 Non Standard Equipment 2.2.3 Actuated Valves 3.1 Normal Operation Figure 3: SP298 Station Level Set Points 3.4 Non Standard Control 3.6 Non Standard IDTS Picture	18
		Hyperlink Files\SPSV3.doc Standard Functional Specification SPSV3	57
2	2	**Proprietary Equipment Manuals/Maintenance and Service**	
	2.1	**Weir Services: Hydrostal Pumps**	
		Hyperlink Files\Hydrostal Pump I & O manual Lytton Rd - rev A.doc Including the following	52
		Description of Equipment	
		Operation and Maintenance	
		Maintenance and Service	
		Impeller Clearance Adjustment for Wear	
		Recommended Spare Parts	

BRISBANE CITY COUNCIL BW30137-02/03
Brisbane Water
Lytton Road P/S SP298 Australia Trade Coast Sewer Project

Volume	Section	Description	Pages
		Section 1.0 General Description of Operation	
		Section 2.0 General Description of System (Componenets)	
		Hyperlink Files\Common Logic.pdf Section 3.0 As Construction Drawings. Including Door Key Allocation	13
		Hyperlink Files\Drg Transmittal Common Logic.pdf Section 3.1 Drawing Transmittal	3
		Hyperlink Files\Parts List Common Logic.pdf Section 4.0 Part List	3
		Hyperlink Files\Tech Data Sheets Common Logic.pdf Section 5.0 Technical Manuals and Data Sheets	1
		Hyperlink Files\TDS1804S277.pdf Section 5.0 TDS-DinLine Surge Suppressor. Installation Instructions	32
		Hyperlink Files\TDF10A240V.pdf Section 5.0 Transient Discriminating Filter Model Number TDF-10A-240V. Installation Instructions	2
		Hyperlink Files\DAR275V.pdf Section 5.0 DinLine Alarm Relay (DAR) Model Number DAR275v. Installation Instructions.	2
		Hyperlink Files\3000-000-06.pdf Section 5.0 Rotork Circuit Diagram N0-REV 3000-000-06	1
		Hyperlink Files\Rotork Electric E170E2.pdf Section 5.0 Rotork IQ Range Installation and Maintenance Instructions	86
		Hyperlink Files\RWS300 (IQ IQT Remote Control 24Vdc).pdf Section 5.0 Rotork Standard IQ/IQT Remote Control Circuitry (24V DC)	1
		Hyperlink Files\multitrode_mtr_international-datasheet.pdf Section 5.0 Liquid Level Control Relay	2
		Hyperlink Files\Switchboard Electrical Accessories\AustSol\CA10 switches.pdf Section 5.0	56
		Hyperlink Files\Switchboard Electrical Accessories\CROMPTON\analogue244.pdf Section 5.0	21
		Hyperlink Files\Switchboard Electrical Accessories\CROMPTON\din250 trip relay.pdf Section 5.0	8
		Hyperlink Files\Switchboard Electrical Accessories\Mann Ind\MannIndQS_FTXDMV.pdf Section 5.0	2
		Hyperlink Files\Switchboard Electrical Accessories\Phoenix Contact\3004032[1].pdf Section 5.0	7
		Hyperlink Files\Switchboard Electrical Accessories\Phoenix Contact\3004100[1].pdf Section 5.0	7
		Hyperlink Files\Switchboard Electrical Accessories\Phoenix	2

BRISBANE CITY COUNCIL BW30137-02/03
Brisbane Water
Lytton Road P/S SP298 Australia Trade Coast Sewer Project

Volume	Section	Description	Pages
		Contact\uk5n_en.pdf Section 5.0	
		Hyperlink Files\Vegabar27525-EN.pdf Section 5.0 Vegabar 64 Pressure Transmitter 4—20 mA/HART. Operating Instructions	72
		Hyperlink Files\Vegadis20591-EN.pdf Section 5.0 Adjustment Module for Pressure Transmitter. Operating Instructions	16
		Hyperlink Files\Vegawell27630-EN.pdf Section 5.0 Vegawell 72 is a suspension pressure transmitter for level and gauge measurement. Operating Instructions	48
		Hyperlink Files\MagMaster flowmeter.pdf Section 5.0 Instruction Manual	24
		Section 5.1 Contents Sheet	
		Hyperlink Files\mg10p222.pdf Section 6.0 Danfoss VFD Instruction Manual Modbus RTU	33
		Hyperlink Files\SP298 VFD Settings Pump No 1 and No. 2 As Built rev 1.pdf Section 6.1 VFD Settings and Parameters	3
		Hyperlink Files\doc_C_1_MG80A802.pdf Section 6.2 Danfoss VFD Operating Instructions VLT 8000 AQUA	197
		Hyperlink Files\Lytton Rd ITP.pdf Hyperlink Files\Lytton Rd FAT.pdf Section 7.0 ITP Procedure, Test Sheets & Factory Acceptance Test	5 11
		Hyperlink Files\BW Factory Acceptance Test Document Switchboard.pdf BW Factory Acceptance Test Document Switchboard	4
3	**3**	**Drawings & Drawing Register**	
		Electronic copy of the following drawings on CD. Table of Contents	
	3.1	Hyperlink Files\Drawing Register.xls	7
		Hyperlink Files\486 5 7-TR201 001.pdf Locality Keyplan Drawing	1
		Hyperlink Files\Location Map SP298.doc Street Location Map	1
		As Constructed Drawings Rising Mains	
	3.2	Hyperlink Files\Pages from Rising Main Lindum Rd to Lytton Rd.pdf Sewer Rising Main from Connection to Kiawanah Road P/S SP49 Rising Main at Lindum Road to Lytton Road No 4 Pump Station.	10
	3.3	Hyperlink Files\Pages from Rising Main Prichard St to Lytton Rd.pdf Sewer Rising Main Prichard Street Pumping Station to Lytton Road No.4	13

BRISBANE CITY COUNCIL BW30137-02/03
Brisbane Water
Lytton Road P/S SP298 Australia Trade Coast Sewer Project

Volume	Section	Description	Pages
		Pumping Station	
	3.4	Hyperlink Files\Rising Main Drg Lytton Rd to Serpentine Rd.pdf Sewer Rising Main Lytton Road Pump Station (SP298) to Serpentine Road Pump Station (SP300)	16
		As Constructed Drawings Pump Station SP298 Mechanical/Electrical/Switchboard/Generator/Pit Covers	
	3.5	Hyperlink Files\lytton rd.pdf As-constructed drawings Lytton Rd Pump Station SP298. Mechanical/Electrical/Switchboard/Generator/Pit Covers	89
		Weir Services: Pump General Arrangement Drawing	
	3.6	Hyperlink Files\wd8159_2 Layout1 (1).pdf	1
4	4	**Traning/System Testing/Pre-Commissioning/Installation Method Statement/QA Records**	
		BW Site Based Traning Hyperlink Files\BW Site Based Training.pdf	4
	4.1	**BW: System Integration Testing**	
		Hyperlink Files\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\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\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\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\Check List 1.pdf (BW) Inspection Check List No1 Lytton Rd	1

BRISBANE CITY COUNCIL BW30137-02/03
Brisbane Water
Lytton Road P/S SP298 Australia Trade Coast Sewer Project

Volume	Section	Description	Pages
		Hyperlink Files\Check List 2.pdf (BW) Inspection Check List No 2 Serpentine Rd	1
		Hyperlink Files\SP300 Serpentine Road Functional Spec 1-10.doc Hyperlink Files\SP300 FS Document Signoff Approval.pdf	24 1
		Hyperlink Files\SP300 Functional Specification Rev 3.doc Parsons Brinckerhoff Date of Issue: 4 November 2004	26
		Hyperlink Files\SP298 Lytton Road 4 Functional Spec 1-10.doc Hyperlink Files\SP298 FS Document Signoff Approval.pdf (BW) 1-05. doc	18 1
		Hyperlink Files\SP298 Functional Specification Rev 4.pdf Parsons Brinckerhoff Date of Issue: 5 November 2004	24
		Hyperlink Files\Trends SP298 13-06-2005 (2-6-24 hours).pdf Lytton Rd P/S SP298 No.4 Pump Trends (2/6/24hours)	3
		Hyperlink Files\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\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\BW Site Acceptance Test Document Switchboard.pdf BW Site Acceptance Test Document Switchboard	3
		Hyperlink Files\BW IDTS Point Commissioning Sheet Switchboard.pdf BW IDTS Point Commissioning Sheet Switchboard	5
		Hyperlink Files\BW Site Inspection Report Switchboard.pdf BW Site Inspection Report Switchboard	6
	4.2	**Leighton/Parsons Brinckerhoff: Pre-Commissioning Report**	
		Hyperlink Files\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\RPT020Bvb - Precommissioning Lytton Rd PS.pdf Pre-commissioning Report Lytton Road Pump Station SP298. Including the following.	34
		Introduction	
		Appendix A: Pre-commissioning plan	
		Appendix B: Temporary pre-commissioning pipework arrangement	
		Appendix C: Manufacturers test data	
		Appendix D: Pre-Commissioning test data	

5	5	**Leighton/Parsons Brinckerhoff: Design Report**	
		Hyperlink Files\SP298 design report.zip Revised Developed Design Report Separable Portion No.2 Lytton Road Pump Station SP298. Including the following	213
		Introduction	
		Design Summary	
		Drawings	
		Input Design Data	
		Developed Design	
		Environmental Management	
		Permits and Approvals	
		List of Appendices A to I	

5

Australia Trade Coast Sewer Project
Contract No. BW 30137-02.03

Revised Developed Design Report Separable Portion No. 2
Lytton Road Pump Station SP298

August 2004

Brisbane Water

Awards won in 2003

Winner
Engineering Excellence Award
Category: Project Management

Highly Commended
Engineering Excellence Award
Category: Project Management

Winner
National and Queensland Case Earth Award
Category 3: Environmental Excellence - projects over $10 million

Highly Commended
Queensland Stormwater Industry Association State Award
Category: Major WSUD Project >$1.0 million

Minister's Grand Prize
Healthy Waterways Awards
Category: Industry Award

Finalist
Healthy Waterways Awards
Category: Industry Award

Commendation
Public Domain Awards
Category: Bridges

2138110B-RPT018Cic

PARSONS BRINCKERHOFF

Parsons Brinckerhoff Australia Pty Limited ACN 078 004 798 and Parsons Brinckerhoff International (Australia) Pty Limited ACN 006 475 056 trading as Parsons Brinckerhoff ABN 84 797 323 433

12th floor, IBM Centre
348 Edward Street
Brisbane Qld 4000
GPO Box 2907
Brisbane Qld 4001
Australia
Telephone +61 7 3218 2222
Facsimile +61 7 3831 4223
Email brisbane@pb.com.au

ABN 84 797 323 433
NCSI Certified Quality System ISO 9001

Author: Ian Cameron, Design Manager.....

Signed: .....

Reviewer: Victor Bowyer, Pump Station Designer.....

Signed: .....

Approved by: Ian Cameron, Design Manager.....

Signed: .....

Date: 6 August 2004, Revision C.....

Distribution: Brisbane Water .....

PARSONS BRINCKERHOFF

Contents

PARSONS BRINCKERHOFF

Contents (continued)

Page Number

List of appendices

PARSONS BRINCKERHOFF

1. Introduction

This Developed Design Report has been prepared in accordance with the requirements of Section 1.12.1 of Annexure 4:Part 1 (Engineering Design) to the Contract.

The Report consolidates, in relation to Separable Portion 2, design information relating to the underlying design concepts, calculations and assumptions, correspondence relating to discussions with statutory authorities and other relevant stakeholders, and details permits and approvals that have been obtained for the Lytton Road SP298 pump station and associated rising mains.

Separable Portion 2 consists of:

- design and construction of a new sewage rising main between the proposed Lytton Road SP298 and the Brisbane River;
- design and construction of a new sewage rising main under the Brisbane River;
- design and construction of new sewage rising main from the Brisbane River (Yarra Street) to proposed Serpentine Road SP300.

The above works are described in the *Separable Portion 2 Pipelines Developed Design* Report. The following SP2 works are described in this report.

This design report has been prepared for the following proposed works:

- Lytton Road SP298 pump station works.

It should be noted that a separate design report has been prepared for the proposed Serpentine Road SP300 pump station.

This Design Report has been revised to reflect Leighton Contractor review comments and Brisbane Water (BW) comments provided for the SP299 Viola Place Design Report (as applicable to SP298).

This Design Report supersedes the previous Design Report dated 16 July 2004.

PARSONS BRINCKERHOFF

2. Design summary

2.1 Lytton Road SP298

2.1.1 Pump station

The flow required to be pumped by SP298 (160 L/s) was nominated by BW in the tender documentation.

2.1.2 Construction access

For the construction of SP298 and associated rising main to the Brisbane River, construction access will be available from Lytton Road.

2.1.3 Operations and maintenance access

Permanent access to SP298 will be maintained off Lytton Road.

The proposed roadworks associated with SP298 have been designed for articulated trucks as instructed by BW.

2.2 Associated rising main

The Separable Portion 2 pipeline associated with the Lytton Road SP298 may be summarised as follows:

Section	Length	Pipe Materials
SP298 to River	606 m	DN450 PN12.5 PE100
River Crossing	749 m	DN400 PN20 PE100
River to SP300	2073 m	DN450 PN12.5 PE100
Total	**3428 m**	

PARSONS BRINCKERHOFF

3. Drawings

The Developed Design Report should be read in conjunction with the following design drawings:

Lytton Road SP298

Drawing No	Description
486/5/7-WR101/000	Drawing List
486/5/7-WR101/020	Locality and Site Plan
486/5/7-WR101/021	Road Plan
486/5/7-WR101/022	River Access Road Plan
486/5/7-WR101/023	Road Sections
486/5/7-WR101/024	General Arrangement
486/5/7-WR101/025	Pump Station Overflow
486/5/7-WR101/026	Roof Plan
486/5/7-WR101/030	Sectional Plan
486/5/7-WR101/031	Sections
486/5/7-WR101/032	Structural – General Notes
486/5/7-WR101/033	Concrete Details-1
486/5/7-WR101/034	Concrete Details-2
486/5/7-WR101/035	Concrete Details-3
486/5/7-WR101/036	Reinforcement Details-1
486/5/7-WR101/037	Reinforcement Details-2
486/5/7-WR101/038	Reinforcement Details-3
486/5/7-WR101/039	Future Pig Launcher Concrete Details
486/5/7-WR101/040	Odour Scrubbing and Septicity Control
486/5/7-WR101/041	Future Pig Launcher
486/5/7-WR101/042	Future Pig Launcher Reinforcement Details
486/5/7-WR101/043	Hardstand and Ladder Details
486/5/7-WR101/050	Rag Reduction Tube for the Vega Level
486/5/7-WR101/051	Power Distribution Schematic Diagram
486/5/7-WR101/052	Pump 01 Schematic Diagram
486/5/7-WR101/053	Pump 02 Schematic Diagram
486/5/7-WR101/054	Motorised Valve 01 Schematic Diagram
486/5/7-WR101/055	Motorised Valve 02 Schematic Diagram
486/5/7-WR101/056	Generator Control Schematic Diagram
486/5/7-WR101/057	DC Power Supply Schematic Diagram
486/5/7-WR101/058	MITS RTU Digital Input

PARSONS BRINCKERHOFF

Drawing No	Description
486/5/7-WR101/059	MITS RTU Digital Input
486/5/7-WR101/060	MITS RTU Digital Output
486/5/7-WR101/061	MITS RTU Analogue Input
486/5/7-WR101/062	PLC Digital Inputs Slot 3
486/5/7-WR101/063	PLC Digital Inputs Slot 4
486/5/7-WR101/064	PLC Digital Inputs Slot 5
486/5/7-WR101/065	PLC Digital Inputs Slot 6
486/5/7-WR101/066	PLC Analogue Inputs Slot 7
486/5/7-WR101/067	PLC Analogue Inputs Slot 8
486/5/7-WR101/068	PLC Analogue Inputs Slot 9
486/5/7-WR101/069	Switchboard General Arrangement
486/5/7-WR101/070	Switchboard Construction Notes
486/5/7-WR101/071	Equipment List
486/5/7-WR101/072	Switchboard Construction Details
486/5/7-WR101/073	Switchboard Label Schedule Diagram
486/5/7-WR101/074	Electrical Site Layout
486/5/7-WR101/075	Cabling Block diagram
486/5/7-WR101/076	Cable Schedule
486/5/7-WR101/077	Cathodic Protection Wiring Diagram
486/5/7-WR101/078	Sump Pump Electrical Schematic

BCC Standard Drawings

486/5/25-SC002/1	"G" Type Maintenance Hole General Arrangement
486/5/25-SC002/2	"G" Type Maintenance Hole Top Slab Reinforcement
486/5/25-SE001/1	Standard Overflow Flap Type 1 Chamber Details
486/5/25-SE001/2	Standard Overflow Flap Type 1 Top Slab & Flap Details
486/5/25-SF002/1	Maintenance Hole Cover Sewer Class B – Conc Infill Frame Details
486/5/25-SF002/2	Maintenance Hole Cover Sewer Class B – Conc Infill Frame Details
486/5/25-SF002/3	Maintenance Hole Cover Sewer Class B – Conc Infill Lifting Hole Details
486/5/25-SF003/1	Maintenance Hole Cover Sewer Class B – Bolt Down Frame Details
486/5/25-SF003/2	Maintenance Hole Cover Sewer Class B – Bolt Down Cover Details
486/5/25-SF003/3	Maintenance Hole Cover Sewer Class B – Bolt Down Cover Details

486/5/25-SF009	Standard M.S. Ladders and Associated Fittings
486/5/25-S25	Standard 2440 Dia Sewage Pump Station Section B
486/5/25-S26	Standard 2440 Dia Sewage Pump Station Section C
486/5/25-S27	Standard 1830 Dia Dia Grit Collector Maintenance Hole Details
486/5/25-S28	Standard 1830 Dia Grit Collector Maintenance Hole Details
486/5/25-S29	Standard 1830 Dia Grit Collector Maintenance Hole Details
486/5/25-S30	Standard 2440 Dia Sewage Pump Station Vent Pole Details
486/5/25-S31	Standard 2440 Dia Sewage Pump Station Potable Water Details
486/5/25-S32	Standard 2440 Dia Sewage Pump Station Level Probe Bracket Detail
486/5/25-S33	Standard 2440 Dia Sewage Pump Station Level Probe Bracket Detail
486/5/25-S34	Standard 2440 Dia Sewage Pump Station Anode Hook Detail
486/5/25-S35	Standard 2440 Dia Sewage Pump Station Electrical Connection Box Detail
486/5/25-S50	Standard 1830 Dia Grit Collector Maintenance Hole Bar Screen Details
486/5/25-S51	Standard 1830 Dia Grit Collector Maintenance Hole Bar Screen Details

IPWEAQ Standard Drawings

R-0080	Kerbs and Channels Profiles and Dimensions
G-0030	Electrical Cable Drawing Pits
G-0041	Fencing Chain Wire Security Fencing
D-0050	Field Inlet and Overflow Gully Type 1 and Type 2
D-0080	Inlet and Outlet to Stormwater Drains

HALLCO Standard Drawings (Sample only)

BCC-03	1650x1600 Valve Pit Cover details of Recesses for Cover Installation
BW-1/1	Recess Details – P.S. 1/1 For 2400x2600 C/O cover for Cover Installation
BW-01	Multi-part Removable Alum. Cover
BW-02	Multi-part Removable Alum. Cover
BW-03	Multi-part Removable Alum. Cover
BW-10	Multi-part Removable Alum. Cover
HE-02	End & Centre Hinge Details

PARSONS BRINCKERHOFF

4. Input design data

4.1 Survey

BW provided topographic survey in the vicinity of SP298. Additional survey has been carried out by Leighton Contractors to validate the survey provided by BW and to provide supplemental information, including the location of services, location of RP boundaries and changes to ground profiles that have occurred since the BW survey was carried out.

4.2 Public utility plant (PUP) location

4.2.1 Dial Before You Dig (DBYD)

DBYD searches have been carried out and relevant services are shown on the Drawings.

4.2.2 Lytton Road SP298

Details of existing PUP in the vicinity of Lytton Road SP298 have been obtained from the as-constructed drawings and potholing by Leighton Contractors and relevant services are shown on the Drawings.

4.2.3 On-site service location

All services, identified from DBYD information, site inspection and discussions with service authorities, which may influence the alignment or construction of the works have been located on site by potholing and surveying. The location and level of each service has been surveyed and recorded.

4.3 Service authorities

Following a review of DBYD searches information, field verification of service locations was completed by LCPL construction personnel using visual inspection and pipeline location equipment.

On-site meetings with all relevant service authorities have also been completed either to verify the location of services and or to supervise the potholing and surveying of buried services.

The detailed services information was provided to drafting staff to design the pump station and associated pipelines.

4.4 Geotechnical information

4.4.1 Brisbane Water

For the proposed Separable Portion 2 pipeline works, BW had completed extensive geotechnical investigations for the river crossing and for the pipeline routes north and south of the Brisbane River.

A significant volume of geotechnical reports was included in the tender documents for the project, the most relevant of which for the SP298 works were the following:

- *Geotechnical Data Report, Australia Trade Coast Sewerage Project, Brisbane River Crossing, Lytton to Pinkenba*, BCC, City Design, March 2003.

During the detailed design phase of the project, BW supplied the following geotechnical report:

- *Supplementary Geotechnical Data Report, Australia Trade Coast Sewerage Project, Lytton Road to Brisbane River, Lytton*, BCC, City Design, 7 November 2003.

We have not included the above geotechnical reports in this Developed Design Report, due to the volume of information included in the above reports, and readers are referred to the existing documentation held by BW.

4.4.2 Coffey Geosciences

Coffey Geosciences (Coffeys) were commissioned by PB to complete settlement investigations at the SP298 Lytton Road pump station site.

A further assessment of the site was undertaken by Coffey Geosciences to indicate the likely settlements of the site under the additional loading to be applied to the site by the construction of the pump station.

A total settlement of 80 mm is predicted after 50 years for an applied loading of 10 kPa, with a possibility of 33% that this settlement will be exceeded by more than 10%. A copy of the Coffeys reports are included in Appendix E1.

4.4.3 Parsons Brinckerhoff

Parsons Brinckerhoff (PB) completed a geotechnical review of available information for SP298 based upon previous BW geotechnical investigations.

A copy of the PB geotechnical report is included in Appendix E2 (and includes comments upon SP299 and SP300 also).

4.4.4 Settlement issue

Due to the poor ground conditions identified at SP298, the project team recommended that a settlement analysis be completed to determine likely long term settlement rates.

Geotechnical engineers from PB initially reviewed the available geotechnical information. This review confirmed the weak nature of the underlying soils and showed that settlements were likely under any additional loading. It was determined that the additional allowable bearing pressure should be limited to 15 kPa at a depth below RL-6.8m to limit settlement to 25–30 mm.

PB completed a preliminary settlement analysis which is included in Appendix E2.

Coffey Geosciences were subsequently commissioned to complete a study, the results of which are included in Appendix E1. Additional information is also included in Design Minutes of 2 June 2004.

The following results summarise the calculated settlement rates:

Consultant	Settlement Information
Parsons Brinckerhoff (Memo 27/4/04)	▪ Not greater than 25–30 mm (long term settlement)* ▪ About 150 mm settlement from dewatering excavation*
Coffey Geosciences (Design Minutes 2/6/04)	▪ 20 kPa loading produces 75 mm settlement in 0.1 year ▪ Benefit of preloading ▪ Settlement of 50–100 mm expected after 10 years ▪ Differential settlement could be 25–50 mm

Note: *Based upon limited data.

Based upon the settlement investigations to date the following recommendations have been adopted:

- preloading of fill for construction purposes is recommended (fill placed at end of May 2004);
- move pump station an extra three metres away from the mangrove lined open drain;
- combine valve pit, pump well, and grit collector into a single structure to minimise differential settlement and to prevent tilting of structures; and
- adopt "neutral buoyancy" design for structures.

4.5 Land and property issues

There are a number of land and property issues which have impacted upon the design and construction of the proposed SP298 works, as detailed below:

Lytton Road SP298:

- Port of Brisbane Corporation (POBC) transfer of land to BCC for SP298 Lytton Road access and drainage reserve and vegetation/wildlife corridor; and
- Development Approval (DA) from POBC for the proposed works;

Part of Lot 719 SP110610 has been excised (2308 m^2) to provide vehicular access and a route for rising mains and services into SP298. (Refer to Appendix G for detailed information.)

A Development Application (DA) was submitted to POBC for the proposed works as part of the purchase agreement with the Brisbane City Council (BCC) for the land excised from Lot 719 SP110610. The DA was approved by POBC.

5. Developed design

5.1 Lytton Road SP298

5.1.1 Site

The Lytton Road SP298 pump station is located on land in the process of ownership being transferred from POBC to Brisbane City Council and described as part of Lot 719 RP110610.

The Lytton Road SP298 site adjoins the common boundary with Lot 716 SP110610 which with Lot 713 SP110610 will form a vegetation corridor linking Lytton Road to the Brisbane River.

It should be noted that the SP1 pipeline works have been designed and constructed so that Pritchard Street SP085 pumps to Gibson Island WWTP, until such time as the SP298 pump station is commissioned.

When SP298 is commissioned, manually operated valves on Lytton Road at the entrance to SP298 will be operated to direct Pritchard Street SP085 and Kianawah Road SP049 flows into SP298.

5.1.2 Structures

Cardno MBK were responsible for the structural design of the Lytton Road Pump Station SP298.

The structures comprising the pump station include the wet well, valve pit, grit collector manhole, ferric chloride dosing area slab, odour scrubber pad, transformer base, switchboard base, generator pad, pig launcher pit and unlet valve pit.

Structures will include:

- 3.6 m diameter RC wet well with valve chamber and grit chamber as single structure;
- non-standard BW grit collector maintenance hole (volume increased);
- an inlet valve pit with actuated valves on rising mains from Kianawah Road SP049 (and Pritchard Street SP085); and
- overflow (without screen) discharging to the open drain adjacent to SP298.

Concrete structures have been designed in accordance with *AS 3600 Concrete Structures* except where *AS 3735 Concrete Structures for Retaining Liquids* requires greater cover to steel reinforcement.

It should be noted that the grit chamber design has been modified to include the following features:

- submerged inlet with 500 mm above obvert of inlet pipe to invert level of connecting pipe (375 ND) to wet well; and
- size of grit chamber increased by inserting 500 mm straight section to elongate the structure between the 900 ND radius circular ends; and
- the overflow has been relocated from the grit collector to the wet well.

5.1.3 Design construction requirements

Settlement

It was realised that settlement of the pump station structures was inevitable as the minimum depth of fill applied to the site for the construction of the required pavements would apply significant loading and result in consolidation of the underlying soil. As a result, design was directed towards the design of structures with uniform foundation bearing pressures to ensure that structures would settle uniformly, rather than tilting. The performance of the pump station would not be affected by uniform settlement provided sufficient flexibility was allowed in connecting pipework to allow for differential movement between adjacent structures. Similarly, any pipelines leading to or from the pump station would be not affected by the consolidation as the settlement bowl would extent out from the pump station due to the depth of compressible material.

Construction issues

The tender method of construction for the pump station was developed by Coffey Geosciences Pty Ltd (Reference facsimile dated 16 June 2003 to PB). This method comprised the use of an open excavation above the water table and a steel sheet pile supported excavation for the structures below the water table.

Leighton Contractors developed an alternative method of construction for the pump station that eliminated the requirement for steel sheet piling. This alternative method recognised the strength of the near surface soils and the ability for open excavations to remain stable for a limited period of hours. The excavation would be made and stabilised with a rapidly placed internal lining of mass concrete.

The near surface soils have been observed to have a low permeability, indicating that ground water seeping into the open excavations will be unlikely to be a major issue and can be readily managed using small drainage sumps and dewatering pumps during the work.

Design issues

There are two design cases for the in-ground pump stations.

- Provision of sufficient mass in the structure to overcome buoyancy forces under high water table conditions. It is considered that the design should allow for the water table to be located at the ground surface. The weak soil conditions also indicate that no allowance should be made for friction on the surrounding soil assisting to hold down the structures.

- Limiting the additional bearing pressure to the underlying soils during dry conditions when the ground water level is low.

In both cases, the centre of buoyancy and the centre of mass should correspond to limit tilting.

5.1.4 Structural design outcomes

General arrangement

The design process considered several arrangements of the valve pit, pump well and grit collector manhole to develop a layout acceptable to Brisbane Water that would address the geotechnical issues of the site.

The design development arrangements considered were as follows.

- A standard arrangement of valve pit and wet well combined in a single structure was considered. It was found that uniform foundation bearing pressures could not be achieved to ensure uniform settlement. The use of fly ash as backfill to the structures to control settlement was considered but was not viable due to the overall settlement of the pump station.
- The use of separate valve pit and wet well structures was considered as each structure would have uniform foundation bearing pressures and hence would settle uniformly. The use of extended foundation slabs to limit non-uniform settlement was considered. Brisbane Water rejected this arrangement.
- It was found that an acceptable bearing pressure distribution could be obtained by combining the valve pit, wet well and grit collector manhole into a single structure as the valve pit would balance the grit collector manhole opposite from the valve pit.

The final solution comprises the valve pit and grit collector balancing each other on opposite sides of the wet well. The grit collector manhole is attached to the wet well by twin reinforced concrete walls.

It was preferable to locate the grit collector manhole adjacent to the pump well to minimise the requirements for the structural members joining the wet well and grit collector manhole. BW required the grit collector to be located further from the wet well and this resulted in a significant increase in the size of the connecting members.

The other structures, including the ferric chloride dosing area slab, odour scrubber pad, transformer base, generator slab, pig launcher pit and inlet valve pit were designed with uniform foundation bearing pressures. The majority of these structures were sized to limit the maximum additional bearing pressure applied to the subgrade.

Structural details

All structures were detailed in reinforced concrete. All significant structures were founded on a compacted clean sand-bedding layer placed on the soft subsoils on completion of excavation to provide a sound-bearing surface. Blinding concrete was specified to provide a firm surface for construction of the structures.

Sand was also specified to be used for the backfilling of excavations as this material can be readily placed and compacted using light equipment.

A jointed reinforced concrete pavement was designed for the access roadway to the pump station to provide a stable base for maintenance vehicle parked at the pump station. The pavement consists of a 200 mm concrete slab and 200 mm sub-base of CBR 25 material overlying the natural subgrade or construction fill.

The foundation for the substation comprises a ground slab at depth supporting a standard Energex uniculvert precast transformer base and substation plinth.

Corrosion

The pump station is located in recent alluvium identified as having significant potential acid sulphate soil conditions and groundwater very aggressive towards concrete structures. The concrete structures should be protected against groundwater attack.

However, the general soil permeability is low and little groundwater movement is expected once equilibrium conditions develop following the completion of construction. An appropriate treatment to protect the concrete structures against attack include a double layer of polyethylene sheeting either laid under the structures prior to the pouring of concrete and placed on completed concrete surfaces prior to backfilling. This protection should extend under all foundations and walls located below RL 2.2 m.

An exposure classification of B2 is considered appropriate for concrete protected against the corrosive groundwater as described above.

5.1.5 Construction methods

Concrete structures containing sewage will be cast in-situ in accordance with BW's requirements. Constructability reviews by LCPL have indicated that sheetpiling will not be required for construction of the wet well. The lower section of the wet well will be constructed using a blinding layer of concrete against the excavation and an internal form for the wet well.

5.1.6 Duty points

160 L/s at 26.0 m with one pump operating (peak). (See Appendix C for additional information.)

5.1.7 Pumps

Two Hidrostal H08K–M02R 68 kW submersible pumps in duty/standby arrangement. (See Appendix C for additional information.) The power supply for the pumps and associated equipment on the site will be provided from a pad mounted transformer within the fenced perimeter of the site.

5.1.8 Starters

Two Danfoss VLT8000 variable speed drives.

5.1.9 Discharge system

DN200/DN250 DICL discharge pipework connected to a single DN450 PE100 PN12.5 rising main with magnetic flowmeter. The HDD river crossing will be constructed in DN400 PE100 PN 20 pipework, with the remaining rising main to SP300 constructed in DN450 PE100 PN 12.5 pipework.

5.1.10 Power supply

Negotiations with Energex–Greenslopes have resulted in a commitment to provide an underground power supply to the Lytton Road SP298 site from the opposite side of Lytton Road.

The underground power supply to SP298 will be constructed in conduits terminating at a pad mounted transformer (500 kVA) constructed on the northern side of the access driveway.

A contribution by BW for the proposed works is required (see Appendix B1).

SP298 will incorporate a 150 kVA diesel powered backup generator that will cut in if the main power supply is unavailable. The generator will have sufficient capacity to start and run one of the duty pumps, plus any essential loads from ancillary equipment such as lighting, chemical dosing and control gear.

5.1.11 Controls and instrumentation

The following equipment is proposed:

- one "multitrode" digital level switch;
- one ABB Magmaster magnetic flow transmitter controlling pump set points of 90 L/s and 160 L/s;
- one Vega D84 analogue pressure transmitter;
- PLC to be free-issued by BW; and
- telemetry equipment to be free-issued by BW.

5.1.12 Control philosophy

The incoming flows to SP298 will come from the Pritchard Street SP085 pump station and the Kianawah Road SP049 pump station.

Sewage from the developing SP298 catchment will be discharged into the inlet valve pit at SP298, under pressure to the grit chamber and then gravitate to the SP298 wet well.

An actuated valve on the Kianawah Road SP049 rising main will regulate the amount of flow discharged to SP298. Under some operating conditions, BW will direct flows from Kianawah Road SP049 towards the Gibson Island WWTP, rather than to SP298.

As part of contingency planning, BW has requested that an actuated valve be installed on the SP085 Pritchard Street rising main so that SP298 may be bypassed for operational purposes. (See details in S2.2.7 of Functional Specification [Appendix H].)

SP298 will operate as a flow banded pump station using the variable speed drives (VSDs) which will be supplied and installed. The DN450 ABB Magmaster electromagnetic flowmeter on the discharge line will be used for a control function for the pump set points.

The control philosophy for the SP298 pump station is included in Appendix H.

5.1.13 Water hammer analysis

Initial assessment

Design Detail and Development was commissioned by PB as a specialist sub-consultant to complete the water hammer analysis for the overall project.

The water hammer report for SP298 and associated rising main Separable Portion 2 works is included in Appendix F, and the following conclusions were reached:

- *transient pressures are within the design rating of the pipe material;*
- *compliance with WSA 01 has been met;*
- *check valves do not require counterweights;*
- *the use of variable speed drives for the pumps will further reduce any possible fatigue damage of pipeline components or the pumps; and*
- *the manual air vent should be changed to a DN100 automatic double acting air valve.*

Design Detail and Development have completed water hammer modelling work for a number of options for the provision of double acting air valves.

The least air is drawn into the SP298 rising main when two double acting air valves are constructed, with the following volumes of air drawn in upon pump trip and pump stop:

- DN100 DAV at SP298 (0.7 m^3); and
- DN100 DAV at CH492 (5.3 m^3).

Subsequent assessment

On the basis that the BW Operations Group does not prefer air valves because of odour and other operational issues, PB was requested to re-consider the design of the SP298 to SP300 pipeline and to eliminate the air valves.

Following a review of possible options by PB Principal Engineer David Kent, a change in pump philosophy to flow banding was identified as a possible solution for momentum and water hammer issues:

- upper part of wet well 160 L/s; and
- lower part of wet well 90 L/s.

Design Detail and Development was subsequently requested to run new scenarios for the water hammer analysis to determine if the air valves could be eliminated for both normal pump stop and power failure using the revised pump control philosophy.

The following parameters were modelled for the new scenarios, with the elevated inlet at SP300 at RL 2.25, as outlined in the PB letter to Leighton Contractors dated 4 August 2004 (included in Appendix F).

Flow banding has been adopted as follows:

- Duty A to 160 L/s RL 0.25
- Duty A to 90 L/s RL -0.18
- Stop Duty B RL -0.38
- Stop Duty A RL -0.98

The scenarios which were modelled were as follows:

- pump stop is normally from 90 L/s;
- pump stop is normally controlled from 160 L/s to 90 L/s;
- single pump trip at 90 L/s, due to loss of power; and
- single pump trip at 160 L/s, due to loss of power.

Modelling results

A copy of the "Supplement to the Review of Unsteady State Hydraulic Design, SPS 298 Lytton Road to SPS 300 Serpentine Road" (2 August 2004) is attached as Appendix F (in this report).

The extra water hammer analysis may be summarised as follows:

Event	Integrated Volume (cu. m.)	Minimum Volume Available to BWL (cu. m.)
90 L/s Single Pump Trip Due to Loss of Power	1.85	3.3
160 L/s Single Pump Trip Due to Loss of Power	3.75	9.5

Note: 3.6 m diameter pump well has a cross-sectional area of 10.2 m^2.

Conclusion: The SP298 wet well has sufficient capacity not to empty under normal stop or power failure mode provided the nominated set points are used with VSD control of the pumps.

On the basis of the successful water hammer modelling the following revised settings are recommended:

- Duty A to 160 L/s RL 0.15
- Duty A to 90 L/s RL -0.30
- Stop Duty B RL -0.60
- Stop Duty A RL -1.10

The final pump settings will be optimised during the commissioning of the SP298 pump station. This will allow minimisation of the volume of sewage in the wet well after a normal pumping cycle.

The following conclusions were drawn from the additional water hammer review of the system of Lytton Road PS to SPS 300 Serpentine Road PS DN 450 PE100 PN 12.5/DN 400 PE100 PE20 pipeline that crosses the Brisbane River:

- *transient pressures are within the design rating of the pipe material;*
- *compliance with WSA 01 has been met;*
- *check valves do not require counterweights;*
- *the use of variable speed drives for the pumps will further reduce any possible fatigue damage of pipeline components or the pumps; and*
- *two speed operation overcomes the concern by Brisbane Water of using air valves on sewage systems.*

Readers are referenced to the "Supplement to Review of Unsteady State Hydraulic Design" (2 August 2004) included in Appendix F.

5.1.14 Odour and septicity equipment

A specialist odour and septicity sub-consultant, The Odour Unit has been commissioned by PB to analyse liquid and gas phase results sampled by BW.

The need for odour scrubbing and/or septicity control will be investigated further following receipt of the report from The Odour Unit.

It is likely that odour scrubbing equipment and septicity control equipment will be constructed at SP298 at this time.

A standard BW 12.5 m high vent pole will be constructed to vent the wet well and grit chamber.

5.2 Associated rising main

5.2.1 Pipe sizing

The sizing of the rising mains has been based on a suitable flow velocity to provide a trade-off between minimising headloss and maximising slime stripping and sediment transport.

The rising main from the Lytton Road SP298 to will be DN450/DN400 (River Crossing section).

5.2.2 Pipe material

All rising mains will be constructed from PE100 PN12.5 pipe, except for the river crossing which will be constructed in PE100 PN20 pipe.

5.2.3 Pigging point

The installation of a pigging point is recommended to allow for the removal of grit and slimes between SP298 and SP300. The SP300 inlet works will be designed to receive and recover

the pig launched at SP298. (BW has decided at this time not to proceed with the construction of the pigging point.)

5.2.4 Siphoning issue

In order to prevent the siphoning of raw sewage from the wet well of SP298, the following measures will be implemented:

- use of flow banded controls for SP298 pumps using VSD control; and
- construction of an inlet at SP300 with top water level of RL 2.25 m AHD.

5.2.5 Momentum issue

In the event of a sudden failure of the SP298 pumps (e.g. power failure), prior to the standby generator activating, there was some risk of the momentum of the water column to drain the SP298 pump well. Additional water hammer modelling has however identified a solution based upon flow banded pumping from SP298.

The momentum issue can be controlled by using VSD drives, flow banded pumping at 90 L/s and 160 L/s and the elevated inlet at SP300.

5.3 Changes since tender design

The following changes have been catalogued between the tender drawings and the developed design drawings:

General arrangement

- Linear pump station layout beside open drain.
- Provision for articulated truck access.
- Inlet valve pit rather than gravity inlet.
- Combined structure grit collector/pump well/valve pit.

Inlet pipework

- Additional high level pipe between grit chamber and wet well (added and deleted by BW).
- Extra actuated valve added in inlet valve pit.

Pumps

- Change to Hidrostal pumps — 68 kW (from Flygt pumps — 44 kW).

Pigging point

- Pigging point recommended and included in design (construction on hold).

Level of pump station

- Reduced from RL 4.0 m to RL 2.75 m AHD.

Electricity supply

- Change from overhead 11 kV to underground supply to pad mounted transformer.

Rising main

- Elevated breather air release at RL 2.25 m at SP300 inlet works.

6. Environmental management

Environmental management issues associated with the proposed works include the following:

- presence of marine clays;
- presence of mangroves which need to be protected;
- tidal drains in the vicinity of the proposed works;
- the presence of acid sulphate soils;
- the presence of high groundwater levels; and
- declared Fire Ant area.

PARSONS BRINCKERHOFF

7. Permits and approvals

The following permits and approvals have been obtained and are contained in Appendix A:

- S51 Fisheries Act
- BCC/DRS
- POBC

2

PARSONS BRINCKERHOFF

Appendix A

Permits and approvals
A1. S51 Fisheries Act
A2. Brisbane City Council (DRS)
A3. POBC

PARSONS BRINCKERHOFF

A1. S51 Fisheries Act

Queensland Government

Department of Primary Industries

Enquiries: Mathew Johnston
Telephone: +61 7 3817 8554
Your Ref: CD/W4-040201/LEE9
Our Ref: 04DEC530/533

23 April 2004

Mr Peter Turnbull
Product Manager
City Design
Brisbane City Council
Locked Mail Bag 6986
ALBION QLD 4010

Dear Mr Turnbull

Section 51 Fisheries Act application
Proposed ATC sewer main – Marine Parade, Eagle Farm Road and Unknown Road, Pinkenba, and Clunies Flat section, Lytton

I refer to your application of 19 December 2003, and your correspondence, for a Permit under Section 51 of the *Fisheries Act 1994* to remove marine plants associated with the construction of the Australian Trade Coast (ATC) sewer pipeline at Marine Parade, Eagle Farm Rd, Serpentine Rd and Unknown Rd, Pinkenba, and Clunies Flat, Lytton.

I would advise that consideration of your application has now been finalised. Please find attached:

- A Permit (No. 04SODB0007), and a Plan (No. 04SODB9543MP0007), to authorise removal / disturbance of marine plants as requested;
- A Receipt (No. 1400290583 dated 11 March 2004) for the $1353.00 Assessment Fee (Cheque Number 118779).
- Invoice No. 530266 to the Brisbane City Council for $600.00 Survey Fee.

The Department of Primary Industries is required to notify and consider comments of relevant indigenous groups prior to final assessment of any applications for approvals under Section 51 of the *Fisheries Act*. The relevant indigenous groups were notified. QFS will advise the relevant indigenous bodies of the issue of Permit No. 04SODB0007.

Please note that the onus is on you, the Permittee, to be aware of the provisions of the *Fisheries Act 1994* and *Fisheries Regulations 1995* with respect to the issue of Permits for the removal/disturbance of Marine Plants. A list of the most relevant sections is attached for your information.

CC: **Mr Don Garnett, District Support Officer, Qld Boating & Fisheries Patrol, PO Box 10, PINKENBA QLD 4008**

Queensland Fisheries Service

Southern Fisheries Centre
13 Beach Road
Box 76
Deception Bay Queensland 4508

Facsimile +61 7 3817 8522
Email
Mobile
Website www.dpi.qld.gov.au
Call Centre 13 25 23
RecFind 00/RecFind 40007CovAsst.doc

ABN 78 342 684 030

Your attention is drawn to the Schedule of Conditions on Permit and the need to comply with all Conditions. You should also be aware that under fisheries legislation there are requirements that all Permit holders must adhere to, and these requirements include:

- the holder is required to make the Permit or a copy available at the works site for inspection at any time by an officer authorised under the Queensland *Fisheries Act 1994*;
- this Permit does not grant permission to pass through or enter upon lands and does not infer the issue of any other Permit or Approval necessary to the purpose proposed.

If you wish to obtain a copy of the legislation it is available from Goprint, 371 Vulture Street, Woolloongabba, Qld, 4102 (Telephone (07) 3246 3399). You must also comply with all other legislation (Local, State and Commonwealth) relevant to your activities. Please note all legislation is law and penalties apply to breaches.

Additionally, QFS would draw your attention to conditions 1, 2 and 4 of the Permit. Failure to notify this Department of the commencement and completion of works by the specified dates is a breach of the Permit conditions and may render the applicant open to prosecution.

I advise that there is provision under the *Fisheries Act* for appeal, under certain circumstances, should you feel dissatisfied with the Authority's decision. For further information you should contact the Secretary of the Fisheries Tribunal on (07) 3239 3734. You should note that a notice of appeal against a decision of the Authority must be lodged with the Tribunal within twenty-eight (28) days after receiving notice of the decision. In special circumstances, the Tribunal may extend the period for filing of the notice of appeal.

If you have any further queries please contact Mathew Johnston on (07) 3817 9554.

Yours sincerely

Dan Mayer
Habitat Manager (South)
Fisheries & Aquaculture Development

Att/Enc

Fisheries Act 1994 and Fisheries Regulation 1995 Sections referring to marine plants:

Fisheries Act:

Section 4 - Main definitions:- "aquaculture", "area", "fish", "fisheries resources", "fish habitat", "marine plant", "permit", "tidal land", "tribunal", "unlawfully".

Section 6 - Fish

Section 7 - Fishery

Section 8 - Marine plants

Sections 32, 33, 34, 35, 36, 39, 40, 41, 42 - Management plans/ process/ content

Sections 49, 50, 51, 52, 53, 54, 55, 57, 59, 60 - Authorities

Section - 123, 124, 125 - Protection of marine plants, rehabilitation and restoration

Section - 196, 197, 198, 199 - Appeals

Fisheries Regulations:

Section 12, 13 - Management plans/ process/ content

Section 34, 39 - Permit issue/ restrictions

Section 77 - Aquaculture

Section 79 - Authority does not apply

Section 85 - Contravening an authority

Section 112, 113 - Fees/ payment/ waive

Schedule 10 - Fees payable

23-APR-2004 FRI 14:24 FAX NO. P. 05

Queensland Government
Department of Primary Industries and Fisheries
ABN 78 342 684 030

TAX INVOICE/RECEIPT
140029058 3

PRIMARY INDUSTRIES BUILDING, 80 ANN ST, GPO BOX 46, BRISBANE QLD 4001.

Name and Address

BRISBANE CITY COUNCIL
LOCKED MAIL BAG 6996
ALBION 4010

Receipt Details

Customer ABN
Date 11 03 2004
Cheque No 000011877 9
Drawer BRISBANE CITY COUNCIL
Payment Amount $ 1,353.00
Page 1 of 1

Qty	Particulars	Value (excl GST)	GST Amount	Price (incl GST)
1	BCC - APPLIC. FOR MARINE PERMIT	1,353.00	0.00	1,353.00
	Amount Paid	$ 1,353.00	$ 0.00	$ 1,353.00

DOCUMENT
SFC - 32E
23 APR 2004
File No.
File Location
Action By
Registered Mail Date Date
MOVEMENT INSTRUCTIONS MUST BE SHOWN ON FRONT COVER.

Do Not Pay

Cheques and other negotiable instruments are accepted subject to clearance

Queensland Government
Department of Primary Industries

QUEENSLAND
FISHERIES ACT 1994
Section 51
FISHERIES REGULATIONS 1995

PERMIT NUMBER
04SODB0007

MARINE PLANT PERMIT

This is to certify that THE CHIEF EXECUTIVE OFFICER OF BRISBANE CITY COUNCIL

of LEVEL 3 TC BEIRNE CENTRE 315 BRUNSWICK STREET MALL FORTITUDE VALLEY QLD 4006

is authorised to: remove, damage, destroy and transplant marine plants

at the approved area described as:

WITHIN LOT 716 ON SP 110610 AND PART OF LOT 2749 ON SP 110610 WESTERN EDGE OF CLUNIES FLAT, as described in DPI Plan No 04SODB0007

WITHIN UNCONSTRUCTED ROAD RESERVES OF MARINE PARADE AND AN UNNAMED ROAD, PINKENBA, as described in DPI Plan No 04SODB0007

WITHIN THE CONSTRUCTED ROAD RESERVE OF EAGLE FARM ROAD AND SERPENTINE ROAD, PINKENBA, as described in DPI Plan No 04SODB0007

for the purpose of: construction of part of the Australian Trade Coast Sewer Scheme

for the period 23 April 2004 **until** 22 April 2006

Issued at DECEPTION BAY **this** 23 **day of** April 2004

Delegate of the
Chief Executive

CONDITIONS

1 The District Officer of the Queensland Boating and Fisheries Patrol, PO Box 10, PINKENBA, QLD 4008 (Fax. No. 3860 3550), and the Habitat Manager, Department of Primary Industries and Fisheries, PO Box 76, DECEPTION BAY, QLD 4508 (Fax. No. 3817 9522), must be notified, in writing, of the date of commencement of works, fifteen (15) days prior to the commencement of works.

2 Works are only authorised if the holder has notified the Queensland Boating and Fisheries Patrol and the Habitat Manager, Department of Primary Industries and Fisheries of the commencement of works PRIOR to the commencement of those works. Any works commenced without prior notification are deemed not to be authorised.

3 A survey fee of $600.00 (for monitoring and report preparation) must be paid to the Department of Primary Industries, PO Box 76, DECEPTION BAY, Qld 4508, prior to the commencement of works, but in no case later than thirty (30) days after the effective date of this Permit.

4 A written report which details the completed works must be provided within fifteen (15) days of completion of works to the District Officer, Queensland Boating and Fisheries Patrol, PINKENBA, and the Habitat Manager, Department of Primary Industries and Fisheries, DECEPTION BAY.

5 This Permit authorises persons identified by the holder to assist in the authorised activities on the approved area.

6 The holder must comply with:
a) the requirements of all relevant legislation and obtain approvals from the relevant administering organisations, including approvals to access and use the land for the authorised activity; and
b) any Codes of Practice or management arrangements relevant to the authorised activity.

7 At least two (2) signs must be displayed around each of the works sites in positions where they are clearly visible to the public for fifteen (15) days prior to the commencement of the authorised activity and during all authorised works. Each sign must advise and describe the authorised activity as follows: "Works authorised under QDBI Permit No. 04SODB0007".

8 This Permit is given for necessary disturbances within the approved area only and the works involved must be performed in such a manner as to not cause direct or indirect disturbance or damage to adjacent land or plants or unnecessary disturbances within the approved area.

9 The holder must adequately mark (peg) the boundaries of the approved area to allow for ease of identification.

10 The holder is to ensure that all spoil from the approved area is not disposed on to land or within waterways and is managed to prevent acid spoil development, if relevant.

Delegate of the
Chief Executive

CONDITIONS (continued)

11 All marine plants authorised for removal, exclusive of those to be used for a restoration project acceptable to the Department of Primary Industries, and other debris, is to be removed from the intertidal zone and disposed of in a neat and tidy manner.

12 The holder must pay the annual fee by the due date each year.

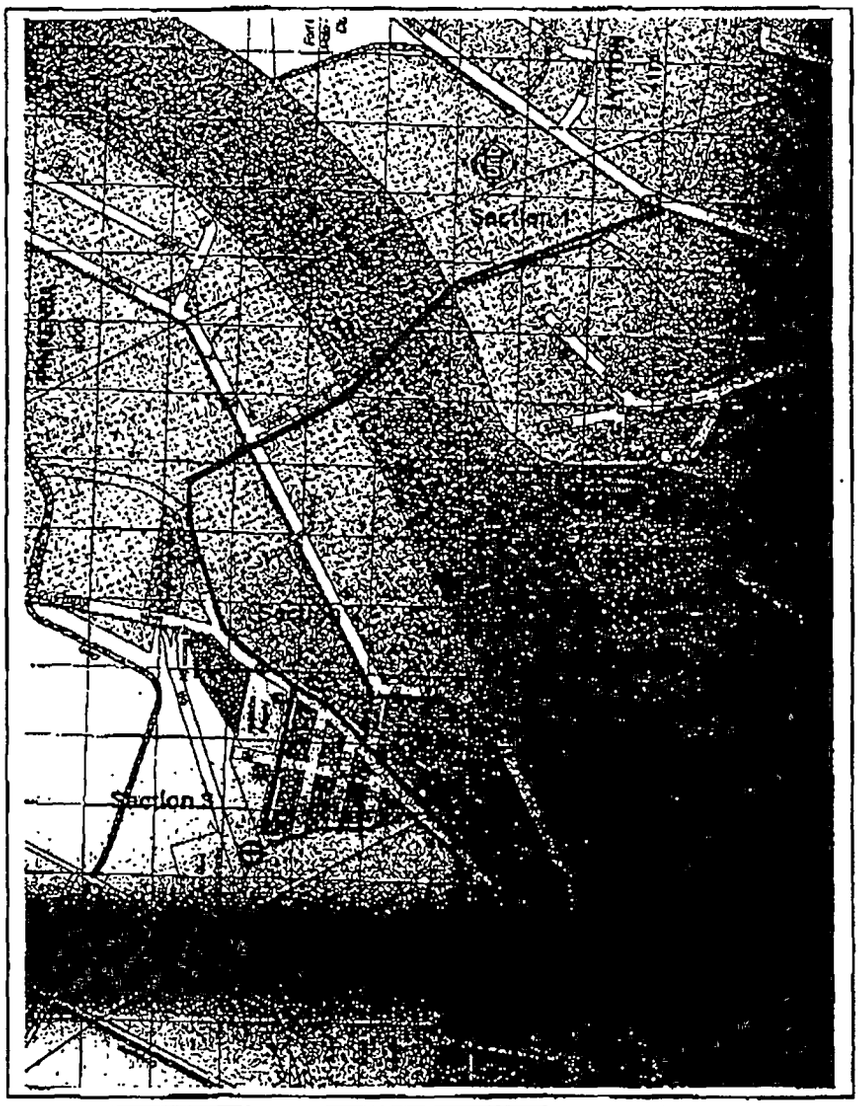
SCHEDULE OF FEES

Date	Fee	Receipt No	Fee Type
5/01/2004	$147.00	130282	Marine Plant Permit Fee - 2002 - GST exempt
11/03/2004	$1,353.00	1400290583	Assessment Fee - Marine Plant Permit - 2003 - GST exempt

Page 3 of 3 of Marine Plant Permit No. 04SODB0007

Delegate of the Chief Executive

23-APR-2004 FRI 14:24 FAX NO. P. 08



Key

Red line indicates proposed sewer pipeline route where marine plant disturbance will occur (mostly scattered saltcouch and samphires, however some mangrove trimming and removal will be required);

Black line indicates proposed sewer pipeline route where there will be no disturbance of marine plants;

⊕ Indicates position of pump stations.

Area of Permit

Brisbane City Council is authorised to disturb, damage, destroy and transplant marine plants for the construction of the Australian Trade Coast Sewer Scheme at the following locations:

Section 1 - Clunies Flat, Lytton
Marine plant disturbance at this location includes removal of saltcouch and samphire species, trimming of mangroves and the removal of one *Avicennia marina* specimen. Total estimated disturbance area is 4880m^2.

Section 2 – Marine Parade, Eagle Farm Road, and an Unnamed Road between Eagle Farm Road and Mundin Street, Pinkenba
Marine plant disturbance at these locations includes removal of saltcouch, scattered saltcouch and samphire and some minor mangrove trimming. Total estimated disturbance area is 6979m^2.

Section 3 – Serpentine Road, Pinkenba
Marine plant disturbance at this location includes the removal of less than 10m^2 of poor quality saltcouch.

Figure is a computer scan of a section of Maps 141 and 142 in the 2004 Brisbane UBD Street Directory, and an interpretation of plans submitted by the proponent.

PARSONS BRINCKERHOFF

A2. Brisbane City Council (DRS)

4138110B

#39 RMC

Contact Name: John Donaghy
Telephone: 3403 8888
Fax (Direct): 3407 0750
Your Ref: 2138110B-LTR01

RECEIVED
18 FEB 2004

Brisbane City Council
ABN 72 002 765 795

North Regional Business Centre
Development and Regulatory Services
Customer & Community Services Division
960 Gympie Road
Chermside Qld 4032
Locked Bag 960 Virginia Qld 4014

Telephone 07 3403 8888
Facsimile 07 3407 0750

February 16, 2004

Noted
JRB
18/2/04

Parsons Brinckerhoff
GPO Box 2907
BRISBANE QLD 4001

Attn: Ian Cameron – Design Manager

Dear Sir,

NOTICE OF INTENTION TO PERFORM WORK ON ROAD
at Lytton Road Pump Station to Serpentine Road Pump Station –
Re: Australia Trade Coast Sewer Project –
Approval of Alignments for Sewerage Rising Mains

I refer to your notice, dated 10 February 2004, in which you seek permission to perform work at the above location.

The alignment for the work is to be as per Drawings submitted and any work in footways is to have a permanent level of 1:50 above the top of kerb. You are required to adopt this alignment for the full length of the proposed works.

Service Pillars or Boxes are to be placed on an alignment of 0.6m from the Real Property Alignment. If your proposal includes the placement of any RIMs, RCMs or any type of Cabinet in new subdivisions they are to be placed in parkland or in a small area of land inside the real property alignment excised by the developer.

Any variation to any of the above conditions or alignments must be authorised by the Region' s Team Leader, Licensing and Compliance, Development and Regulatory Services.

Local Area Precincts, Queen Street and Brunswick Street Malls will require separate approvals.

If you require a work zone permit, the hooding or removal of parking meters, or a road or part road closure permit you will be required to lodge a separate application. The approval to commence the proposed work does not allow you to park vehicles on footways, loading zones, bus stops or any restricted parking area.

The preferred method of laying of cables, conduits or pipes within the City of Brisbane is by boring or tunnelling.

As you are responsible for the repair of any damage that you may cause to any Council asset during this proposed work, you will be required to fully restore the asset. Repair of the asset may involve full restoration of any signature type of asset. You are also required to notify this office stating the date of repair and type of damage that has been caused to Council=s assets. You should also be aware that Council requires you to maintain any repairs to its assets for a period of not less than six (6) months from the date of notification of the repairs. Council will not accept repairs that do not conform to Council Standards.

Road trenching where necessary is to be saw cut and backfilling is to be compacted to Mod 95% AASHO before resealing. Council may require proof from you that this compaction has been attained. All roadwork is to conform to Brisbane City Council's Standard Road Patching Design Guide.

Concrete footpath is to be removed in 1m sections by saw cutting and replaced to standard drawing UMS.231 or for full width concrete footpath UMS.232. Signature and Banded Footpath is to be fully replaced. Pavers are to be lifted (not saw cut) and stored in a secure location until replaced.

Concrete kerb and channel is to be saw cut in a minimum length of 1m and replaced to standard drawing UMS.211.The use of paint for marking site locations is to be kept to a minimum and all paint marks are to be removed at the completion of work.

Where damage may occur to Council Footpath Trees, Council's Vegetation and Pest Services are to be contacted prior to commencement of work. Where damage may occur to Bushland Rehabilitation Areas, Council's Local Assets Services are to be contacted prior to commencement of work.

Driveways across footpaths are considered by Council to be privately owned by the property owner, prior to commencing any work, that may damage a private driveway, you should negotiate with the property owner and agree on the standard of repair.

It is also your responsibility to check for any heritage, vegetation or environmental listings and also to check for the location of all other Public Utility Services, and to repair any damage that may occur to any street furniture or Council asset.

Council has a policy of notifying the Ward Councillor, all residents and local businesses that may be affected by any planned works in advance of the commencement of this work. It is considered that part of your consultation process should be the same and to also notify any other person that may be affected by your proposed work.

Where work is to be performed on roads under the control of Department of Main Roads, then they are to be contacted for approval of the works, prior to the commencement of any work.

Development and Regulatory Services has no objection to you proceeding with the proposed work from the date of this letter

Yours sincerely

for John Donaghy
Licensing and Compliance Officer North
DEVELOPMENT AND REGULATORY SERVICES

A3. POBC

Parsons Brinckerhoff

12th floor, IBM Centre
348 Edward Street
Brisbane Qld 4000
GPO Box 2907
Brisbane QLD 4001
Australia
Telephone +61 7 3218 2222
Facsimile +61 7 3831 4223
Email brisbane@pb.com.au

ABN 84 797 323 433
NCSI Certified Quality System ISO 9001

Our Reference: 2138110B-LTR003Aic:rmk

15 December 2003

Projects Branch
Brisbane Water
GPO Box 1434
BRISBANE QLD 4001

Attention: Project Manager, Mr Andrew Bannink

Dear Andrew

Australia Trade Coast Sewerage Project
Proposed Lytton Road Sewage Pump Station Site
Excision of Port of Brisbane Corporation Land

In relation to the proposed excision of Part of Lot 719, SP110610 to create a site for the proposed Lytton Road sewage pump station SP298, we provide the following information on the proposed works on the subject land.

A. Construction Phase (by Leighton Contractors)
   1. Construction access road.
   2. Laydown area for construction materials and equipment.
   3. Sheetpiling for formwork for construction of pump well.
   4. Excavation of spoil material.
   5. Construction of reinforced concrete submersible sewage pump station including dual pumps, switchboard and SCADA control system.
   6. Installation of standby generator for pump station and odour control equipment.
   7. Provide access to south bank of Brisbane River to allow for construction of river crossing either by horizontal directional drilling (HDD) or micro-tunnelling.

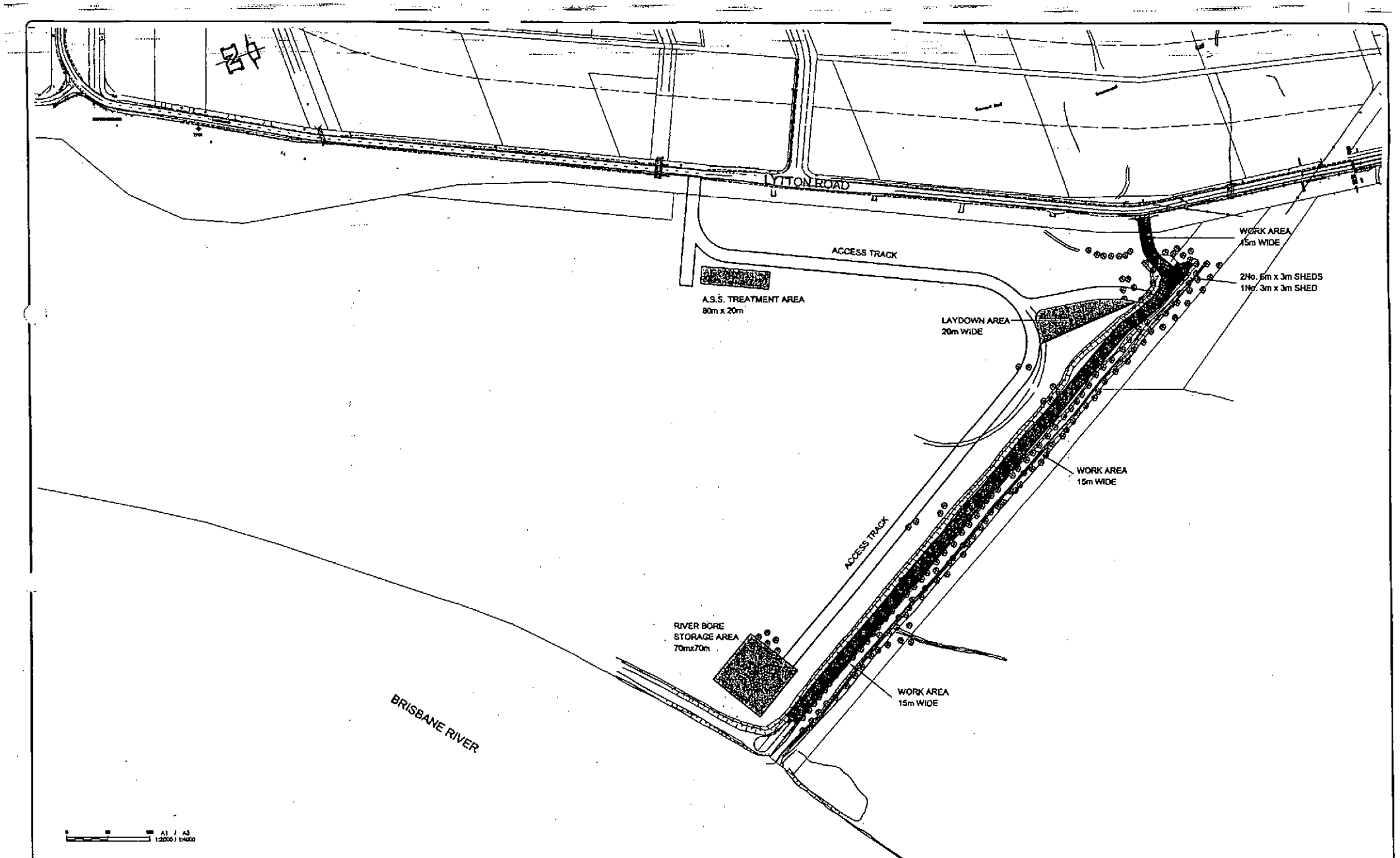
B. Operations Phase (by Brisbane Water)
   1. Visits by Brisbane Water operations and maintenance staff to check on pump station.
   2. Visits for maintenance activities at the pump station.
   3. Access for vacuum trunks to pump out the pump well for emergency repairs to the pump station.

We trust that this information meets your requirements. Should further information be required, please call me on 07 3218 2644 or 0401 148 142.

Yours sincerely

Ian Cameron
Water Executive
Parsons Brinckerhoff Australia Pty Limited

Over a Century of Engineering Excellence


LYTTON ROAD
ACCESS TRACK
A.S.S. TREATMENT AREA
80m x 20m
WORK AREA
15m WIDE
2No. 6m x 3m SHEDS
1No. 3m x 3m SHED
LAYDOWN AREA
20m WIDE
WORK AREA
15m WIDE
ACCESS TRACK
RIVER BORE
STORAGE AREA
70mx70m
WORK AREA
15m WIDE
BRISBANE RIVER
A1 / A3
1:2000 / 1:4000
Cardno MBK
PB PARSONS BRINCKERHOFF
DESIGN MANAGER
R.P.E.Q. NO. 2241
DATE 20/06/03
MANAGER ENGINEERING
DATE
CADD FILE
JOB FILE
SURVEYED
SURVEY NO.
FIELD BOOK
DESIGN
DESIGN CHECK
DRAWN
DRAFTING CHECK
NO. DATE AMENDMENT INITIALS
Brisbane Water
PROJECT
AUSTRALIA
TRADE COAST SEWERAGE
PROJECT
TITLE
BASE PLAN
CLUNIES FLAT AREA
BW CONTRACT No. 30137-02/03
LEIGHTON JOB No.
PB JOB No. 2138110A
SCALE AS SHOWN
A.H. DATUM
No. OF SHEETS
DRAWING No. PD206
AMEND.

PARSONS BRINCKERHOFF

Appendix B

Communications
B1 — Energex

PARSONS BRINCKERHOFF

Australia Trade Coast Sewer Project
Contract No. BW30137-02.03
Revised Developed Design Report
Separable Portion No. 2
Lytton Road Pump Station SP298

B1. Communications — Energex

2138110B
Noted SRL

5 June 2004

e-copy to Andrew Bannink 7-6-04

energex

Parsons Brinkerhoff
GPO Box 2907
Brisbane QLD 4001

Attention Ian Cameron

Dear Sir

AUSTRALIA TRADE COAST SEWER PROJECT –
POWER SUPPLY FOR LYTTON ROAD PUMP STATION SP298

ENERGEX has now finalised all the arrangements regarding the installation of a 500kVA Padmount Transformer for the above development, I advise as follows;

The customers responsibilities:

- To prepare the Substation site 3.0m x 2.8m to ENERGEX Specifications. This includes the supply and installation of the culvert.
- To pay a Padmount Transformer fee of $4,400 plus $440.GST and an excess cable fee of $7,500 plus $750 GST (Total $11,900 plus $1,190GST = $ 13,090).
- To supply and install 4 x 125mm conduits from the proposed transformer site to 150mm beyond the front property boundary to ENERGEX Specifications.
- The customer's point of supply will be from the low terminals of the transformer. The maximum fault level for a 500KVA transformer is 15.7kA

Please note a tax invoice will be issued when the supply of goods or services has been completed. For tax invoice purposes, could you please provide ENERGEX with the name of whom the invoice is to be made out to, including their address and A.B.N. number etc.

INTERNATIONAL QUALITY MANAGEMENT SYSTEM

Enquiries
Robert Mitchell
Telephone
(07) 3000 6682
Facsimile
(07) 3407 5660
Email
robertmitchell@energex.com.au

Corporate Office
150 Charlotte Street
Brisbane Qld 4000
GPO Box 1461
Brisbane Qld 4001
Telephone (07) 3407 4000
Facsimile (07) 3407 4609
www.energex.com.au

ENERGEX Limited
ABN 40 078 849 055

Reference C0054564

Please find attached:

A 'Business Connection – Electricity & Gas' form, which is to be filled out by the customer and returned to this office with all other associated paperwork and payments.

A 'Metering CT Order' form, which is to be filled out by the electrician when they require the new CT's. In order for this form to be filled out in full, the customer must have first returned the above 'Business Connection – Electricity & Gas' form to obtain their new account number.

Two copies of the 'Proposed Electricity Supply Arrangements' form, which summarises the supply arrangements including dates and explains the customer's responsibilities. Please read this form, sign one copy and return it to this office with all other associated paperwork and payments.

ENERGEX has nominated a target date for supply of the 30/09/2004. To achieve this target the substation site is to be ready by the 10/09/2004 for inspection. All paperwork and payments are to be received at our Greenslopes Office by the 30/07/2004.

The transformer will be placed on site on the 17th of September 2004, the electrician has the week from the 17th of September 2004 to the 24th of September 2004 to pull their consumer mains into the transformer whilst the transformer is de-energised. After the transformer is energised on the 24th of September 2004, the electrician will need to pay for a safety observer to open the transformer, over see their work, and then close the substation on completion.

Should you require any further information regarding the above, please do not hesitate to contact myself on telephone (07) 3000 8882.

Yours sincerely

Robert Mitchell
Planning Officer

energex
160 Charlotte Street Brisbane 4000
GPO Box 1461 Brisbane Queensland 4001

Proposed Electricity Supply Arrangements

Industrial and Commercial Customers requiring a Substation Site

Project				
Reference Numbers	ENERGEX - C0054564	Location – Greenslopes Depot		
Project Name	Australia Trade Coast Sewer Project – SP298			
Location of Project	Lytton Rd, Hemmant			
Real Property Description	Lot 716 on SP110610			
Customer Details				
Name of Customer (please print)				
Customer's Representative	Parsons Brinckerhoff			
Telephone Number	3218 2222		**Facsimile Number**	3831 4223
Address	GPO Box 2907			
	Brisbane QLD 4001			
Contact Person (please print)	Ian Cameron			
Exist Account No.(s)				
Supply Information				
Type of Industry or Purpose of Building				
AS 3000 Calculated Demand	500kVA		**Estimated Demand**	500kVA
Size of Largest Motor / Special Apparatus	kW			
Location of Substation	Located as per ENERGEX fax dated 19-04-2004			
Type of Substation	Padmount Transformer			
Major ENERGEX Equipment and Rating	Initially	500kVA	Ultimately	500kVA
High Voltage Method of Supply	From	the existing underground mains in Lytton Road.	To	to the RMU inside the proposed padmount transformer.
Low Voltage Circuits	To Customer	ONE		
	To ENERGEX Network	Up to three.		
Metering Type (High Voltage / Low voltage)	Low			
Customer to install/uprate metering CT's (yes/no)	Yes			
Customer's Point of Supply (Customer's Terminals) is the LV terminals of the transformer				
Possible Fault Level at Customer's Point of Supply	15.7kA at 433V			
Customer to Carry Out	Preparation of substation site as per ENERGEX Specifications. Install 4 x 125mm conduits from the proposed padmount transformer site to 150mm beyond the front property boundary to ENERGEX Specifications.			
Customer to Bear Cost of	All costs to prepare the substation site including the supply of the culvert. The cost to supply and install the conduits. A transformer fee of $4,400 plus $440 GST and excess cable fee of $7,500 plus $750 GST (Total $13,090). Any work required outside normal working hours.			

ENERGEX Contacts	**Type**	**Name**	**Telephone No.**	**Facsimile No.**
	Design	Rob Mitchell	(07) 3000 8882	(07) 3407 6660
	Metering/Inspection of Customer's Installation	Gary McCormick	(07) 3407 6606	(07) 3407 6800
	Construction and Transformer Delivery	Rob Mitchell	(07) 3000 8882	(07) 3407 6660

Relevant Drawings	*Enclosed		
Application for Supply	*To be lodged	**Date Lodged**	/ /
Date Supply Required	30/09/2004		

* Cross out where not applicable

To be completed by ENERGEX

ENERGEX will proceed with detailed planning for supply to the above project after receipt of acceptance of the supply arrangements as set out in this form and the drawings above.

Note: If this is a new account, the customer is required to apply for electricity supply and provide the relevant security deposit before electricity supply can be connected to the property. This can be done by telephoning ENERGEX's Call Centre on telephone number 13 12 53. Please quote ENERGEX project number D1401385 when making application for supply.

Nothing contained herein or shown on the drawings absolves the customer from obtaining building approval for the proposed substation from the relevant Authority.

Under the provisions of the Electricity Act 1994 -

1 the space necessary for and suitable to the erection of a substation shall be provided free of cost to ENERGEX
2 right-of-way for electricity lines and cables and access to install, maintain and remove its equipment without hindrance or obstruction shall be available at all times to ENERGEX
3 maintenance and repair of the substation space including building structure to the requirements of ENERGEX shall be the responsibility of the Customer

The Customer shall make the transformer site ready for inspection by the date nominated and is required to notify ENERGEX to arrange a site inspection. Failure of the site to pass inspection or be ready by the required date may delay the supply availability date.

Details of the time and date of delivery will be negotiated between the Customer and ENERGEX's representative after the site has passed inspection. A minimum period of five (5) working days shall be allowed for delivery to the site. ENERGEX estimate that supply will be made available within 10 working days of delivery of the transformer(s) to site.

Once the transformer has been placed on site, the customer's electrician will have 5 working days, prior to energising of the transformer, to pull the consumers mains into the transformer. If the electrician fails to install the consumer's mains into the transformer prior to energising of the transformer, ENERGEX will require the electrician to engage an approved safety observer at their cost. The safety observer will open the transformer, oversee the task and close the transformer on completion of works.

Name (please print)	Rob Mitchell
Position (please print)	Electrical Paraprofessional
Signature (for Chief Executive)	**Date** 05/06/2004

To be completed by the Customer or Customer's Representative

I, on behalf of the Customer specified in this document, accept the electricity supply arrangement as described in the above information. I confirm that the substation site will be completed to ENERGEX's requirements and ready for inspection by ENERGEX on 10/09/2004. Taking into account the lead times required by ENERGEX, I also confirm that the "Date Supply Required" 30/09/2004.

Name (please print)	
Position (please print)	
Organisation	
Signature	**Date** / /

energex

Attention	Michael Brand		
Company	PB		
Fax Number	3831 4223	**Reference**	C0054564
Date	19 April 2004	**Number of Pages**	14
Subject	LYTTON ROAD SEWAGE PUMPING STATION POWER SUPPLY		

Noted
4-5-04

Dear Sir

Further to your fax dated the 20th of February 2004 regarding the electrical supply to the above development, I advise as follows;

Customer's responsibilities:

- To supply and install 4 x 125mm conduits to ENERGEX Specifications.
- To prepare the padmount transformer site to ENERGEX Specifications. This includes the supply and installation of the culvert.
- The customer is pay a transformer fee of $4,400 plus GST and an excess cable fee of $7,500 plus GST (Based on 75m run). Total $11,900 plus $1,190 GST Totalling $13,090.
- Customer's point of supply will be from the fuse terminals of the LV board inside the transformer. The maximum fault level for a 500kVA transformer is 15.7kA.

ENERGEX Responsibilities:

- To run 4 x 125mm conduits under Lytton Rd to Pole 39752.
- Run 240mm underground cable from pole 39752 to the proposed transformer site and terminate to the transformer.

Enquiries
Robert Mitchell
Telephone
(07) 3000 8882
Facsimile
(07) 3407 5660
Email
robertmitchell@energex.com.au

Corporate Office
150 Charlotte Street
Brisbane Qld 4000
GPO Box 1461
Brisbane Qld 4001
Telephone 07 3407 4000
Facsimile 07 3407 4809
www.energex.com.au

ENERGEX Limited
ABN 40 078 849 055

- The installation of a 500kVA padmount transformer at the proposed transformer site, including all required earthing.

Please note the transformer site on the opposite side of the road to your Switchboard. Because there is no low voltage network in the street, this transformer is not able to be tied into the common MEN network and will require is own separate earthing. This means that the transformer must be separated by a minimum of 5 meters from any other structure or building.

ENERGEX has noted your required supply date of the end of August 2004 and on written acceptance of the above offer, ENERGEX will program the date. To achieve your required supply date ENERGEX will require acceptance by the 30th of April 2004.

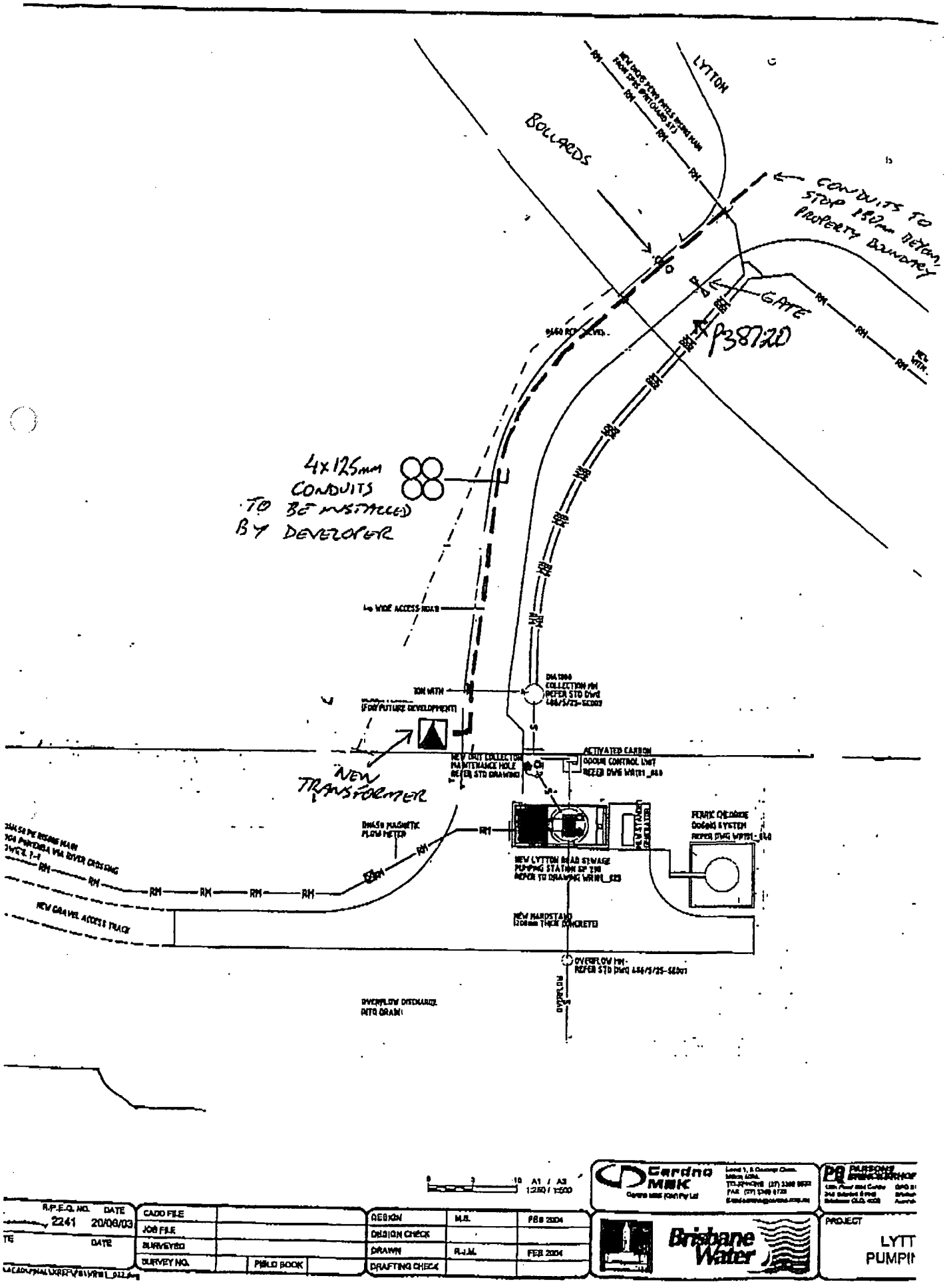
Attached is a brief of the ENERGEX Specifications for padmounted transformers, the full Specifications can be found on the ENERGEX web Page (www.energex.com.au). From the home page there is a heading in the top right called "Service Providers", click on it and then click on "Technical Documents", scroll half way down the page to "Commercial And Industrial Padmounted Substations".

If you have any questions, please call.

Yours sincerely

Robert Mitchell
Planning Officer

19-APR.'04(MON) 12:47 ENERGEX PLANNING TEL:61 7 30008886 P.003



1 Introduction

This specification covers padmounted distribution substations on consumers' premises. Sites and foundations for these substations are to be prepared according to the site sketch and design standards contained in this document.

The consumer's consultant is responsible for ensuring that all information and drawings are passed on to the relevant contractor(s). ENERGEX may charge for the supply of additional copies.

2 Site

2.1 General

Where practicable, padmount substation sites for commercial and industrial developments shall be located at the real property street alignment with the substation cabinet doors facing the adjoining footpath. Sites located on the street alignment shall be surveyed and dedicated as part of the road reservation.

The site shall:

- have stable soil conditions
- be flood free
- have level topography
- where possible free from steep batters
- be at least 4 metres from the edge of permissible residential dwelling construction area

Services such as drains, sewers, water services, air-conditioning installations, electrical and communications cables etc, other than those specified by ENERGEX, must not pass through or encroach into the substation site.

Along coastal areas, the padmount substation site must be located as far as possible from the shoreline and sheltered from salt spray.

2.2 Preparation

Padmounted substation sites shall be prepared in accordance with the included construction drawings.

2.3 Space Requirements

The recessed area off the footpath required for "square" type padmounted substations shall be:

- level sites 3000 mm length x 2800 mm depth
- retaining wall sites 3400 mm length x 3000 mm depth

2.3.1 Restricted Areas

If the padmounted substation site does not front the road reserve, then an additional minimum width of 2.0 metres of clear access shall be provided in front and for the full width of the substation site (making a 4.8 m deep site). This will provide a safe working platform and access around the lockable doors when opened for emergency operations.

2.3.2 Landscaped Areas

When the padmounted substation is located in a landscape area (gardens) the following shall be complied with:

- An additional minimum width of 2.0 metres of clear access shall be provided in front and for the full width of the substation site (4.8 m depth). This will provide a safe working platform and access around the lockable doors when opened for emergency operations.

UNCONTROLLED COPY

- A formed pathway from the footpath real property street alignment to the padmounted substation site. This will provide safe access to the substation site for field personnel.

When planting vegetation in landscaped areas and gardens, take into consideration the fully matured size of vegetation, ensuring access to the site, one metre clear access around the sides and back of the substation is maintained and two metres clear access to the front of the substation is maintained.

The site surface is to be finished with a concrete slab (refer to the construction drawings).

The 2.0 metre wide apron in front of the substation cabinet shall be finished with a concrete slab sectioned with construction joints for easy removal to excavate.

The formed pathway is to be a concrete slab (refer to the construction drawings). The concrete pathway slab shall be clear of cables and conduits to the substation.

The surface of the pathway slab may be finished with clay brick pavers or concrete tiles over the slab. Installation to be in accordance with the paver/ tile manufacturer's installation specification.

2.3.3 Truncated Street Alignment

If the padmounted substation site boundary is located at a truncated section of the street alignment, the following applies:

- The front edge of the substation plinth shall be 200 mm from and as near to parallel as possible to the real property street alignment.
- A minimum of 600 mm clear access around the substation sides and back shall be maintained to the real property boundary.

2.3.4 Spacing Between Padmount and Other Metal Objects – Separate Earthing

The distance between the edge of the plinth and the consumer's building/ residences, fences, LV switchboard earth and metal builder's poles, shall be a minimum of 5 metres at sites where separate LV and HV earthing systems are installed. The additional area shall be road reserve or an easement to prevent encroachment.

The distance between the edge of the plinth and telecomunications plant and equipment shall be 15 metres at sites where separate LV and HV earthing systems are installed.

3 Concrete Apron

The site surface is to be finished with a concrete slab (refer to the construction drawings). The 2.0 metre wide apron in front of the substation cabinet shall be finished with a concrete slab sectioned with construction joints for easy removal to excavate.

4 Retaining Walls

Retaining walls shall be constructed to ENERGEX standards around the perimeter of a padmounted substation site when a change in ground level of 300 mm or more occurs within two metres of the boundary of the padmounted substation site.

5 Future Development

Sites that may restrict future development of the premises should be avoided. Future relocation of the substation and electrical equipment would be extremely costly to the owner of the premises. In addition future development of the site must not encroach on the agreed access route to the substation.

6 Site Access to Restricted Areas

6.1 Personnel Access

ENERGEX staff must have access to the substation at all times without having to enter security areas. The onus is on the consumer to maintain access 24 hours a day, seven days a week.

6.2 Heavy Equipment

Padmounted transformers are transported by flat bed trucks with self contained cranes. As such an all-weather access roadway suitable for use by these vehicles is required from the street to the substation site. An equipment handling area and room for vehicle manoeuvring must be allowed for adjacent to the substation.

Suitable headroom is required along the route of passage of the vehicles and in the equipment handling area and vehicle manoeuvring room such that operation of the crane is not impeded. The headroom required is not less than 4.3 m, for structures on a level access route. Where the access route is on sloping ground and/or where there are humps or dips in the access route, the headroom for structures must be increased as necessary to compensate. Each case will need to be determined to the satisfaction of ENERGEX's liaison officer.

The width of the access route should be increased on bends and in the manoeuvring area near the substation site to allow for the off loading of the padmounted transformer from the truck.

The above clearance requirements must be achieved after completion of building surface treatments including cladding of overhead structures, and paving of the access route.

Any reinstatement necessary in the event of damage to concrete slab, paving tiles or road surfaces, doors etc., is the responsibility of the owner of the property.

7 Foundations

7.1 General

Where padmounted substation sites are very unstable, and conventional foundation construction techniques as described in this document cannot be applied, a special design shall be required.

In such circumstances, the developer shall provide a certified design from a civil engineer (RPEQ) for ENERGEX's consideration. No special designs for padmount substation foundation construction shall be used without the approval of ENERGEX (design).

7.2 Uniculvert Foundation

Uniculvert foundations for both stable and unstable soil conditions shall be constructed in accordance with the construction drawings.

7.3 Concrete Pier Foundation

Concrete piers shall be installed where the site ground conditions do not provide an even or equal bearing capacity for the padmount foundation.

The concrete pier foundation is suitable for substations from 200 to 500 kVA 11 kV/ 433- 250 V only.

For 750 to 1000 kVA 11 kV/ 433- 250 V, use the uniculvert foundation type if applicable.

Concrete piers shall be constructed in accordance with the construction drawings.

8 Backfilling and Final Restoration of Surface

All backfill of the padmount substation site must be compacted before final restoration of the site surface.

Sealing of the cable apertures in the precast concrete plinth and construction of the concrete surround slab over the ground surface shall be in accordance with the construction drawings.

9 Cable Conduits

9.1 General

ENERGEX cable conduits for the development may be placed in the substation site and shall pass down the sides or through the uniculvert foundation. No conduits shall pass under the uniculvert foundation. Conduits shall be 600 mm minimum depth below the finished surface level. Ensure end wall knockouts are grouted with a high strength sand and cement grout after conduit/ cable installation through uniculvert foundation.

9.2 Specification

All conduits, associated fittings and bends shall comply with the requirements of AS/ NZS 2053.

Conduits shall be 125 mm or 150 mm as specified by ENERGEX and shall be supplied and installed by the consumer.

To provide for a change in direction of conduits, bends shall be installed. Bends can be cut to suit the particular deviation angle required. Conduit bends shall be of the same class and colour as the conduits. All conduit couplings shall be fitted in accordance with the manufacturer's instructions.

An adequate quantity of solvent and cement shall be used in performing connections; and shall be disposed of using the approved manufacturer's method.

9.3 Draw Rope

A continuous length of draw rope having a minimum breaking strength of 1.0 kN, shall be left in the full length of conduits.

9.4 Cleaning and Testing

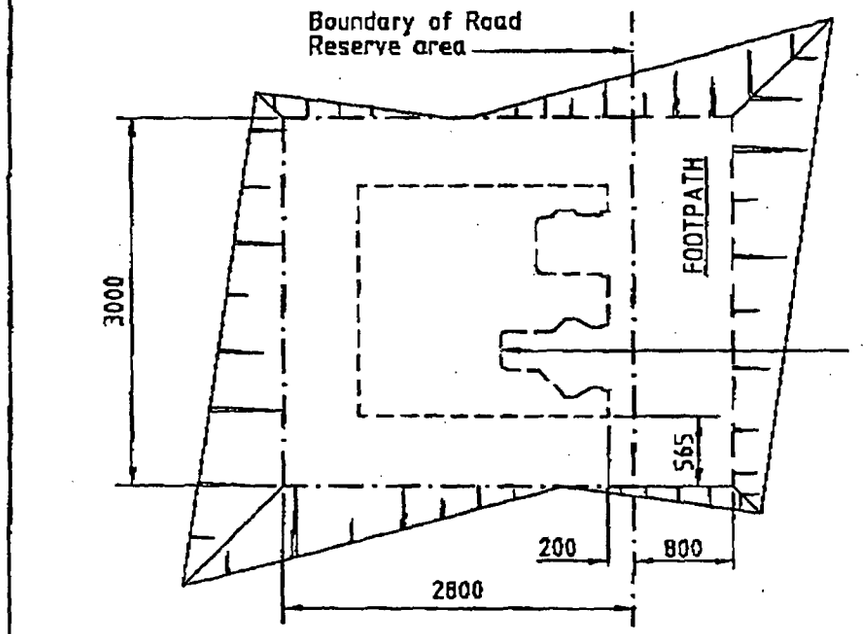
After completing the laying and backfilling of each section of conduit, the bore of the conduits shall be cleaned of dirt or other substances and tested for obstructions.

9.5 Sealing

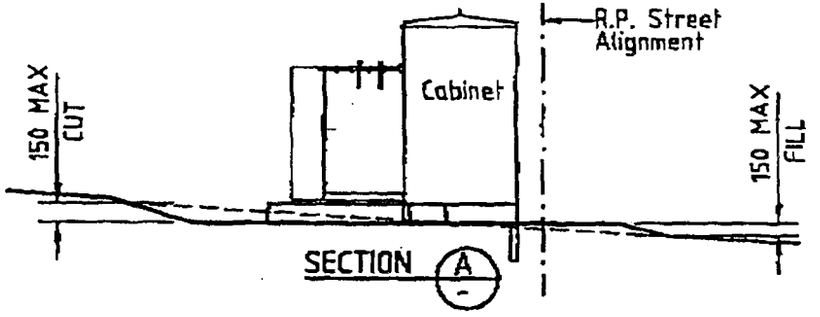
After completing the laying and backfilling of each section of conduit, the bore of the conduits shall be cleaned of dirt or other substances and tested for obstructions.

9.6 Entry to Permanent Structures

Where conduits enter any permanent construction such as a pit or a substation building, the conduit entry aperture is to be resealed. The exposed ends of all conduits shall be squarely cut and plugged.



PLAN



For SEPARATE LV & HV earthing provide a five metre clearance zone from the edge of the plinth, The clearance zone is to be maintained free from metalic objects, buildings and structures.
- including their foundations.

NOTE:

1. ENERGEX's 3000mm x 2800mm access area (road reserve) shall be levelled and surrounding area graded to ensure NO PONDING of water occurs.
2. No services other than the ENERGEX's electric cables shall pass through this substation site.
3. Clear access to the transformer shall be maintained for ENERGEX's personnel and heavy equipment.
4. After installation is complete the site surface is to be finished with a concrete slab.
5. Mature landscaping (including trees, sprinklers etc) shall not encroach onto the substation site.
6. The finished surface of the adjacent footpath in front of the padmount cabinet shall be level to ensure padmount doors will swing into the fully open position.

A	ORIGINAL ISSUE				

UNCONTROLLED COPY

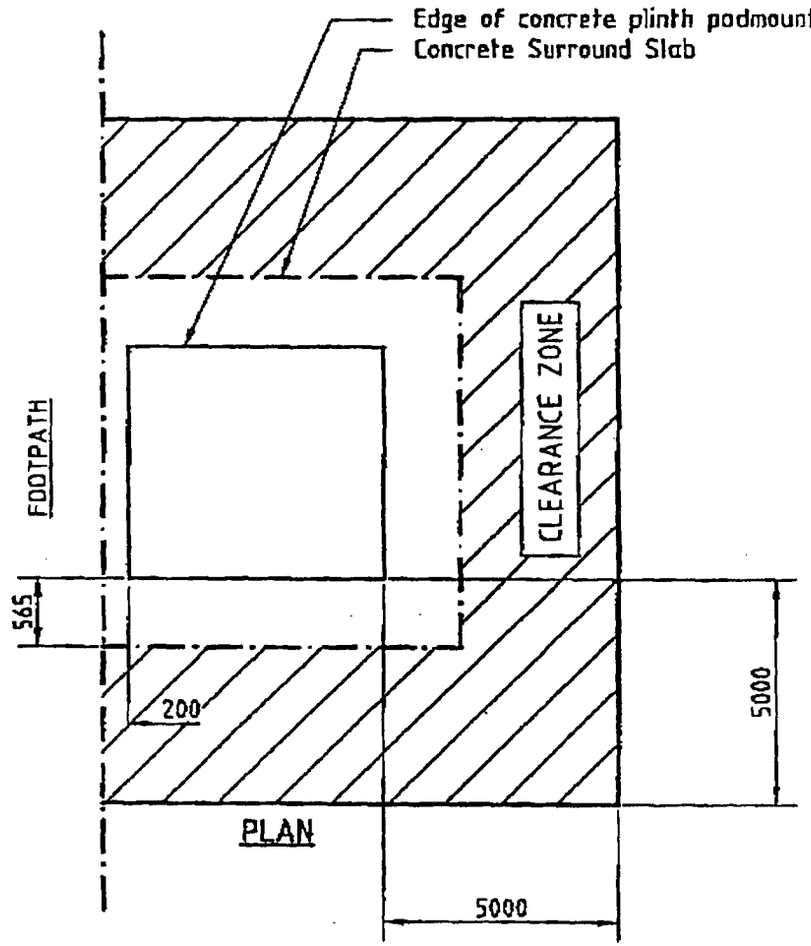
energex

SCALE	1:50
APP'D	D Lloyd
DATE	31 May 2002
REC'D	D.Taylor
CK'D	J.Tunney
DRN	W.W.
	CAD

PADMOUNTED TRANSFORMER
CONSTRUCTION
SITE PREPARATION
SLOPING SITE - MAXIMUM CUT & FILL

SHEET 1 OF 2 | 7472-A4 | A

PY



NOTES

1. For SEPARATE LV & HV earthing provide a five metre clearance zone from the edge of the plinth. The clearance zone is to be maintained free from metallic objects, buildings and structures - including their foundations.
2. HV earth electrodes are to be contained within the padmount site.
3. The clearance zone shall be turfed or landscaped with mulched beds and shrubs.
4. Every attempt should be made to locate separately earthed padmounts in areas remote from residential dwellings.
5. The clearance zone shall be road reserve or an easement to prevent encroachment.

A	ORIGINAL ISSUE		

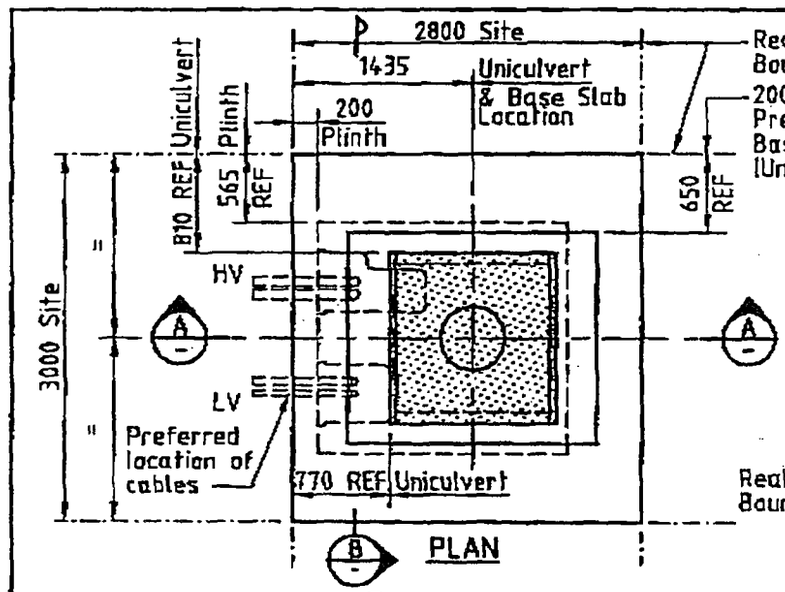
PY

energex

SCALE	NTS
APP'D	D Lloyd
DATE	31 May 2002
REC'D	E.Taylor
CKD	J.Turney
DRN	W.W.
	CAD

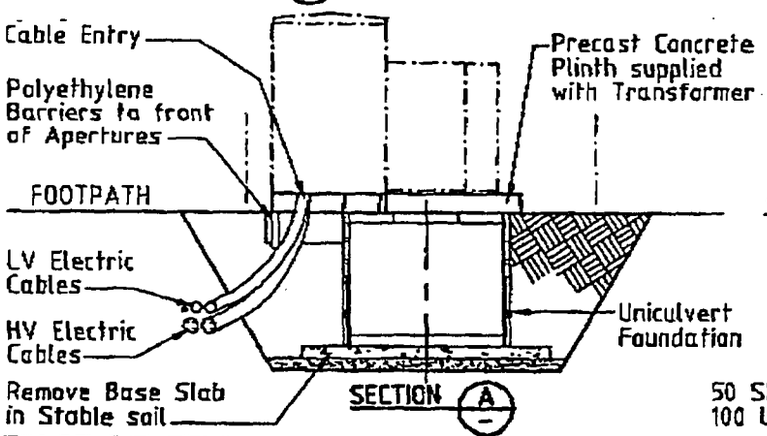
PADMOUNTED TRANSFORMERS
CONSTRUCTION - PADMOUNTED SUBSTATION
SITE PREPARATION
SEPARATE LV AND HV EARTHING

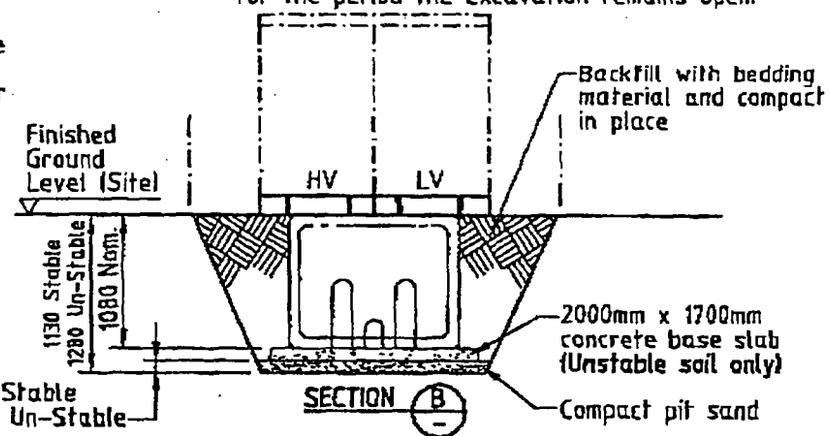
SHEET 1 OF 1 | 7466-A4 | A



NOTES:

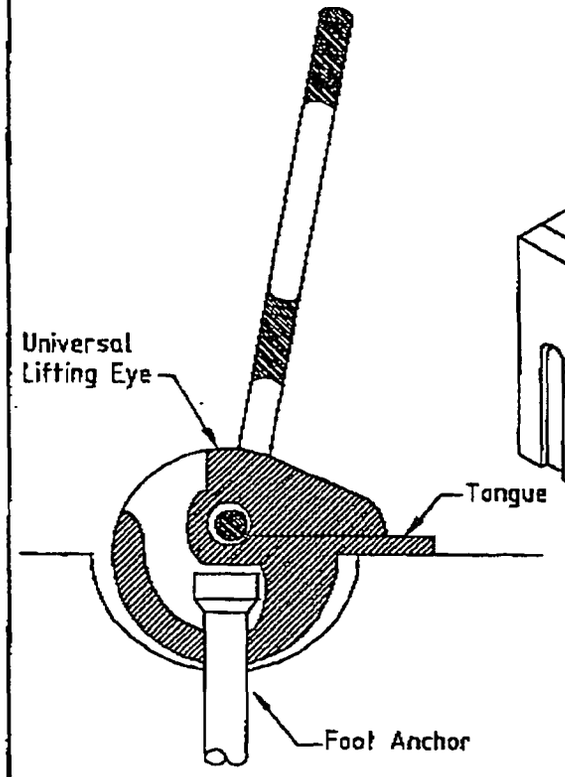
1. Foundation design details are as follows:
   - Unstable soils are soft clay to sandy gravel with a soil strength 50 - 150 kPa. These soil types REQUIRE a base slab as shown.
   - Stable soils are very stiff clay to shale/rock with soil strength of 150KPa or higher. These soil types DO NOT REQUIRE a base slab.
2. Lift the uniculvert and Base Slab separately with 4 x 1.3t Reid Swiftlift lifting eyes. Refer to construction drawing.
3. Position the top face of the Uniculvert at the finished ground level of the site, as detailed on the Project's Civil Construction drawings.
4. The uniculvert shall be constructed level. Under no circumstances shall it be allowed to tilt forward towards the footpath.
5. If a deep excavation is constructed under the transformer cabinet and in front of the foundation then the front edge of the plinth shall be propped for the period the excavation remains open.



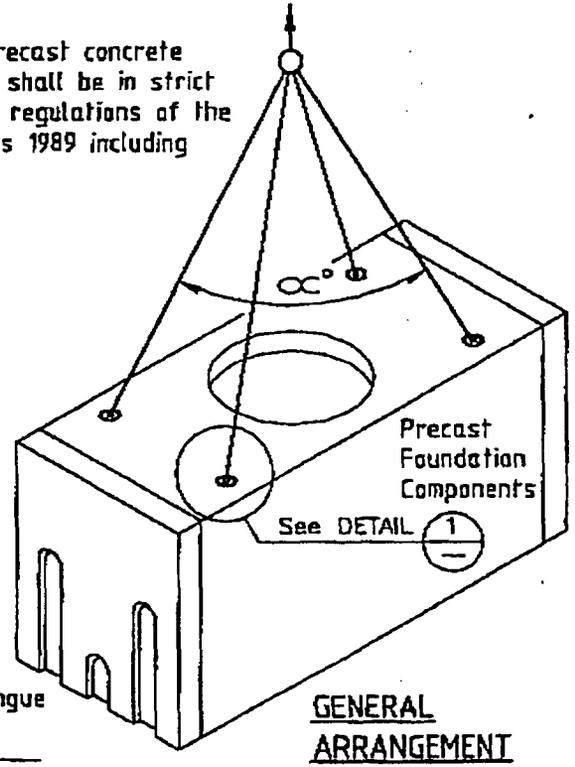


A	ORIGINAL ISSUE	energex	SCALE 1:50	PADMOUNTED TRANSFORMERS	
		©COPYRIGHT 2002 ENERGEX	APP'D D Lloyd	CONSTRUCTION - PADMOUNTED SUBSTATION TRANSFORMER	
		This document must not be reproduced in part or whole without written permission from ENERGEX	DATE 31 May 2002	UNICULVERT FOUNDATION DETAILS	
			REC'D D.Taylor	SHEET 1 OF 2	7468-A4 A
			CKD J.Tunney		
			DRN W.W.		
			CAD		

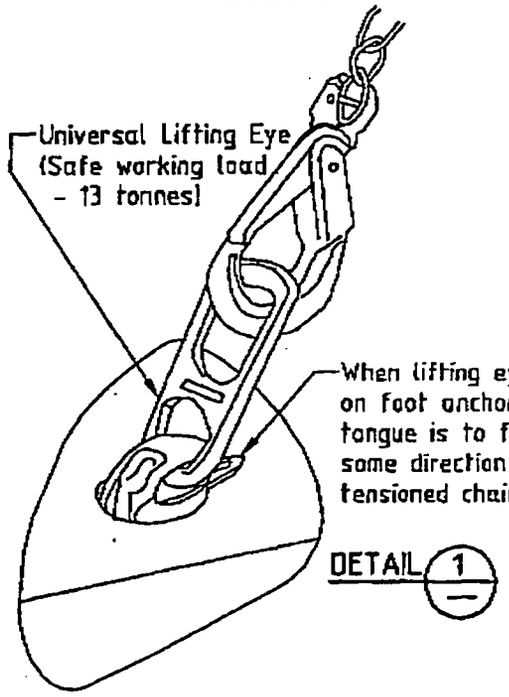
Notes:
Lifting, Handling and Installation of precast concrete foundations on a construction project shall be in strict accordance with the requirements and regulations of the Workplace Health & Safety regulations 1989 including latest amendments.



SECTION DETAIL 1



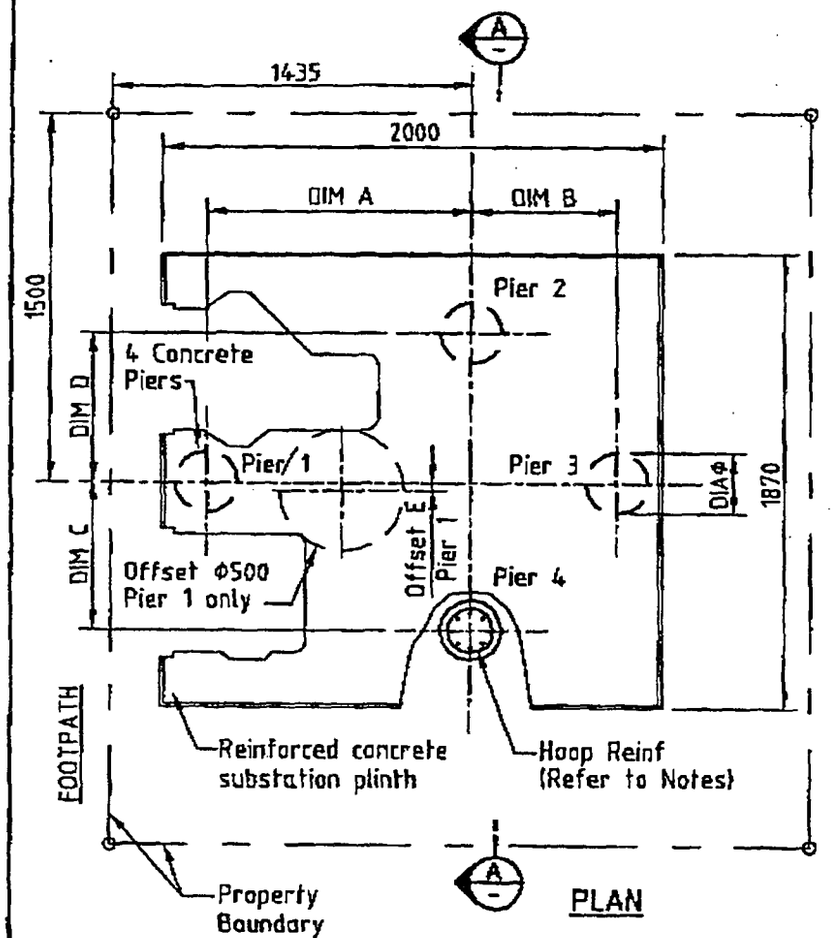
GENERAL ARRANGEMENT

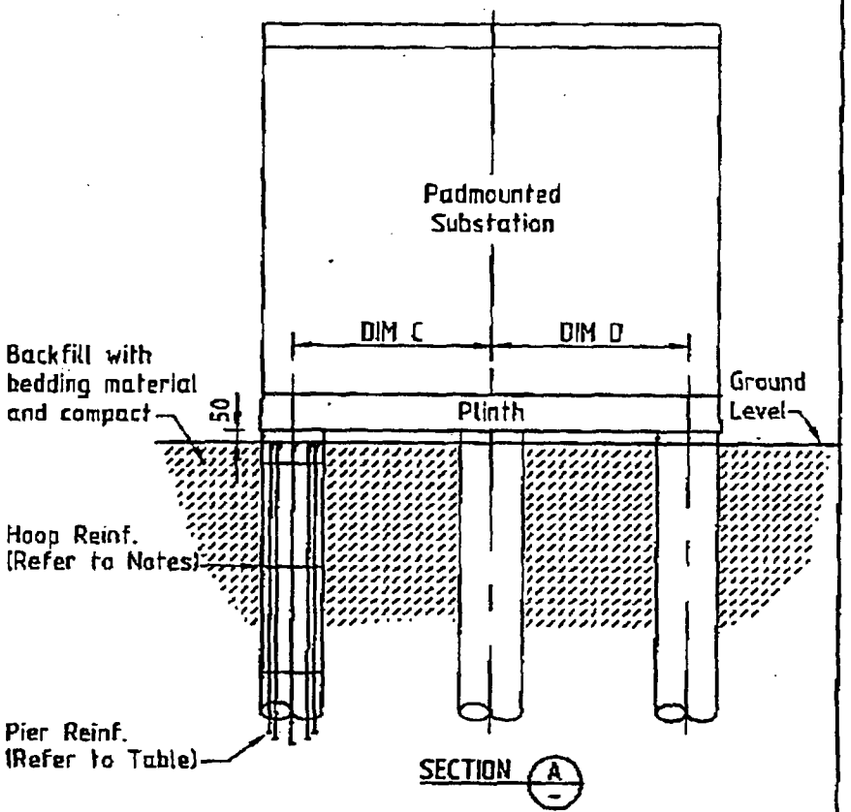


DETAIL 1

Notes:
The "Reid Swiftlift" concrete lifting system is used for lifting modules.
(Manufacturer - Alan H Reid Pty Ltd)
Use only nominated Reid Swiftlift components to lift foundation by Swiftlift anchors.
Lift foundation from all four anchors only.
The load wall always be shared between two diagonal points and
ANGLE α° IS NOT TO EXCEED 60°.

A	ORIGINAL ISSUE	UNCONTROLLED COPY	energex	SCALE NTS APP'D D Lloyd DATE 31 May 2002 RECO D.Taylor CKD J.Turney DRN W.W. CAD	PADMOUNTED TRANSFORMERS CONSTRUCTION - PADMOUNTED SUBSTATION UNICULVERT FOUNDATION LIFTING & HANDLING DETAILS SHEET 1 OF 1 | 7469-A4 | A





A	ORIGINAL ISSUE				
		UNCONTROLLED COPY A46508	energex ©COPYRIGHT 2002 ENERGEX This document must not be reproduced in part or whole without written permission from ENERGEX	SCALE 1:25	PADMOUNTED TRANSFORMERS
				APP'D D Lloyd	CONSTRUCTION
				DATE 31 May 2002	UNSTABLE SOIL CONDITIONS
				REC'D D.Taylor	PIER FOUNDATION DETAILS
				CKD J.Tunney	
				DRN W.W.	SHEET 1 OF 3
				CAD	7470-A4 A

NOTES:

1. The foundation is suitable for substations from 200 to 500kVa-11kV/433-250V only. For 750 to 1000kVa -11kv/433-250V use the uniculvert foundation.
2. The diameters of concrete piers is dependant on the supporting stratum bearing capacity as detailed from the table below.
3. The minimum depth of a pier shall be at least 450mm into the stratum of the undisturbed natural soil and 600mm below cable entry excavation.
   If the material is unsuitable then the hole shall be drilled deeper until a firm bearing stratum is reached.
4. A bored pier up to eight times the pier diameter (depth <8Φ) shall be constructed in mass concrete and poured continuously in one operation. Bored piers of depth greater than eight times the diameter (depth >8Φ) shall be reinforced.
5. Plain round steel bar reinforcement to AS1302 shall be installed.
6. Hoop reinforcement shall be 4mm diameter and spaced at 750mm centres.
7. The minimum concrete cover to steel shall be 50mm.
8. The minimum concrete strength shall be 25MPa.
9. Concrete piers shall be constructed using a continuous single concrete pour.
10. The top of piers shall be level. The maximum variation between the 4 piers shall be 3mm.

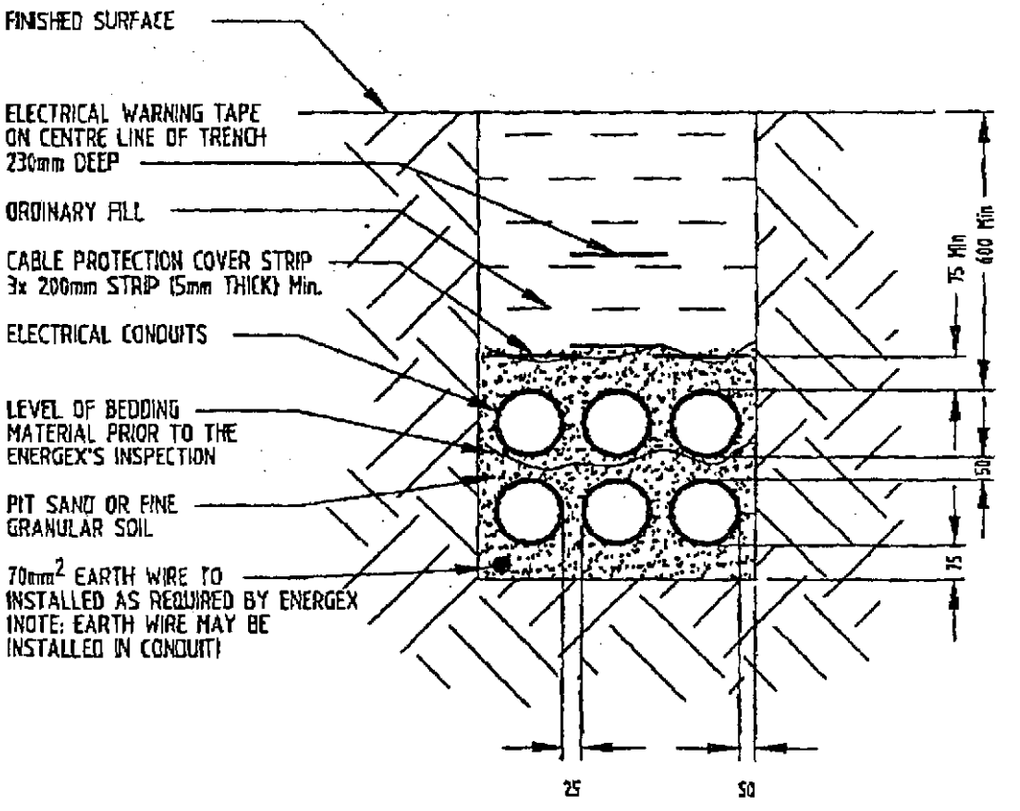
SUPPORTING STRATUM	ALLOW. BEARING CAPACITY (kPa)	BORED PIER DIA 'Φ' (mm)	DIMENSION 'A' (mm)	DIMENSION 'B' (mm)	DIMENSION 'C' (mm)	DIMENSION 'D' (mm)	OFFSET 'E' (mm)	DIMENSION 'F' (mm)	REINF. WHEN PIER DEPTH >(8x'Φ')	
									No. OF RODS	DIA. OF RODS(mm)
FIRM	50	500	520	460	635	635	35	1150	8	12
STIFF	100	400	700	510	610	610	-	1250	6	12
VERY STIFF	200	250	1060	585	610	610	-	1350	4	10
HARD	400	250	1060	585	610	610	-	1350	4	10

A	ORIGINAL ISSUE	UNCONTROLLED COPY	energex ©COPYRIGHT 2002 ENERGEX This document must not be reproduced in part or whole without written permission from ENERGEX	SCALE NTS APP'D D Lloyd DATE 31 May 2002 REC'D D.Taylor CK'D J.Tunney DRN W.W. CAD	PADMOUNTED TRANSFORMERS CONSTRUCTION UNSTABLE SOIL CONDITIONS PIER FOUNDATION DETAILS SHEET 2 OF 3 | 7470-A4 | A

PY

NOTES

1. CABLE CONDUIT SHALL BE OF THE FOLLOWING TYPE:
   - LIGHT DUTY ELECTRICAL CONDUIT TO AS/NZS 2053 CONDUIT BENDS SHALL HAVE A MINIMUM RADIUS OF 1830mm.
2. CONDUITS SHALL BE 125mm OR 150mm AS SPECIFIED BY ENERGEX AND SHALL BE SUPPLIED AND INSTALLED BY THE DEVELOPER.
3. CONDUITS SHALL BE SECURELY SEALED TO PREVENT INGRESS OF DIRT UNTIL CABLE INSTALLATION BY ENERGEX AND THEN RESEALED BY ENERGEX.
4. EACH CONDUIT TO BE FITTED WITH A 6mm BRAID POLYPROPYLENE DRAW ROPE (MINIMUM BREAKING STRENGTH OF 1.0kN)
5. ENERGEX MAY NEED TO INSTALL AN EARTH WIRE AND EARTH RODS IN CONDUIT TRENCHES FROM THE SUBSTATION SITE.
6. ELECTRICITY SUPPLY CONDUITS AND CABLES SHALL HAVE POLYMETRIC CABLE PROTECTION COVER STRIPS PLACED 75mm ABOVE THE TOP CONDUIT FACE OF THE ELECTRICITY SUPPLY CONDUITS AND CABLES. CABLE PROTECTION COVER STRIP SHALL BE LAPPED WHEN PLACED TOGETHER; 100mm MINIMUM ALONG THE LOGITUDINAL AXIS, 40mm MINIMUM ALONG THE TRAVERSE AXIS AND SHALL EXTEND 40mm MINIMUM PAST THE EXTERNAL EDGES OF THE CONDUIT/CABLE BANK.
7. POLYMETRIC CABLE PROTECTION COVER SHALL BE A MINIMUM OF 5mm THICK AS DESCRIBED IN THE AUSTRALIAN STANDARD; AS4702 FPR POLYMETRIC CABLE PROTECTION COVERS.



TYPICAL CONDUIT DETAIL

A	ORIGINAL ISSUE	energex	SCALE	NTS	TRENCH SECTIONS
			APP'D	D Lloyd	CONSTRUCTION - CONDUITS
			DATE	31 May 2002	COMMERCIAL AND INDUSTRIAL SITES AND PRIVATE PROPERTY
			REC'D	D.Taylor	
			CKD	J.Tunney	
			DRN	W.W.	SHEET 1 OF 1
	PY			CAD	7576-A4 A

7450191?

[redacted]

4

[redacted]

PARSONS BRINCKERHOFF

Australia Trade Coast Sewer Project
Contract No. BW30137-02.03
Revised Developed Design Report
Separable Portion No. 2
Lytton Road Pump Station SP298

Appendix C

Design Calculations SP298

Parsons Brinckerhoff Australia ABN. 84 797 323 433

REVISION RECORD

Document Type:	PB Document Name:	Page
DESIGN CALCULATIONS	**SP 298 Design**	Cover

Document Title:	Rev.:
SP 298 (Lytton Rd) DESIGN CALCULATIONS	**1.9**

Rev No.	Prepared Initials & Date	Verified Initials & Date	Approved Initials & Date (Effective Date)	Description
0.0	MB 21-May-03			Initial issue
0.1	MB 1-Jun-03			Flotation calcs added
0.2	MB 17-Jun-03			Various crossing sizes analysed
0.3	MB 23-Jun-03			For Tender
1.0	MB 28-Jan-04			Start of Detailed Design
1.1	MB 6-Feb-04			HDD reduced to OD400 PN20
1.2	MB 9-Feb-04			Hydraulic algorithm standardised
1.3	MB 5-Mar-04			Issue for Pump Selection Report
1.4	MB 31-Mar-04			Design changed to fixed speed PS
1.5	MB 14-Apr-04			Surface levels lowered
1.6	MB 12-May-04			For Purchase
1.7	MB 29-May-04			Top slab level altered
1.8	MB 18-Jun-04			HDD length altered
1.9	MB 25-Jun-04			Hidrostal performance curve added

Project Use

Notes:

Client:	Client Project No:	Client Rev.:
Brisbane Water		
Plant Area: **SP 298 - Lytton Rd Lytton**	Client Doc No:	
Superintendent: Rod Richards	Project Name: **Australia Trade Coast Sewerage Project**	
PB Project Manager: Ian Cameron		
	PB Project No.: **2138110B**	

I:\2138110B Trade Coast Sewerage post-Award\WORK\Pumping Stations\SPS 298 Lytton Road\[SP 298 Design Rev 1.9.xls]REVISION

Parsons Brinckerhoff - Brisbane Office
Client: Brisbane Water
Project: Australia Trade Coast Sewerage Project
PB Job Code: 2138110B

Comments and Questions

9/05/2003
Design friction factors based on Sydney Water's design values for sewage rising mains

material	k value
MSCL / DICL	0.60 mm
PE	0.15 mm

9/05/2003
Initial friction factors based on AS2200 values for sewage rising mains

material	k value
MSCL / DICL	0.03 mm
PE	0.003 mm

15/05/2003
Brisbane Water - Water and Sewerage Standards

2.1.2.1	PWWF of 1200L/ep.day two pumps - one duty one standby three pumps - two duty one standby
2.1.2.2	Types of pumps standardised. Info available from BCC.
2.1.2.3	Std overflows required. Preferably off incoming sewer.
2.1.2.5	Minimum 10m x 10m area. Access road min 4m wide, all weather, heavy vehicles Fenced and landscaped.
2.1.3.1	Preferable velocity 0.9m/s to 1.5m/s. Min 0.6m/s, max 3.0m/s.
2.1.3.3	Bedding to comply with reqts for DICL gravity sewers.
2.1.3.4	Rising mains to be located in road verge or road pavement. Minimum easement width 6m.
2.1.3.5	Cover 600mm - but check Table 2.9 for other reqts.
2.1.3.6	Air valves -std dwg SB006
2.1.3.7	Scours - std dwg SB005
2.1.3.8	Discharge MH - std dwg SC005 Not in private property.

2.1.8	Dwg stds
2.2.7	Accredited pipe laying programmes Metal detector tapes on plastic pipes
2.2.10.4	Pipe testing
2.3.2	Pipe, valve and fitting materials
2.3.3	Manhole construction

4/03/2004
All head loss calcs checked against ITT Flygt Colebrook White calculator in FLYPS.

30/03/2004
Design changed to fixed speed PS

Parsons Brinckerhoff - Brisbane Office
Client: Brisbane Water
Project: Australia Trade Coast Sewerage Project
PB Job Code: 2138110B

Entered
Calculated

SUMMARY OF DUTY FOR SP 298

SP 298 - Lytton Rd

Design PWWF (Tender Docs)	160.0 L/s	per duty pump
Total Flow (Tender Docs)	160.0 L/s	maximum duty flow
Static Head (from Pump Calcs)	1.5 m	
Total Head (from Pump Calcs)	26.0 m	design duty
Smooth Pipe Duty Head (at 160L/s)	20.4 m	smooth pipe duty (insert smooth k in calcs)

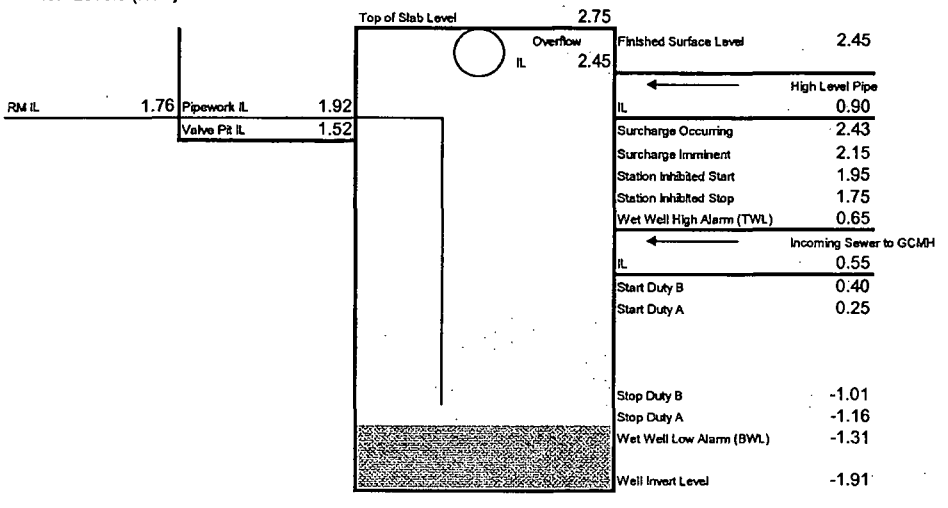
Persons Brinckerhoff - Brisbane Office
Client: Brisbane Water
Project: Australia Trade Coast Sewerage Project
PB Job Code: 2138110B

Entered
Calculated

SP 298 DIMENSIONS AND LEVELS (Datum is AHD)

Proposed SP 298	Source	Design Values	
Wet Well Internal Diameter	dwg WR101 / 031	3.60 m	
Max Water Depth: Overflow Level to SPS Fl	calc	4.36 m	
Total Depth: FSL to Underside of Base	calc	4.96 m	
Incoming "Sewer" Diameter [to GCMH]	dwg WR101 / 031	300 mm	
Rising Main Diameter	OD450 PE100 PN12.5	450 mm	
Discharge Pipe and Valve Diameter	velocity < 3m/s at max flow from single pump (160L/s)	300 mm	
Switchgear Level	150 above top slab	2.90 RL	
Roof Slab - Finished Level	LCPL (constructability)	2.75 RL	
Flood Level	Q100 is at RL2.56	2.56 RL	
Finished Surface Level	build up to 300 below top slab	2.45 RL	
Roof Slab - Underside	nominal 350 thick	2.40 RL	
Air Vent - Obvert Level (horizontal section)	directly under top slab - check ground cover and overflow level	2.40 RL	
Physical Overflow Level (OF)	dwg WR101 / 031 [300 above IL of high level pipe]	2.45 RL	ground cov
Surcharge Occurring Level	25 below OF	2.43 RL	OF can be
High Level Pipe Invert at Wet Well		0.90 RL	
Surcharge Imminent Alarm Level	300 below OF	2.15 RL	
Station Inhibited Start Level	200 below Surcharge Imminent	1.95 RL	
Discharge Pipework - Invert Level	dwg WR101 / 031	1.92 RL	
Rising Main - Invert Level	dwg WR101 / 031	1.76 RL	
Station Inhibited Stop Level	200 below Station Inhibited Start	1.75 RL	
Valve Pit Floor - Invert Level	400 below discharge pipework IL	1.52 RL	
Incoming RMs - Invert Level	dwg WR101 / 031	0.75 RL	
Wet Well High Alarm (TWL)	400 above Start Duty A	0.65 RL	
Incoming Sewer to GCMH - Invert Level	dwg WR101 / 031	0.55 RL	
Start Duty B	150 above Start Duty A	0.40 RL	
Start Duty A	300 below Incoming sewer	0.25 RL	
Grit Collector - Invert Level	900 below Incoming sewer	-0.35 RL	
Stop Duty B	150 above Stop Duty A	-1.01 RL	
Stop Duty A	GOAL SEEK THIS TO GIVE 10 STARTS PER HOUR ON DUTY PUMP	-1.16 RL	
Wet Well Low Alarm (BWL)	150 below Stop Duty A	-1.31 RL	
Required Pump Submergence	Hidrostal submergence not supplied - use Flygt CP3231 (680mm)	0.75 m	
Wet Well Invert Level	Stop Duty A less submergence	-1.91 RL	
Flotation Calcs:			
Top Level of Roof Slab	from above	2.75 RL	
Roof Slab Thickness	assume 350	0.35 m	
Diameter of Roof Slab	well ID + 2 x wall thickness	4.30 m	
Mass of Roof	calc at 2400kg/m3	12198 kg	
Wall Thickness	assume 300	0.30 m	
Depth of Walls (excluding roof and floor)	calc	4.31 m	
Mass of Walls	calc at 2400kg/m3	44976 kg	
Floor Slab Thickness	change this by goal seek (see below)	0.60 m	
Mass of Floor	calc at 2400kg/m3	20912 kg	
Total Concrete Mass	calc at 2400kg/m3	78086 kg	
Total Volume of Structure	volume of wet well	42 m3	
Total Mass of Water Displaced	assume 1000kg/m3	42450 kg	
Net Buoyancy (positive down)	GOAL SEEK THIS TO ZERO BY CHANGING FLOOR THICKNESS	35636 kg	
Underside of Structure	calc	-2.51 RL	

Station Levels (NTS)



Parsons Brinckerhoff - Brisbane Office
Client: Brisbane Water
Project: Trade Coast Sewerage D&C
PB Job Code: 2138110B

DYNAMIC LOSS CALCULATION — DN200 DICL K12
Pump Discharge Pipework (DN200 sections)

Flow rate	576.0	m3/hr	0.16	m3/s	**Flowrate** 160.0 L/s
Pipe internal diameter	**232.0**	mm	0.23	m	**single pump flow (2031)**
Surface area	0.042	m2	9	inch	
Water velocity	3.785	m/s	0.0006	m	
Reynolds Number	872,859.08				
Roughness coefficient	**0.600**	mm	1.01E-06	m2/s	
Equivalent length of pipe	**0**	m			
Temperature	20	deg. C			
Kinematic viscosity	1.006	m2/s			
Hydraulic gradient	79.57	m/km			
Pipe dynamic loss	**0.00**	m			

Component fitting losses:	k value	fitting loss	
90 degree bend R=1D	0.75	0.55 m	check formulae when inserting rows
200 / 300 taper	0.04	0.03 m	
		0.00 m	
		0.00 m	
		0.00 m	
Total component losses		**0.58** m	

Total dynamic loss in section **0.58** m

DYNAMIC LOSS CALCULATION — DN300 DICL K12
Pump Discharge Pipework (DN300 sections)

Flow rate	576.0	m3/hr	0.16	m3/s	**Flowrate** 160.0 L/s
Pipe internal diameter	**313.0**	mm	0.31	m	**single pump flow**
Surface area	0.077	m2	12	inch	
Water velocity	2.079	m/s	0.0006	m	
Reynolds Number	646,975.42				
Roughness coefficient	**0.600**	mm	1.01E-06	m2/s	
Equivalent length of pipe	**5**	m			length is an estimate only
Temperature	20	deg. C			
Kinematic viscosity	1.006	m2/s			
Hydraulic gradient	16.51	m/km			
Pipe dynamic loss	**0.08**	m			

Component fitting losses:	k value	fitting loss	
90 degree bend R=1D	0.75	0.17 m	check formulae when inserting rows
check valve (John fig. 404)	0.63	0.14 m	
gate valve (John Fig 694)	0.11	0.02 m	
tee - line to branch - radiused	0.80	0.18 m	left side pump is hydraulically disadvantaged
tee - branch to line - radiused	0.80	0.18 m	
300 / 450 taper	0.04	0.01 m	
Total component losses		**0.69** m	

Total dynamic loss in section **0.77** m

DYNAMIC LOSS CALCULATION — OD450 PE100 PN12.5
DN450 Rising Main Up to River Crossing

Flow rate	576.0	m3/hr	0.16	m3/s	**Flowrate** 160.0 L/s
Pipe internal diameter	382.0	mm	0.38	m	**single pump flow**
Surface area	0.115	m2	15	inch	
Water velocity	1.396	m/s	0.0002	m	
Reynolds Number	530,113.37				
Roughness coefficient	0.150	mm	1.01E-06	m2/s	
Equivalent length of pipe	616	m	from CMBK long sections 14/4/04		
Temperature	20	deg. C			
Kinematic viscosity	1.006	m2/s			
Hydraulic gradient	4.39	m/km			
Pipe dynamic loss	2.71	m			

Component fitting losses:	k value	fitting loss	
		0.00	m
		0.00	m
		0.00	m
		0.00	m
		0.00	m
Total component losses		0.00	m
Total dynamic loss in section		2.71	m

check formulae when inserting rows

The proposed pigging pit is in this section but the enlarged section and fittings are not expected to increase the duty head - only decrease it slig - therefore it is ignored in the calcs.

DYNAMIC LOSS CALCULATION — OD400 PE100 PN20
DN400 River Crossing

Flow rate	576.0	m3/hr	0.16	m3/s	**Flowrate** 160.0 L/s
Pipe internal diameter	307.0	mm	0.31	m	**single pump flow**
Surface area	0.074	m2	12	inch	
Water velocity	2.161	m/s	0.0002	m	
Reynolds Number	659,619.89				
Roughness coefficient	0.150	mm	1.01E-06	m2/s	
Equivalent length of pipe	749	m	from CMBK long sections 14/4/04 (path length, not chainage)		
Temperature	20	deg. C			
Kinematic viscosity	1.006	m2/s			
Hydraulic gradient	13.48	m/km			
Pipe dynamic loss	10.09	m			

Component fitting losses:	k value	fitting loss	
		0.00	m
		0.00	m
		0.00	m
		0.00	m
		0.00	m
Total component losses		0.00	m
Total dynamic loss in section		10.09	m

check formulae when inserting rows

DYNAMIC LOSS CALCULATION — OD450 PE100 PN12.5

DN450 Rising Main From River Crossing to SP300

Flow rate	576.0	m3/hr	0.16	m3/s	Flowrate 160.0 L/s
Pipe internal diameter	**382.0**	mm	0.38	m	single pump flow
Surface area	0.115	m2	15	inch	
Water velocity	1.396	m/s	0.0002	m	
Reynolds Number	530,113.37				
Roughness coefficient	**0.150**	mm	1.01E-06	m2/s	
Equivalent length of pipe	**2,066**	m	from CMBK long sections 14/4/04		
Temperature	20	deg. C			
Kinematic viscosity	1.006	m2/s			
Hydraulic gradient	4.39	m/km			
Pipe dynamic loss	**9.08**	m			

Component fitting losses:	k value	fitting loss		
open discharge	1.00	0.10	m	check formulae when inserting rows
		0.00	m	
		0.00	m	
		0.00	m	
		0.00	m	
Total component losses		**0.10**	m	
Total dynamic loss in section		**9.18**	m	

PUMP DUTY CALCULATION — SP298 Lytton Rd Lytton

Middle of operating band	**0.7**	RL	
Normal TWL in SP300 Wet Well	**2.3**	RL	TWL in SP300 inlet structure
Static head	**1.5**	m	
Total dynamic loss in suction	**0.0**	m	submersible station
Total dynamic loss in discharge	**23.3**	m	
Safety margin on dynamic loss for unaccounted fittings	5%		
Pump duty head	**26.0**	m	
Pump efficiency	76	percent	
Pump shaft power	**54**	kW	
Selected pump	Hidrostal H08K / 68kW		

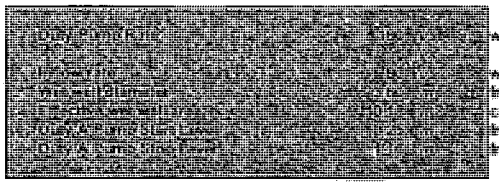
NPSH CALCULATION	SP298 Lytton Rd Lytton		
NPSHa = Static head at the inlet + surface pressure head - the vapor pressure of your product - the friction losses in the suction piping, valves and fittings			
Pump centreline	**(1.3)**	RL	nominally 100mm below Stop Duty A
Stop Duty A	**(1.2)**	RL	
Surface pressure head	**10.3**	m	normal atmospheric pressure 10.34m
Temperature	20	deg. C	
Vapour pressure	**0.2**	m	
Loss in suction	**0.0**	m	
NPSH Available	**10.2**	m	check Hidrostal curves for NPSHr
NPSH Required	**3.0**	m	from pump curve at the operating point
Safety Margin	**7.2**	m	positive is OK (prefer >1)

System Curve

Single Pump Flow L/s	Duty Head m
	26.0
1	1.5
10	1.7
20	2.0
30	2.5
40	3.2
50	4.1
60	5.2
80	7.9
100	11.4
120	15.5
140	20.4
160	26.0
180	32.4
200	39.5

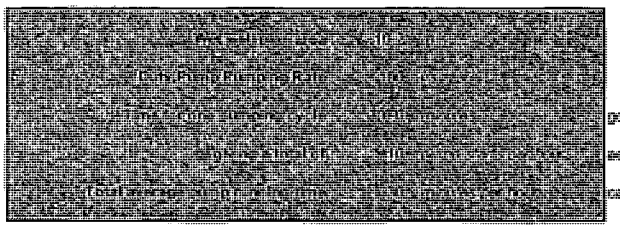
Parsons Brinckerhoff - Brisbane Office
Client: Brisbane Water
Project: Australia Trade Coast Sewerage Project
PB Job Code: 2138110B

MAXIMUM PUMP STARTS CALCULATION - SP 298



work out starts on delivery flow of 160L/s for fixed speed

worst case inflow = half duty pump discharge rate
from SPS dimensions and levels
calculated
from SPS dimensions and levels
from SPS dimensions and levels



3 from wet well dimensions above
3
0 from above

goal seek this to 6 minutes by changing the pump cut out level on SPS dimensions and levels

adopt 15 starts per hour for this PS

calculated

- The total pump running time is the average time per hour a pump is running.
  In alternating duty/standby systems each pump will run for half the total running time.

Parsons Brinckerhoff - Brisbane Office
Client: Brisbane Water
Project: Australia Trade Coast Sewerage Project
PB Job Code: 2138110B

PERFORMANCE CURVE DATA
SP 298 - Lytton Rd

Pump Type	Hidrostal H08K-M
Curve No.	84-K3229c
Imp. Diameter.	
Rated Power	68 kW

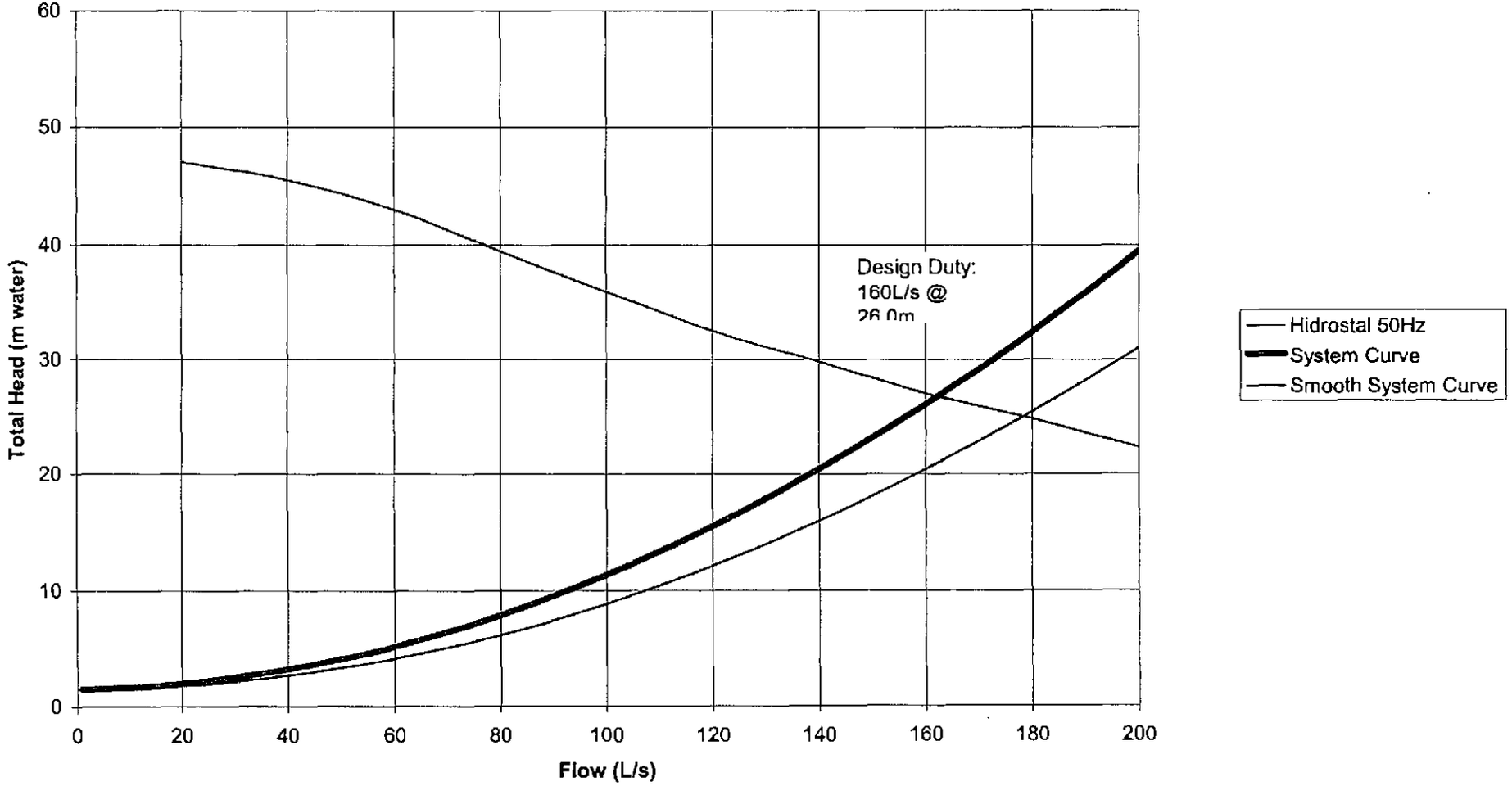
1 Hidrostal 50 Hz

L/s	Total Hd
20	47
40	45.5
60	43
80	39.5
100	36
120	32.5
140	29.8
160	27
180	24.8
200	22.3
220	20
240	18
260	16
280	13
300	10

Smooth Pipe System Curve

L/s	Total Hd	
0	1.5	created by FLYPS
15.4725	1.67674	
30.945	2.20697	
46.4174	3.09069	
61.8899	4.32789	
77.3624	5.91857	
92.8349	7.86274	
108.307	10.1604	
123.78	12.8115	
139.252	15.8162	
154.725	19.1743	
170.197	22.8859	
185.67	26.951	
201.142	31.3695	
216.615	36.1416	
232.087	41.2671	
247.56	46.7462	
263.032	52.5787	
278.505	58.7647	
293.977	65.3042	
309.45	72.1971	

SP 298 (Lytton Rd) - Performance Curves - One Hidrostal H08K / 68kW



SP 298 Design Rev 1.9

Performance Curves

Page 1 of 1

Parsons Brinckerhoff - Brisbane Office
Client: Brisbane Water
Project: Australia Trade Coast Sewerage Project
PB Job Code: 2138110B

Properties for Water

Temperature C	Density kg/m3	Kin viscosity m^2/s	Vapour Press m H2O
0	999.84	1.787E-06	0.062
4	999.97	1.514E-06	0.083
10	999.7	1.304E-06	0.125
15	999.09	1.137E-06	0.174
20	998.2	1.002E-06	0.238
25	997.04	8.910E-07	0.323
30	995.65	7.980E-07	0.433
40	992.22	6.540E-07	0.752
50	977.77	5.480E-07	1.258

Ref GCD 332 - 1.1

Interpolator

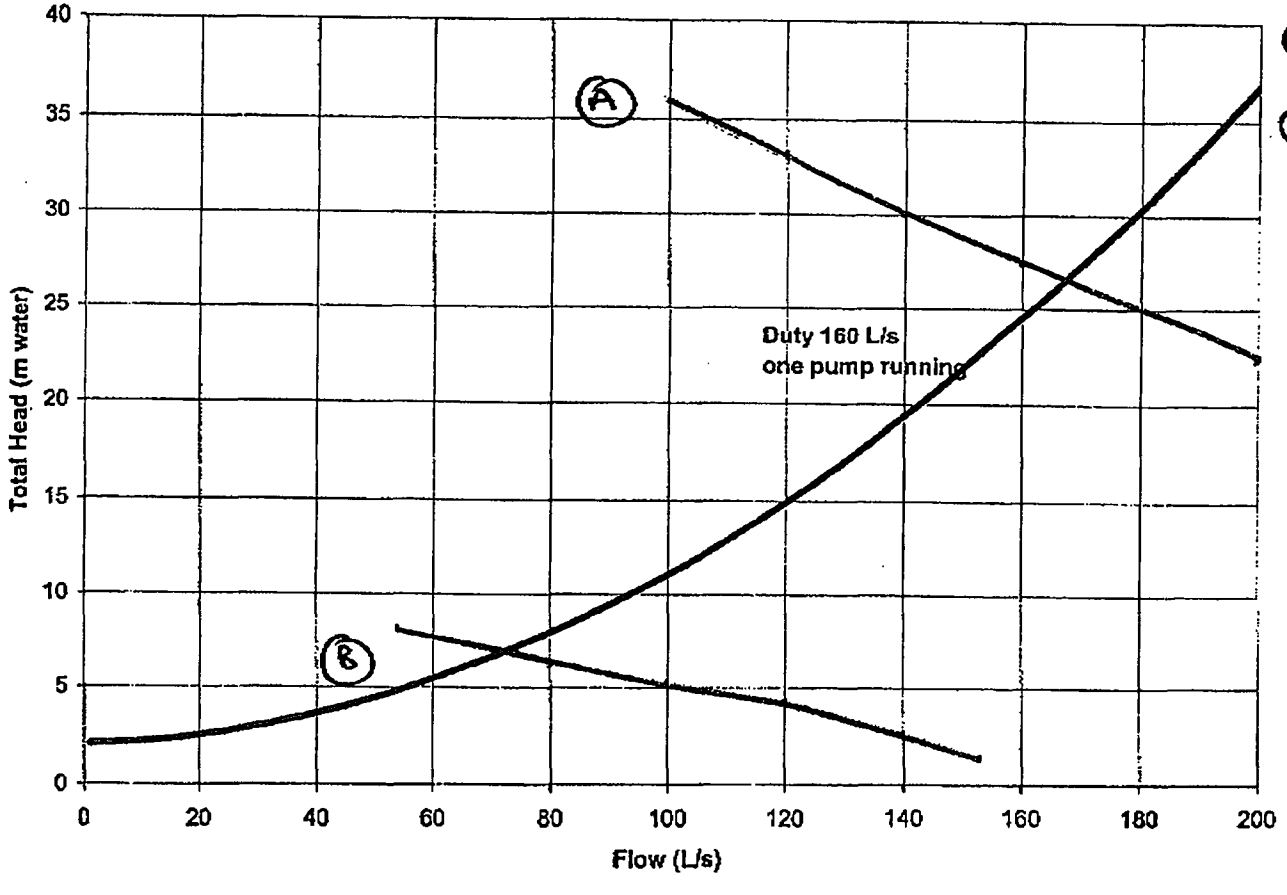
x=	30	a=	0.433
y=	35	b=	0.5925
z=	40	c=	0.752

$$b = a - \frac{(a-c)*(x-y)}{(x-z)}$$

For fluids other than water, parameters need to be investigated. Figures for water should not be used for other fluids.

(VSD)

SP 298 (Lytton Rd) - System Curve (Subm)



(A) = H08K-M @ 14.60 RPS

(B) = H08K-M @ 730 RPM

17-MAR-2004 07:58 FROM WEIR SERVICES TO 0-0738314223 P.02

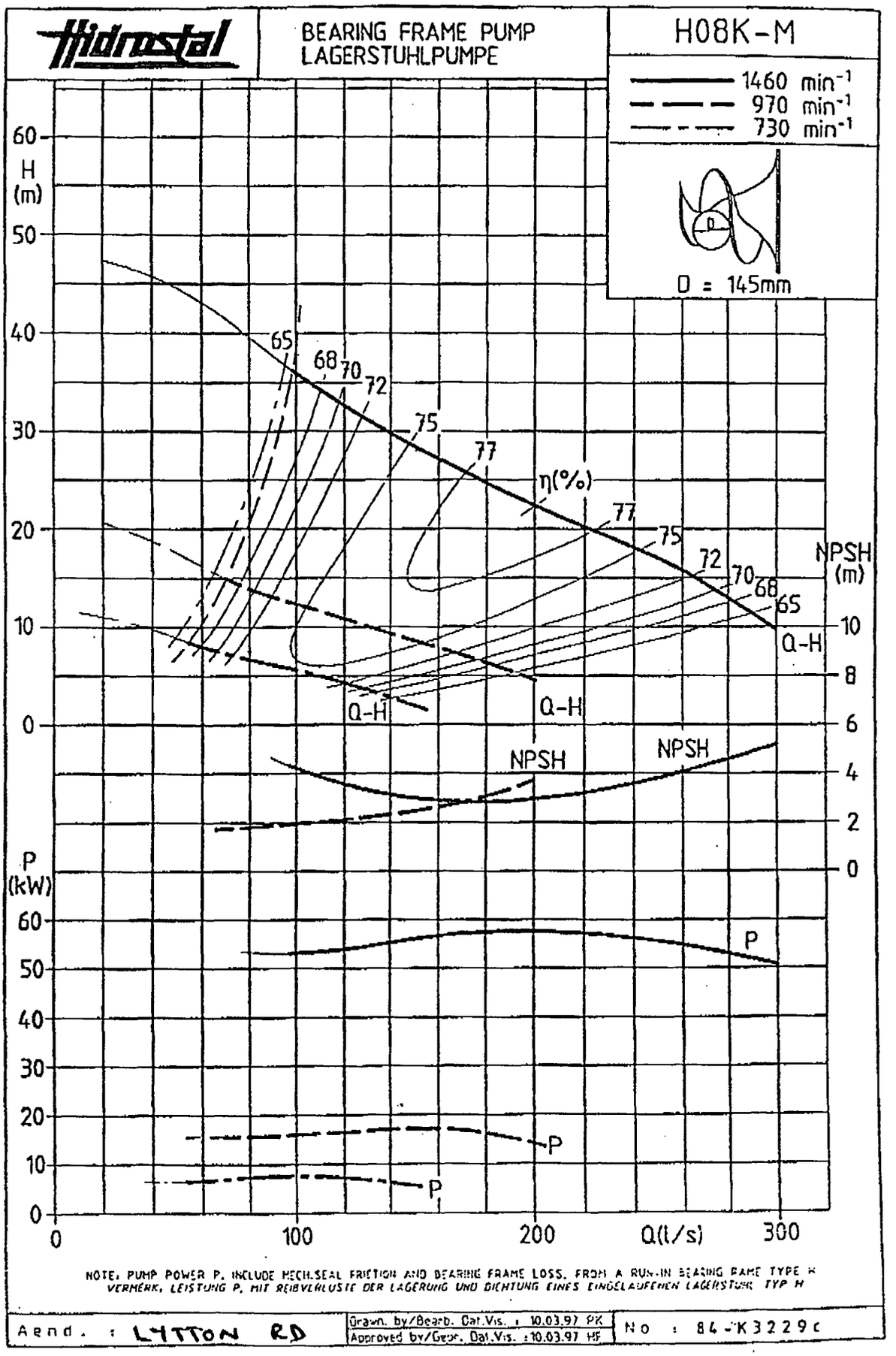
15/3/04

SP 298 Design Rev 1.3a

Performance Curves

Page 1 of 1

17-MAR-2004 07:58 FROM WEIR SERVICES TO 0-0738314223 P.03



[redacted]

5

[redacted]

PARSONS BRINCKERHOFF

Australia Trade Coast Sewer Project
Contract No. BW30137-02.03
Revised Developed Design Report
Separable Portion No. 2
Lytton Road Pump Station SP298

Appendix D

Odour and Septicity Study (In Progress)

6

PARSONS BRINCKERHOFF

Appendix E

Geotechnical Information
E1. Coffeys Reports
E2. PB Report

PARSONS BRINCKERHOFF

Australia Trade Coast Sewer Project
Contract No. BW30137-02.03
Revised Developed Design Report
Separable Portion No. 2
Lytton Road Pump Station SP298

E1. Coffeys Reports

Coffey Geosciences Pty Ltd ACN 056 335 516

Geotechnical | **Resources** | Environmental | **Technical** | Project Management

53B Fairlawn Street Nathan
QLD 4111 Australia
PO Box 108 Salisbury
QLD 4107 Australia
Telephone +61 7 **3274 4411**
Facsimile +61 7 3274 4977
Email brisbane@coffey.com.au

Coffey

Facsimile Transmission

To	**PARSONS BRINCKERHOFF**	From	**DAN ABOOD**
Attention	**IAN CAMERON**	Date	**27 MAY 2004**
Facsimile number	**3831 4223**	Our Reference	**B17928/01-B**
cc		Number of pages including this page	**4**
Subject:	**SETTLEMENT ASSESSMENT - AUSTRALIA TRADE COAST SEWER, LYTTON ROAD, SP298**		

Parsons Brinckerhoff engaged Coffey Geosciences Pty Ltd to conduct various assessments associated with consolidation settlements for the area around the proposed Lytton Road Pump Station. The scope of work commissioned comprised the following three elements:

1. Assessment of settlement magnitude and duration (primary and secondary consolidation) for a range of vertical stress increments for the area of the pump station.
2. Assessment of the impacts of the adjacent Port of Brisbane Corporation (POBC) fill bund and hydraullically placed fill upon the long term settlement of the pump station site.
3. Provision of recommendations with respect to a recommended buffer zone around the pump station for additional fill on the POBC land.

This letter presents the results of the first of the items above. The settlement assessment was based on:

- Ground models and settlement parameters developed by Coffey during our involvement with the Port of Brisbane Motorway, which is very close to the pump station location;
- Specific subsurface information for the pump station site presented in the City Design report of 7 November 2003.

Based on the City Design data, the subsurface conditions at the pump station site are considered to be generally consistent with those near the eastern extents of Stage 1 of the Port of Brisbane Motorway. A general ground model showing settlement analysis parameters is shown on Figure 1. The model considers 27m of Recent alluvium, mainly comprising soft and firm clay, overlying stiffer, older alluvium of uncertain age. It also shows influence factors for an embankment up to 15m wide.

Figure 2 shows time versus settlement curves over a range of vertical stress increase. The significantly greater settlement beyond 30 kPa is due to a preconsolidation pressure of about 35kPa in excess of effective in-situ vertical stress, which affects the majority of the soil profile. The settlement curves do not follow a classical shape because they have been derived by integrating curves from several different layers, which have differing rates of settlement.

Although the curves are based in a detailed data set, they should be used with caution. Analyses of the reliability of the settlement data using the method of Duncan (2000) provide an approximate guide to the likely accuracy of settlement calculations by examining the potential error in the main parameters. Results of the reliability calculations for the model

shown in Figure 1 are summarised in Table 1. The calculations show that there is about a 10% probability that the settlement may be 1.5 times greater than that predicted.

TABLE 1: SUMMARY OF RELIABILITY OF SETTLEMENT CALCULATIONS

Ratio of Actual Settlement to That Predicted	% Probability of Exceedance
1.1	33
1.25	23
1.5	11
2	3

Should you require further information, please contact the undersigned.

For and on behalf of

COFFEY GEOSCIENCES PTY LTD

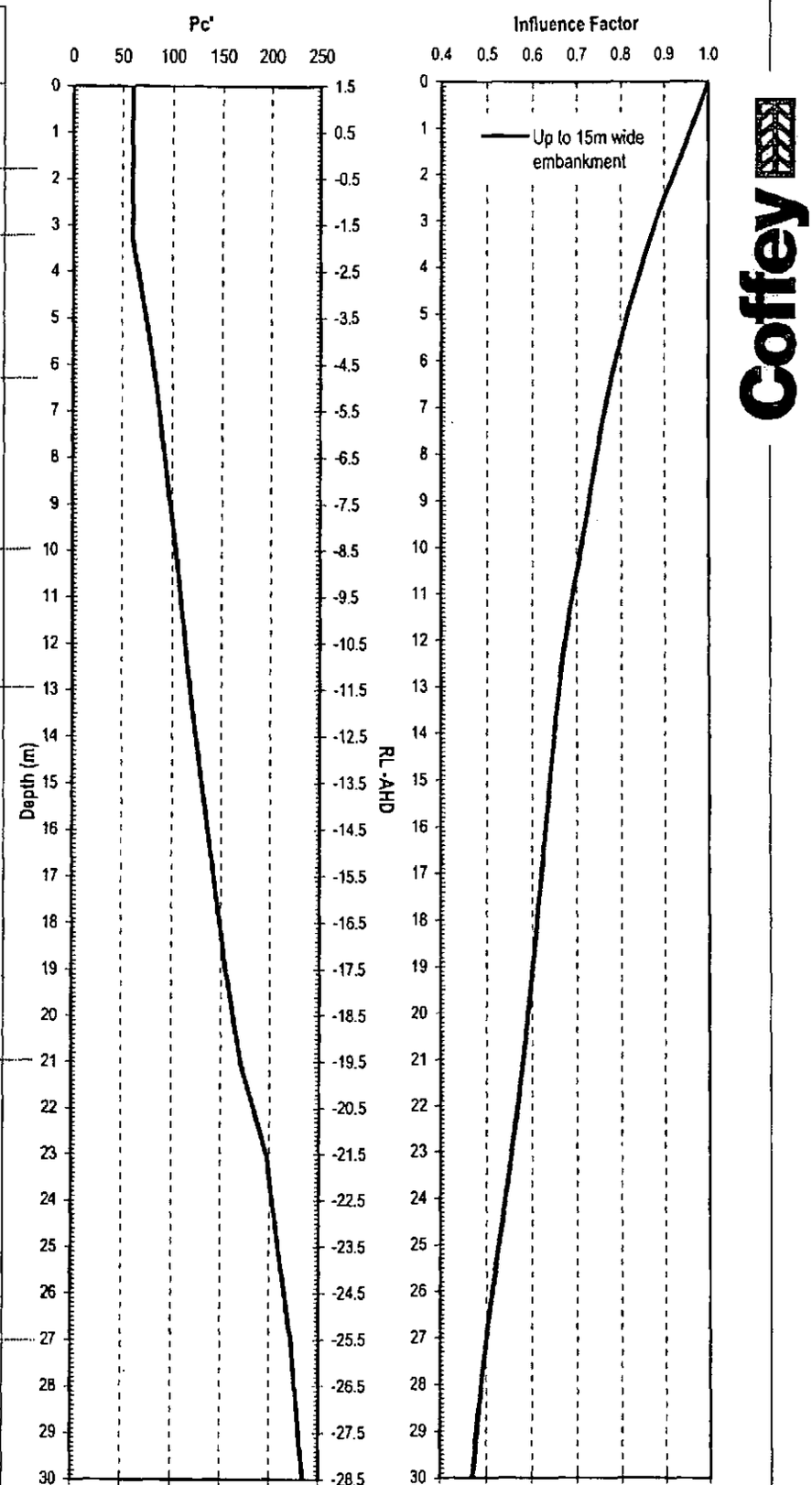
IAN SHIPWAY

Manager, Brisbane

Attachment: Figure 1. Settlement Model
Figure 2. Calculated Settlements

B:\BRISBANE\B17928-1\Correspondence\B17928.01-B.Doc

Material & C_v	$Cc/1+e_o$	$Cr/1+e_o$
Alluvium C_v=150m²/yr	0.13	0.070
Estuarine Clay C_v=150m²/yr	0.20	0.026
Sand Member C_v=150m²/yr	0.10	0.010
Estuarine Clay C_v=8m²/yr	0.32	0.032
	0.28	0.028
	0.30	0.030
	0.23	0.023
Old Alluvium C_v=150m²/yr	0.10	0.010



Coffey

Coffey Geosciences Pty Ltd ACN 058 335 516 | Geotechnical I **Resources** I Environmental I **Technical** I Project Management

Drawn	DA
Approved	
Date	27/05/2004
Scale	NTS

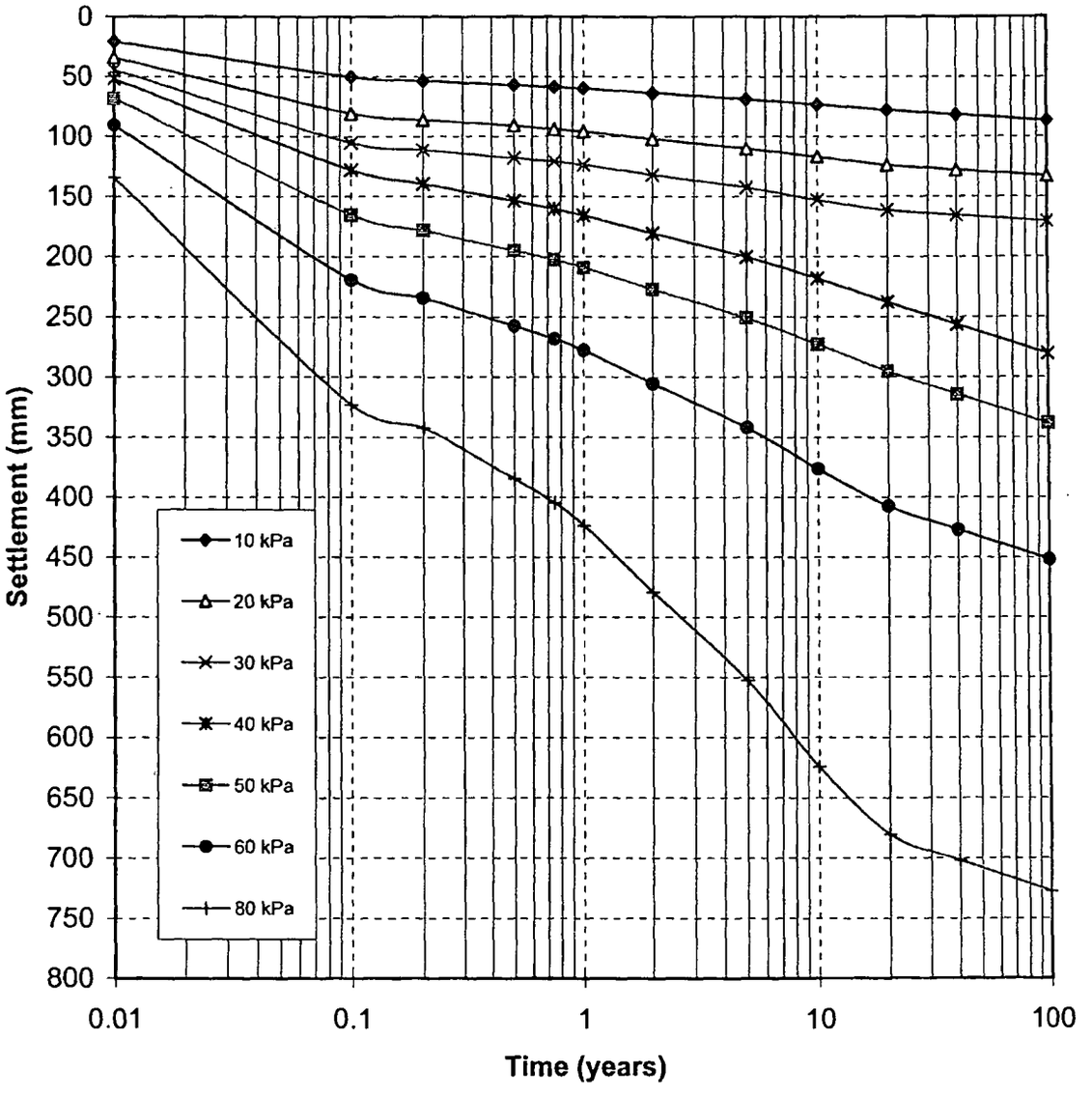
PARSONS BRINCKERHOFF
TRADE COAST SEWER PROJECT
LYTTON RD PUMP STATION
SETTLEMENT ANALYSIS MODEL

FIGURE 1

Report no: B17928/1

B:\BRISBANE\B17928-1\Calculations\Spreadsheets\[Settlement Analysis Refined.xls]A4 Portrait Figure

ASSESSMENT OF PRIMARY & SECONDARY SETTLEMENT OVER TIME



Coffey

Coffey Geosciences Pty Ltd ACN 056 335 516		Geotechnical I **Resources** I Environmental I **Technical** I Project Management	
Drawn	DA	PARSONS BRINCKERHOFF	FIGURE 2
Approved		TRADE COAST SEWER PROJECT	
Date	27/05/2004	LYTTON RD PUMP STATION	
Scale	NTS	CALCULATED SETTLEMENTS	Job no: B17928/1

B:\BRISBANE\B17928-1\Calculations\Spreadsheets\[Settlement Analysis Refined.xls]A4 Portrait Figure

15-JUN-2004 17:38 FROM COFFEY TO 038314223 P.01

Coffey Geosciences Pty Ltd ACN 056 335 516

Geotechnical | **Resources** | Environmental | **Technical** | Project Management

53B Fairlawn Street Nathan
QLD 4111 Australia
PO Box 108 Salisbury
QLD 4107 Australia
Telephone +61 7 3274 4411
Facsimile +61 7 3274 4977
Email brisbane@coffey.com.au

Facsimile Transmission

To	**PARSONS BRINCKERHOFF**	From	**DAN ABOOD**
Attention	**IAN CAMERON**	Date	**15 JUNE 2004**
Facsimile number	**3831 4223**	Our Reference	**B17928/1-C**
cc		Number of pages including this page	**2**
Subject:	**SETTLEMENT ASSESSMENT** **AUSTRALIA TRADE COAST SEWER LYTTON ROAD SP398**		

Parsons Brinckerhoff (PB) engaged Coffey Geosciences Pty Ltd (Coffey) to conduct various assessments associated with consolidation settlements for the area around the proposed Lytton Road Pump Station. The scope of work commissioned comprised the following three elements:-

1. Assessment of settlement magnitude and duration (primary and secondary consolidation) for a range of vertical stress increments for the area of the pump station.
2. Assessment of the impacts of the adjacent Port of Brisbane Corporation (POBC) fill bund and hydraulically placed fill upon the long term settlement of the pump station site.
3. Provision of recommendations with respect to a recommended buffer zone around the pump station for additional fill on the POBC land.

The first of these items above was addressed in our facsimile (ref. B17928/1-B) dated 27 May 2004. This letter presents the results of items 2 and 3 above. The settlement assessment was based on:-

- Ground models and settlement parameters developed by Coffey during our involvement with the Port of Brisbane Motorway, which is very close to the pump station location; and
- Specific subsurface information for the pump station site presented in the City Design report of 7 November 2003.

Based on the City Design data, the subsurface conditions at the pump station site are considered to be generally consistent with those near the eastern extents of Stage 1 of the Port of Brisbane Motorway. The model considers 27m of recent alluvium, mainly comprising soft and firm clay, overlying stiffer, older alluvium of uncertain age.

Based on the plans provided to Coffey by PB (Brisbane Water drawing No 486/5/7 – WR 101_023/P1 and POBC plan No 104727) the following assumptions have been made:-

- The natural ground level at the pump station site and surrounding area is approximately RL~2m;
- The finished level of the Hardstand area is to be RL~2.75m; and
- The current height of the adjacent Port of Brisbane Corporation hydraulically placed fill is RL~3.5m and it has

Coffey Geosciences Pty Ltd ACN 056 335 516

been in place for a minimum of 5 years.

Based on the above assumptions and adopted ground model, the following settlement assessments and recommendations have been made:-

- Assuming the existing hydraulically placed fill has been in place for a minimum of 5 years, then it is expected that over 95% of the expected primary consolidation at the pump station location will have already occurred. It is estimated that the remaining primary settlement resulting from the adjacent hydraulically placed fill will be minimal. Assuming a design life for the pump station of 40 years, then up to an additional 10mm of secondary creep settlement may to occur over the life of the structure.
- Placement of the Hardstand fill (0.75m thick) will result in an estimated settlement of ~95mm primary settlement. It is predicted that 95% of the primary settlement will occur within 5 years of placement of the fill. Assuming a design life for the pump station of 40 years, then up to an additional 10mm of secondary creep settlement is predicted over the life of the structure.
- Should an additional 2m of fill be placed on the existing hydraulically placed fill area, then it is estimated 110mm of primary consolidation settlement (additional 15mm to that expected from hardstand fill) will occur at the pump station within 5 years of completion of filling, an additional secondary creep settlement of up to 10 mm will occur over the life of the structure.
- Placement of additional loads adjacent to the pump station will result in increased settlements. The extent of such settlement is dependant on the magnitude and extent of the load and on the proximity of the loaded area to the pump station; as such it is difficult to define a buffer zone around the pump station. It is predicted that provided any additional filling carried out on the adjacent POBC land is not greater than 2m in height and is set back a minimum of 10m from the crest of the existing fill bund then the resulting additional settlements at the pump station location should be less than 10mm. It is recommended that specific settlement analysis be carried out once proposed development details for the adjacent land are known.

The predicted settlements should be used with caution. As indicated in our previous facsimile there is about 10% probability that the actual settlement may be 1.5 times greater than that predicted.

Should you require further information, please contact Dan Abood or the undersigned.

For and on behalf of
COFFEY GEOSCIENCES PTY LTD

IAN SHIPWAY
Manager, Brisbane

B:\BRISBANE\B17928-1PARSONS (IS)\Correspondence\B17928-1-C.Doc

TOTAL P.02

Cameron, Ian

From: Cameron, Ian
Sent: Wednesday, 16 June 2004 8:54 AM
To: John Bower (ec1psbw@brisbane.qld.gov.au)
Subject: FW: FAX From Coffey - 15/06/04

Importance: High

Floor 7 Fax Received_001.pdf (..

John

Coffeys settlement report for SP298

Ian Cameron
Executive - Water
Parsons Brinckerhoff Australia Pty Limited
12th floor, IBM Centre
348 Edward Street
GPO Box 2907
Brisbane QLD 4001 Australia
tel: +61(0)7 3218 2222
direct: +61(0)7 3218 2644
fax: +61(0)7 3831 4223
mob +(61) 0401 148 142
email: icameron@pb.com.au
www.pb.com.au and www.pbworld.com

Parsons Brinckerhoff (PB), formerly PPK Environment & Infrastructure, is a leading transport, infrastructure and environment consultancy and has been providing this service in Australia for over 38 years.

-----Original Message-----
From: AU BNE, Reception
Sent: Tuesday, 15 June 2004 5:32 PM
To: Cameron, Ian
Subject: FAX From Coffey - 15/06/04
Importance: High

-----Original Message-----
From: Parsons Brinckerhoff [mailto:bnereception@pb.com.au]
Sent: Tuesday, 15 June 2004 5:31 PM
To: Brisbane Reception
Subject: Incoming Fax Floor 7
Importance: High

FROM=61732744977
TO=+61 7 3831 4223
DATE=15/06/2004
TIME=17:30:47
TIMEZONE=+10:00

[redacted]

7

[redacted]

PARSONS BRINCKERHOFF

Australia Trade Coast Sewer Project
Contract No. BW30137-02.03
Revised Developed Design Report
Separable Portion No. 2
Lytton Road Pump Station SP298

E2. PB Report

MEMORANDUM

Parsons Brinckerhoff
12th floor, IBM Centre
348 Edward Street
Brisbane Qld 4000
GPO Box 2907
Brisbane QLD 4001
Australia
Telephone +61 7 3218 2222
Facsimile +61 7 3831 4223
Email brisbane@pb.com.au

ABN 84 797 323 433
NCSI Certified Quality System ISO 9001

Date: 27 April 2004
To: Ian Cameron
cc: Malcolm Pound (Cardno MBK Qld Pty Ltd)
From: Jason Williams
Job No: 2138110B/1800
Re: **Trade Coast Sewer Project, Geotechnical Advice**
FINAL

This engineering assessment is based on supplied information, listed in the references section of this report. The information is limited and sometimes contradictory. Section 3 discusses the reliability of this assessment in more detail.

BACKGROUND

Ian Cameron from Parsons Brinckerhoff (PB) requested on behalf of Cardno MBK (Qld) Pty Ltd (MBK) that the following issues be addressed regarding three pump stations relating to the Trade Coast Sewer Project, Brisbane. For the Viola Place, Lytton Road and Serpentine Road pump stations each of the following issues were required to be addressed:-

- Establish a ground model using existing data.
- Establish expected foundation pressures (MBK to supply).
- Provide advice on allowable bearing pressure and likely settlement beneath structures, considering possible tilt.
- Comment on foundation options.
- Provide advice on sheet piling in terms of construction sequence.
- Provide advice on ultimate shear at perimeter of pump station structures under uplift situation, for both long and short term situations.
- Consider effect on ground if dewatered.
- Comment on reliability of engineering assessment.

Previous work at the pump station sites was undertaken by Coffey Geosciences (CG) and Brisbane City Council (BCC).

1.0 GROUND MODELS

Ground model sketches are contained in Attachment A.

1.1 Viola Place

The ground model is based on one CG borehole (BH 1) and may be summarised as follows:-

Fill Ground surface (about RL 3.9 m) to about RL 1.3 m. Consisting of hard Sandy CLAY. For the purposes of the ground model it is assumed that weaker areas are

present in the fill, as indicated by BCC bores 120 m south of the pump station where SPT N values of 2 were recorded.

Recent Alluvium About RL 1.3 m to about RL -2.1 m. Comprising CLAY of variable consistency, from soft through to stiff. Lenses or bands of generally discontinuous sand might reasonably be expected.

Older Alluvium Occurring from about RL -2.1 m to at least about RL -6.1 m (limit of testing) and consisting of stiff to very stiff CLAY interbedded with medium dense SAND. CG describe this layer as hard clay but give a design Cu of 150 kPa. For the ground model it will be assumed this layer is stiff to very stiff.

Groundwater Groundwater was noted by CG at about RL 2.8 m (1.1m bgl). Given the proximity of the site to tidal water it may be reasonable to assume that fluctuation in groundwater levels is possible. It is understood no monitoring data is available.

Assumptions in the ground model include that the horizons encountered in the single CG borehole are uniform across the site. The RL of the CG borehole was not measured and is assumed to be about RL 3.9 m. It is understood that no other additional test boreholes are proposed at this stage.

1.2 Lytton Road

The ground model is based on comparison of soil horizons between BH 27 situated adjacent to the site and CPT 6 and CPT 21 situated near to the site. It was not possible to ascertain the exact distances of the test positions relative to the proposed infrastructure given the lack of features on respective site plans for cross-referencing. Additionally, relative levels are not available for CPT 6 and CPT 21. The ground model may be summarised as follows:-

Fill Ground surface (about RL 3.1 m) to about RL 1.55 m. The nature of the fill is unknown and for the purposes of the ground model it is assumed that weak areas are present, given the lack of available test data. The presence of fill is largely assumed based on existing ground contours which show the ground surface at about RL 3.1 m.

Recent Alluvium About RL 1.55 m to about RL -25.0 m. Comprising soft CLAY grading to stiff to very stiff CLAY, with loose SAND lenses throughout. Horizons based on correlation between test locations are recognised approximately as follows:

RL 1.55 m to RL -6.8 m	**Very soft CLAY** with very loose SAND between RL -2.15 m and RL -5.0 m. Other thin sand bands possible.
RL -6.8 m to RL -17.8 m	**Soft to firm CLAY.** Loose SAND bands possible, particularly between RL -14.0 m and RL -17.8 m.
RL -17.8 m to RL -25.0 m	**Firm to stiff CLAY.** Loose SAND bands possible.

Older Alluvium About RL -25.0 m to at least about RL -31.1 m (limit of testing). Consisting of stiff to very stiff CLAY interbedded with medium dense SAND. Test refusal is recorded in CPT 21 at about RL -27.4 m.

Groundwater Groundwater was recorded in BCC BH 27 at about RL 1.25 m on 28 May 2003. Given the proximity of the site to tidal water it may be reasonable to

assume that fluctuation in groundwater levels is possible. It is understood no monitoring data is available.

Assumptions in the ground model include that the horizons encountered in BCC BH 27 are generally uniform across the site. It is understood that no other additional test boreholes are proposed at this stage.

1.3 Serpentine Road

The ground model is based on comparison of soil horizons in the following boreholes:-

- BCC (2002) - BH 1 situated at the proposed pump site and BH 2 situated 35 m north of the pump site
- BCC (1994) - BH 1 and BH 2, both situated near to the pump site. Exact test positions relative to pump station footprint unknown.

Ground level data was not available for the site, or for the boreholes. However, CG refer to a ground level of RL 2.0 m at the site in a fax to PB dated 16 June 2003 relating to sheet piling. Based on a ground surface level at the site of about RL 2.0 m, the ground model may be summarised as follows:-

Fill Occurring from ground surface (assumed RL 2.0 m) to between about RL -0.1 m and RL 1.5 m, and consisting of Gravelly Clayey SAND. For the purposes of the ground model it is assumed that weak areas are present, given the lack of available test data.

Recent Alluvium Occurring from between about RL -0.1 m and RL 1.5 m, to about RL -26.9 m. Horizons based on correlation between test locations are recognised approximately as follows:

RL -0.2 m to RL –9.2 m	**Very loose SAND, Silty SAND & Clayey SAND.**
RL -9.2 m to RL -12.9 m	**Soft CLAY.** Loose SAND bands possible.
RL -12.9 m to RL -26.9 m	**Firm CLAY.** Loose SAND bands possible.

Older Alluvium Occurring from about RL -26.9 m to at least about RL -33.3 m (limit of testing) and consisting of stiff to very stiff CLAY interbedded with medium dense SAND.

Groundwater Groundwater inflow was recorded in BCC (2002) BH 1 at 1.7m bgl (about RL 0.3 m) and BH 2 at 2.1 m bgl (about RL -0.1 m). Additionally, given the proximity of the site to tidal water it may be reasonable to assume that fluctuation in groundwater levels is possible.

Assumptions in the ground model include that the horizons encountered in BCC (2002) BH 1 are generally uniform across the site. Site levels and borehole levels have been assumed. It is understood that no other additional test boreholes are proposed at this stage.

2.0 ENGINEERING COMMENTS

2.1 Applied Foundation Pressures

Information regarding expected pressure applied to the foundation soils for the Viola Place pump station has been supplied by MBK. It is understood applied pressures vary

linearly from 80 kPa under the outer edge of the pump well to 20 kPa under the outer edge of the valve pit. For the purposes of this report it is assumed that the applied pressures described above will also be the same for the Lytton Road and Serpentine Road pump stations. It is understood that Viola Place and Lytton Road are wet well pump stations and that Serpentine is a dry well pump station and that the applied pressures supplied by MBK are for both wet and dry conditions.

PB structural engineers indicate applied pressure for the Viola Place ferric chloride dosing area is 18 kPa and for the generator hardstand is 13 kPa.

2.2 Sheet Piling Advice

Sheet piling is considered necessary for Viola Place, Lytton Road and Serpentine Road pump stations. Sheet piling is suggested for the entire construction site. This is considered to be the most practical approach, rather than sheet piling around certain parts of the pump structure only. The construction sequence suggested is as follows:-

- Driven sheet piles surrounding entire construction site are to be driven from the surface.
- Sheet pile depths to be sufficient to maintain internal stability of unsupported sections where significant level differences are present.
- Install internal sumps with dewatering pumps.
- External partial dewatering around perimeter of sheet piles using close spaced spear points, providing resulting settlement is satisfactory in terms of nearby buildings, structures, services etc.
- Excavation to design levels.
- Construction of pump station inside steel sheet piling.
- Backfilling with select engineered fill as and when required during construction of various pump station sections.
- Backfill to comprise select engineered fill, clayey gravel mix (to give maximum adhesion with pump walls).
- All backfill to be compacted to recognised standards.

CG provided geotechnical parameters for sheet pile design for Viola Place (Table 1) in their 2004 site investigation report. PB can design sheet pile support for Viola Place, Lytton Road and Serpentine Road if required. It would be an advantage if MBK could advise if the sheet piles can be internally braced and/or ground anchored.

Table 1. Viola Place material properties supplied by CG for sheet pile design.

Material	Undrained Parameters (Short Term)		Drained Parameters (Long Term)		Bulk Density (t/m^3)
	C_u (kPa)	ϕ_u (°)	C' (kPa)	ϕ' (°)	
Fill	40	0	2	25	1.7
Firm to Stiff Clay	40	0	2	25	1.6
Hard Clay	150	0	5	25	1.8
Medium Dense Sand	0	35	0	35	1.7

* Extracted from CG 2004 Site Investigation Report for Viola Place.

2.3 Allowable Bearing Pressure and Settlement

Clay is the predominant soil type in the Viola Place and Lytton Road ground models and as such the allowable bearing pressure (ABP) is assessed based on the shear strength of the clays. As no triaxial data is available it was necessary to assume shear strengths based on pocket penetrometer data supplied on geotechnical bore logs. Additionally, no consolidation test data is available making it necessary to assume coefficient of volume compressibility (m_v) parameters using standard m_v values based on clay type, found in soil mechanics texts. The ABP at Serpentine Road is assessed based on SPT N values. Values of allowable bearing pressure (ABP) and estimated settlements are provided in Table 2.

Table 2. Suggested allowable bearing pressure and estimated settlements.

	ABP (kPa) of Natural Soils *(based on 4m wide pad footings)*	**Settlement** *(exclusive to settlement due to dewatering) (values approximate & based on limited data)*
Viola Place	Greater than about 5 m depth, ABP = 80 kPa. Parts of the pump structure founded at depths shallower than 5 m, ABP = 35 kPa. The existing fill is considered unsuitable to found on. ABP in compacted select fill, to 98% standard compaction, is assessed at 100 kPa provided it is at least 1.5 m thick below the founding element.	<30 mm beneath footings at about 5 m depth (supplied by CG). Potential is recognised for differential settlement between adjoined parts of the pump structure which are founded at varied levels, given the presence of a soil profile with variable strength character. Without restricting ABP to 35 kPa in the upper 5m of soil profile, potential exists for differential settlement of 25-35 mm and total settlement of 50-60 mm. It is not known what the pump structure tolerances are.
Lytton Road	Very soft clay from about RL 1.85 to RL -6.8, ABP = 5 kPa For the soft to firm clay beneath RL -6.8, an ABP of 15 kPa is suggested for design purposes. The existing fill is considered unsuitable to found on.	Not greater than 25-30 mm. Not greater than 25-30 mm.
Serpentine Road	Very loose sand from about RL -0.2 to RL -9.2, ABP = 10 kPa. Soft to firm clay below about RL -9.2, ABP = 15 kPa is suggested for design purposes. The existing fill is considered unsuitable to found on.	Not greater than 25-30 mm. Not greater than 25-30 mm.

It is understood that the intention at tender design stage was to design buoyant pump station structures, thus minimising the applied stress at foundation level and avoiding the need for robust foundation solutions such as piling. It is understood piling had been discussed for each site and been considered not warranted. Since tender design stage various design levels have changed and new geotechnical information has been obtained. The outcome regarding foundation options for each of the pump stations is assessed as follows:- (providing groundwater levels are consistent with ground models)

Viola Place
A floating design is viable. However, it is suggested that foundations at less than about 5m depth be placed on >1.5 m thickness of compacted select fill to minimise total and differential settlement impacts.

Lytton Road
Assumptions at tender design stage include that the pump station structure would be lighter than the soil being replaced. Using current design levels and BCC BH 27 which was obtained after tender discussions, the net effective stress increase at foundation level is estimated to range from 20 kPa to 30 kPa, with groundwater at RL 1.25 m. The structure is therefore heavier than the soil it replaces and additionally exceeds the ABP of 5 kPa, with differential settlement and tilting a likely outcome. It is suggested that other foundation options be considered. Options include piling, lowering the level of the pump station if the design would allow, or possibly spreading the load over broader foundations. With broader foundations there are concerns about possible eccentric loads given the extra breadth of foundation required to comply with 5 kPa ABP.

In the consideration of piled foundations it is suggested that the sheet piling construction sequence allow for installation of piled foundations prior to sheet pile installation. Bored or driven piles could be considered however caution may be required with driven piles. The effects of vibration from driven piles on the soft clay founding soils are unknown and may be undesirable in terms of settlement. Further consideration of the effects of vibration would be recommended.

Serpentine Road
Current design levels (invert level about -3.9 m) are approximately 2.5m deeper than those shown at tender design stage. Based on a groundwater level of RL -0.1 m (BCC-2002 BH 2), the net effective stress change at foundation level is estimated to range between -30 kPa to -55 kPa (uplift), also possibly inducing tilt. If additional weight cannot be accommodated in the design to resist uplift then an anchor system may need to be considered. Anchor piles would be an option. Broader foundations or outstands (possibly buttressed) may also be suitable as anchors but would warrant further structural consideration.

2.4 Buoyancy and Uplift Resistance

BUOYANCY
Given that the proposed structures are generally lighter than the soil being replaced, and that foundations occur beneath groundwater levels there is potential for buoyancy of the pump structures. The magnitude of the buoyant forces will act differentially on the structures given that foundation levels vary within the sites. Complicating the buoyancy issue is the likelihood of the groundwater level to fluctuate above or below the measured level due to possible tidal effects. Groundwater monitoring has not been conducted and consequently for design purposes it may be applicable to consider the following:-

1. Flood conditions. Flood data should be obtained to verify flood heights, and therefore the likely uplifts due to buoyancy.

2. If groundwater occurs below the deepest founding level (i.e. should pumping be required to maintain the construction area, or groundwater levels drop due to other phenomenon).

TILTING DUE TO BUOYANCY
There is potential for tilt due to buoyancy at each of the pump stations when groundwater levels are high given the likelihood of stronger buoyancy forces beneath the deeper pump sections. It is expected that the structures will be designed to be heavy enough to resist buoyancy. This is a design issue and it becomes a balancing exercise between providing enough weight to resist the buoyancy forces whilst not exceeding the ABP during times of possible lower groundwater. A solution to limit tilting impacts would be to design the pump station foundations to the same level.

UPLIFT RESISTANCE
Provided sheet piling surrounds the entire construction the ultimate shear at the perimeter of the pump station depends primarily on the adhesion between the select backfill material and the pump station walls. For design purposes a value of zero for ultimate shear is suggested for assessment of uplift at the perimeter of the pump station elements.

2.5 Effect on Ground if Dewatered

NEARBY GROUND
Dewatering will increase the effective stresses acting on the soils which would result in settlement. CG quote in their 2004 site investigation report 75 mm consolidation settlement for Viola Place depending on the drawdown and this seems a reasonable estimate based on limited data. Soils are softer at Lytton Road and Serpentine Road pump stations and consolidation settlement at both stations could exceed about 150 mm, depending on the drawdown. The consolidation settlements stated above could be potentially damaging to nearby structures (roads, buildings, services, etc) requiring external dewatering to be reconsidered and suitable sheet piles designed. PB structural engineers indicate there are no structures or services at risk at the Viola, Lytton or Serpentine pump station sites.

Without any groundwater monitoring or consolidation data it is difficult to estimate the size of the area that may be influenced by settlement and the severity. Dewatering around the perimeter of sheet piling driven to about 4 to 5 m depth is likely to influence an area of about 35 m to 40 m out from the sheet piles, providing water levels are monitored and allowance for re-injection of the water is made.

FOUNDATION SOILS
Settlements stated above due to drawdown also apply to the foundation soils. Foundation soils could settle about 75mm at Viola Place and about 150mm at Lytton Road and Serpentine Road, depending on the drawdown. If settlement is taking place when construction of the pump stations and associated infrastructure has commenced then there is a risk of differential settlement. In this regard tilting may be an issue during construction and allowance should be made in the pipe work to take account of differential movements.

3.0 GENERAL COMMENT ON RELIABILITY OF ENGINEERING ASSESSMENT

The reliability of this engineering assessment for the pump stations is subject to the following:

- There is no groundwater level monitoring data for any of the sites.
- The range of groundwater level fluctuations at each site due to tidal influences is unknown.
- RL data of the test boreholes and CPTs at the ground surface is mostly absent.
- Ground levels are absent for Serpentine Road.
- No triaxial (shear strength) or consolidation test data is available for any of the sites, which has resulted in our assumptions of this data. Dale Waters from BCC confirms there were no triaxial tests ever conducted and only one oedometer consolidation test conducted, which is located about 1.7km from the Lytton Road pump station.

No accountability can be taken for any of the assumptions made in this assessment or of their impact on the ultimate designs. Including the above, assumptions for the sites include:-

Viola Place
The ground model provided in this report is based on 1 borehole (CG BH 1) for which there is limited geotechnical test data and no measured RL. The borehole RL at the ground surface was assumed.

Lytton Road
The ground model provided in this report is based on 1 borehole (BCC BH 27) and two CPT tests (CPTs 6 & 21) for which there is limited geotechnical test data. It was necessary to assume the relative levels of the ground surface of the CPTs. Data is contradictory where some SPT N values are zero but pocket penetrometer values are between 10 kPa to 110 kPa.

Serpentine Road
The ground model provided in this report is based on four boreholes (BCC-1994 BHs 1 and 2, and BCC-2002 BHs 1 and 2) for which limited geotechnical test data is available. It was necessary to assume the relative levels of the site and of the ground surface at the test boreholes.

For each of the above sites, settlement limits the suggested ABP values. The settlement estimates are based on assumed m_v values which is not desirable given the sensitivity of settlement calculations to m_v values. The ABP values cannot be further refined without laboratory oedometer consolidation data. The ABP for Viola Place and Lytton Road is assessed based on pocket penetrometer derived estimates of shear strength whereas typically undrained triaxial or multi-stage triaxial laboratory test data would be relied on.

With alluvial strata found at each of the pump station sites, changes in ground profile could occur over short distances and there is a risk that the ground models on which the engineering assessment is based could be different than as modelled. Refer to attachment B regarding further limitations of geotechnical advice.

4.0 CONCLUSIONS

- The ground models are based on limited data.
- Laboratory test results would typically be relied on when assessing ABP, settlement and foundation options. However, laboratory test data is not available for any of the pump station sites under consideration.
- Ground conditions at Lytton Road consist of very soft clay and at Serpentine Road consist of very soft clay and very loose sand.
- Low ABPs apply for each of the pump station sites, more so for Lytton Road and Serpentine Road than Viola Place. The low ABPs are in order to limit total and differential settlements impacts and tilting.
- Sheet piling is suggested for construction of all pump station sites.
- At each pump station site there is potential for significant buoyancy effects due to high ground water levels, particularly at Serpentine Road.
- At each pump station a value of zero for ultimate shear is suggested for assessment of uplift at the perimeter of the pump station elements.
- Dewatering will induce settlement in foundation soils and in nearby ground.
- At Viola Place it is suggested that foundations at less that about 5m depth be placed on >1.5 m thickness of compacted select fill to minimise total and differential settlement impacts.
- Pile foundations are a suggested option for Lytton Road to accommodate the low ABP. More geotechnical data could further refine the assessment of the site and allow closer scrutiny of foundation options but the general view is that the soils at the site are softer than expected and the design needs to accommodate this.
- An anchor system is one solution for Serpentine Road pump station to counter buoyancy effects. Possible options requiring further consideration include additional weight in the structure, broader foundations or outstands (possibly buttressed) or anchor piles.
- The level of the ground water is assessed to play a crucial role in the design of a buoyant structure, and at each of the pump station sites no ground water level monitoring has been conducted.
- The pump stations will be constructed in an environment described in BCC reports as sometimes highly aggressive to steel and concrete due to the pH of the ground water and the sulphur content of the soils. Although no data is available specific to the pump station sites, the design should consider that these corrosive conditions are likely.
- The foundation soils may be sensitive to vibrations.

5.0 REFERENCES

Viola Place

Coffey Geosciences Pty Ltd (2004). Australia Trade Coast Sewer Project. Viola Place Pump Station (SP299), Geotechnical Investigation for Parsons Brinckerhoff.

Brisbane City Council (1994). Brisbane Water Limited, Contaminated Land & Acid Sulphate Soil Assessment, ATC Sewerage (North) Viola Street to Serpentine Road, Pinkenba – Appendix B. Soil Bore Logs.

Drawings: Viola Place Pumping Station (Mar 2004): SP299 Sectional Plan, Dwg No 486/5/7-SQ700/010 Amend P2, and (Jan 2004) SP299 Sections, Dwg No 486/5/7-SQ700/011 Amend P2, and (Feb 2004) SP299 Locality & Site Plan Dwg No 486/5/7-SQ700/001 Amend P3.

Lytton Road

City Design (2003). Geotechnical Data Report, Australia Trade Coast Sewerage Project, Lytton Road, Lytton to Serpentine Road, Pinkenba. March 2003. Ref: CD/T6-G10389095-PR001Bjsb

City Design (2003). Supplementary Geotechnical Data Report, Australia Trade Coast Sewerage Project, Lytton Road to Brisbane River, Lytton. November 2003. Ref: CDT6-G10389095-PR002Bjsb

Soil Surveys (2002). Port of Brisbane Corporation, Clunies Flat Industrial Subdivision, Lytton Road, Lytton. Project No 102-6514, August 2002.

Drawings: Lytton Road Pumping Station (Feb 2004): SP298 Sections, Dwg No 486/5/7-WR101_031 Amend P1, and (Feb 2004) SP298 Site Plan, Dwg No 486/5/7-WR101_022, Amend P1.

Serpentine Road

Brisbane City Council (1994). Investigation Report 93038 - Appendix B. Borehole and CPT Locations & Records. Department of Water Supply & Sewerage Projects Design Section, Eagle Farm to Luggage Point Rising Main, Serpentine Road Structures. August 1994.

Brisbane City Council (2002). Attachment B. Soil Bore Logs. Australia Trade Coast North, Viola St to Serpentine Road. Project CD/T6 – G1/0389212.

Coffey Geosciences fax to Parsons Brinckerhoff. 16 June 2003. Ref B17625/1-D. Australia Trade Coast Sewer, Serpentine Road Pump Station Temporary Works.

Drawings: Serpentine Road Pumping Station (Jan 2004): SP300 Section, Dwg No 486/5/7-TR201_031 Amend P1.

Other Drawings
Tender Drawings – 20/062003: Australia Trade Coast Sewerage Project. Drawings PD201-204, PD301-304, PD101-104.

Australia Trade Coast Sewerage Project 3/06/03: Borehole Locations, Dwg No PD005, Amend A, and 3/06/03 Key Plan, Dwg PD003, Amend A.

Attachment B. Limitations of Geotechnical Advice

Reliance on Data

In preparing the report, PB has relied upon data, surveys, analyses, designs, plans and other information provided by the Client and other individuals and organisations, most of which are referred to in the report ("the data"). Except as otherwise stated in the report, PB has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report ("conclusions") are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. PB will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to PB.

Geotechnical Investigation

Geotechnical engineering is based extensively on judgment and opinion. It is far less exact than other engineering disciplines. Geotechnical engineering reports are prepared to meet the specific needs of individuals. A report prepared for a consulting civil engineer may not be adequate for a construction contractor or even some other consulting civil engineer. This report was prepared expressly for the Client and expressly for purposes indicated by the Client or his representative. Use by any other persons for any purpose, or by the Client for a different purpose, might result in problems. The Client should not use this report for other than its intended purpose without seeking additional geotechnical advice.

This Geotechnical Report is based on Project-specific Factors

This geotechnical engineering report is based on a subsurface investigation, which was designed for project-specification factors, including the nature of any development, its size and configuration, the location of any development on the site and its orientation, and the location of access roads and parking areas. Unless further geotechnical advice is obtained this geotechnical engineering report cannot be used:

when the nature of any proposed development is changed; or

when the size, configuration location or orientation of any proposed development is modified.

This geotechnical engineering report cannot be applied to an adjacent site.

The Limitations of Site Investigation

In making an assessment of a site from a limited number of boreholes or test pits there is the possibility that variations may occur between test locations. Site exploration identifies specific subsurface conditions only at those points from which samples have been taken. The risk that variations will not be detected can be reduced by increasing the frequency of test locations; however this often does not result in any overall cost savings for the project. The investigation programme undertaken is a professional estimate of the scope of investigation required to provide a general profile of the subsurface conditions. The data derived from the site investigation programme and subsequent laboratory testing are extrapolated across the site to form an inferred geological model and an engineering opinion is rendered about overall subsurface conditions and their likely behaviour with regard to the proposed development. Despite investigation the actual conditions at the site might differ from those inferred to exist, since no subsurface exploration programme, no matter how comprehensive, can reveal all subsurface details and anomalies.

The borehole logs are the subjective interpretation of subsurface conditions at a particular location, made by trained personnel. The interpretation may be limited by the method of investigation, and cannot always be definitive. For example, inspection of an excavation or test pit allows a greater area of the subsurface profile to be inspected than borehole investigation, however, such methods are limited by depth and site disturbance restrictions. In borehole investigation, the actual interface between materials may be more gradual or abrupt than a report indicates.

Subsurface Conditions are Time Dependent

Subsurface conditions may be modified by changing natural forces or man-made influences. A geotechnical engineering report is based on conditions, which existed at the time of subsurface exploration.

Construction operations at or adjacent to the site, and natural events such as floods, or groundwater fluctuations, may also affect subsurface conditions, and thus the continuing adequacy of a geotechnical report. The geotechnical engineer should be kept appraised of any such events, and should be consulted to determine if additional tests are necessary.

Avoid Misinterpretation

A geotechnical engineer should be retained to work with other appropriate design professionals explaining relevant geotechnical findings and in reviewing the adequacy of their plans and specifications relative to geotechnical issues.

Bore/Profile Logs Should Not Be Separated from the Engineering Report

Final bore/profile logs are developed by geotechnical engineers based upon their interpretation of field logs and laboratory evaluation of field samples. Customarily, only the final bore/profile logs are included in geotechnical engineering reports. These logs should not under any circumstances be redrawn for inclusion in architectural or other design drawings. To minimise the likelihood of bore/profile log misinterpretation, contractors should be given access to the complete geotechnical engineering report prepared or authorised for their use. Providing the best available information to contractors helps prevent costly construction problems. For further information on this matter reference should be made to "Guidelines for the Provision of Geotechnical Information

in Construction Contracts" published by the Institution of Engineers Australia, National Headquarters. Canberra 1987.

Geotechnical Involvement During Construction

During construction, excavation is frequently undertaken which exposes the actual subsurface conditions. For this reason geotechnical consultants should be retained through the construction stage, to identify variations if they are exposed and to conduct additional tests, which may be required, and to deal quickly with geotechnical problems if they arise.

Report for Benefit of Client

The report has been prepared for the benefit of the Client and no other party. PB assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including without limitation matters arising from any negligent act or omission of PB or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in the report). Other parties should not rely upon the report or the accuracy or completeness of any conclusions and should make their own enquiries and obtain independent advice in relation to such matters.

Other Limitations

PB will not be liable to update or revise the report to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the report.

Attachment A. Ground Model Sketches

PB 100 YEARS

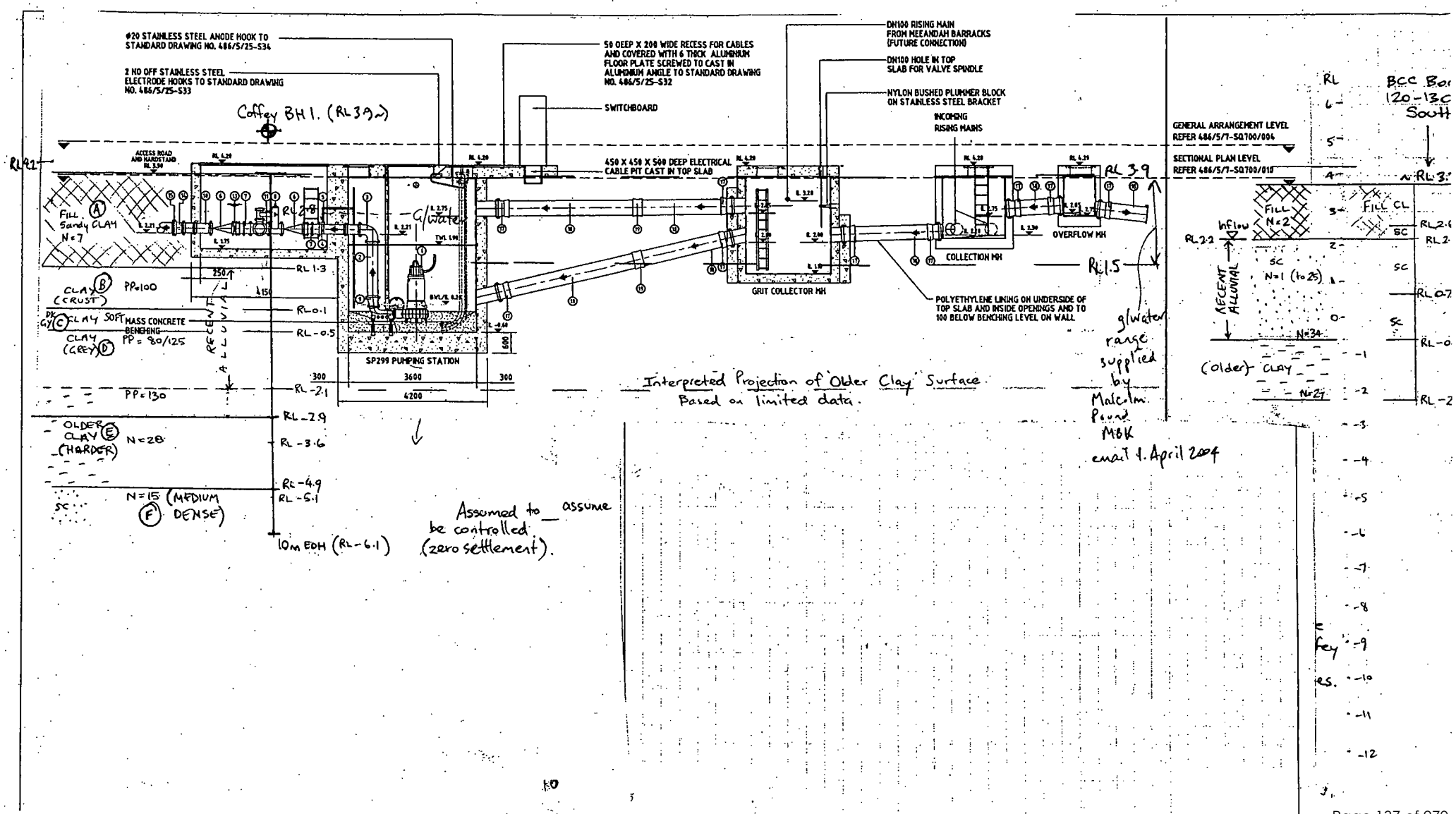
Calculation Sheet

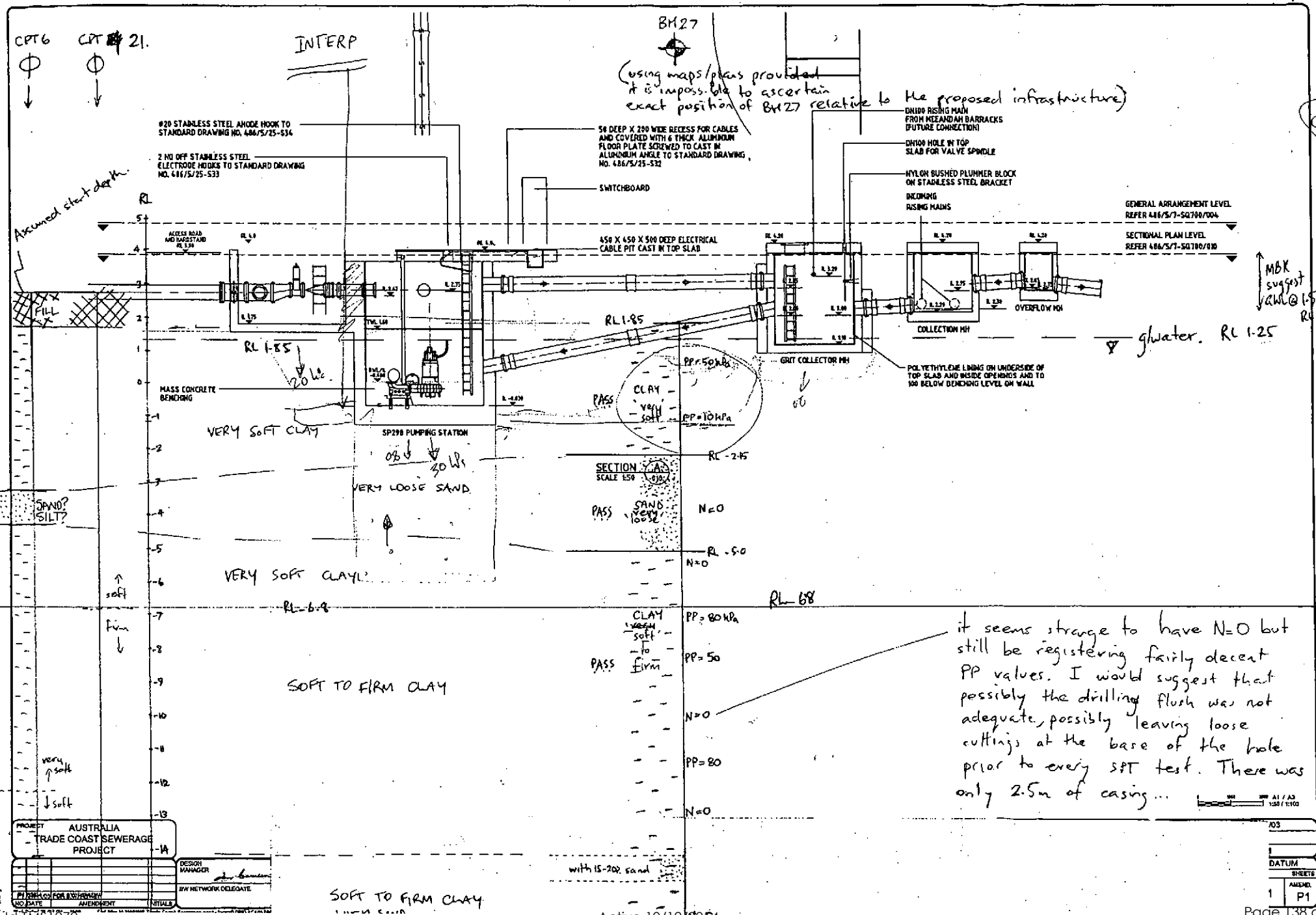
Job TRADE COAST SEWER
VIOLA - PUMP STATION

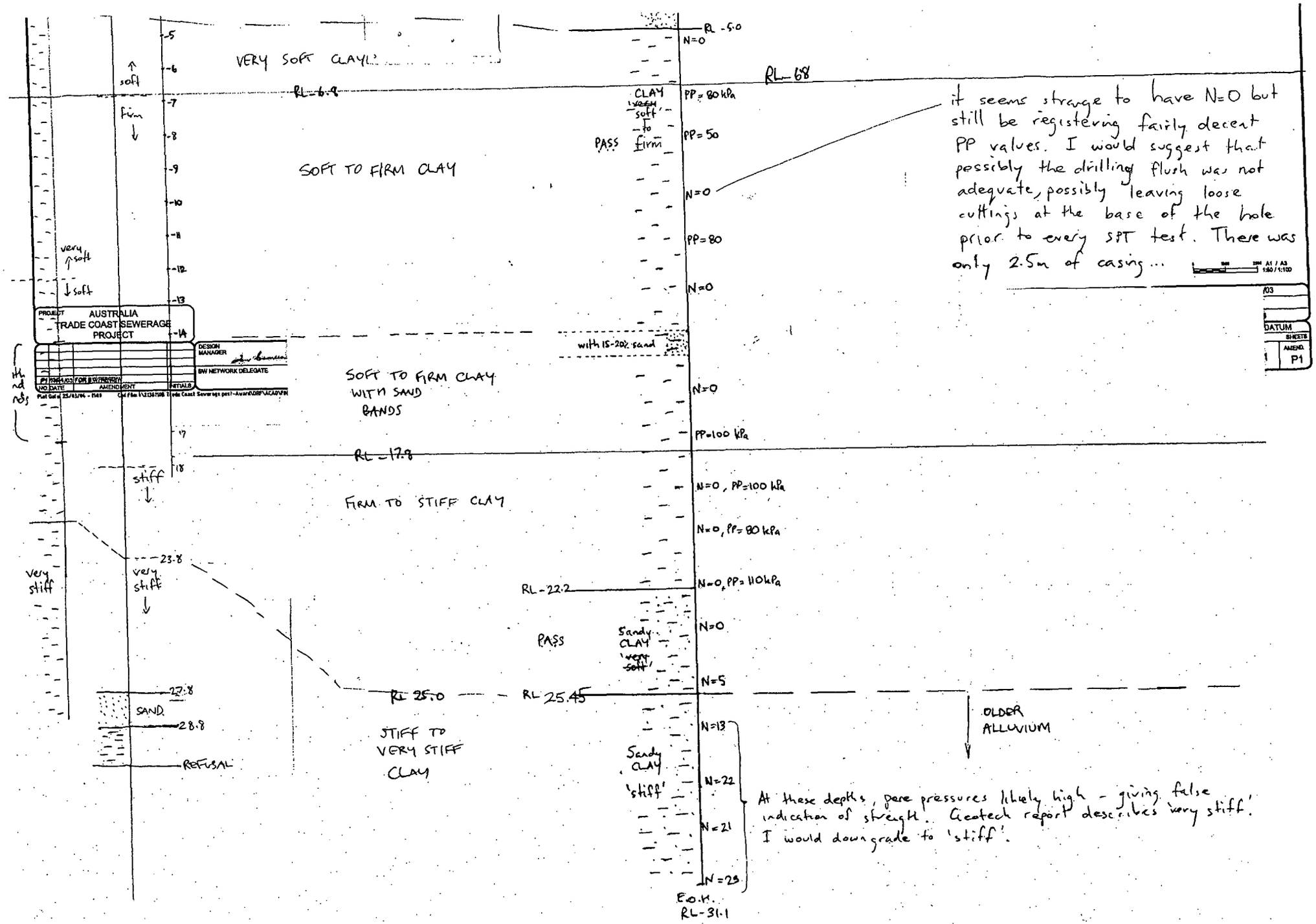
Design JAW
Date
Checked
Date 31/3/04

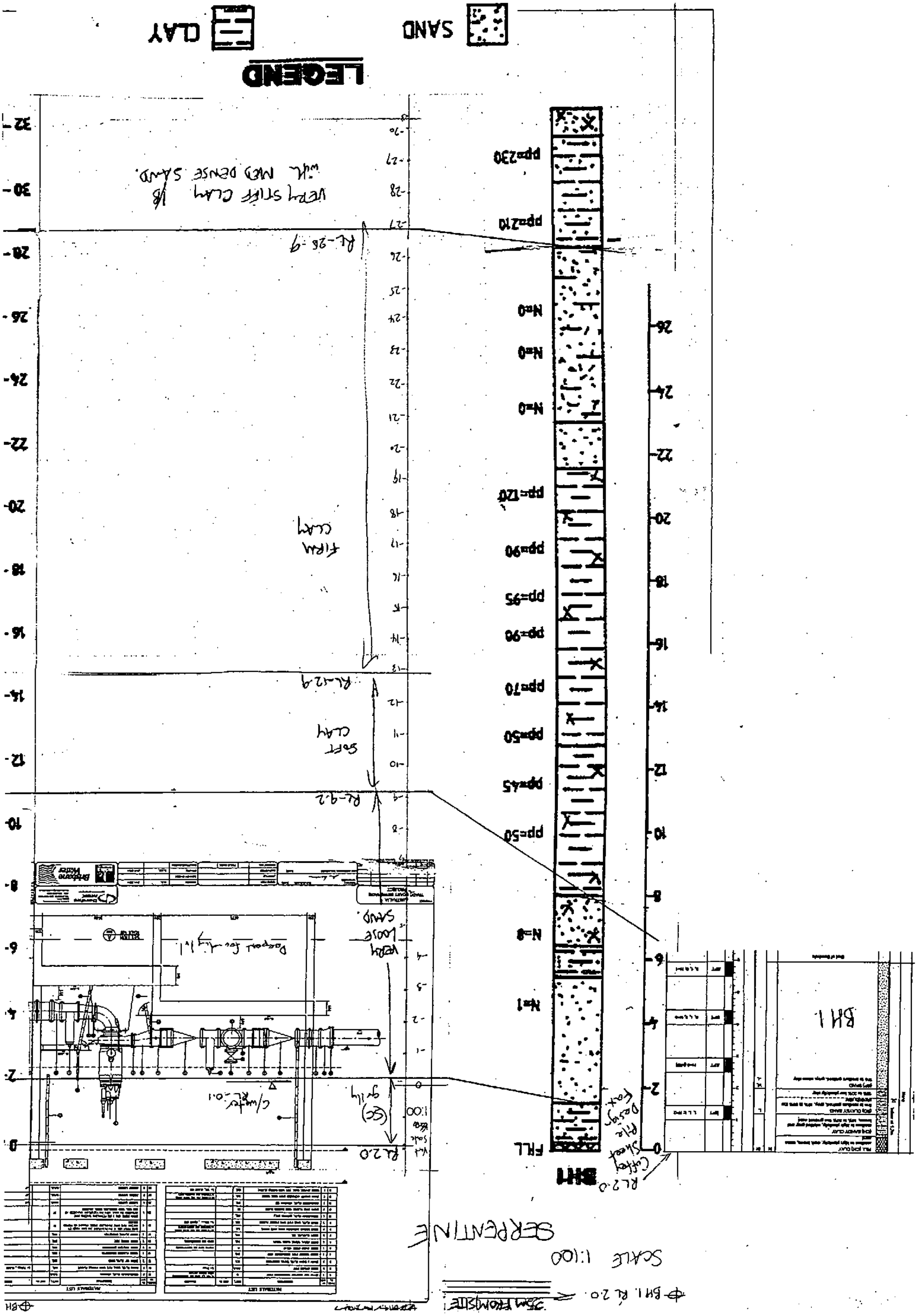
Office PB - BRIS
Job No. 21381108/1800
Page No.

SCALE 1:100




1x4x5 = 80m³ = 800kN
x 1.2 = 960kN.
160kN / 16m² = 10
/ 32m² = 5 kPa. ~6m.
LYTTON
RELEVANT INFO.
BM27, CPT 21, CPT 6
CPT6
CPT 21.
INTERP
BM27
(using maps/plans provided it is impossible to ascertain exact position of BM27 relative to the proposed infrastructure)
#20 STAINLESS STEEL ANODE HOOK TO STANDARD DRAWING NO. 486/S/25-S34
2 NO OFF STAINLESS STEEL ELECTRODE HOOKS TO STANDARD DRAWING NO. 486/S/25-S33
50 DEEP X 200 WIDE RECESS FOR CABLES AND COVERED WITH 6 THICK ALUMINIUM FLOOR PLATE SCREWED TO CAST IN ALUMINIUM ANGLE TO STANDARD DRAWING NO. 486/S/25-S32
SWITCHBOARD
DN100 RISING MAIN FROM MEEANDAH BARRACKS (FUTURE CONNECTION)
DN100 HOLE IN TOP SLAB FOR VALVE SPINDLE
NYLON BUSHED PLUMMER BLOCK ON STAINLESS STEEL BRACKET
INCOMING RISING MAINS
GENERAL ARRANGEMENT LEVEL REFER 486/S/7-SQ700/004
SECTIONAL PLAN LEVEL REFER 486/S/7-SQ700/010
450 X 450 X 500 DEEP ELECTRICAL CABLE PIT CAST IN TOP SLAB
Assumed start depth
RL
FILL
RL 1.85
20 Ls
MASS CONCRETE BENCHING
VERY SOFT CLAY
SP298 PUMPING STATION
30 Ls
VERY LOOSE SAND
SAND? SILT?
soft
firm
VERY SOFT CLAY
RL -6.8
SOFT TO FIRM CLAY
very soft
soft
with 15-20% sand
SOFT TO FIRM CLAY
COLLECTION MH
OVERFLOW MH
GRIT COLLECTOR MH
POLYETHYLENE LINING ON UNDERSIDE OF TOP SLAB AND INSIDE OPENINGS AND TO 100 BELOW BENCHING LEVEL ON WALL
MBK suggest gWL @ 1.5 to 3.9 RL
gwater. RL 1.25
PASS
CLAY very soft
PP=50kPa
PP=10kPa
RL -2.15
SECTION A
SCALE 1:50
PASS
SAND very loose
N=0
RL -5.0
N=0
RL 6.8
CLAY very soft to firm
PP=80kPa
PP=50
PASS
N=0
PP=80
N=0
it seems strange to have N=0 but still be registering fairly decent PP values. I would suggest that possibly the drilling flush was not adequate, possibly leaving loose cuttings at the base of the hole prior to every SPT test. There was only 2.5m of casing...
TP
TP2
TP1
CPT1
30.
gw.
PROJECT AUSTRALIA TRADE COAST SEWERAGE PROJECT
DESIGN MANAGER
BW NETWORK DELEGATE
NO. DATE AMENDMENT INITIALS
P1 20/04/12 FOR BW REVIEW
DATUM
SHEETS 1
AMEND. P1


RL -5.0
N=0
VERY SOFT CLAY
RL -6.8
RL -6.9
soft
firm
CLAY
'very soft' to firm
PP = 80 kPa
PP = 50
PASS
SOFT TO FIRM CLAY
N=0
PP=80
N=0
very soft
soft
AUSTRALIA TRADE COAST SEWERAGE PROJECT
DESIGN MANAGER
BW NETWORK DELEGATE
NO. DATE AMENDMENT INITIALS
with 15-20% sand
SOFT TO FIRM CLAY WITH SAND BANDS
N=0
PP=100 kPa
RL -17.9
stiff
FIRM TO STIFF CLAY
N=0, PP=100 kPa
N=0, PP=80 kPa
23.8
very stiff
very stiff
RL -22.2
N=0, PP=110kPa
PASS
Sandy CLAY 'very soft'
N=0
N=5
27.8
SAND
28.8
REFUSAL
RL 25.0
RL 25.45
OLDER ALLUVIUM
STIFF TO VERY STIFF CLAY
N=13
Sandy CLAY 'stiff'
N=22
N=21
N=25
E.O.H. RL -31.1
it seems strange to have N=0 but still be registering fairly decent PP values. I would suggest that possibly the drilling flush was not adequate, possibly leaving loose cuttings at the base of the hole prior to every SPT test. There was only 2.5m of casing...
At these depths, pore pressures likely high - giving false indication of strength. Geotech report describes 'very stiff'. I would downgrade to 'stiff'.
DATUM
SHEETS
AMEND.
P1


LEGEND
CLAY
SAND
BH1
FILL
SERPENTINE
SCALE 1:100

Calculation Sheet
LEGEND
CLAY
SAND
BH2
FILL
N=0
N=1
N=0
N=0
N=0
N=0
N=25
N=17
N=29
PP=40
PP=45
PP=70
PP=80
PP=70
PP=75
PP=80
PP=90
PP=100
PP=100

PARSONS BRINCKERHOFF

Australia Trade Coast Sewer Project
Contract No. BW30137-02.03
Revised Developed Design Report
Separable Portion No. 2
Lytton Road Pump Station SP298

Appendix F

Dynamic Surge Analysis Information

Parsons Brinckerhoff

12th Floor, IBM Centre
348 Edward Street
Brisbane QLD 4000
GPO Box 2907
Brisbane QLD 4001
Australia
Telephone +61 7 3218 2222
Facsimile +61 7 3831 4223
Email brisbane@pb.com.au

ABN 84 797 323 433
NCSI Certified Quality System ISO 9001

Our Reference: 2138110B-LTR043Aic:rmk

4 August 2004

Mr James Whybrow
Project Manager — Australia Trade Coast Sewer Project
Leighton Contractors Pty Limited
C/- Level 3, 143 Coronation Drive
MILTON QLD 4064

Dear James

Australia Trade Coast Sewer Project
Additional Water Hammer Analysis SP298 to SP300 Rising Main

Further to the Design Meeting held on 28 July 2004, we commissioned sub-consultant Design Detail and Development (Geoff Stone) to complete further water hammer analyses based upon the control philosophy outlined by PB Principal Engineer David Kent.

1. Scenario Modelling

The preference of Brisbane Water (BW) not to have automatic air valves on the SP298 to SP300 rising main has been included in the scenarios modelled.

Additionally we have included an elevated inlet at RL 2.25 m AHD at SP300 in order to provide static head to ~~five~~ provide some resistance to fluid momentum upon pump stop. This is required to limit the volume drawn from SP298 after pump stop.

For the elevated inlet at SP300 we propose an air valve pit with a blanked tee mounted on an air valve tee with a 100 ND breather pipe connected to the SP300 wet well (which will be vented through an odour scrubber). (See attached sketch.)

The elevated inlet with venting to atmosphere will ensure that the hydraulic grade line remains at RL 2.25 m AHD at the break pressure pit immediately adjacent to SP300.

We understand that Leighton Contractors will locate the proposed elevated inlet valve pit on the southern side of the existing rising mains so that a directional drill can be constructed down to the inlet works which will reduce the cost of the proposed inlet works. (See attached sketch.)

Flow banding has been adopted as follows:

- Duty A to 160 L/s RL 0.25
- Duty A to 90 L/s RL -0.18
- Stop Duty B RL -0.38
- Stop Duty A RL -0.98

The scenarios which were modelled were as follows:

- pump stop is normally from 90 L/s;
- pump stop is normally controlled from 160 L/s to 90 L/s;
- single pump trip at 90 L/s, due to loss of power; and
- single pump trip at 160 L/s, due to loss of power.

2. Modelling Results

A copy of the "Supplement to the Review of Unsteady State Hydraulic Design, SPS 298 Lytton Road to SPS 300 Serpentine Road" (2 August 2004) is attached as Appendix A.

The extra water hammer analysis may be summarised as follows:

Event	Integrated Volume (cu. m.)	Minimum Volume Available to BWL (cu. m.)
90 L/s Single Pump Trip Due to Loss of Power	1.85	3.3
160 L/s Single Pump Trip Due to Loss of Power	3.75	9.5

Note: 3.6 m diameter pump well has a cross-sectional area of 10.2 m^2.

Conclusion: The SP298 wet well has sufficient capacity not to empty under normal stop or power failure mode provided the nominated set points are used with VSD control of the pumps.

On the basis of the successful water hammer modelling the following revised settings are recommended:

- Duty A to 160 L/s RL 0.15
- Duty A to 90 L/s RL -0.30
- Stop Duty B RL -0.60
- Stop Duty A RL -1.10

The final pump settings will be optimised during the commissioning of the SP298 pump station. This will allow minimisation of the volume of sewage in the wet well after a normal pumping cycle.

3. Brisbane Water Approval

On the basis of the additional water hammer modelling we now formally seek the approval of Brisbane Water for the proposed rising main arrangement so that the detailed design of SP298 and SP300 can now be finalised.

Should further information be required, please contact the undersigned on 3218 2644 or 0401 148 142.

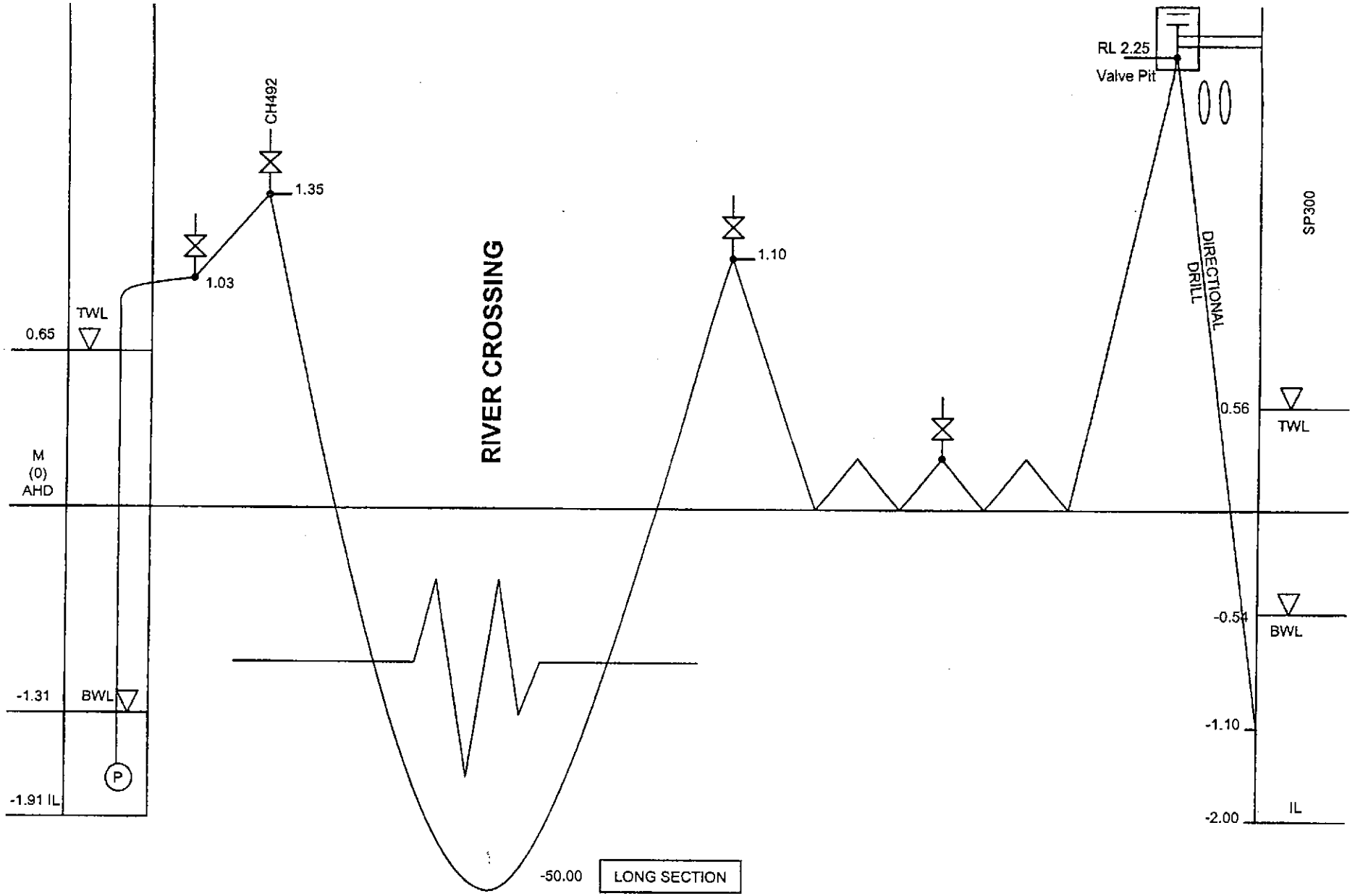
Yours sincerely

Ian Cameron
Design Manager
Parsons Brinckerhoff Australia Pty Limited

Encl. Supplement to the Review (2 August 2004)
Rising Main Sketch

Cc. Andrew Bannink — BW
John Bower — BW
Greg Wright — BW

Over a Century of Engineering Excellence


CH492
1.35
1.03
1.10
RIVER CROSSING
RL 2.25
Valve Pit
DIRECTIONAL DRILL
SP300
TWL
0.65
M
(0)
AHD
0.56
TWL
-0.54
BWL
-1.31
BWL
-1.10
P
-1.91 IL
IL
-2.00
-50.00
LONG SECTION

Supplement to the Review

of

Unsteady State Hydraulic Design

Australian Trade Coast Sewerage Project

SPS 298 Lytton Road
to
SPS 300 Serpentine Road

Commissioned by Parsons Brinkerhoff Australia
Client : Brisbane Water
Prepared by Geoffrey D Stone F I Mech E C. Eng; F I E Aust C.P. Eng
Date 2nd August 2004
Status Revision D1

Design Detail & Development *0402 35 2313*

TABLE OF CONTENTS

Design Detail & Development *0402 35 2313*

Preamble

Parsons Brinckerhoff Australia (PBA) have undertaken a design for the Australia Trade Coast Sewerage Project for Brisbane Water. This Supplement covers the unsteady state analysis of the hydraulic design for the SPS 298 Lytton Road PS to SPS 300 Serpentine Road PS where the air valve option has been deleted but the elevated IL at SP300 is retained..

Summary

The following key points summarize the supplemental findings of the review of the systems design:-

- The analysis was carried out using the latest version of AFT Impulse
- The pressure transients in the system are within the design rating of the pipeline
- The steady state hydraulics are in general agreement with those used for pump selection however the pump is now speed control to a maximum of 160 Ls-1
- Two speed operation based upon wet well level is the proposed operating strategy
- The results are based upon Hidrostal pump curve modified to represent the desired speed
- The volume of fluid siphoned from the SP298 wet well is within the Capacity of the well
- Column separation doesn't occur in significant volumes

Revisions to Report

The following revisions have been undertaken:-

Revision D1

- SP300 inlet box was increased to RL 2.25m
- No double air valves are modelled in the line
- Pump stop is normally controlled from 160 Ls-1 to 90 Ls-1
- Pump stop is normally from 90 Ls-1

Software Used

The software used to undertake the system unsteady state hydraulics was AFT's Impulse vr 3.0. This software enables single or dual pump modelling using the HQ curve, moment of inertia and other criteria of the selected pumps. Details of the software and its verification are available from www.aft.com.

Design Detail & Development *0402 35 2313*

Scenarios Modelled

This models developed were used to determine the following scenarios:-

- Loss of power for all modes of pumping

System Modelling

The modelling was undertaken to demonstrate that the 3.6m diameter wet well at SP298 would not be emptied on normal or emergency pump stop. The pump was modelled with a curve for each speed scenario based upon the maximum flow rate of 160 Ls-1 and for the low wet well level where the flow rate was reduced to 90 Ls-1. This replicates the advised form of two speed control using the VSD of the pumps..

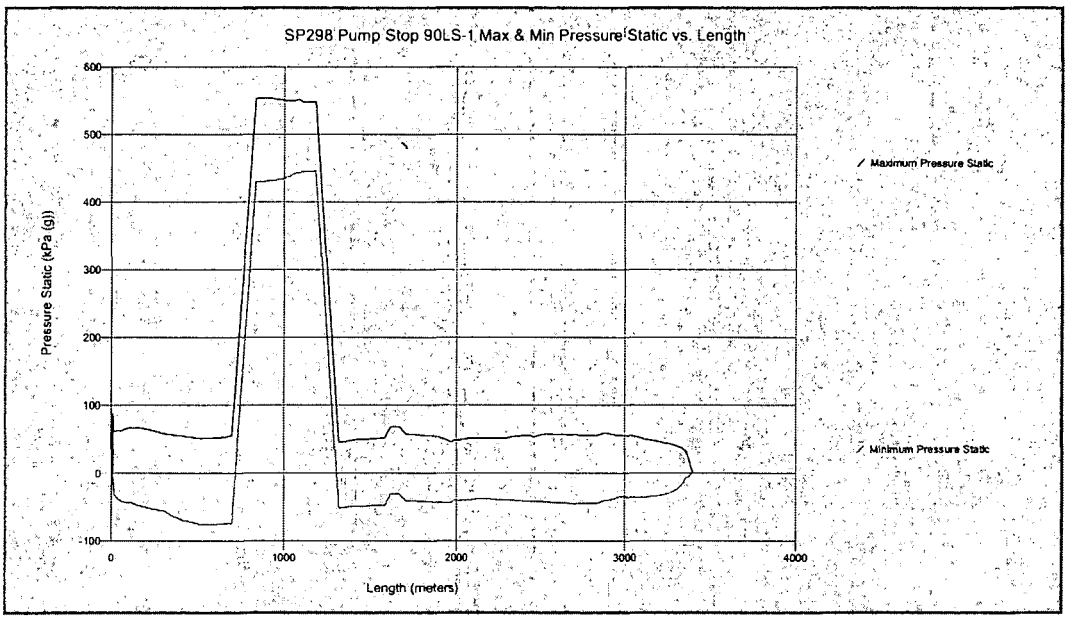
Unsteady State Response Pipelines and Pumps

SPS 298 Pumping Station

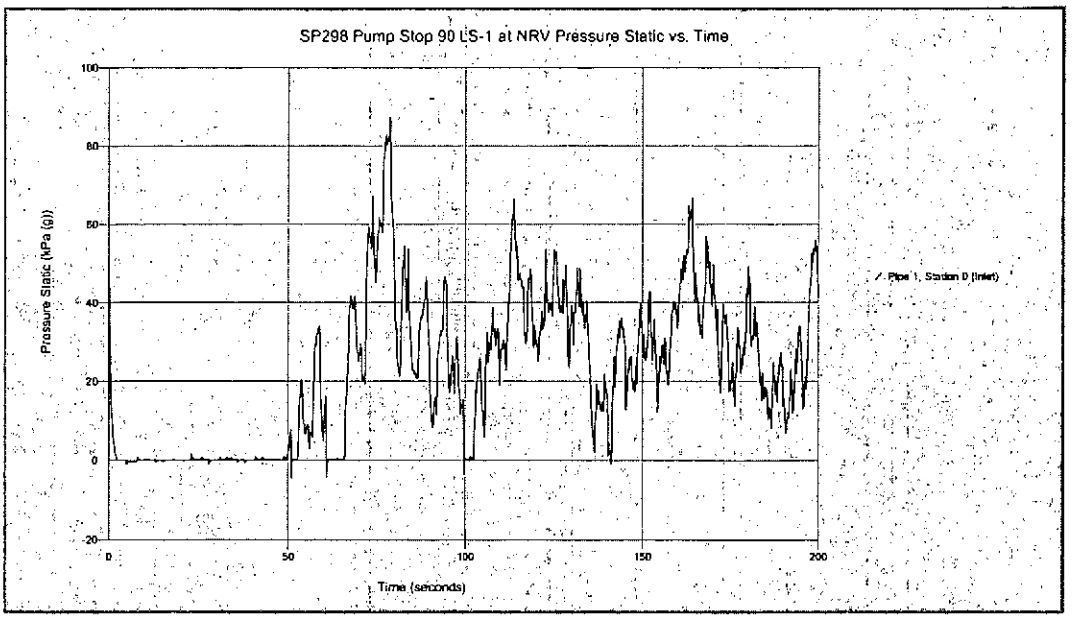
Single Pump Trip Due to Loss of Power from 90 Ls-1

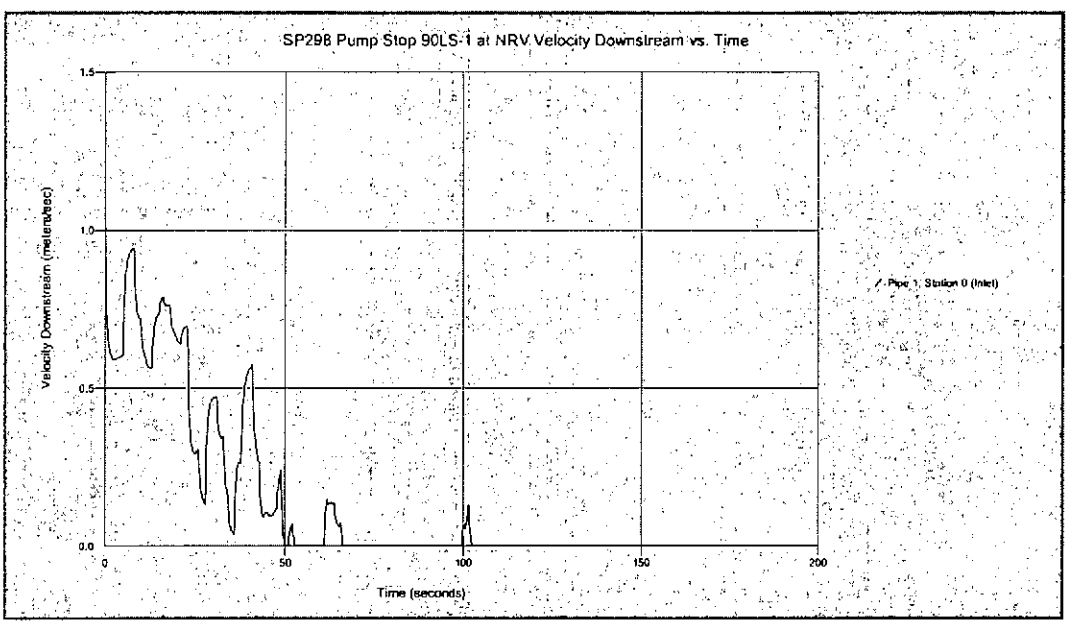
This scenario models the behaviour of the system when the duty pump trips due to loss of power or emergency stop action. The normal stopping under VSD control is considered to be even less of an issue and has not been modelled.

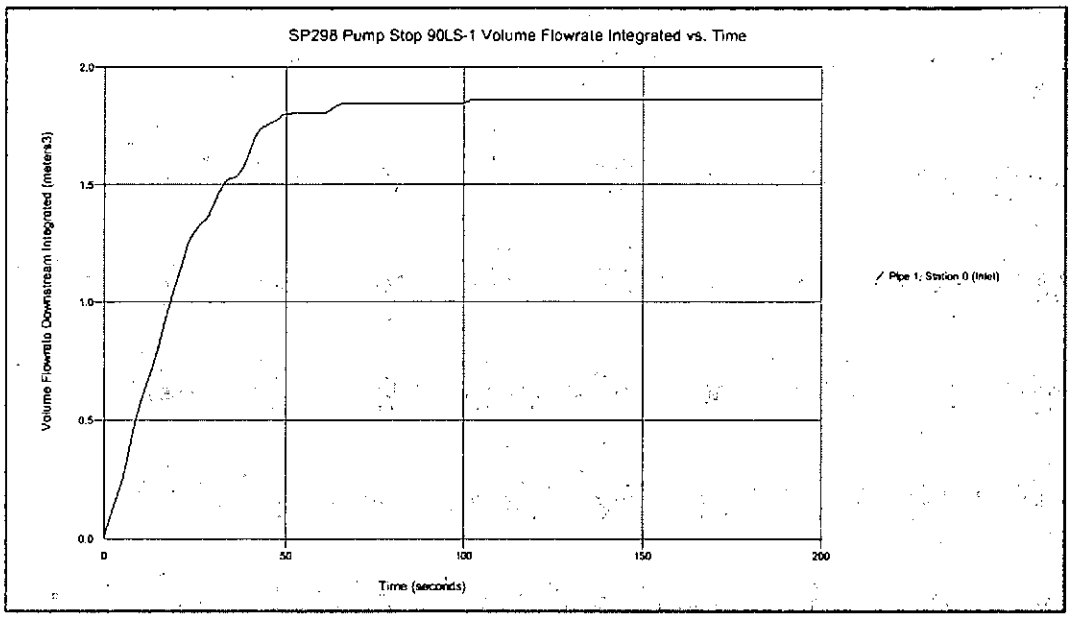
The maximum & minimum surge pressure is 550 kPag positive & -80 kPag respectively for the scenario of a single pump trip.



Design Detail & Development 0402 35 2313





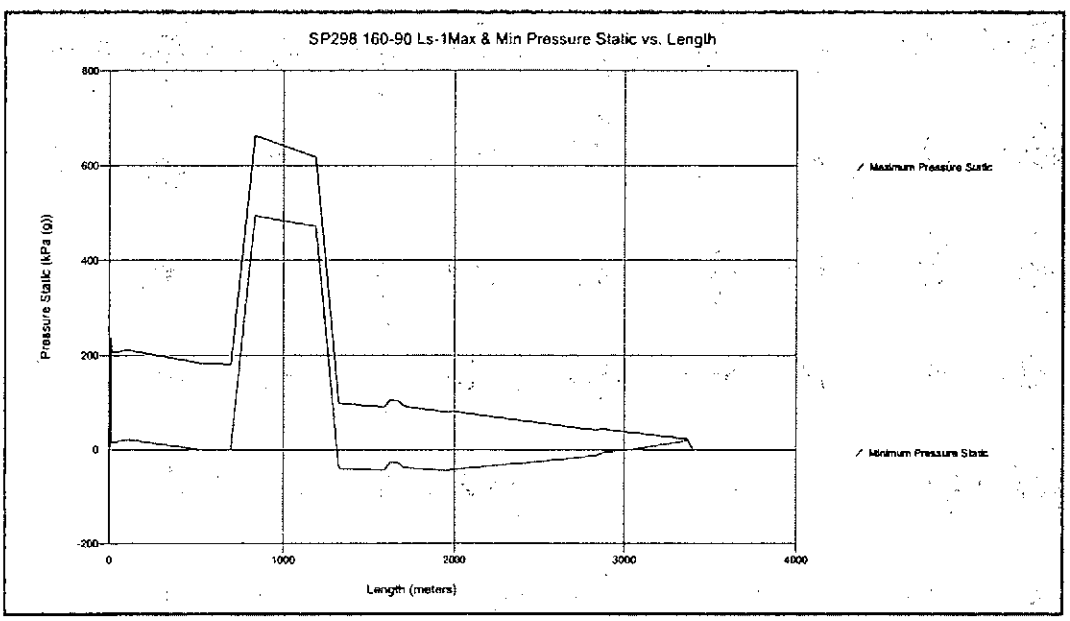


The above curve demonstrates the integrated volumetric flow into the pump upon pump trip. The momentum of the water column in the pipeline results in the volume siphoned reaching a plateau of less than $2m^3$.

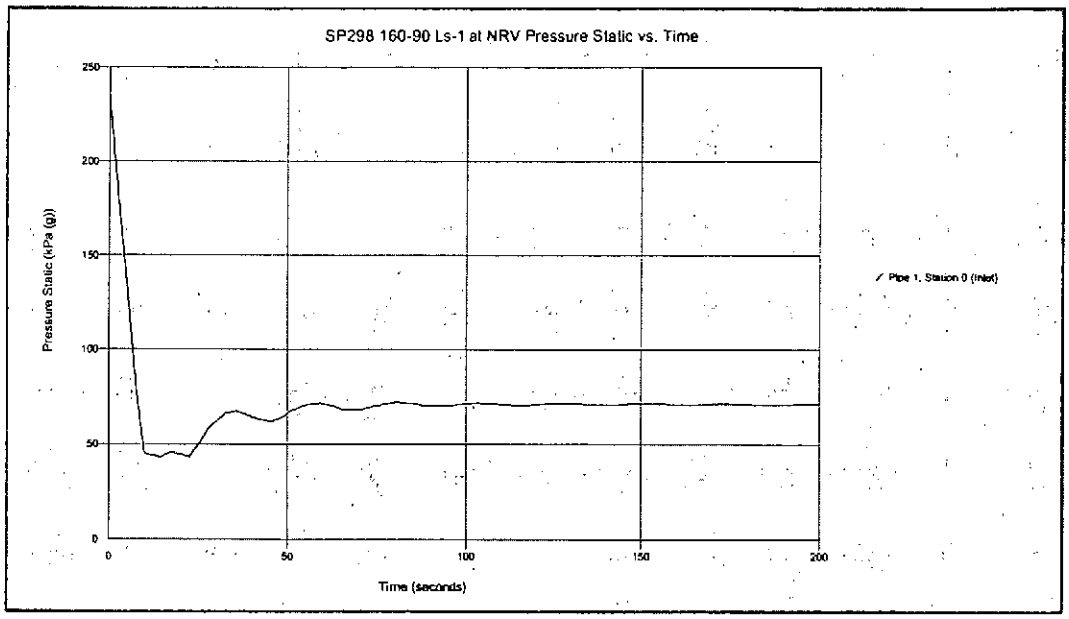
Flow Rate Change from High Speed to Low Speed

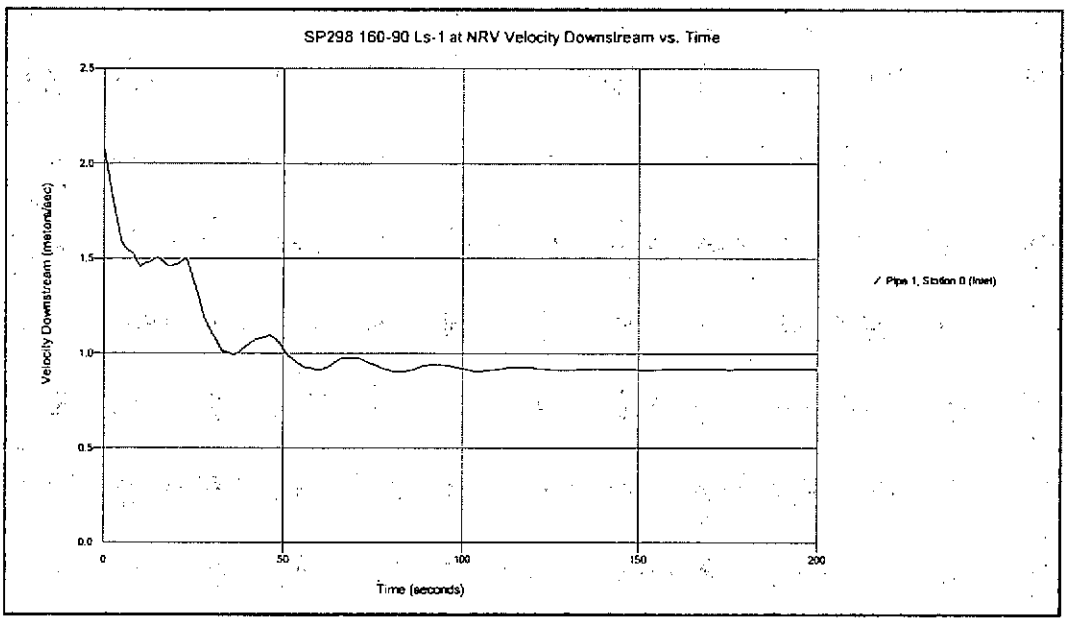
This scenario models the behaviour of the system when the pump is operating at high speed and is changed to low speed using the VSD and flow meter control philosophy. Speed change is effected in 10 seconds.

The maximum & minimum surge pressure is 530 kPag positive & -30 kPag respectively for this scenario.

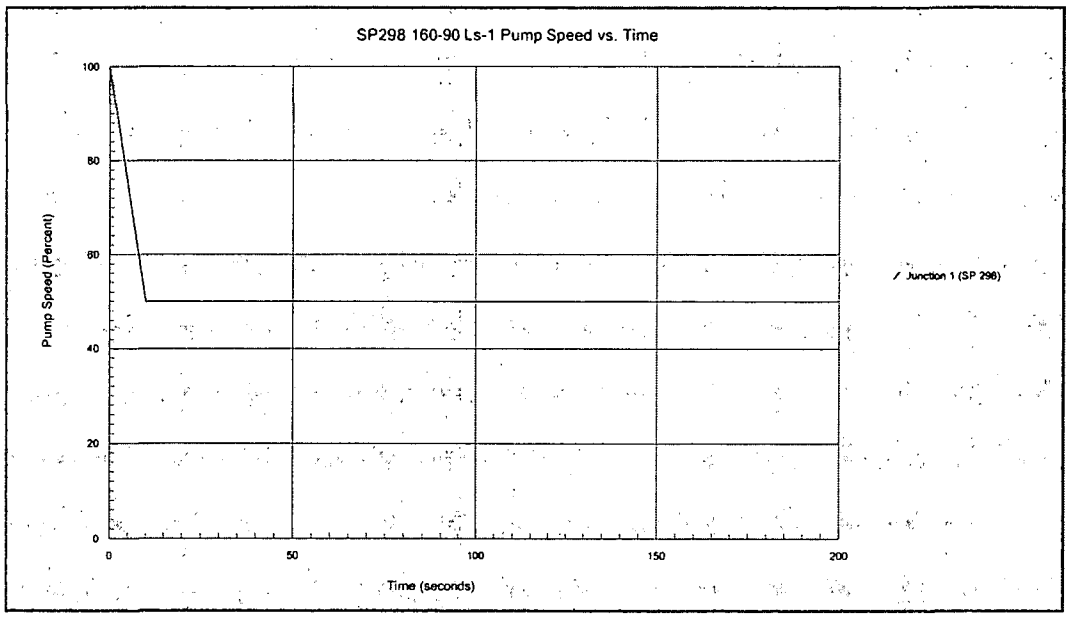


Design Detail & Development ***0402 35 2313***





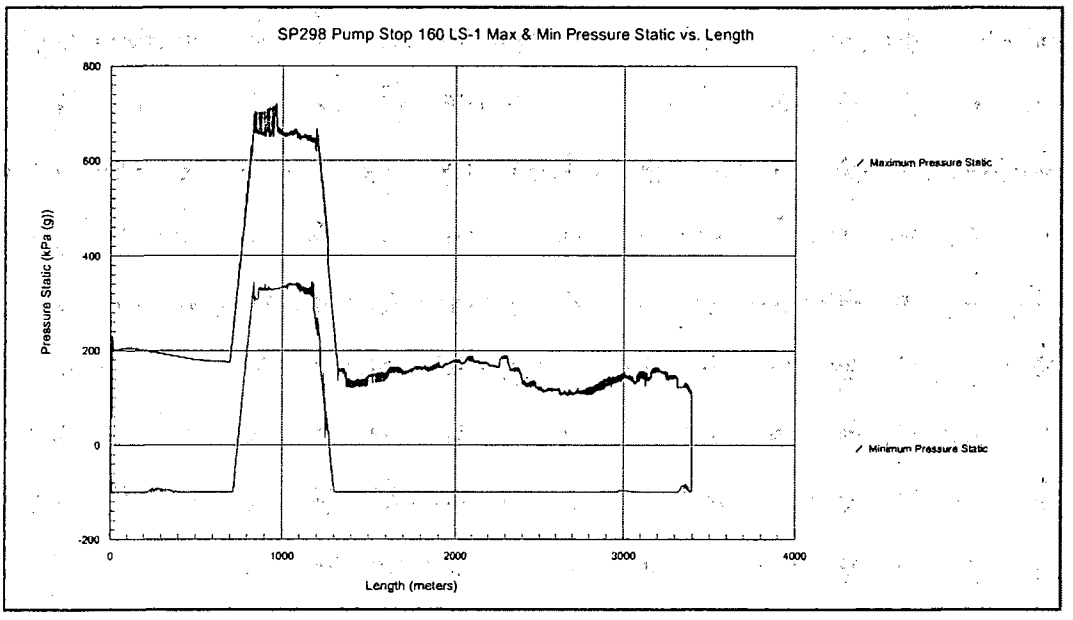
Design Detail & Development *0402 35 2313*



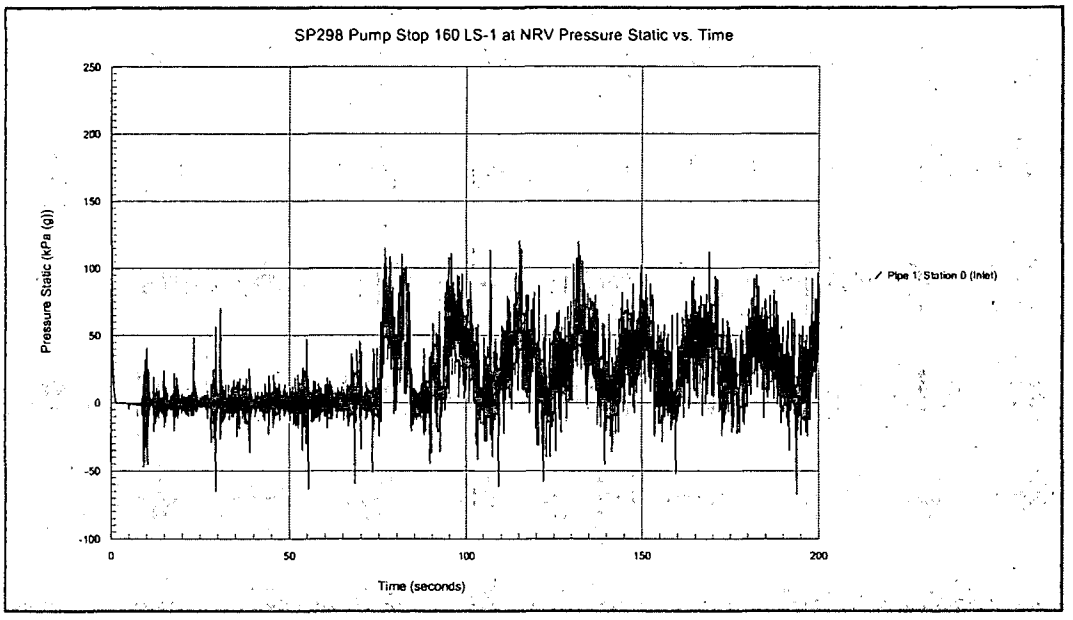
Single Pump Trip Due to Loss of Power from 90 Ls-1

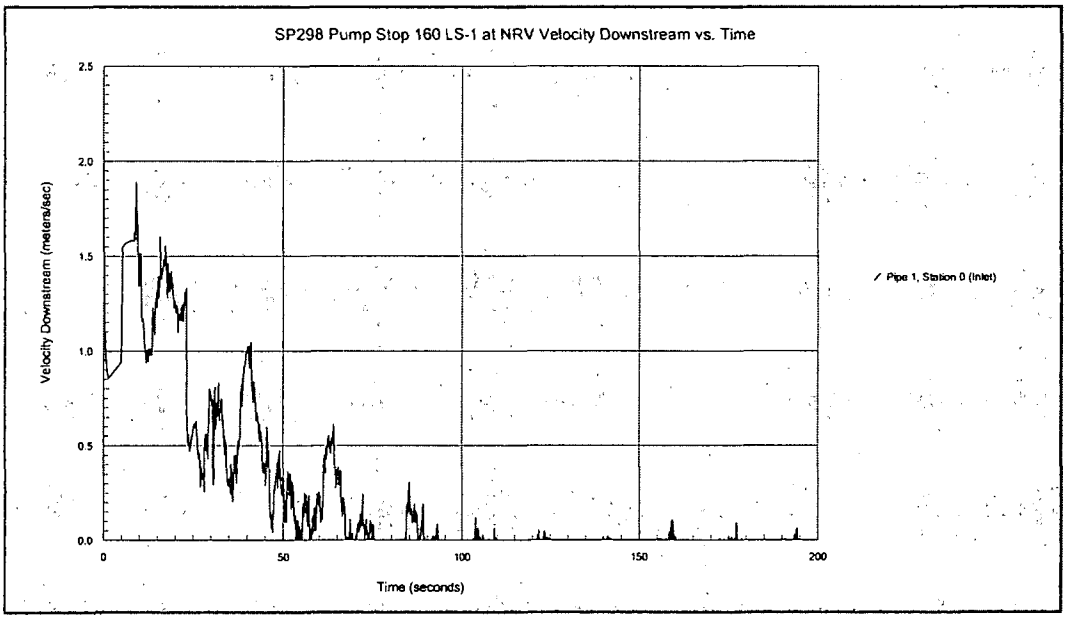
This scenario models the behaviour of the system when a pump is tripped from 160 Ls-1 by electric power outage or emergency stop. Although the selected pump can deliver more than this flow rate, the flow rate is controlled by a controller from a signal from the magflowmeter.

The maximum & minimum surge pressure is predicted as 700 kPag positive & -100 kPag respectively for the scenario of the pump starting with the valve closed at the station valve pit. Examination of the vapour volumes revealed extremely low vapour boundary separation. This explains the low surge levels in this system.

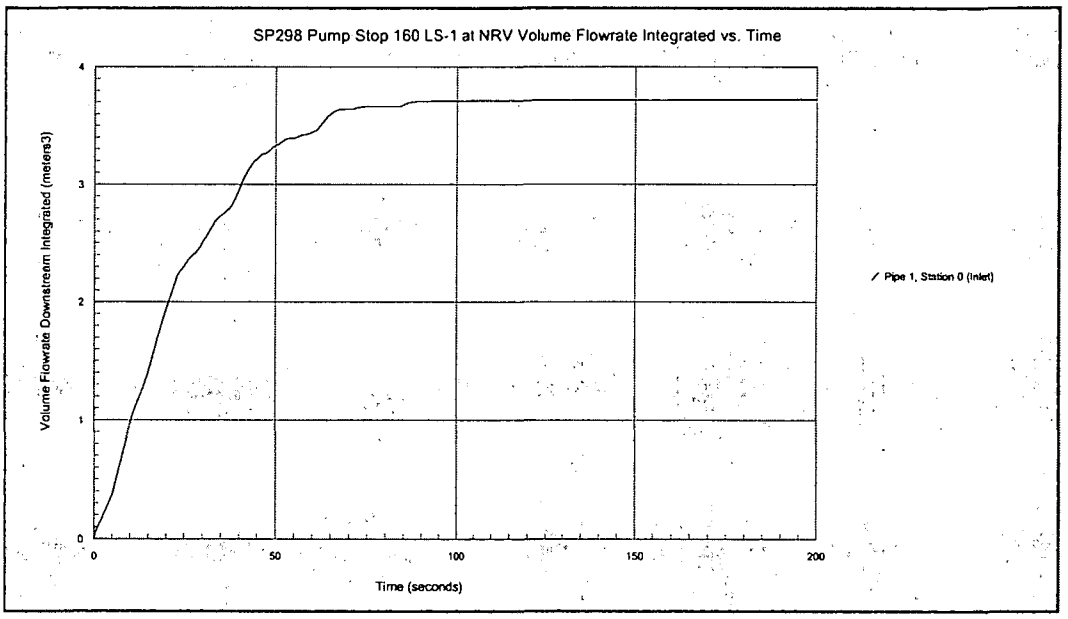


Design Detail & Development 0402 35 2313





Design Detail & Development *0402 35 2313*



The curve above demonstrates that the fluid volume siphoned from the SP298 wet well is less than the capacity available.

Outcomes of the Modelling

The transient pressures are within the design rating of the pipe for all the above scenarios. The design rating of the pipe class selected is 1250 kPa at 20°C. Should the station operate four times an hour the derating factor for a 50 year life would be 0.81 and for a 100 year life 0.74. The maximum derating would thus be to 1012.5 kPa bar for the latter case. Thus the selection complies with the requirements of WSA 01 Polyethylene Pipeline Code.

The check valves selected are suitable for this application and do not require counterweights. The use of counterweights can in some instance magnify a pressure transient in the case of a poorly maintained valve. Should the valve remain open and close swiftly upon reverse velocity of the fluid column, the counter weight increases the acceleration causing a higher valve slam. However it is suggested that the check valve spindle be extended in case devices are to be fitted at a later date.

The wet well at SP298 appears to have sufficient capacity to handle pump stop from all these scenarios.

Negative pressures at the pump discharge may be of concern to the pump manufacturer in terms of seal damage. This may become a maintenance issue over the longer term. The solution would be to install the Ventomat air valves as originally suggested.

Design Detail & Development *0402 35 2313*

Conclusions

The following conclusions are drawn from this supplemental review of the system of Lytton Road PS to SPS 300 Serpentine Road PS DN 450 PE100 PN 12.5 pipeline that crosses the Brisbane River: -

- Transient pressures are within the design rating of the pipe material
- Compliance with WSA 01 has been met
- Check valves do not require counterweights
- The use of variable speed drives for the pumps will further reduce any possible fatigue damage of pipeline components or the pumps
- Two speed operation overcomes the concern by Brisbane Water of using air valves on sewage systems.

oooOOOooo

Review

of

Unsteady State Hydraulic Design

Australian Trade Coast Sewerage Project

SPS 298 Lytton Road
to
SPS 300 Serpentine Road

Commissioned by Parsons Brinkerhoff Australia
Client : Brisbane Water
Prepared by Geoffrey D Stone F I Mech E C. Eng; F I E Aust C.P. Eng
Date 22nd June 2004
Status Revision D

Design Detail & Development *0402 35 2313*

TABLE OF CONTENTS

Design Detail & Development *0402 35 2313*

Preamble

Parsons Brinckerhoff Australia (PBA) have undertaken a design for the Australia Trade Coast Sewerage Project for Brisbane Water. This Report covers the unsteady state analysis of the hydraulic design for the SPS 298 Lytton Road PS to SPS 300 Serpentine Road PS.

Summary

The following key points summarize the initial findings of the review of the systems design:-

- The analysis was carried out using the latest version of AFT Impulse
- The pressure transients in the system are within the design rating of the pipeline
- The steady state hydraulics are in general agreement with those used for pump selection
- The results are based upon Hidrostal pump
- The manual air vent at SP298 should be changed

Revisions to Report

The following revisions have been undertaken:-

Revision D

- SP300 inlet box was added increasing depth to 2.25m
- A DN25 air valve was modelled at SP298 valve pit to replicate the manual valve
- Investigation of larger double air valve at SP298 valve pit

Software Used

The software used to undertake the system unsteady state hydraulics was AFT's Impulse vr 3.0. This software enables single or dual pump modeling using the HQ curve, moment of inertia and other criteria of the selected pumps. Details of the software and its verification are available from www.aft.com.

Scenarios Modelled

This models developed were used to determine the following scenarios:-

- Loss of power for all modes of pumping
- Sudden valve closure along the length of the pipeline
- Pumps starting against a closed valve
- Single pump failure whilst another pump is running

Design Detail & Development *0402 35 2313*

System Modelling

The maximum momentum of the water column arises when pumping from top water level upstream of the pump to bottom water level of the receiving structure. This is the basis of the modelling.

The pump trip is modelled as *stop on inertia with no backwards flow.* Pump moment of inertia (MOI) has been taken from the Hidrostal pump Curve 84-K3229c. The moment of inertia is given as 0.955 kg-m^2.

The characteristics of the non-return valves to be employed were not available from the manufacturer Tyco Water. They were modelled as swing check type valve using industry data[1].

Pipe materials consist of

- DN 300 AS 2280 K12 DICL for the station piping
- DN400 & 450 PE 100 AS 4130 PN20 & PN12.5 for the main pipeline and river crossingrespectively.

The properties used in establishing the wavespeed was the instantaneous modulus of PE 100 at 20°C. This is consistent with the engineering principle that a thermoplastic when exposed to rapid load will respond based upon its instaneous properties.

The level of the inlet to SP300 has been raised to RL2.25 to prevent the the sump at SP298 emptying when the pumps are tripped and air enters the pipeline due to the negative pressure. The models have all been revised to predict the effects of this arrangment.

It was reported that a DN25 manual air vqalve was located at the SP298 valve pit to allow venting of the line. This was modelled. Further a DN100 air valve was modelled to investigate reducing the likelihood of emptying the station on pump trip.

[1] Fluid Transients in Pipeline Systems Prof. ARD Thorley

Design Detail & Development *0402 35 2313*

Unsteady State Response Pipelines and Pumps

SPS 298 Pumping Station

The modelled pumps for this system are duty/standby configuration based upon a The Hidrostal H08K-M02R-HE5TA-XMSK-NDB6-10 pump for this service. This single stage vertical submersible unit model has a nominal duty of 160 L/s @ 25.6m fitted with a four pole speed motor 70 kW motors. Each pump operates with an efficiency of 77% at 160 L/s in single operation. This pump has a similar moment of inertia of 0.955 kg-m^2.

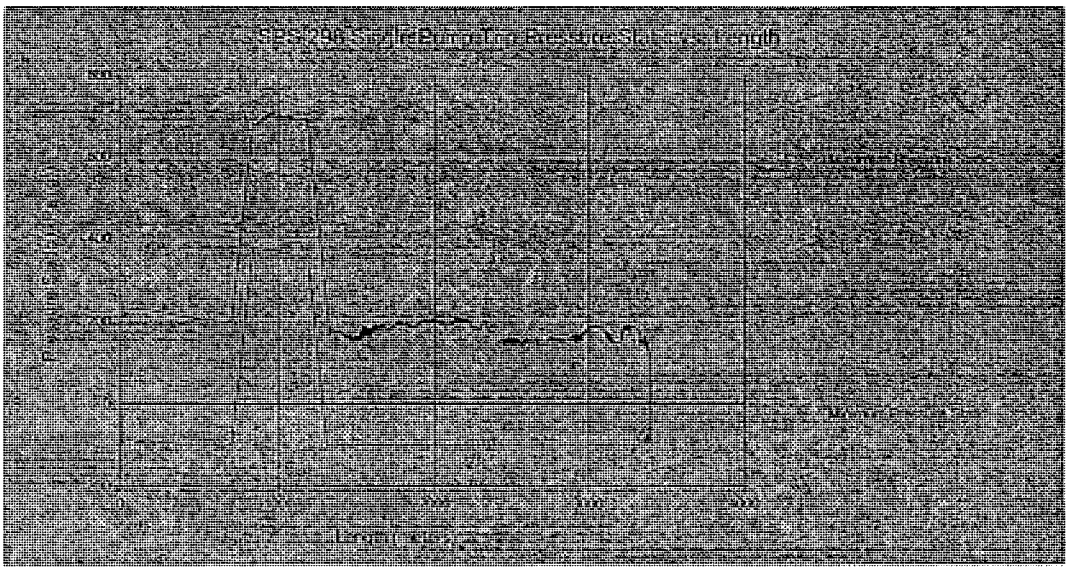
In order for the scenario of *pump failure with a second pump continuing to run* to be considered it has been assumed that parallel pumping is a possible operating mode.

No valve or penstock is located at the discharge end of the pipeline (SP300 inlet) however this was modelled in case one is installed in the future or to represent a pipeline blockage.

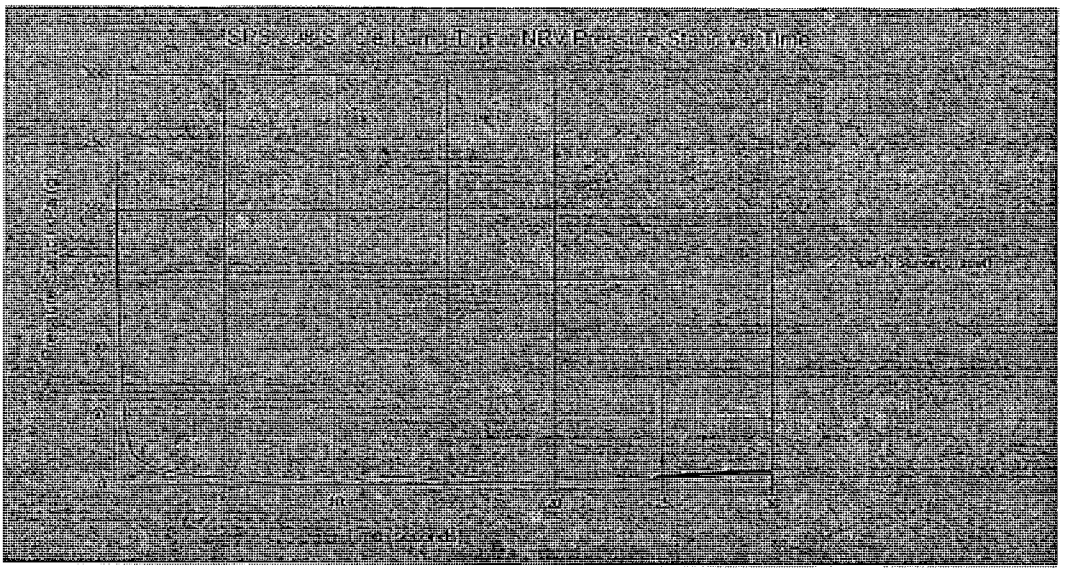
Single Pump Trip Due to Loss of Power

This scenario models the behaviour of the system when the duty pump trips due to loss of power or emergency stop action. The normal stopping under VSD control is considered to be even less of an issue and has not been modelled. This is because the VSD can be characterised for slow stop/start. This will reduce the momentum change in the pipeline and result in lower pressure transients than for a pump trip.

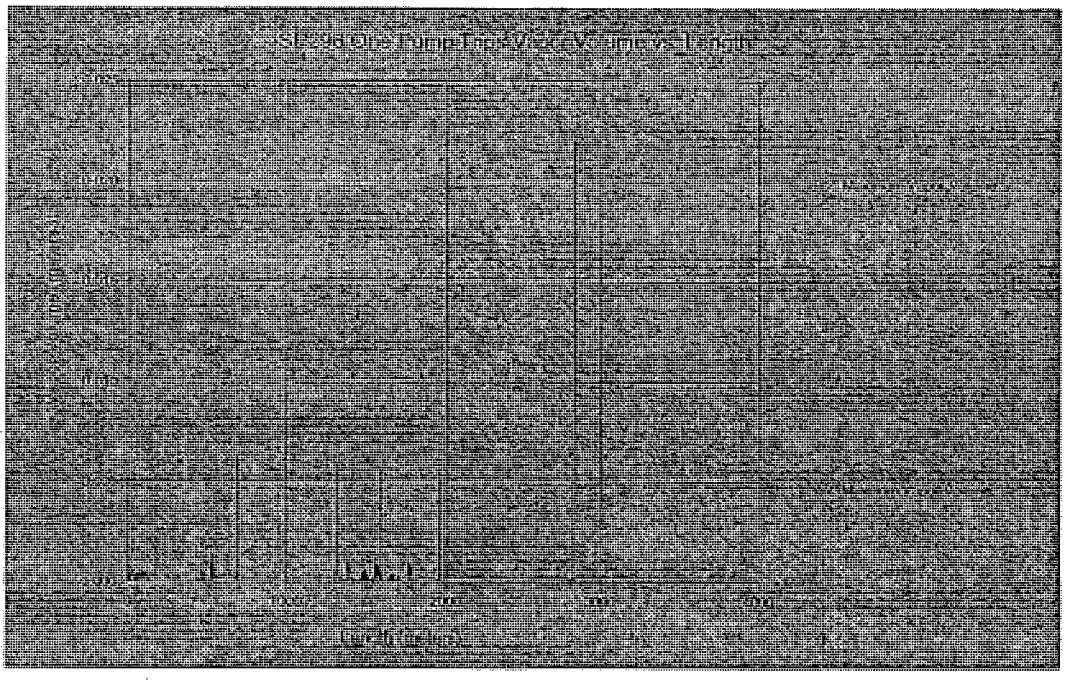
The maximum & minimum surge pressure is 620 kPag positive & -100 kPag respectively for the scenario of a single pump trip.



Design Detail & Development ***0402 35 2313***



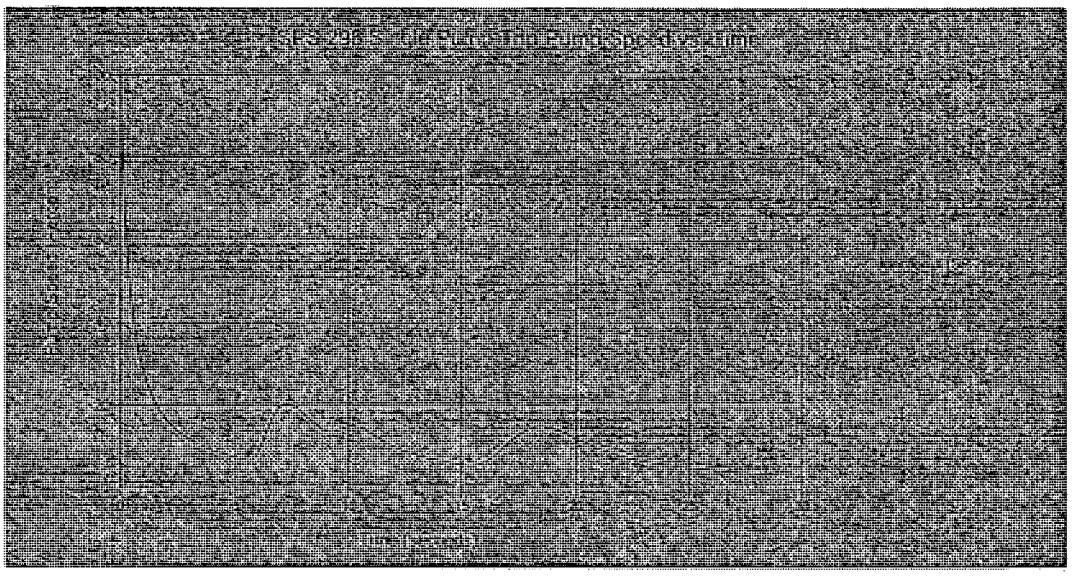
The column separation apparent in the model in this scenario is likely to be an artificial transient or it is of such small volume as to not impact on the pipeline as the graph below illustrates.

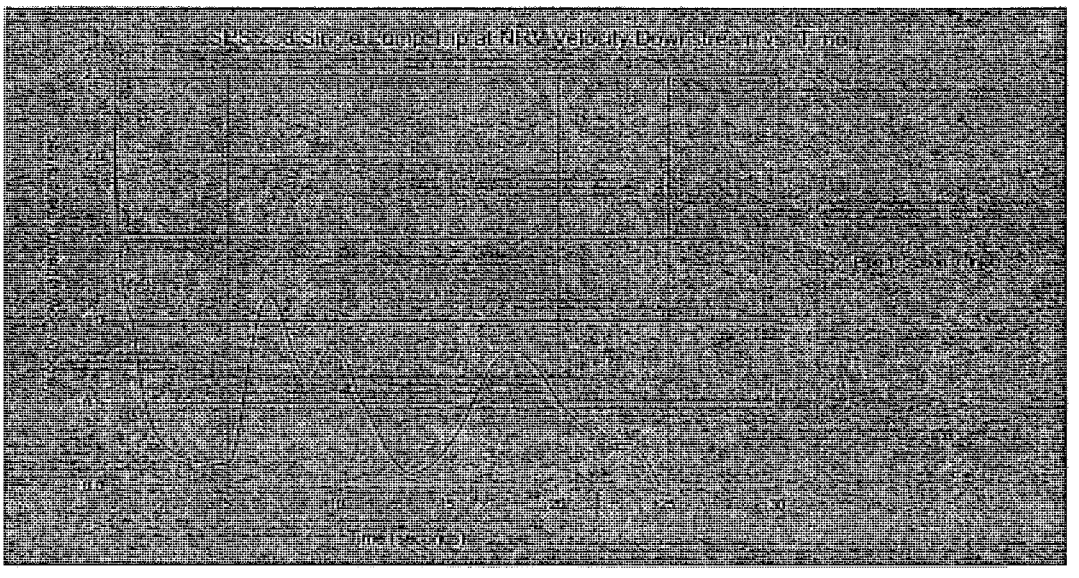


Design Detail & Development 0402 35 2313

The graphs below illustrate the time taken for the water column to come to rest. This duration is to be expected with a long pipeline of PE with near zero static head. This is because there is little friction or head to slow the pipeline fluid velocity and also the DN25 air vent is so small that critical velocity of the air is reached entering the pipeline. It was reported that the air vent is a manual valve and hence could not be operated in the event of a pump trip.

This of course only occurs in the rare case of pump trip due to loss of power or emergency stop activation. In the normal course of events the pumps can be slowed using the VSD. Then the water column would slow in a controlled fashion.

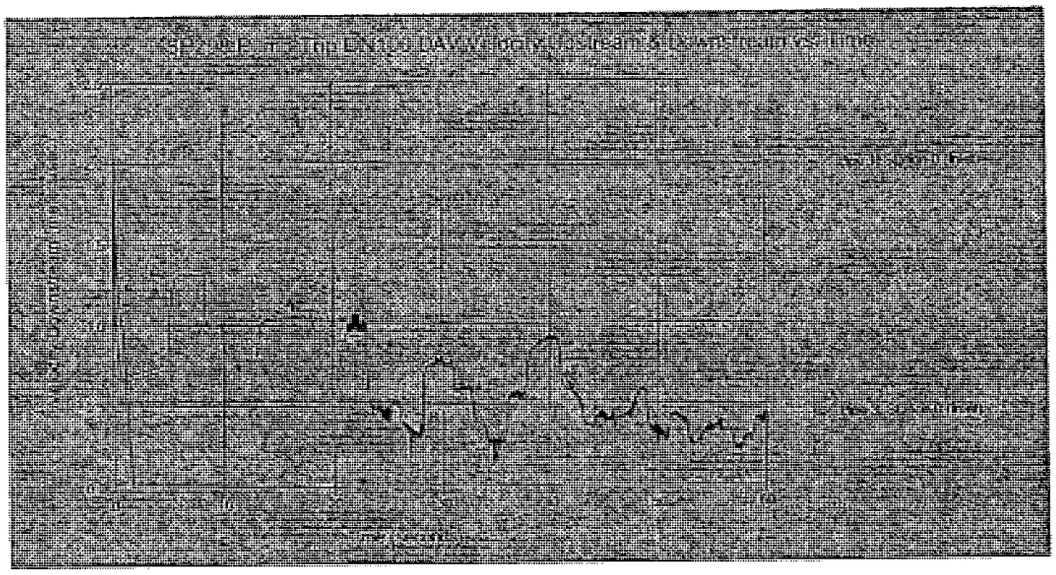


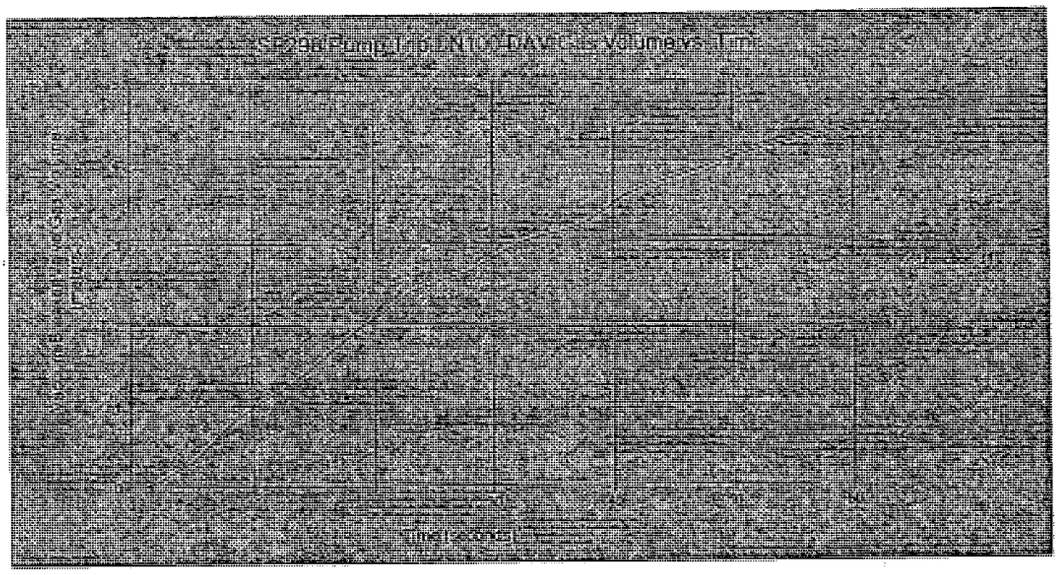


To reduce the water column velocity a DN100 double air valve was modelled at the valve pit. This would allow the ingress of sufficient air so that the SP298 well would not be drained when a pump tripped due to power failure.

Design Detail & Development *0402 35 2313*

The graph below illistrates that the fluid in the pipe immediately downstream of the pump in line 1 comes to rest in 2 seconds whilst that downstream of the air valve in line 3 continues to travel along the pipe as there is little friction or static head to reduce its momentum. The graph of the air valve volume vs time illustrates that air is being drawn into the main when the pump trips.



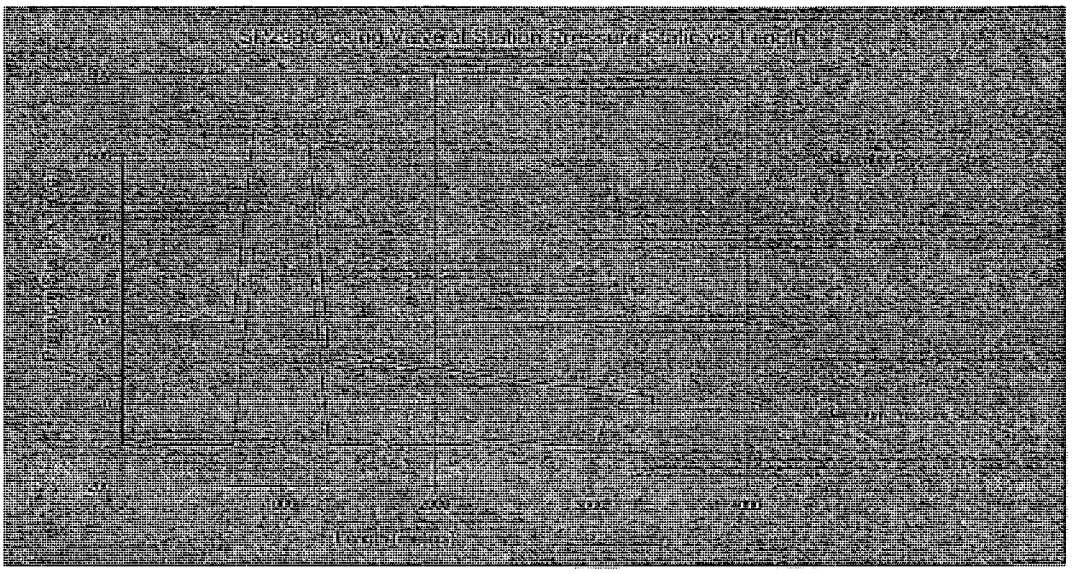


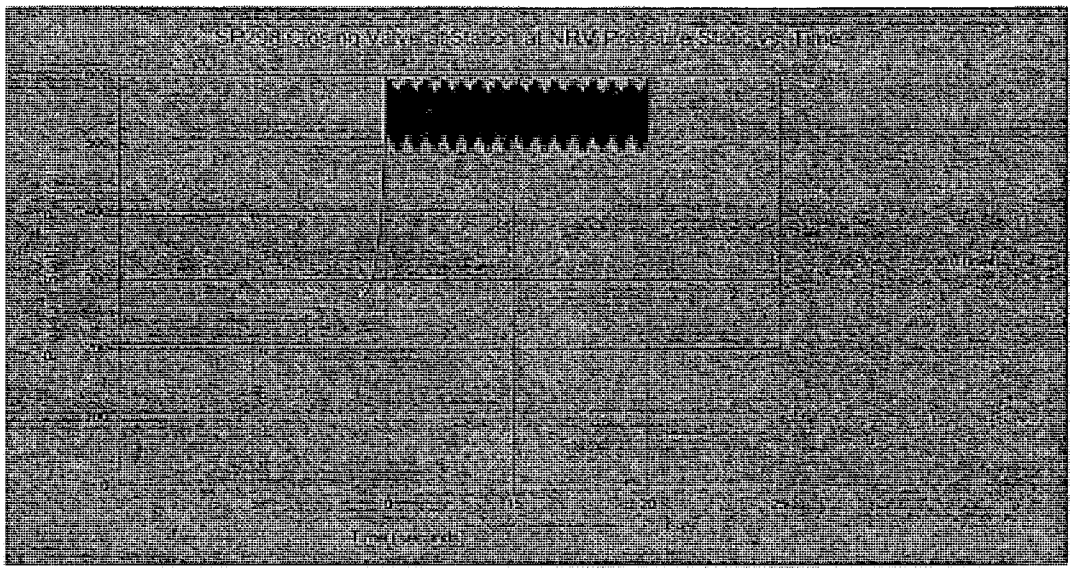
Design Detail & Development *0402 35 2313*

Sudden Valve Closure along the Length of the Pipeline

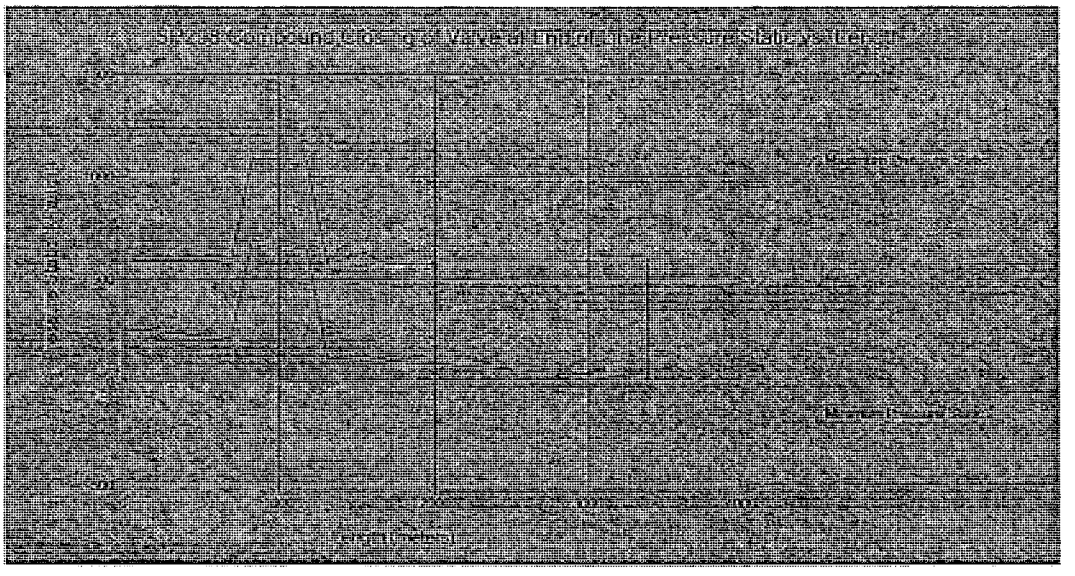
This scenario models the behaviour of the system when a station valve is closed in 10 seconds whilst the pump is operating. The normal stopping under VSD control and valve closing with a stopped pump is considered to be of no consequence for the reasons given in the above scenario.

The maximum & minimum surge pressure is 670 kPag positive & -100 kPag respectively for the scenario of a valve closing at the station in 10 seconds.





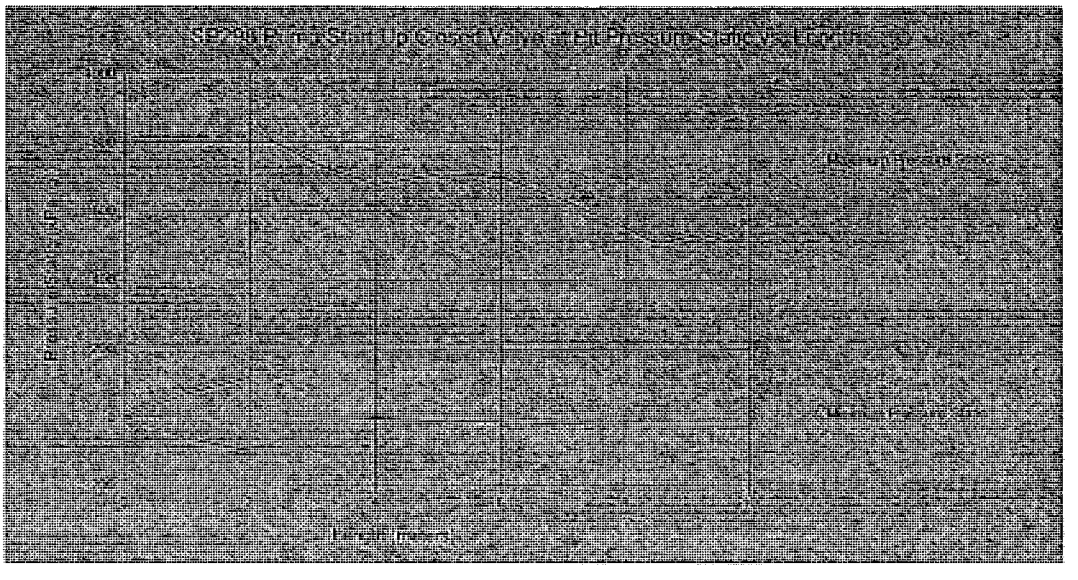
A model was created to demonstrate the effect of a valve or penstock closing at SP300 inlet. The model was evolved to a point where the vlave was closed to 5% open in ten seconds and the balnce in a further 40 seconds in order to limit the pressure transient.The maximum & minimum surge pressure is 1060 kPag positive & 0 kPag respectively.



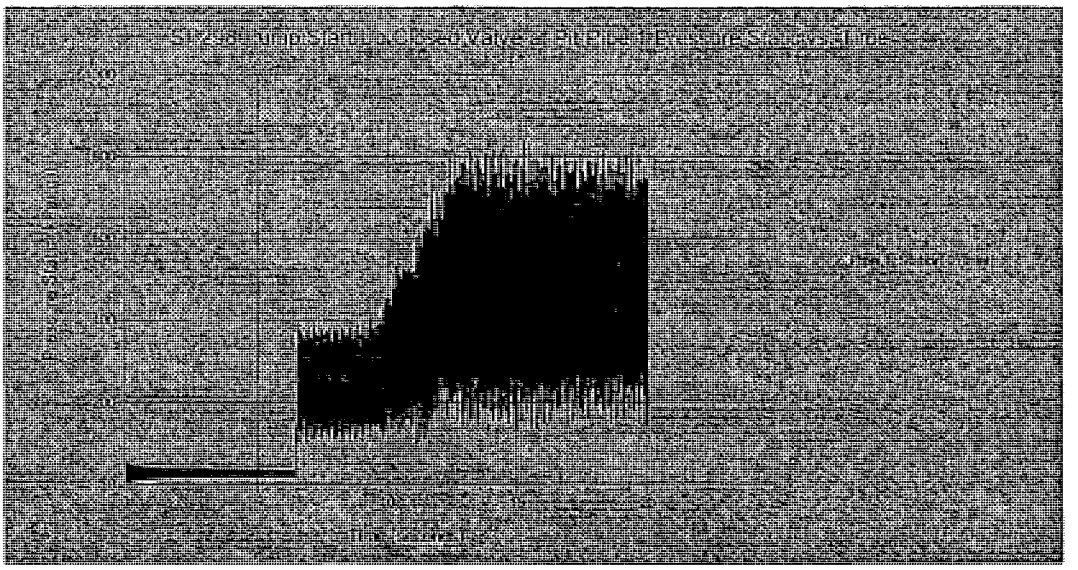
Pumps starting against a closed valve

This scenario models the behaviour of the system when a pump is started against a closed valve. Two scenarios were modelled with one using the station valve and another where a possible valve is installed or there is a blockage in the pipeline. This replicates a future installed valve or a potential blockage of some kind.

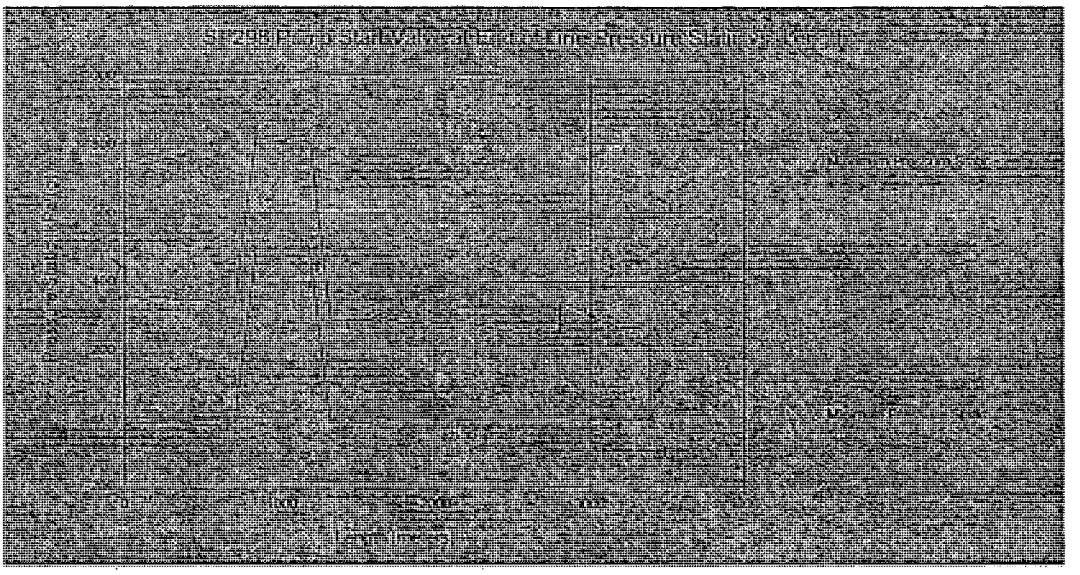
The maximum & minimum surge pressure is predicted as 820 kPag positive & -100 kPag respectively for the scenario of the pump starting with the valve closed at the station valve pit.



Design Detail & Development ***0402 35 2313***



The maximum & minimum surge pressure is predicted as 810 kPag positive & -20 kPag respectively for the scenario where a future valve or penstock is closed at the inlet to SP300 when the pump starts. No column separation was apparent in the model in this scenario.

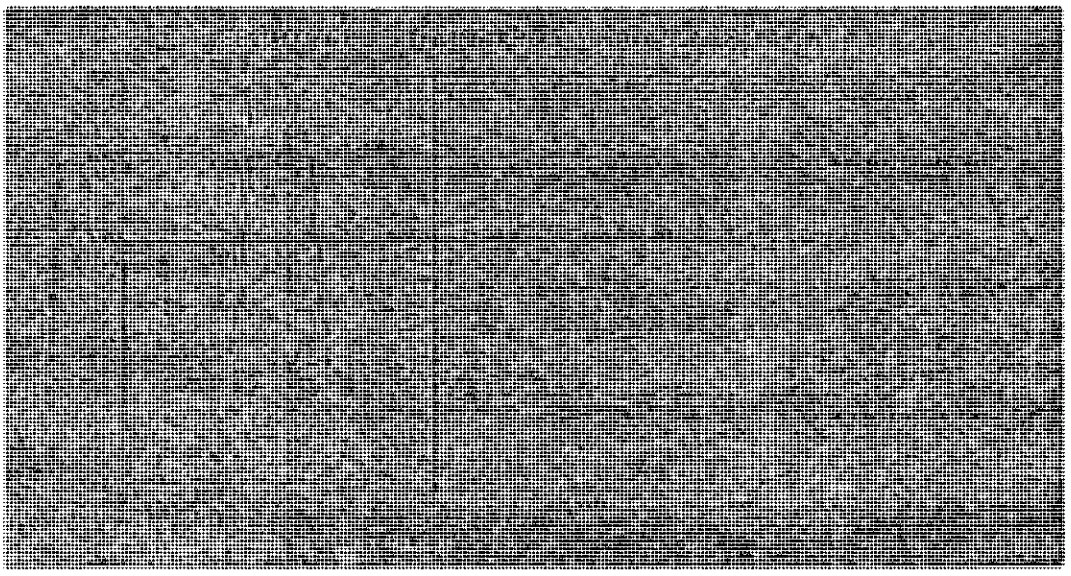


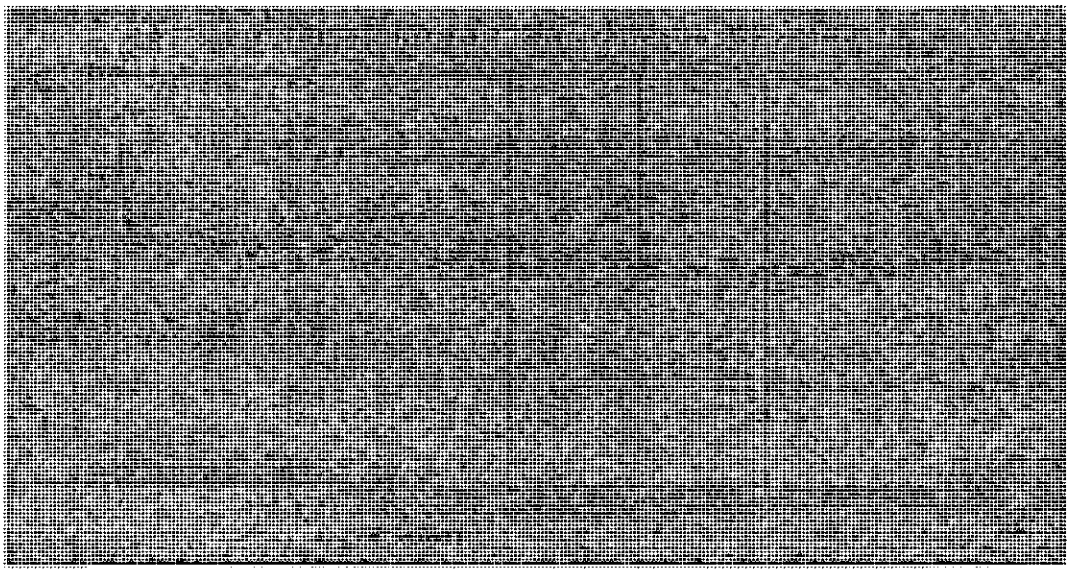
Design Detail & Development *0402 35 2313*

Single Pump Failure Whilst Another Pump is Running

This scenario models the behaviour of the system when two pumps are inoperation and one fails. This operating scenario must be permissible under the normal or emergency control. Some pumping station are inhibited to prevent some such operations whilst others adopt such practices The normal stopping under VSD control and valve closing with a stopped pump is considered to be of no consequence.

The maximum & minimum surge pressure is 740 kPag positive & -30 kPag respectively. No column separation was apparent in the model in this scenario.





Design Detail & Development *0402 35 2313*

Outcomes of the Modelling

The transient pressures are within the design rating of the pipe for all the above scenarios. The design rating of the pipe class selected is 1250 kPa at 20°C. Should the station operate four times an hour the derating factor for a 50 year life would be 0.81 and for a 100 year life 0.74. The maximum derating would thus be to 1012.5 kPa bar for the latter case. Thus the selection complies with the requirements of WSA 01 Polyethylene Pipeline Code.

The check valves selected are suitable for this application and do not require counterweights. The use of counterweights can in some instance magnify a pressure transient in the case of a poorly maintained valve. Should the valve remain open and close swiftly upon reverse velocity of the fluid column, the counter weight increases the acceleration causing a higher valve slam

The manual air vent at SP298 valve pit should be changed to an automatic DN100 double air valve to allow sufficient air to enter the pipeline so as to stop the SP298 well drainng due to siphoning action. The Ventomat RGx is suggested for this application.

Conclusions

The following conclusions are drawn from this original review of the system analysis of the Lytton Road PS to SPS 300 Serpentine Road PS DN 450 PE100 PN 12.5 pipeline that crosses the Brisbane River: -

- Transient pressures are within the design rating of the pipe material
- Compliance with WSA 01 has been met
- Check valves do not require counterweights
- The use of variable speed drives for the pumps will further reduce any possible fatigue damage of pipeline components or the pumps
- The manual air vent should be changed to a larger automatic double acting air vent.

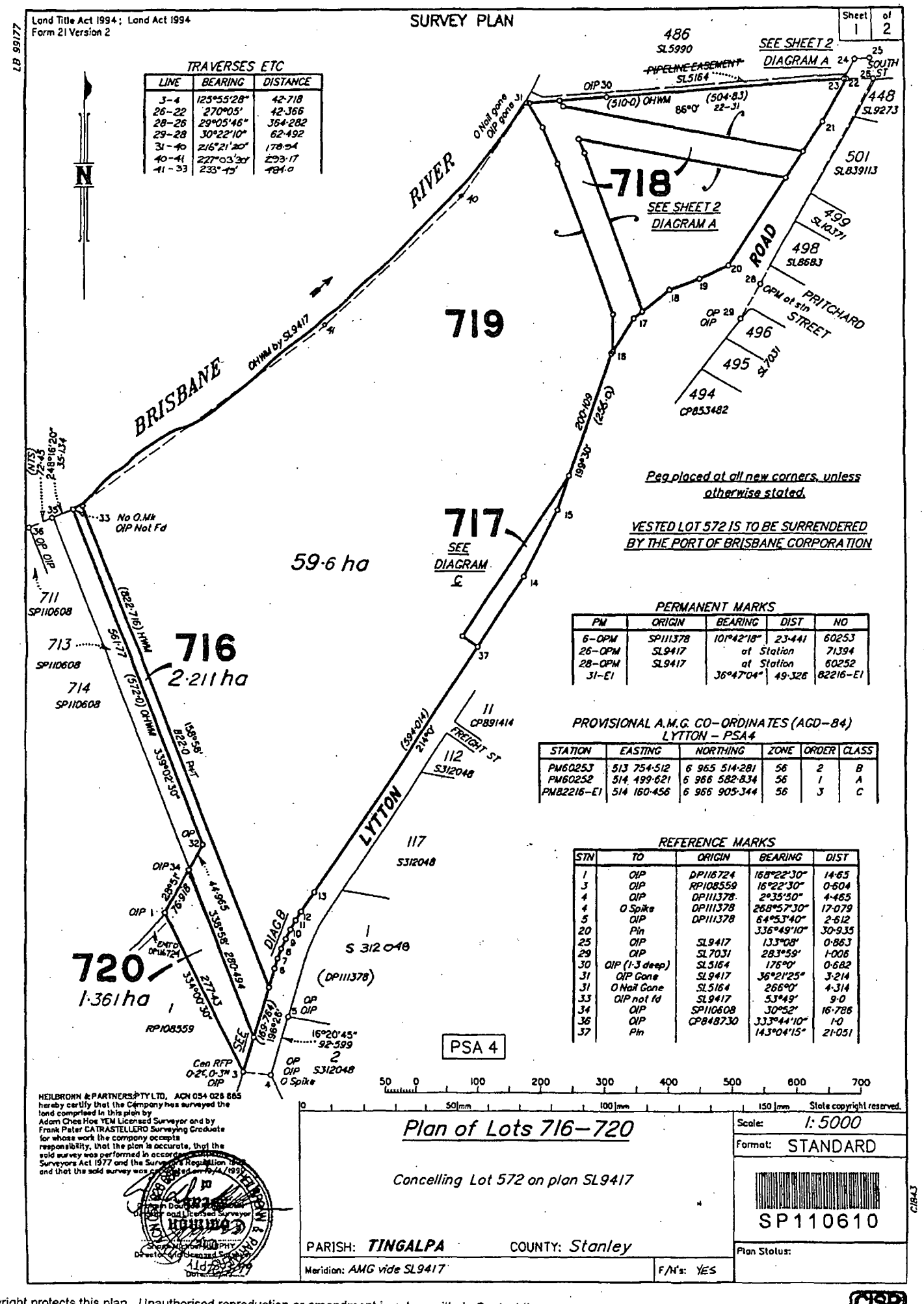
oooOOOooo

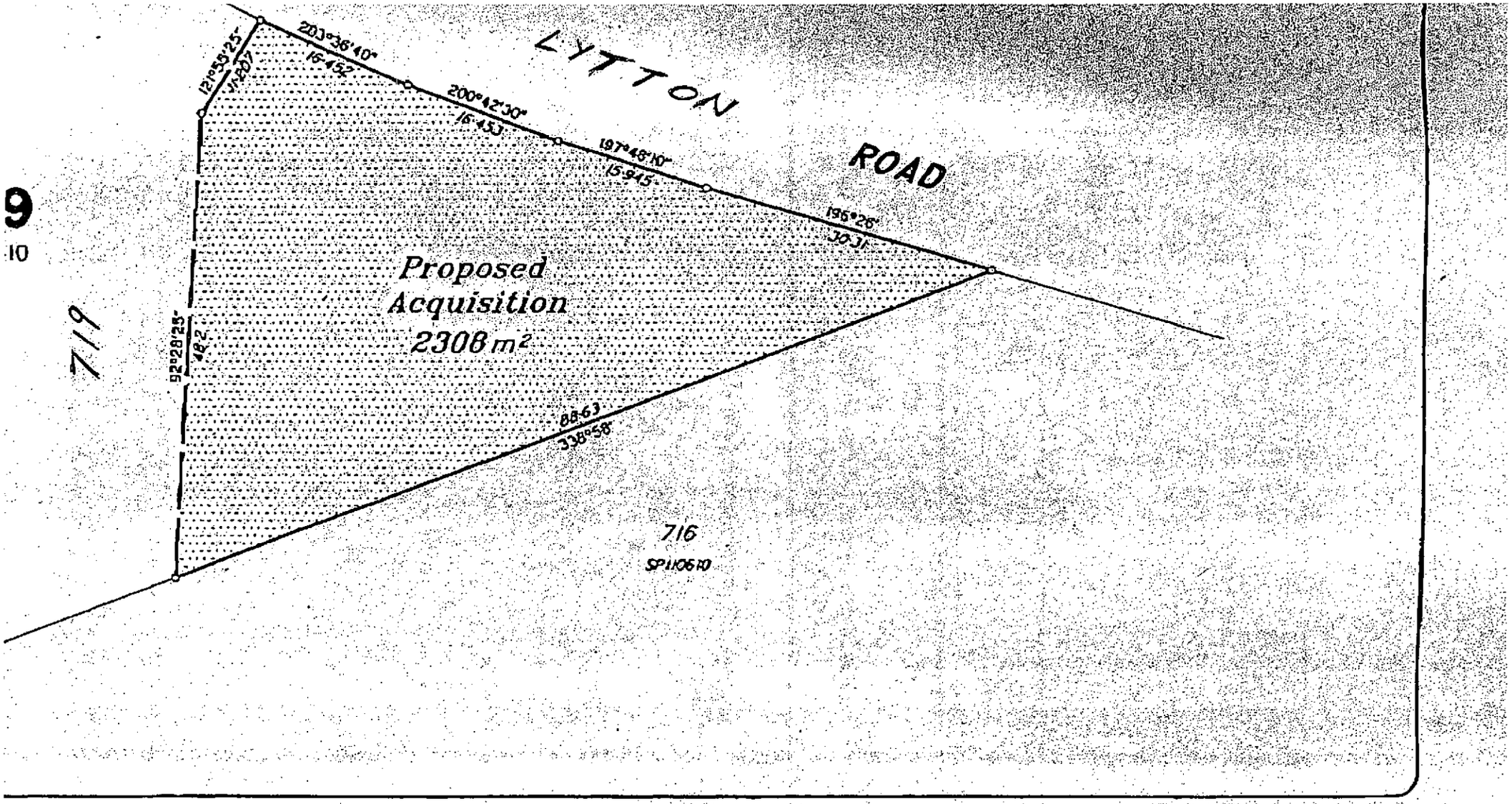
PARSONS BRINCKERHOFF

Australia Trade Coast Sewer Project
Contract No. BW30137-02.03
Revised Developed Design Report
Separable Portion No. 2
Lytton Road Pump Station SP298

Appendix G

SUR Plan and RP Plan





UR PLAN

on of part of Lot 719 on SP110610.
on 3, Parish of Toombul.
nty of Stanley.

Scale 1:500	
Drawn: PMW 05/10/2003	
Search: 1789	
CAD Ref: SUR040313-05	
Instructions: J.Bower Brisbane Water	

CITY DESIGN
TECHNICAL SERVICES
3rd Floor, T.C.Beirne Centre
315 Brunswick St Mall, 4006.
J.Dowling ph.(07)34030489 fax.(07)34033035

Project / Plan number	Amend
SUR040313-05	A

002/002

PARSONS BRINCKERHOFF

Australia Trade Coast Sewer Project
Contract No. BW30137-02.03
Revised Developed Design Report
Separable Portion No. 2
Lytton Road Pump Station SP298

Appendix H

Control Philosophy

SEWAGE PUMP STATION
SP 298
LYTTON ROAD LYTTON

REVISED FUNCTIONAL SPECIFICATION

Revision: **2**

Date of Issue: **6 August 2004**

Document Approval

		Signature	Date
Author	M. Brand		
Design Verifiers			
Projects Engineering Manager			
Project Manager			
Team Leader – Projects Systems & Information Management			
Principal Process Operations Engineer			

Document History and Status

Issue	Date of Issue		Date		Date		Date		Date		Date
Rev 0	21/6/04	MB	21/6/04								
Rev 1	12/7/04	VB	12/7/04								
Rev 2	3/8/04	IC	3/8/04								

Contents

ATTACHMENTS:
SP298 Design Calculations
SP298 Electrical Drawings

1. INTRODUCTION

1.1 Scope of Document

This document outlines the functional requirements for control, monitoring and telemetry at sewage pump station SP298 at Lytton Road Lytton.

1.2 Organisations Involved

The design, construction and commissioning of SP298 were components of Brisbane Water's *Australia Trade Coast Sewer Project*. The project was awarded to Leighton Contractors Pty Ltd (LCPL) in late 2003.

SP298 was designed by Parsons Brinckerhoff — LCPL's design consultant — and was constructed by LCPL in the second half of 2004.

1.3 General Description of SP298

SP298 is a 3.6 m diameter reinforced concrete pump station incorporating two variable speed 68 kW submersible pumps operating in a duty/standby arrangement. SP298 is located on the northwest side of Lytton Road Lytton, approximately 300 m southwest of Freight Street.

SP300 discharges a maximum of 160 L/s of raw sewage through an OD450 PE100 and OD400 PE100 rising main to the inlet structure at SP300 at Serpentine Road Pinkenba, approximately 2.6 km to the northwest. The rising main includes a horizontal directional drilled (HDD) section under the Brisbane River at approximately RL-50mAHD.

2. FUNCTIONAL REQUIREMENTS

2.1 Pump Station Duty

SP298 is required to deliver a maximum of 160 L/s into SP300 at Serpentine Road Pinkenba. The rising main consists of approximately 2700 m of OD450 PN12.5 PE100 pipe installed by "cut and cover" and around 750 m of OD400 PN20 PE100 pipe installed by HDD under the river.

Immediately upstream of SP300 is an elevated valve pit at RL2.25 m AHD on the southern side of the existing rising mains. It has been included in the design to reduce the impact of the momentum associated with pump stop and pump trip events and to prevent the rising main from draining on shutdown.

The pumping station has two duties, 90 L/s and 160 L/s. The duty will be selected depending on water level in the wet well.

System curves, pump performance curves and duty calculations for SP298 are presented in the Attachments.

2.2 Equipment Installed

2.2.1 Pumps

Two Hidrostal H08K submersible pumps with 68 kW four pole electric motors are installed in the wet well.

2.2.2 Pump Protection Equipment

Each pump is fitted with moisture probes in the oil chamber and thermistors in the stator windings.

2.2.3 Starters

Two Danfoss VLT8000 Variable Frequency Drives (VFDs) are installed in the pump station switchboard. VFDs were installed to allow two duty points and for flexibility of operations in the future. The VFDs will also provide soft starting functionality.

2.2.4 Flowmeters

One direct buried DN450 ABB Magmaster electromagnetic flowmeter is installed in the DN450 PE100 discharge main downstream of the valve chamber. The flowmeter will be used to control the flow set points of 90 L/s and 160 L/s.

2.2.5 Level Sensors

One Vega hydrostatic level transmitter and one Multitrode level probe are installed in the wet well.

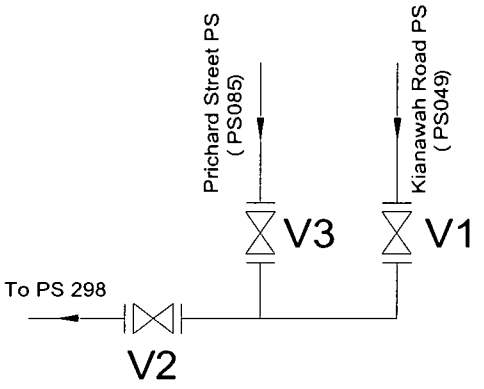
2.2.6 Pressure Transmitters

One Vega D84 pressure transmitter is installed on the discharge pipework in the valve chamber.

2.2.7 Actuated Valves

Normally flow from Prichard Street Pumping Station (PS085) and Kianawah Road Pumping Station (PS049) will deliver flow to the Lytton Road Pumping Station (PS 298). The incoming rising mains to PS 298 shall be fitted with actuated valves to allow flow from PS085 and PS049 to bypass PS 298 (flows from PS085 will be diverted to the PS049 rising main) or to allow each incoming pipeline to be isolated in the event of a pressure main burst.

Two actuated DN300 Keystone Figure 951 knifegate valves shall be installed at the inlet valve pit. These valves will be located on the rising main from PS 049 (V1) and on the common main to PS298 (V2). The actuated valve will be required to operate during an electrical outage. To ensure reliable operation the valves shall be fitted with a 24 VDC electric actuator connected to the grid/ generator and backed by a battery power supply. A manually operated DN300 Keystone Figure 951 knifegate valve would be installed on the rising main from PS 085 (V3). The sketch below shows the proposed arrangement.



The above valve arrangement will have the following modes of operation:

1. Normal Operation Mode 1 – V1, V2 and V3 Open.
   Allows Flow from PS085 and PS049 to discharge to PS298.

2. Normal Operation Mode 2 – V1 Closed, V2 and V3 Open.
   Allows only flow from PS PS085 to discharge to PS298.

3. Failure Mode 1 – V1 Open, V2 Closed and V3 Open.
   Allows from PS 085 to be diverted to Gibson Island WWTP.

4. Failure Mode 2 – V1 and V2 Open, V3 Closed.
   Isolates PS 085 rising main in the event of the PS085 main failing.

5. Failure Mode 3 – V1 Closed, V2 and V3 Open.
   Isolates PS 049 rising main in the event of the PS049 main failing.

2.2.8 Dosing Pumps

Provision was made for two chemical dosing pumps (nominally Alldos 0.09 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. These will need to be flow paced to allow for the two flow duties.

2.2.9 Activated Carbon Scrubber

Provision was made for one activated carbon odour scrubber (nominally RKR Engineering Airclenz) 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.

2.2.10 Emergency Generator

One 150 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.

2.2.11 Pump Station PLC

One GE FANUC PLC is installed in the pump station switchboard.

2.2.12 Telemetry Equipment

One MITS RTU is installed in the pump station switchboard.

2.3 Pump Station Operating States

SP298 has two operating states:

- Remote
- Local

The Local/Remote selector switch dictates the mode of operation. This switch is located in the door of the main switchboard.

2.3.1 Remote State

This is the normal operating state. Pump functionality is directed by the PLC based on automatic stop/start control of the wet well level.

2.3.2 Local State

In Local mode, no automatic control is performed. The PLC controls the pumps based on the manual initiation of the pumps individual start and stop pushbuttons. Once started in manual, the pumps will run until they are requested to stop manually. The operator or electrician is fully responsible for the consequences of running the station in this mode.

THE VFD KEYPADS WILL BE DISABLED AFTER COMMISSIONING TO AVOID OPERATION BY UNTRAINED PERSONNEL.

Electricians with proper training will be able to enable the keypad and allow the pumps to be operational in an emergency situation.

2.4 Pump Start/Stop Sequence

A pump will start if both the following conditions are true:

1. the pump is available for PLC control; and
2. the pump is requested to run.

A pump will stop if either of the following conditions are true:

1. the pump is no longer available for PLC control; or
2. the pump is requested to stop.

Once a start request is accepted by the PLC, the pump is started using the following sequence:

- VFD run/stop relay output shall close;
- a low flow inhibit timer set to 60 seconds inhibits the low flow cut-out (based on the magnetic flowmeter signal) while the pump starts;
- if the magnetic flowmeter has registered a flow of at least 20 L/s after the time delay has expired, then the run/stop relay remains energised; and
- the status indicator lights turns on.

If the pump is unable to match the duty flow with the motor frequency within a set band, then the pump will stop, an alarm will be activated and the standby pump will become the duty pump. (These acceptable frequency bands will be set during commissioning.)

Upon a stop request being reset, the pump is stopped using the following sequence:

- VFD run pump relay output shall open;
- VFD frequency reaches 0 Hz, the drive running light on the panel is de-energised; and
- the status indicator light turns off.

The emergency stop sequence for a pump will be executed in the following manner:

- main switchboard or VFD panel emergency stop pushbutton is pressed;
- the isolating contactor opens;
- VFD run/stop relay is de-energised; and
- run light on VFD panel is de-energised.

2.5 Pump Availability

A pump must be available before it can be started. Any one of the following onsite fault conditions will make the pump unavailable:

Fault Condition	Description	Set Criteria	Reset Criteria
Pump Control Power NOT on	Pump or Control Circuit breaker switched to the "OFF" or "Tripped" position	Physical input inactive	Physical input active
Pump Emergency Stop	Pump Emergency Stop pushbutton pressed	Physical input inactive	Physical input active
Pump VFD NOT Ready	VFD faulted due to any of the conditions listed in 2.5.1	Physical input active	Physical input inactive
Pump VFD Not Ready Count Exceeded	More than 3 VFD Not Ready faults in eight hours	Counter > 2	Local or Remote Reset
Pump Contactor fail to operate (open or close)	Any pump contactor fails to operate. Fail to open or fail to close)	Output command ≠ Input Feedback for two seconds	Local or Remote Reset

In Remote mode, under normal operating conditions (not surcharge pumping), a pump motor restart request is locked out for six minutes to protect the motor starting equipment from thermal failure. This lockout is bypassed by the remote start command from the MITS SCADA system.

A pump cannot be stopped (except emergency stop) once the wet well level is above surcharge imminent.

The emergency stop button is a latched button. The physical button has to be reset before the emergency stop condition is reset.

Local mode prevents the CRO from controlling the site and the pump unavailable alarm is suppressed in this mode. Critical alarms as surcharge imminent and surcharge occurring are sent back to the CRO regardless of his control status.

2.5.1 Pump VFD Ready and in Auto Mode

The local control keypad for the VFD is mounted in the door of the pump compartment. The following control functions are available on the keypad:

"VFD Ready" PLC digital input signal. This signal will be on when the VFD is powered up and the following conditions are not present:

- one of the VFD essential faults has not been detected. The VFD essential faults are:
  - earth fault;
  - switch mode fault;
  - short circuit;
  - auto-optimisation not OK;

- heat sink temperature too high;
- motor phase failure; and
- inverter fault.

If any of these essential faults is detected, the VFD will stop the pump and the "VFD Ready" PLC input signal will be off.

- "VFD Auto Mode selected" this signal will be on , if the drive is selected to Auto on the keypad and is ready for remote control.
- "VFD Running" this signal will be on when the drive is running.
- "VFD Running Speed" PLC analogue input signal will provide 4–20 mA VFD running Hz to the PLC.
- When selected to Auto mode with the pump station mode selector switch in Remote, each VFD speed will be controlled via an analogue output from the PLC. The pump operating speed will be set by the PLC.
- When the VFD is in Auto mode with the pump station mode selector switch in Local, each VFD speed will be controlled via a potentiometer mounted on the pump starter panel part of the main switchboard.

The pumps will be available for PLC control if the "VFD Ready" and "VFD Auto Selected" signals are on.

The pump "VFD Not Ready" fault will be unlatched and the pump will become available for PLC control if any of the following conditions are true:

1. The pump VFD Not Ready fault condition is reset (VFD Ready PLC input signal active) and the local reset pushbutton is pressed.

2. The pump VFD Not Ready fault condition is reset (VFD Ready PLC input signal active) and a reset is issued from the operator workstation.

3. The pump VFD Not Ready reset delay timer times out. This will be indicated by the pump VFD Ready auto reset flag being active.

When the pump VFD faults, the VFD Auto reset timer will start. The VFD Ready delay reset timer is used to allow a preset time to pass before unlatching the fault.

2.6 Running Philosophy

The incoming sewage at SP298 is pumped from SP049 at Kianawah Rd Lindum and SP085 at Pritchard St Lytton. A branch was constructed on the SP049 rising main to allow flow into SP298 from the existing SP049, which originally pumped to Gibson Island WWTP. SP049 is still capable of pumping directly to Gibson Island WWTP when the new branch is isolated at the inlet to SP298. An actuated knifegate valve is installed at the end of the branch to allow this diversion to be triggered remotely.

The Kianawah Road branch and Pritchard Street rising main are connected in a valve chamber upstream of SP298 and discharge through a common pipe into the SP298 grit collector maintenance hole (GCMH). From the GCMH, the sewage flows directly into the wet well through a submerged pipe.

SP298 is designed to discharge through its own dedicated rising main to the inlet structure at SP300. A pressure transmitter and flow transmitter are installed in the discharge pipework. Only the flow setpoints will be used to control the station.

During normal operation, SP298 operates in "fill and drain" mode based on the measurement from the hydrostatic level transmitter. The proposed level control philosophy is described below.

Two flow "banded" set points are proposed for 90 L/s and 160 L/s in the lower and upper well respectively.

At the start of an operating cycle, the level in the wet well will be at *Stop Duty A* and the pumps will be off. As sewage enters the station, the level will rise. When the level reaches the *Duty A* to 90 L/s level, the duty pump will start at 90 L/s. Once the pump starts, the level will fall and the pump will stop at the *Stop Duty A* level. The operating volume between *Duty A* to 90 L/s and *Stop Duty A* is sized for a maximum of ten starts per hour.

If the inflow is greater than the maximum pump discharge rate, the level in the wet well will continue to rise after the *Duty A* pump starts. If the level reaches *Duty A* to 160 L/s, the pump will increase in speed to achieve that required flow. If the level reaches *Start Duty B*, the second pump will start to assist the first pump. The *Duty B* pump will cut out when the level is drawn down to the *Stop Duty B* level.

Under normal circumstances, all control functions will be initiated in response to an analogue signal from the hydrostatic level transmitter. The Multitrode level switches will be used to indicate Surcharge Imminent.

In the event of a failure of the hydrostatic level transmitter, all pumps will immediately stop and control of the pump station will be based on the surcharge imminent digital input alarm. When this alarm is received, the *Duty A* pump will start and run for a predefined time (120 seconds).

When the level reaches the surcharge imminent level, as per the physical surcharge imminent electrode, the station will initiate the surcharge pumping mode. In surcharge pumping mode, all starting interlocks, pump inhibits and wet well level duty setpoints are ignored. All available pumps will be commanded to run.

Surcharge pumping mode is active while surcharge pumping conditions are true and for a set period of time (site specific) after the level falls below the surcharge imminent condition. Once surcharge-pumping mode is deactivated, the station will revert to normal level of operation.

The MITS operator can inhibit one or both station pumps. A single pump can be inhibited if it is not operating in the pump curve. This will remove it from the duty cycle allowing the other pumps to operate as duty pumps until the inhibit is removed.

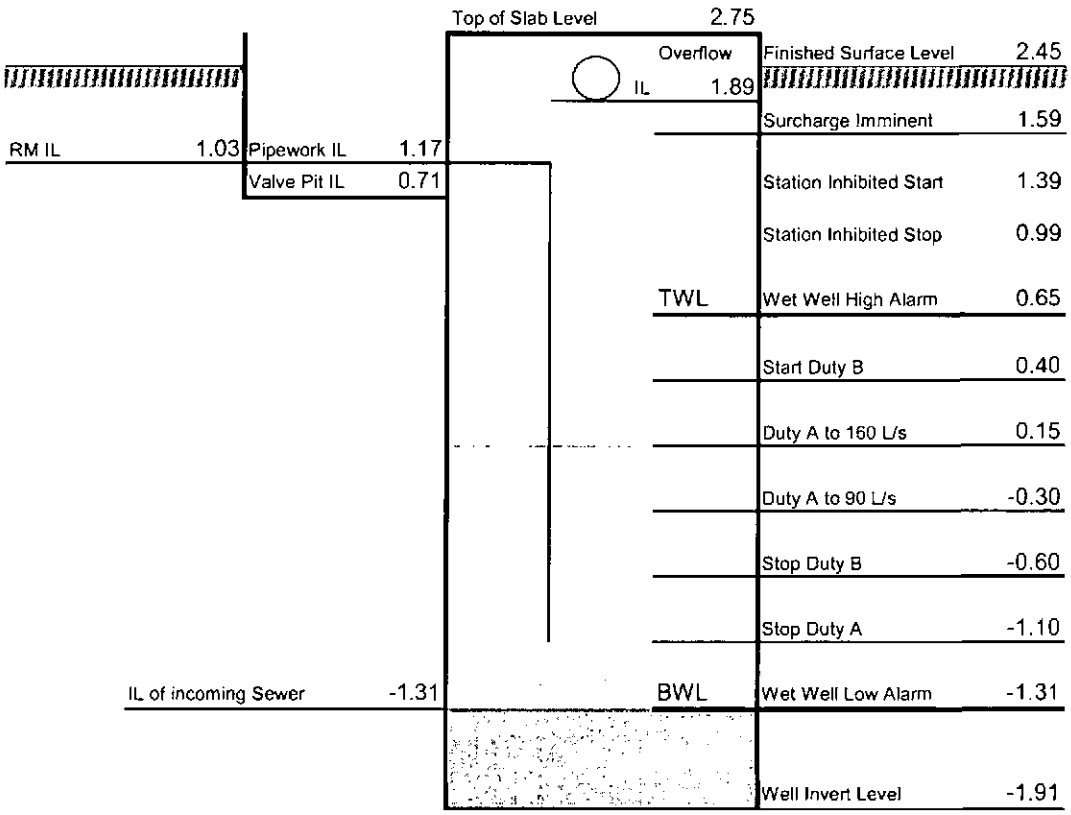
When the whole pump station is inhibited, it is desirable to minimise the volume pumped. This is achieved by utilising the wet well storage capacity to a safe maximum level. The duty start levels are raised to 200 mm below surcharge imminent. At this level, the pumps will run for a minimum of two minutes until the pump lockout time expires. After this period, the pumps will stop at 400 mm below surcharge imminent. While both pumps are inhibited, the wet well high alarm will be suppressed.

SP298 may communicate by telemetry with SP049, SP085 and SP300 through BW's Cullen Avenue Control Centre. This would enable the system to be controlled as a whole, thus minimising the chance of sewage overflows in the event of a breakdown or malfunction. The nature of this system control interconnectivity is to be determined by Brisbane Water.

Operational Diagram

The following diagram shows the station structure levels and operating levels.

Station Levels (NTS)



Note: BW may alter settings during commissioning to provide the best performance for the pump station.

2.7 Site Alarms

2.7.1 Alarm Definition

When alarms are triggered, the PLC immediately transmits them to the MITS master station. These are unsolicited transmissions and, to preserve radio network capacity, these transmissions are kept to a minimum.

The alarm definitions are:

Priority 1: Immediate action

Priority 2: Action next calendar day

Priority 3: Action next working day

Priority 4: No action required, not an "alarm", log as an event for future reference.

Priority 1 alarms need immediate action and are therefore placed in the PLC trigger queue.

The alarm priority class is shown by colour in the CRO's alarm picture on the MITS. The MITS SCADA allows alarm filtering of alarms.

2.7.2 Pump Station Alarms

The following alarms are labelled Pump Station Alarms and cause the PLC to send and immediate alarm to the control room.

MITS SCADA Details		
Plant	**Quantity**	**Alarm Description**
Sewage_pumping_station	Local_Remote	Station in Local mode
Sewer_pump	Available	Sewer pump unavailable
PLC	Isagraph_stopped	PLC software stopped
PLC	Isagraph_failed	PLC software faulted
Sewage_pumping_station	Mains_fail	Site Main Power Fails
PLC	Battery	PLC power failure battery
PLC	Mains_fail	PLC power failure (mains)
Wet_well	Level_invalid	Wet well measuring instrument faulted
Wet_well	Surcharge_imminent	Wet well level reaches the surcharge imminent level
Wet_well	Surcharge_occurring	Wet well level reaches the surcharge occurring level
Wet_well	High	Wet well level rises above a high alarm level

MITS SCADA Details		
Plant	**Quantity**	**Alarm Description**
PLC	Abnormal_operation	Abnormal operation of PLC – PLC has restarted
Wet_well	Low	Wet well level is low
Sewer_pump	Pump_hours_excessive	Pump run hours are excessive
Sewer_pump	Low_run_hours	Pump station run hours are below normal
Pressure_gauge	High	RM Pressure is high
Pressure_gauge	Low	RM Pressure is low
Pressure_gauge	Invalid	RM Pressure is invalid
Sewer_pump	VFD frequency low	Main burst
Sewer_pump	VFD frequency high	Pump or pipe blockage or excessive pump wear
Sewer_pump	Motor_power_high	Pump motor power high
Sewer_pump	Motor_power_low	Pump motor power low
Sewer_pump	Motor_power_invalid	Pump motor power invalid
Sewer_pump	Motor_current_high	Pump motor current high
Sewer_pump	Motor_current_low	Pump motor current low
Sewer_pump	Motor_current_invalid	Pump motor current invalid
Sewer_pump	VFD_Fault	Pump VFD Faulted, signal provided by VFD Not Ready
Sewer_pump	VFD_count_check	Pump VFD has faulted more than 3 times in 8 hrs period
Sewer_pump	Mains_power	Pump has lost mains power
Sewer_pump	Running	Pump running indication
Sewer_pump	Contactor_Fail_to_Close	Pump contactor fail to close
Sewer_pump	Emergency_stop_fault	Pump emergency stop button is active
Sewer_pump	Moisture_In_Oil Chamber	Pump Oil Chamber - Moisture detected
Attention	Automatic_reset	Site attention indication has automatically reset

The pump performance degradation and pump blockage variables have the following values.

Index	DPBkSP (mAHD)	VSDDSP (Hz)	FlwDSP (L/s)	VSDBSP (Hz)	FlwBSP (L/s)
0		Set in code	Set in code	Set in code	Set in code
1	0	TBA	TBA	TBA	TBA
2	TBA	TBA	TBA	TBA	TBA
3	TBA	TBA	TBA	TBA	TBA

The PID loop variables have the following values.

Index	PidIN	PidSP	PidK	pidKd	PidKi	pidInt	pidDb	pidOUT
0	Set in code	Set in code	TBA	0	TBA	0	0.2	Set in code
1	Set in code	Set in code	TBA	0	TBA	0	0.2	Set in code
2	Set in code	Set in code	TBA	0	TBA	0	0.2	Set in code

Pump Performance Degradation (Monitoring Only)

The pump performance degradation alarm flag will be latched if the pump has been running, the VFD speed is valid, the flow rate is valid, the delivery pressure is valid and either of these following alarm conditions becomes active.

- During PID minimum flow control, the VFD speed is above the performance degradation minimum flow rate VFD speed setpoint for that delivery pressure for longer than the time period determined by the performance degradation minimum flow rate VFD speed timer.
- Flow rate less than the performance degradation flow rate setpoint for that delivery pressure and the VFD speed is above the performance degradation flow rate VFD speed setpoint for that delivery pressure for longer than the time period determined by the performance degradation flow rate VFD speed timer.

The alarm flag will be reset when the pump performance degradation conditions no longer exist and either of the following conditions occur:

- local reset (PnLRst) via the pump local reset pushbutton being pressed; and
- remote reset via an operator.

2.7.2.1 Pump Blockage

The pump blockage flag, which inhibits the pump from being available if another pump is available to run, will be latched if the pump station doesn't have a surcharge imminent alarm active, the pump has been running, the VFD speed is valid, the flow rate is valid and either of these following alarm condition becomes active.

While being in PID flow control, the VFD speed is above the upper speed setpoint for the requested duty flow for longer than the time period determined by the pump blockage minimum flow rate VFD speed timer.

The alarm flag will be reset when the pump blockage conditions no longer exist and any of the following conditions occur:

- local reset (PnLRst) via the pump local reset pushbutton being pressed;
- remote reset via an operator; and
- surcharge imminent alarm becomes active.

2.7.2.2 Pump Availability

The pump available flag will only be set when all of the "available" conditions occur and any of the following conditions occur:

- NOT Pump no.n blockage;
- pump no.n blockage and another pump is NOT available to run; and
- pump no.n blockage and surcharge imminent alarm becomes active.

If any of the available conditions are not met then the pump is unavailable for PLC control and will not be able to be run automatically or locally via the local start pushbutton.

2.7.3 Priority 2 Alarms

Priority 2 alarms are stored in the PLC buffer and transmitted when the buffer is full or when the MITS master station polls the PLC. The CRO will be notified of these alarms once they are transmitted.

Since these alarms are non-critical, this delay is acceptable.

No priority 2 alarms are used for this site.

2.7.4 Alarm Suppression

To avoid consequential alarming that is one fault condition triggering multiple alarms at the MITS SCADA system, alarm suppression is used on secondary alarms.

The main consequential alarm condition is Site Power Fail.

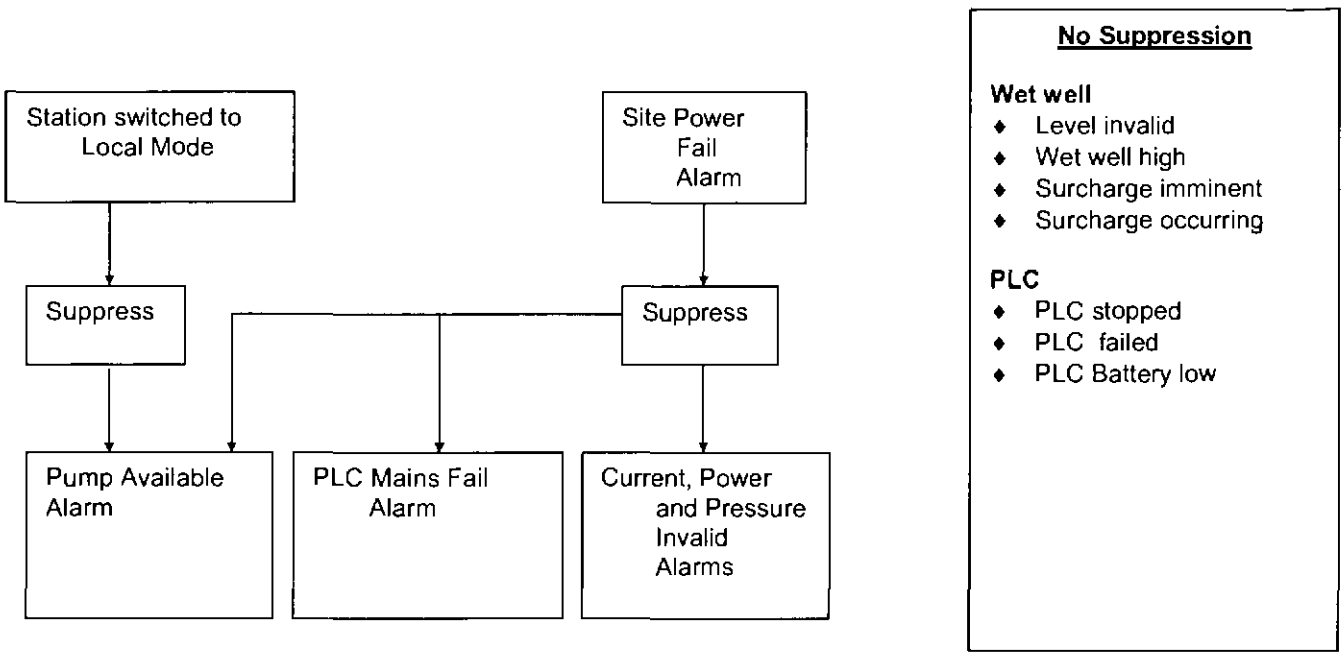
If site power fails, the following secondary alarms are suppressed:

- pump unavailable;
- PLC power fail;
- motor current invalid;
- motor power invalid;
- site pressure invalid; and
- motor speed out of allowable operating bands.

When the station is switched to Local mode, the site is under the control of the on site technician. An alarm is triggered at the 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.

Note: Wet well and PLC alarms are not suppressed.

Alarm Suppression Tree



2.8 PLC Functionality

2.8.1 PLC Calculations

The following calculations are performed by the pump station PLC:

1. Wet Well Level Calculations
2. Wet Well Volume
3. Station Inflow
4. Station Volume Pumped
5. Station Surcharge Duration
6. Station Pressure mAHD

7. Pump Hour Run per day
8. Pump Flow (kL) per day
9. Pump Starts per day
10. Pump kW hours per day

A brief description of the listed items are given below.

2.8.1.1 Wet Well Level Calculations

The onsite wet well level indicator mounted on the switchboard shows well level in percentage (%) of full range. This value is transmitted to control room for ease of comparison with the on site technician.

The operator requires the wet well level in mAHD to be able to do a meaningful comparison between different sites.

The following formulas are used to calculate these values.

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

$$\text{WWL (\%)} = \frac{[WWL(mAHD) - WWLZero(mAHD)]}{WWLRange(m)}$$

2.8.1.2 Wet Well Volume

The wet well level is calculated using a wet well levels versus volume look up table. The look up table has a maximum of 32 point specification of the non-linear relationship of the wells "Level versus Volume". Volume in wet well is an interpolation of the well versus volume look up table values.

		Water Height (mAHD)	Stored Volume (m^3)	Remaining Storage Capacity [m^3]	Comments	% Level	% Volume
1	Wet Well Low	-1.31	0.0	32.5	BWL	0%	0%
2	Incoming Sewer	-1.31	0.0	32.5		0%	0%
3	Stop *Duty A*	-1.10	2.1	30.4		7%	7%
4	Stop *Duty B*	-0.60	7.2	25.3		22%	22%
5	*Duty A* to 90 L/s	-0.30	10.3	22.2		32%	32%
6	*Duty A* to 160 L/s	0.15	14.8	17.7		45%	45%
7	Start *Duty B*	0.40	17.4	15.1		53%	53%

		Water Height (mAHD)	Stored Volume (m^3)	Remaining Storage Capacity [m^3]	Comments	% Level	% Volume
8	High Level Alarm	0.65	19.9	12..6	TWL	61%	61%
9	Station Inhibited Stop	1.19	25.4	7.1		78%	78%
10	Station Inhibited Start	1.39	27.4	5.1		84%	84%
11	Surcharge Imminent Alarm	1.59	29.5	3.0		90%	90%
12	Surcharge Occurring Alarm	1.87	32.3	0.2		99%	99%
13	Overflow Level	1.89	32.5	0.0		100%	100%

2.8.1.3 Total Inflow

The total volume pumped in kilolitres since the start of the year is updated in two seconds increment calculated by integrating the inflow, if the wet well level and flow are valid, using the following calculation algorithm:

Total Inflow = (Inflow x 2) /1000 + Total Inflow

The Inflow rate is the change in volume plus the volume pumped out of the well and is updated in two second increments calculated, if the wet well level and flow are valid, using the following calculation algorithm.

Inflow = ((Volume Now – Volume Old) + (Flow x 2)) / 2

Volume now = Current wet well level volume

Volume old = Previous (2 seconds ago) wet well level volume

Flow = Flow in engineering units

The wet well volume is calculated, if the wet well level is valid, using the wet well level as a reference and interpolation of a level vs. volume vs. surcharge flow lookup table.

2.8.1.4 Total Volume Pumped

The total volume pumped in Kilolitres since the start of the year is updated in two second increments calculated by integrating the inflow if the wet well level and flow are valid.

2.8.1.5 Station Surcharge Duration

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

2.8.1.6 Station Pressure (mAHD)

The pressure probe measures the pressure in kPA. This allows the CRO to compare different sewerage sites. The pressure, in mAHD, is calculated and sent back to the MITS SCADA system.

$$\text{Pressure (mAHD)} = \text{Pressure } \frac{(kPA)}{k} + \text{Pressure Elevation (mAHD)}$$

k = 9.803 (Pressure constant to convert from kPA to metres)

Pressure Elevation = Site Specific Pressure Elevation of Pressure Gauge

2.8.1.7 Pump Hrs Run/day

The VFD of each pump has a Modbus communication card connected to the PLC.

This card provides the PLC with information regarding Current, Speed, kW hours per day and Hours run per day.

2.8.1.8 Pump kL/day

The station magnetic flowmeter will provide flow readings via an analogue 4–20 mA signal connected to the PLC.

2.8.1.9 Pump Starts/day

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

2.8.1.10 Pump kW hrs/day

The VFD of each pump has a Modbus communication card connected to the PLC.

This card provides the PLC with information regarding Current, Speed, kW hours per day and Hours run per day.

2.8.2 Site Attention Indicator

The operator will be able to initiate and cancel the site attention indicator. When a site attention indication is generated, officers on site will be required to acknowledge the attention indicator and then contact the operator.

The site attention indicator digital output is latched by an operator generating a site attention indicator flag.

The output is unlatched if any of the following occurs:

- site attention indicator reset by the operator;
- site attention indicator reset pushbutton digital input being pressed; and
- site attention alarm timer expires.

The site attention alarm timer is enabled by the site attention alarm indicator digital output.

The site attention alarm flag is latched if the site attention alarm expires. The alarm is unlatched when the next site attention indicator output is set.

2.8.3 Local Indication Lamp

The local indication lamp output displays the status of the pump.

Lamp Off	Pump stopped but available
Lamp On	Pump running
Lamp Flashing	Pump Fault

2.8.4 Pump Hours Run

An hours run counter shall be kept for all pumps in the PLC.

A cyclometer type hours run meter has also been mounted on the front door of each pump starter Panel.

An electronic hours run meter also exists in the VFD for the Pumps, these totalise the pump hours run time during its operation.

3. MITS SCADA SYSTEM – OPERATOR INTERFACE

The SCADA Screen shall follow the format and standards of the existing Screens.

Live points from PLC fed back to picture

- Wet well level in metres AHD and % full.
- Pump duty A start level (in metres AHD and % full), pump duty A stop level, and wet well high level
- Status of each pump (available, running)
- Delivery pressure in metres AHD
- Delivery Flow
- 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)

MITS database points in the picture

The Inlet level (metres AHD), Overflow Control Level (metres AHD) and the Site Level (metres AHD) are stored in the MITS database and not in the PLC. These values are displayed in the main station picture.

3.1 PLC Input/Output Listing

Refer to electrical drawings.

12

ATTACHMENTS

PARSONS BRINCKERHOFF

Australia Trade Coast Sewer Project
Contract No. BW30137-02.03
Revised Developed Design Report
Separable Portion No. 2
Lytton Road Pump Station SP298

Appendix I

Cardno MBK Structural Report

Lytton Road Pump Station
Design Report

1.0 Introduction

Cardno MBK were responsible for the structural design of the Lytton Road Pump Station, Number SP298.

The structures comprising the pump station include the wet well, valve pit, grit collector manhole, ferric chloride dosing area slab, odour scrubber pad, transformer base, switchboard base, generator pad, pig launcher pit and unlet valve pit.

2.0 Geotechnical Assessment

The pump station is located in the weak recent sediments of the lower Brisbane River and understating the difficult foundation conditions was critical to developing a design for a pump station that would have adequate structural performance.

2.1 Available Geotechnical Information

The geotechnical conditions at the sites of the above two pump stations, are illustrated by the following materials, supplied to Cardno MBK by Parsons Brinckerhoff:

Borehole 2, Project No. CD/S3-G1/0185661 dated 31 January 2001
Borehole 51, Project No. CD/S3-G1/0185661 dated 14 May 2001.
Borehole 07, Project No. CD/T6-G1/0389629 dated 29 November 2002.
Brisbane City Council, City Design, Geotechnical & Environmental Engineering.

BH2 is adjacent to the proposed pump station.

Supplementary Geotechnical Data Report, Australia Trade Coast Sewerage Project, Lytton Road to Brisbane River, Lytton. 7 November 2003.
Brisbane City Council, City Design, Geotechnical & Environmental Engineering.

This report included BH27 that is adjacent to the proposed pump station.

The location of the pump station is shown on Drawing No. PD003

2.2 Assessment by Parsons Brinckerhoff

Geotechnical engineers from Parsons Brinckerhoff initially reviewed the available geotechnical information. This review confirmed the weak nature of the underlying soils and showed that settlements were likely under any additional loading. It was determined that the additional allowable bearing pressure should be limited to 15 kPa at a depth below RL-6.8m to limit settlement to 25-30 mm.

2.3 Assessment by Coffey Geosciences

A further assessment of the site was undertaken by Coffey Geosciences to indicate the likely settlements of the site under the additional loading to be applied to the site by the construction of the pump station.

A total settlement of 80 mm is predicted after 50 years for an applied loading of 10 kPa, with a possibility of 33% that this settlement will be exceeded by more than 10%.

3.0 Design Construction Requirements

3.1 Settlement

It was realised that settlement of the pump station structures was inevitable as the minimum depth of fill applied to the site for the construction of the required pavements would apply significant loading and result in consolidation of the underlying soil. As a result, design was directed towards the design of structures with uniform foundation bearing pressures to ensure that structures would settle uniformly, rather than tilting. The performance of the pump station would not be affected by uniform settlement provided sufficient flexibility was allowed in connecting pipework to allow for differential movement between adjacent structures. Similarly, any pipelines leading to or from the pump station would be not affected by the consolidation as the settlement bowl would extent out from the pump station due to the depth of compressible material.

3.2 Construction Issues

The tender method of construction for the pump station was developed by Coffey Geosciences Pty Ltd (Reference facsimile dated 16 June 2003 to Parsons Brinckerhoff). This method comprised the use of an open excavation above the water table and a steel sheet pile supported excavation for the structures below the water table.

Leighton Contractors developed an alternative method of construction for the pump station that eliminated the requirement for steel sheet piling. This alternative method recognised the strength of the near surface soils and the ability for open excavations to remain stable for a limited period of hours. The excavation would be made and stabilised with a rapidly placed internal lining of mass concrete.

The near surface soils have been observed to have a low permeability, indicating that ground water seeping into the open excavations will be unlikely to be a major issue and can be readily managed using small drainage sumps and dewatering pumps during the work.

3.3 Design Issues

There are two design cases for the in-ground pump stations:

- Provision of sufficient mass in the structure to overcome buoyancy forces under high water table conditions. It is considered that the design should allow for the water table to be located at the ground surface. The weak

soil conditions also indicate that no allowance should be made for friction on the surrounding soil assisting to hold down the structures.
- Limiting the additional bearing pressure to the underlying soils during dry conditions when the ground water level is low.

In both cases, the centre of buoyancy and the centre of mass should correspond to limit tilting.

4.0 Design Outcomes

4.1 General Arrangement

The design process considered several arrangements of the valve pit, pump well and grit collector manhole to develop a layout acceptable to Brisbane Water that would address the geotechnical issues of the site.

The design development arrangements considered were:

- A standard arrangement of valve pit and wet well combined in a single structure was considered. It was found that uniform foundation bearing pressures could not be achieved to ensure uniform settlement. The use of fly ash as backfill to the structures to control settlement was considered but was not viable due to the overall settlement of the pump station.
- The use of separate valve pit and wet well structures was considered as each structure would have uniform foundation bearing pressures and hence would settle uniformly. The use of extended foundation slabs to limit non-uniform settlement was considered. Brisbane Water rejected this arrangement.
- It was found that an acceptable bearing pressure distribution could be obtained by combining the valve pit, wet well and grit collector manhole into a single structure as the valve pit would balance the grit collector manhole opposite from the valve pit.

The final solution comprises the valve pit and grit collector balancing each other on opposite sides of the wet well. The grit collector manhole is attached to the wet well by twin reinforced concrete walls.

It was preferable to locate the grit collector manhole adjacent to the pump well to minimise the requirements for the structural members joining the wet well and grit collector manhole. Brisbane Water required the grit collector to be located further from the wet well and this resulted in a significant increase in the size of the connecting members.

The other structures, including the ferric chloride dosing area slab, odour scrubber pad, transformer base, generator slab, pig launcher pit and inlet valve pit were designed with uniform foundation bearing pressures. The majority of these structures were sized to limit the maximum additional bearing pressure applied to the subgrade.

4.2 Structural Details

All structures were detailed in reinforced concrete. All significant structures were founded on a compacted clean sand-bedding layer placed on the soft subsoils on completion of excavation to provide a sound-bearing surface. Blinding concrete was specified to provide a firm surface for construction of the structures.

Sand was also specified to be used for the backfilling of excavations as this material can be readily placed and compacted using light equipment.

A jointed reinforced concrete pavement was designed for the access roadway to the pump station to provide a stable base for maintenance vehicle parked at the pump station. The pavement consists of a 200 mm concrete slab and 200 mm sub-base of CBR 25 material overlying the natural subgrade or construction fill.

The foundation for the substation comprises a ground slab at depth supporting a standard Energex uniculvert precast transformer base and substation plinth.

4.3 Corrosion

The pump station is located in recent alluvium identified as having significant potential acid sulphate soil conditions and groundwater very aggressive towards concrete structures. The concrete structures should be protected against groundwater attack.

However, the general soil permeability is low and little groundwater movement is expected once equilibrium conditions develop following the completion of construction. An appropriate treatment to protect the concrete structures against attack include a double layer of polyethylene sheeting either laid under the structures prior to the pouring of concrete and placed on completed concrete surfaces prior to backfilling. This protection should extend under all foundations and walls located below RL 2.2 m.

An exposure classification of B2 is considered appropriate for concrete protected against the corrosive groundwater as described above.

Cardno MBK

Cardno MBK QLD Pty Ltd
ACN: 051 074 992

BRISBANE STRUCTURES
CALCULATION COVER SHEET

PROJECT:	AUSTRALIA TRADE COAST SEWER PROJECT
PROJECT NUMBER:	5219/02-3
DATE:	15-7-4

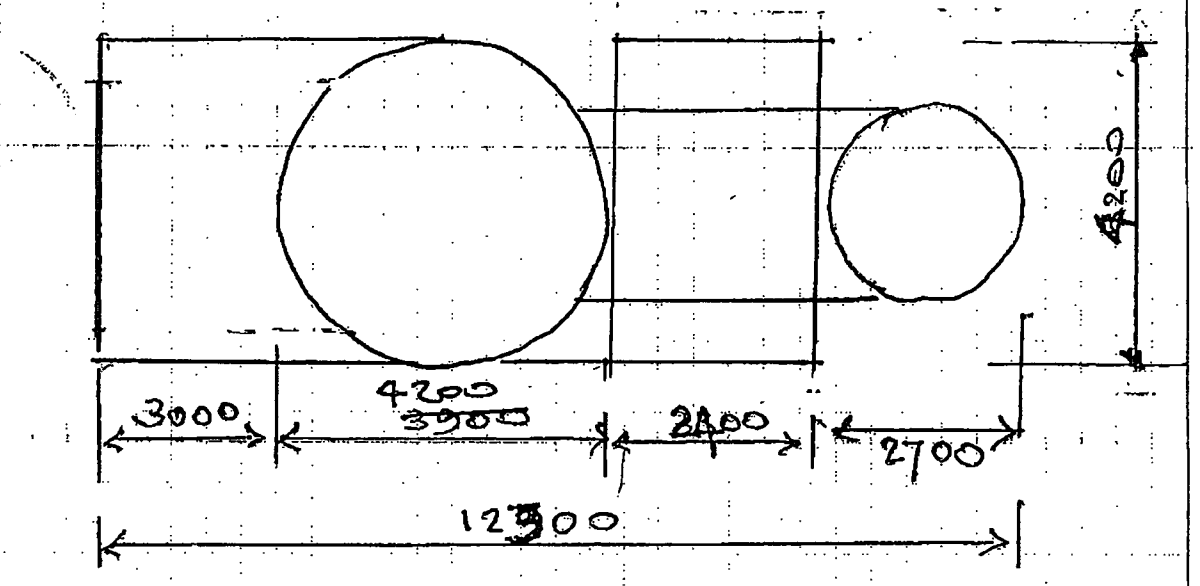
LYTTON RD PUMP STATION

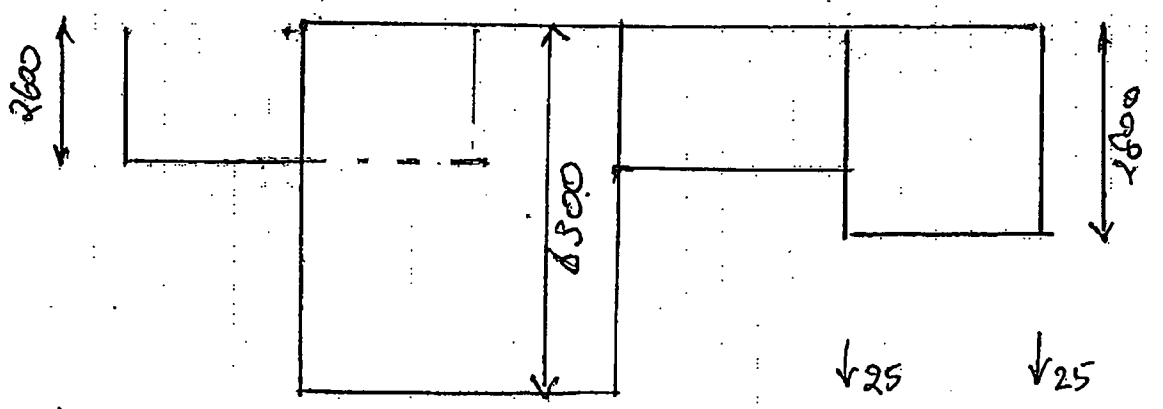
ACTIVITY	SHT. No.	DESIGN	DATE	CHECKED	DATE
Design of pump well structure	1	AdeC	1-5-4	MP	14-7-4
Connection to gas Collector	1	MP	28-6-4	MP	14-7-4
Review for Increased Pump Well					
Gas Collector Spacing	1	MP	14-7-4	MP	15-7-4
Ferric Chloride Dosing System	1	MP	13-5-1	MP	14-7-4
Rig Launcher	1	MP	26-6-4	MP	14-7-4

Cardno

PROJECT Trade Coast · Lytton Road P/S ·

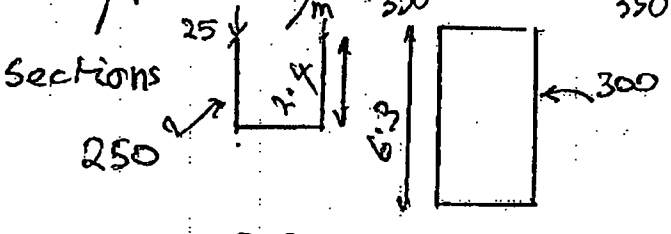
PROJECT NO. 75 91 102
Designed
Date Sheet 1 of





Weight - 80 kN/m

Sections



$I =$	$1.9E12$	$3.0E13$	$1.7E12$	$3.0E12$
$b =$	3900	3900	5000	2700
$d =$	1800	4500	1600	2400

↳ equivalent rectangular sections with same bearing area.

Cardno

PROJECT	PROJECT NO. 75911/2 Designed Date Sheet 2 of

Valve pit.

Walls $(3.95 + \frac{4.25}{2} \times 2) \times 0.25 \times 24 = \frac{75}{125}$ kN

24 kN ↓ 11.9 kN/m, 0 – 8.5 m ↳ 6 kN/m for 1–28

Slab

$0.3 \times 4.2 \times 24 = 30$ kN/m (1–10) 90

$1.25^2 \times 0.3 \times 24 \approx 12$ kN 12

102 kN

Total = 177

Pump well

Wall $3.9 \times \pi \times 4.8 \times 0.3 \times 24 = 423$ kN

Slab $\frac{4.8}{4.2}^2 \times \frac{\pi}{4} \times 0.\frac{45}{0.6} \times 24 = 200$ kN

Lid $4.2^2 \times \frac{\pi}{4} \times 0.35 \times 24 - 1.35 \times 2.6 \times 0.35 \times 24$ (25 kN/m)

$= 118$ kN

Total 742

Switch board

Walls $0.25 \times 32 \times 24 \times 2 = 19.2$ kN/m $\times 2.75$

$= 53$ kN

Slab $4.2 \times \frac{0.25}{0.35} \times 24 = \frac{25.2}{35.2} \times 2.3$

$= \frac{58}{81}$ kN

Grit collector Total $\frac{11}{134}$ kN.

Wall $\pi \times 2.55 \times 0.15 \times 24 = 28$

Slab $\pi \times \frac{2.9^2}{4} \times 0.25 \times 24 = 34$

Lid $2.9^2 \times 0.35 \times 24 = \frac{50}{61}$ $\frac{123}{112}$ kN

Cardno

PROJECT	PROJECT NO. ..... Designed ..... Date ..... Sheet 3 of .....

Stability check

Total Dead Load

$G = 177 + 742 + 134 + 123 = 1176$

Water pressure (Taking W.T. at natural GL)

$P = 4.2^2 \times \frac{\pi}{4} \times 38 = 526$

$+ 4.2 \times 2.5 \times 10 = 105$

$+ \pi \times \frac{2.7^2}{4} \times 15 = 86$

$= 717$

$0.9\,G = 1058$

$1.2\,P = 860 < 0.9G.$

$\therefore$ uplift stability is satisfactory.

Cardno

PROJECT	PROJECT NO. ..... Designed ..... Date ..... Sheet 4 of .....

Loading input for BPT

Elements 1 - 10 36 kN/m

Elements 11 - ~~15~~ 15

$\frac{703}{3.9} + 6 = 186$ kN/m

Elements ~~16~~ 16 - ~~23~~ 23 = 180

Elements 23 - 33 46

Elements 33 - 41 46

Total = $36 \times 3 + 186 \times 5 \times 0.3 + 180 \times 8 + 46 \times 18 \times 0.3$

= 1067 close enough.

Use 2 methods of analysis and design for the worst case

1) Elastic half space

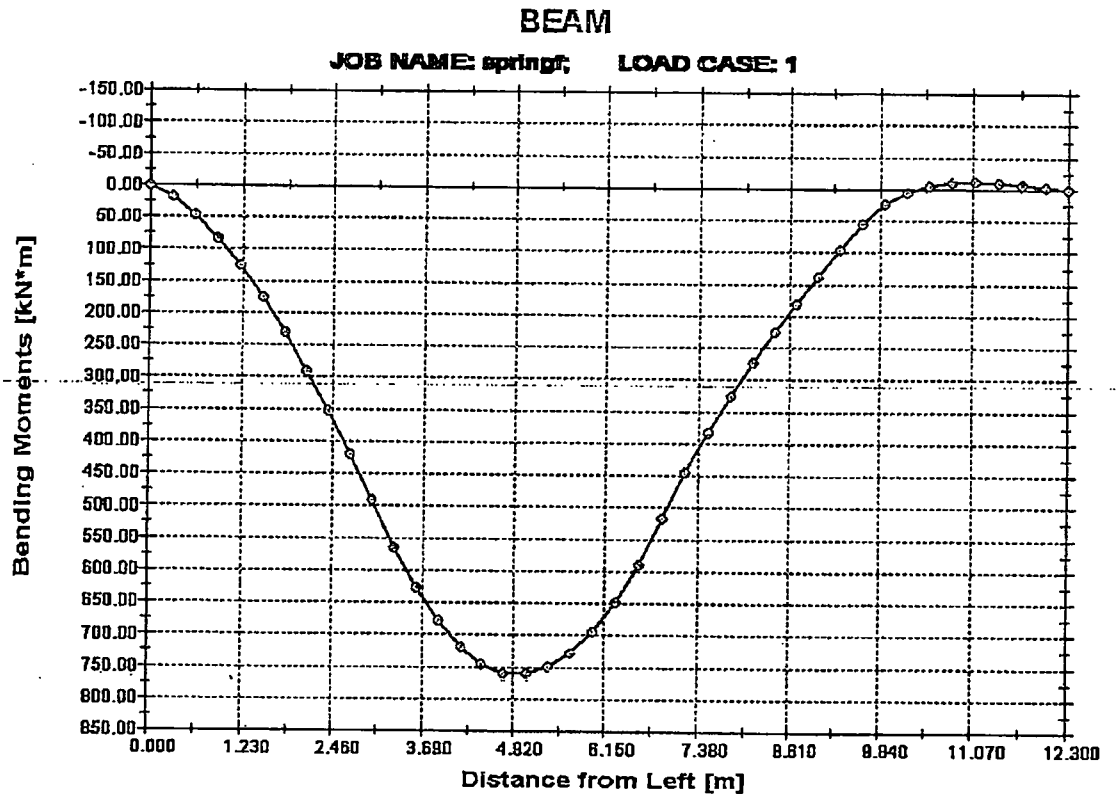
$E_s = 15 \cdot 0$

$\nu = 0.25$

2) Winkler fdn

$k_s = 1000$

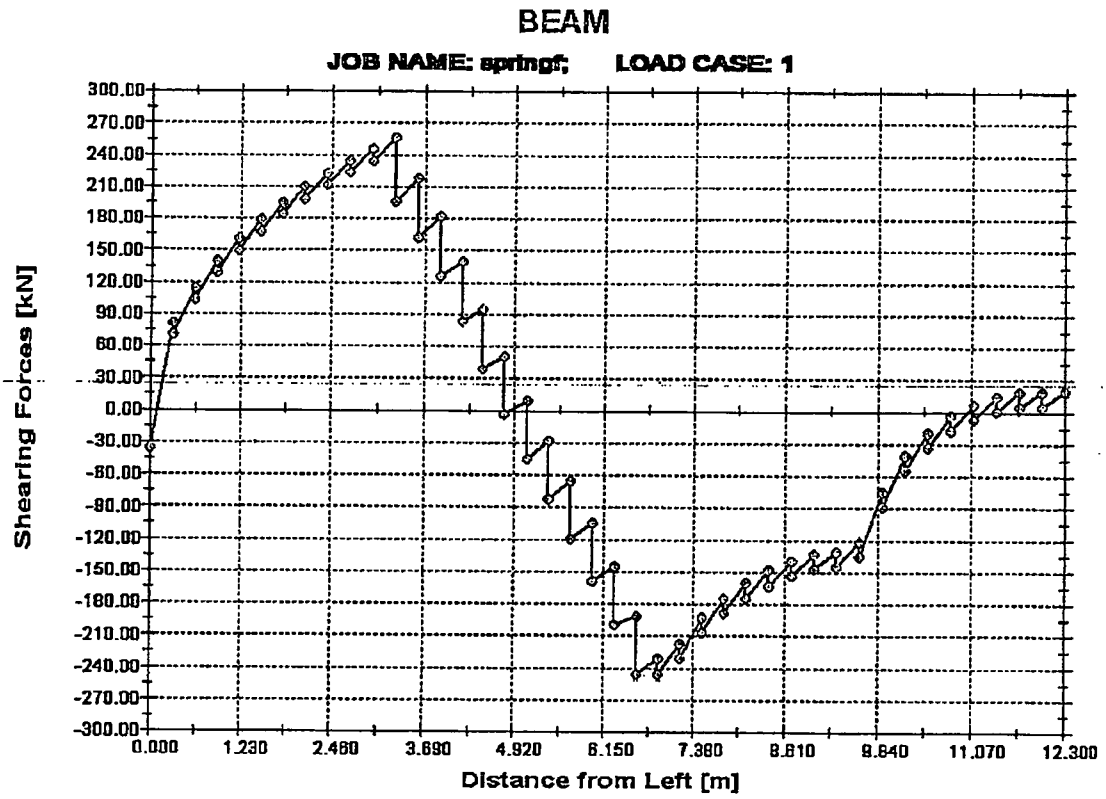
5



Elastic half space

$E_s = 15000$

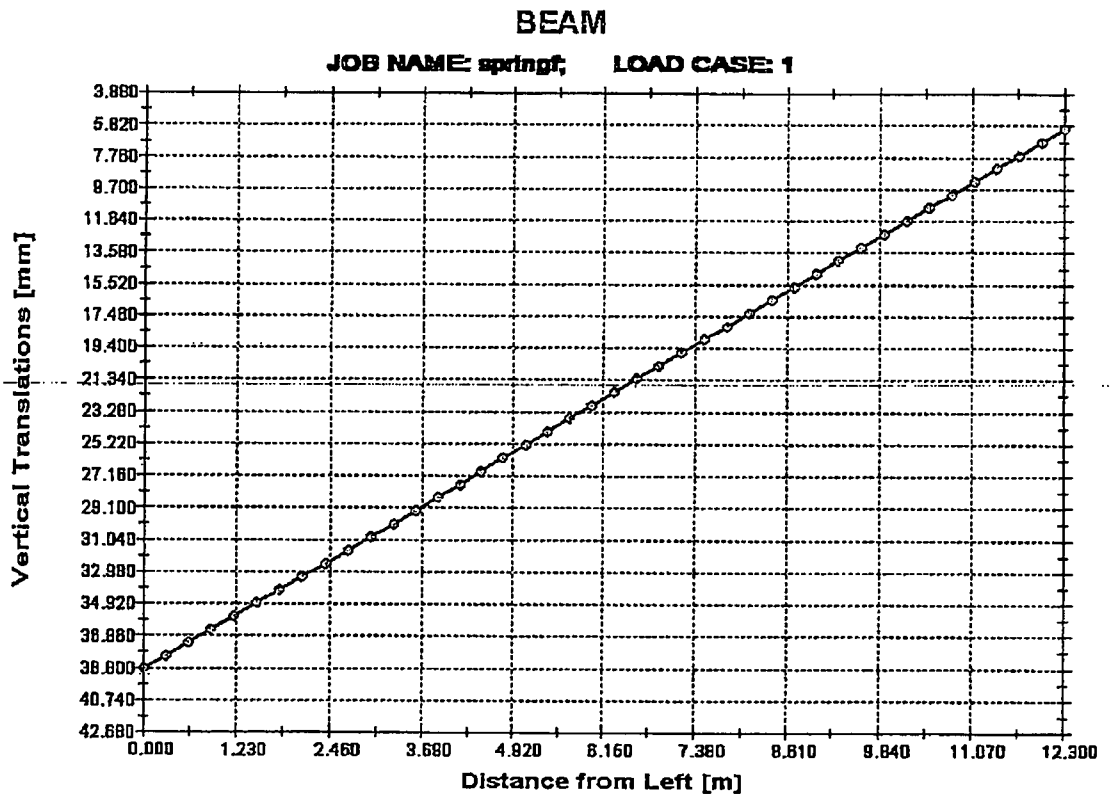
6



Elastic half space

E = 15000

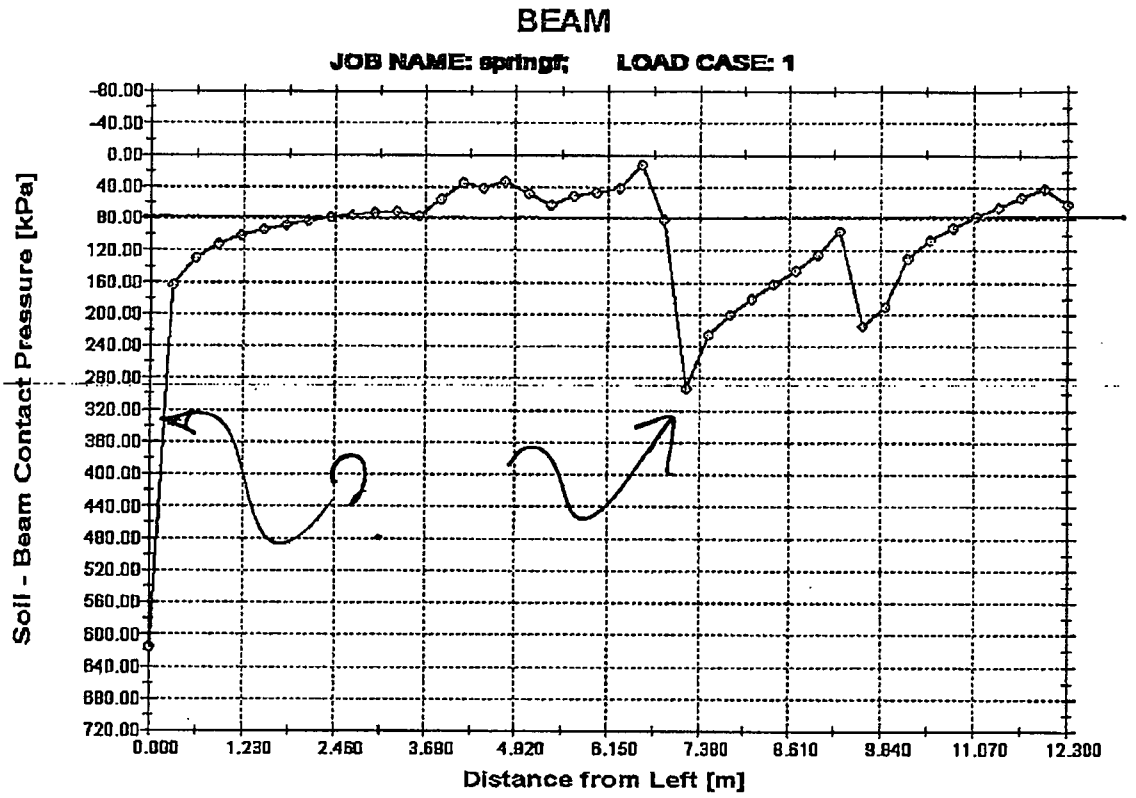
7



Elastic half Space

E = 15000

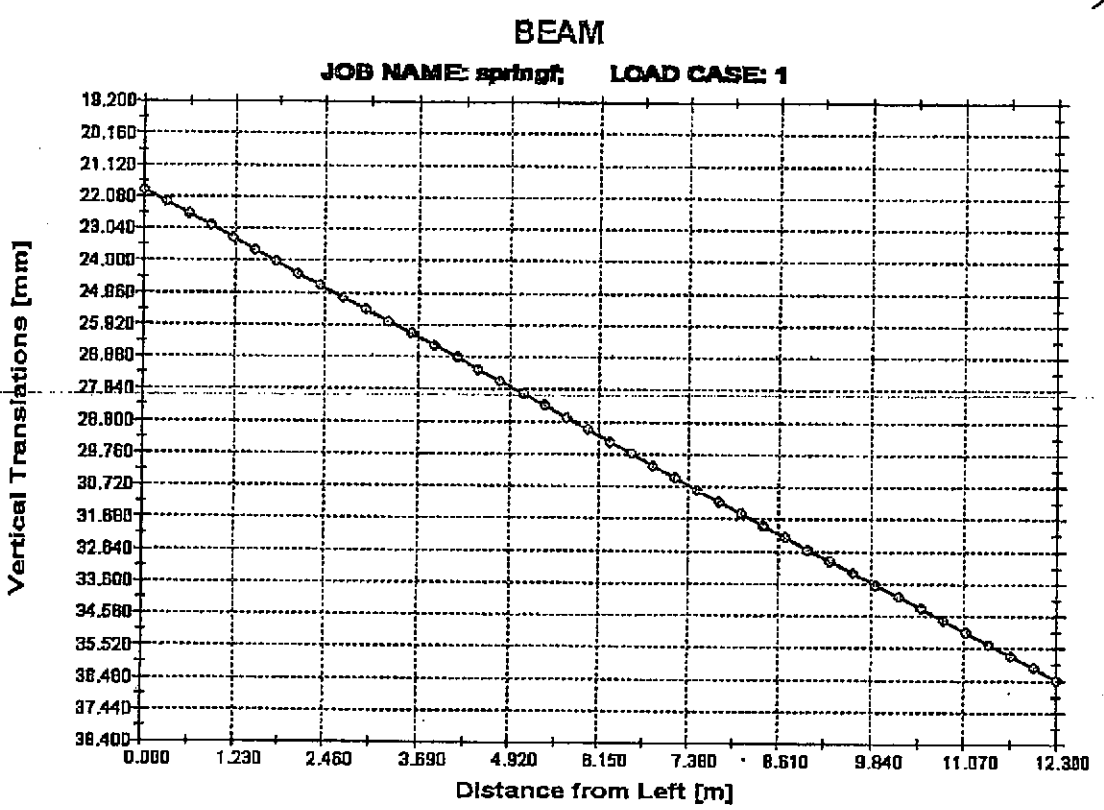
8



Elastic half space

$E_s = 15{\cdot}00$

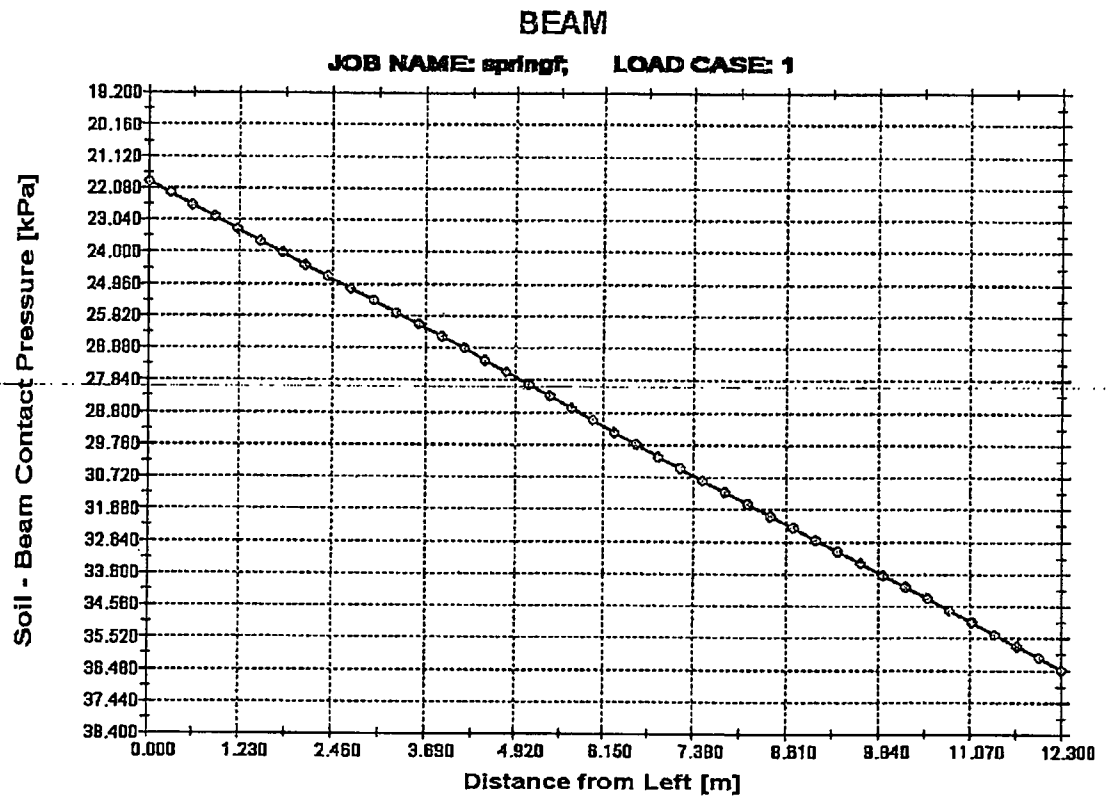
9



Winkler fdn

$k_s = 1000$

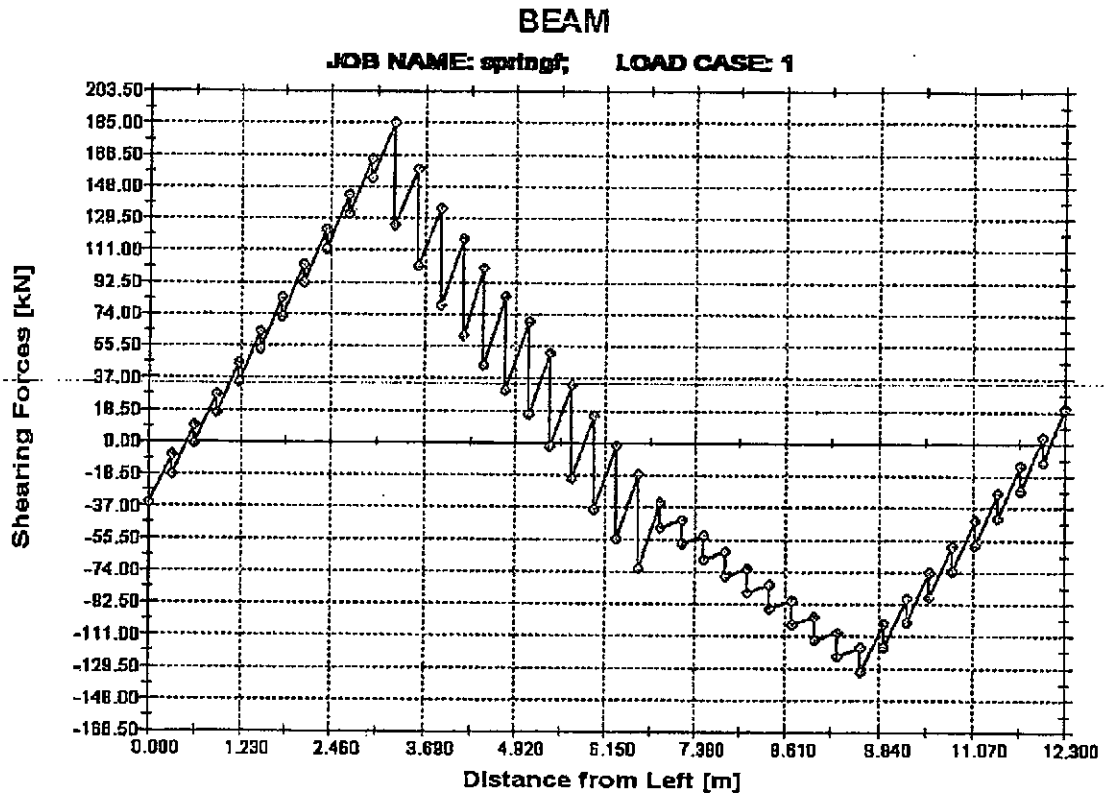
10



Winkler fdn

$k_s = 1000$

11



Elastic ~~buckl spiral~~ wrinkle fdn

K_s = ~~[illegible]~~ 1 ⟹

Cardno

PROJECT	PROJECT NO. .....
	Designed .....
	Date ..... Sheet ..... of .....

Valve pit wall to $M_s = 550$

$M^* = 550 \times 1.5 = 825$

for each wall

$M^* = 413$

$\frac{M}{bd^2} = 0.341$ very small

$A_s = \frac{412 \times 10^6}{0.8 \times 500 \times 0.7 \times 2400}$

$= 613 \text{ mm}^2$

4N16 Rf T&B.

Shear forces to be transferred at CTS

$= 270 \times \frac{2}{2} = 270 \text{ kN}$ ult

Shear stress = 0.5 MPa OK.

Cardno

PROJECT	PROJECT NO. .....
	Designed .....
	Date ..... Sheet ..... of .....

Valve pit bottom slab

3m x 4m

bearing pressure = 80 kPa (sand) (Ref BPT E_s=15k analysis)

q_b = 1.3

$$G_b = \beta \cdot q \frac{b^2}{t^2} = 0.45 \times 80 \times \frac{3^2}{0.35^2}$$

$$M_b = 0.45 \times 80 \times \frac{3.0^2}{0.35^2} \times \frac{1}{6} \times 0.35^2$$

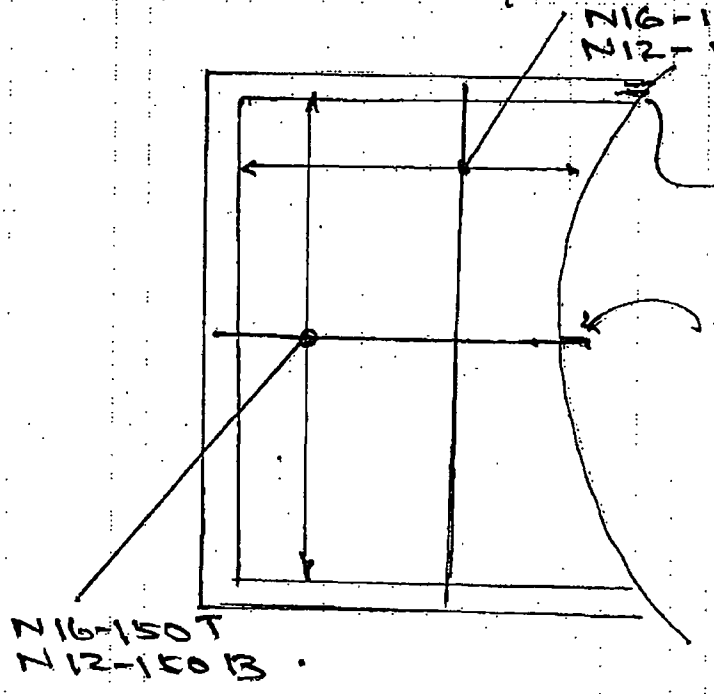
$$= 0.075 \times 80 \times 3^2 = 54 \text{ kNm/m}$$

Provide N16 @ 150 c/c top (50 cover)

$M_{long\ dir^n} = 0.056 \times 80 \times 3^2 = 40$ kNm/m

N16 @ 150 ~~bot~~ Top

Provide N16 - 150 b/w



Cardno

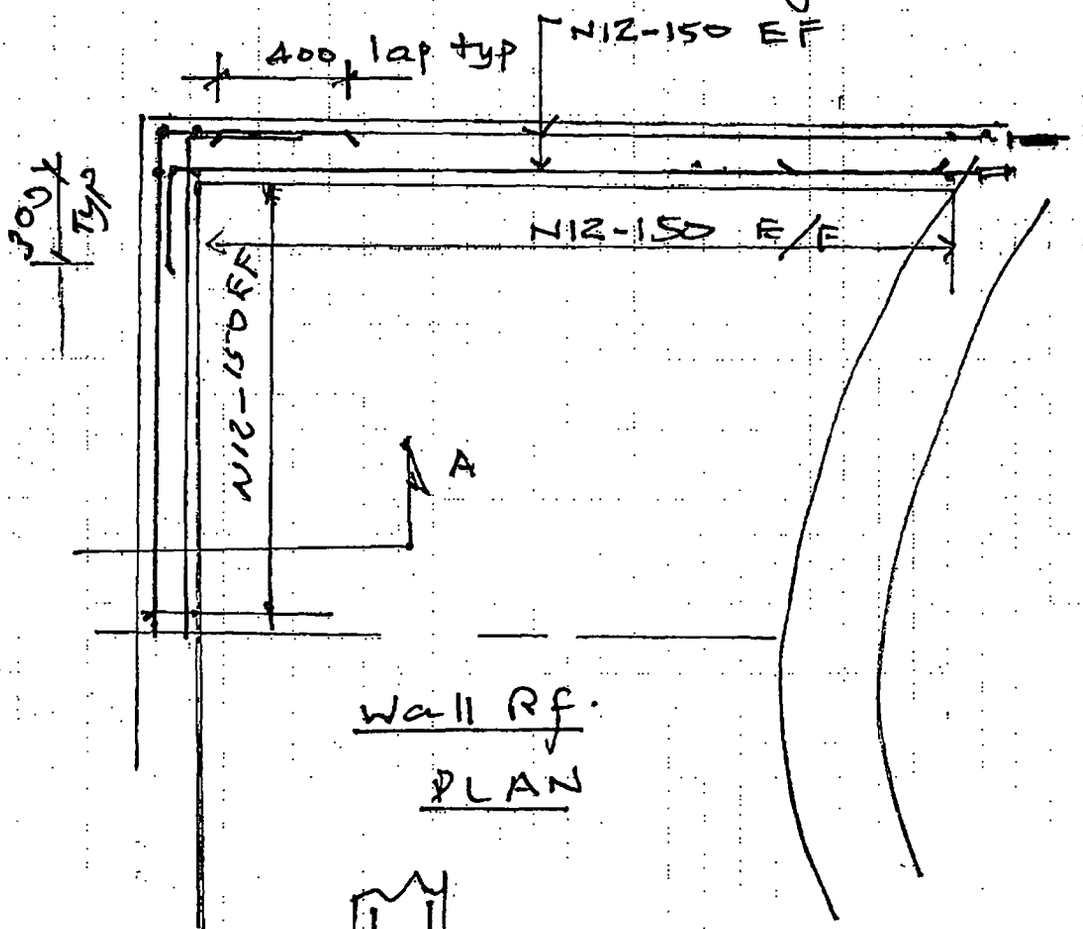
PROJECT	PROJECT NO. .....
	Designed .....
	Date ..... Sheet ..... of .....

Valve pit walls

$M = 21.6 \times 2.4^2/6 = 20$

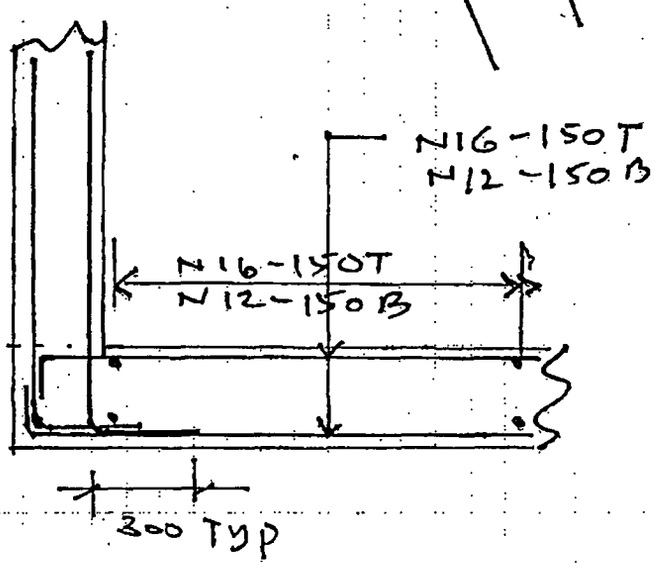
N12 - 150 verticals.

~~Provide N12 - 150 horizontals. too.~~



Wall Rf.

PLAN



Calculation of service stress in steel bars and Crack width estimation

Cover to links, c_{min} =	50 mm	Distance between bars , s =	150 mm
Overall depth, h =	300 mm = a'	Stirrup (or lower rf.) size =	16 mm
Main bar size =	16 mm	Reinforcement available =	As 1340 As' 0
Tensionn rf. ratio	ρ = 0.00593	Compression rf. ratio	ρ' = 0
fcu = 32	fy = 500	Ec(instant) =	26.4 kN/mm2
Service Moment , Ms =	40.0	Balancing Moment , Mp =	0
Axial tensile stress : T / A =	0.00	Strain due to axial tension ,	ε_t = 0.0000
Bonded (+ve) ps strands area, Aps =	0	Depth of p/s steel , dp =	0
Number of tensile stress layers =	1		

M	bf	d	d'	α_e	x/d	z/d	f_s	ε_1	ε_m
40.0	1000	226	74	15.15	0.34	0.89	149	0.0011	0.0007

At the soffit of the member , a_{cr} = 97

Design surface crack width = **0.240** mm $= \varepsilon_m$ / 1+ (2 (acr - Cmin)/(h-x))

Calculation of service stress in steel bars and Crack width estimation

Cover to links, c_{min} =	50 mm	Distance between bars, s =	150 mm
Overall depth, h =	300 mm = a'	Stirrup (or lower rf.) size =	0 mm
Main bar size =	16 mm	Reinforcement available =	As 1340 As' 0
Tensionn rf. ratio ρ =	0.00554	Compression rf. ratio ρ' =	0
fcu = 32	fy = 500	Ec(instant) =	26.4 kN/mm2
Service Moment, Ms =	54.0	Balancing Moment, Mp =	0
Axial tensile stress = T / A =	0.00	Strain due to axial tension, ε_t =	0.0000
Bonded (+ve) ps strands area, Aps =	0	Depth of p/s steel, dp =	0
Number of tensile stress layers =	1		

M	bf	d	d'	α_e	x/d	z/d	f_s	ε_1	ε_m
54.0	1000	242	58	15.15	0.33	0.89	187	0.0013	0.0009

At the soffit of the member, a_{cr} = 87

Design surface crack width = 0.264 mm $= \varepsilon_m$ / 1+ (2 (acr - Cmin)/(h-x))

Calculation of service stress in steel bars and Crack width estimation

Cover to links, c_{min} =	50 mm	Distance between bars , s =	150 mm
Overall depth, h =	250 mm = a'	Stirrup (or lower rf.) size =	0 mm
Main bar size =	12 mm	Reinforcement available =	As 754 As' 0
Tensionn rf. ratio ρ =	0.00389	Compression rf. ratio ρ' =	0
fcu = 32	fy = 500	Ec(instant) =	26.4 kN/mm2
Service Moment , Ms =	20.0	Balancing Moment , Mp =	0
Axial tensile stress : T / A =	0.00	Strain due to axial tension ,	ε_t = 0.0000
Bonded (+ve) ps strands area, Aps =	0	Depth of p/s steel , dp =	0

Number of tensile stress layers = 1

M	bf	d	d'	α_e	x/d	z/d	f_s	ε_1	ε_m
20.0	1000	194	56	15.15	0.29	0.90	151	0.0011	0.0005

At the soffit of the member , a_{cr} = 88

Design surface crack width = **0.131** mm = ε_m / 1+ (2 (acr - Cmin) /(h-x))

Cardno

PROJECT	PROJECT NO. .....
	Designed .....
	Date ..... Sheet ..... of .....

Design of Link beams and SW board

Slabs

Walls

M_{max} = 400 kNm service

M_{ult} = 1000 kNm say

b = 500

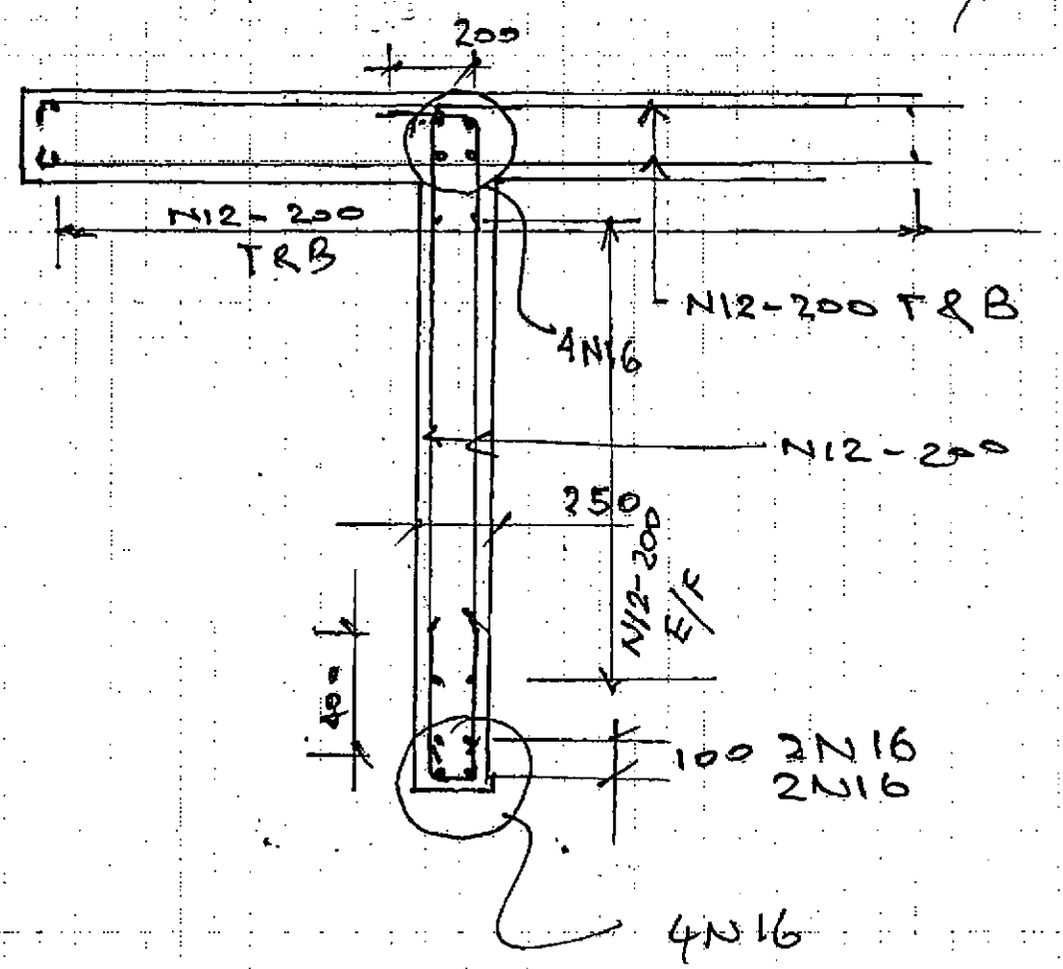
d = 200

A_s = 1600 (8 N16)

slab

M = $25 \times 1.25^2 = 20$

Provide N12 - 200 T&B b/w



Cardno

PROJECT	PROJECT NO. .....
	Designed .....
	Date ..... Sheet ..... of .....

Top slabs for Grit Collector

2.6ϕ. $M = 25 \times \frac{2.6^2}{16}$

$= 10.5$.

nominal ϕ.

Provide N12-200 b/w

Base of Pumpwell

4m ϕ Circular Plate.

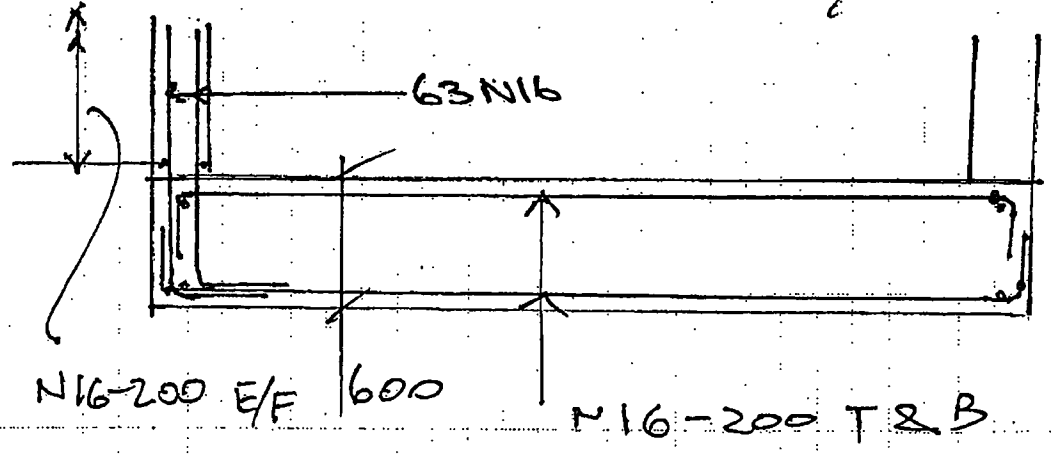
Pressure = 100 kPa (say)

ie $\frac{\pi}{4} \times 4.2^2 \times 100 = 1385$ can take total load.

$M = 100 \times 4.0^2 \times \frac{1}{4} \times \frac{(3+0.2)}{16}$

$= 80$

Provide N16-200 b/w T&B.



Cardno

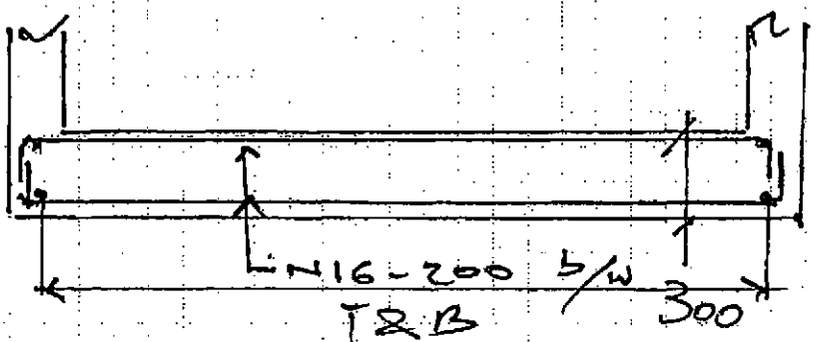
PROJECT	PROJECT NO. ..... Designed ..... Date ..... Sheet ..... of .....

Base slab for grit collector.

$$M = 80 \times \frac{2.7^2}{64} \times 3.2 = 29$$

N16-200 T&B OK.

f_s = 142 c/w = 0.116 max.



Top slab for pump well

$$M = 25 \times \frac{4.0^2}{20}$$ without openings

$$= 20$$

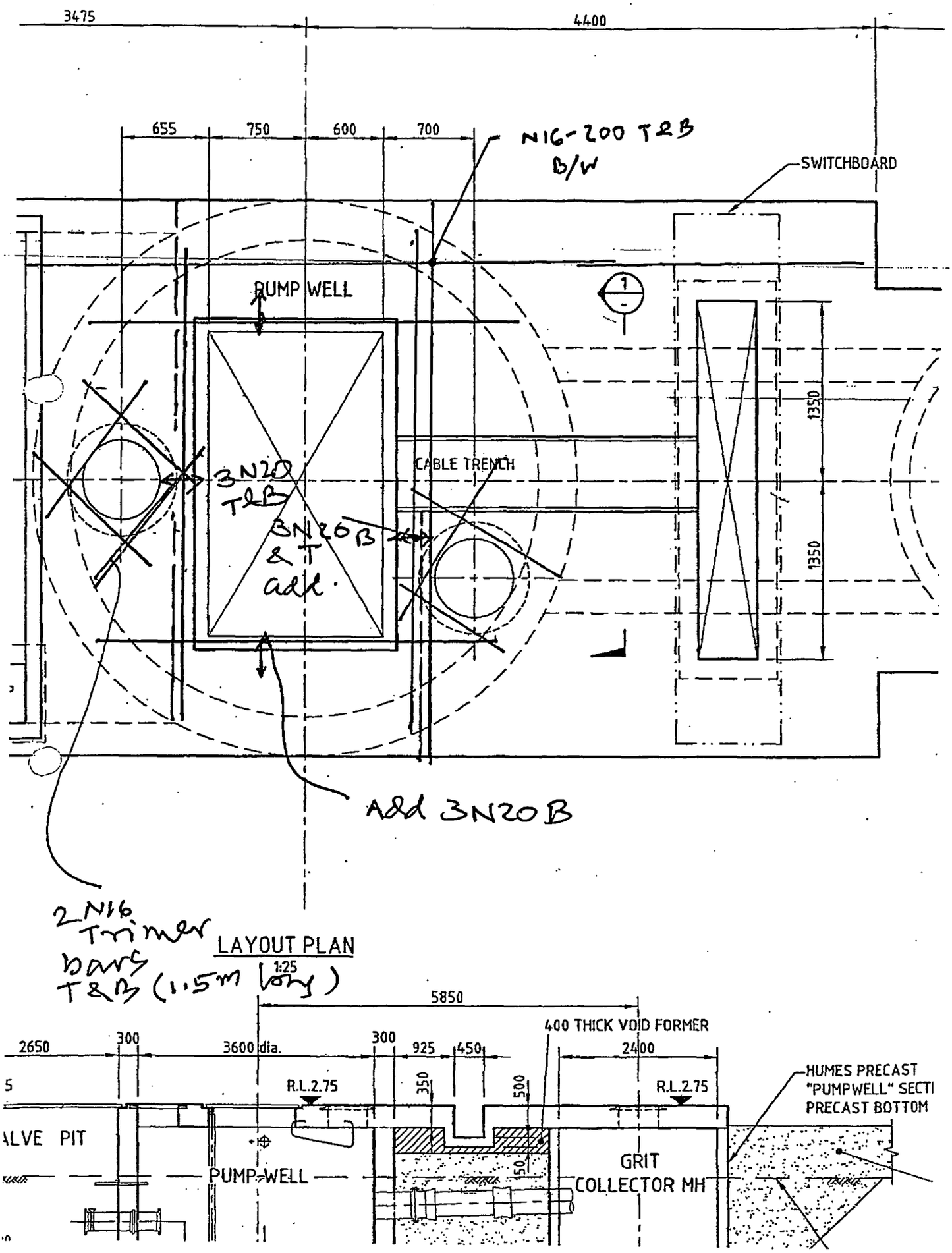
From SLABS analysis

M_{uf} = 23 (generally

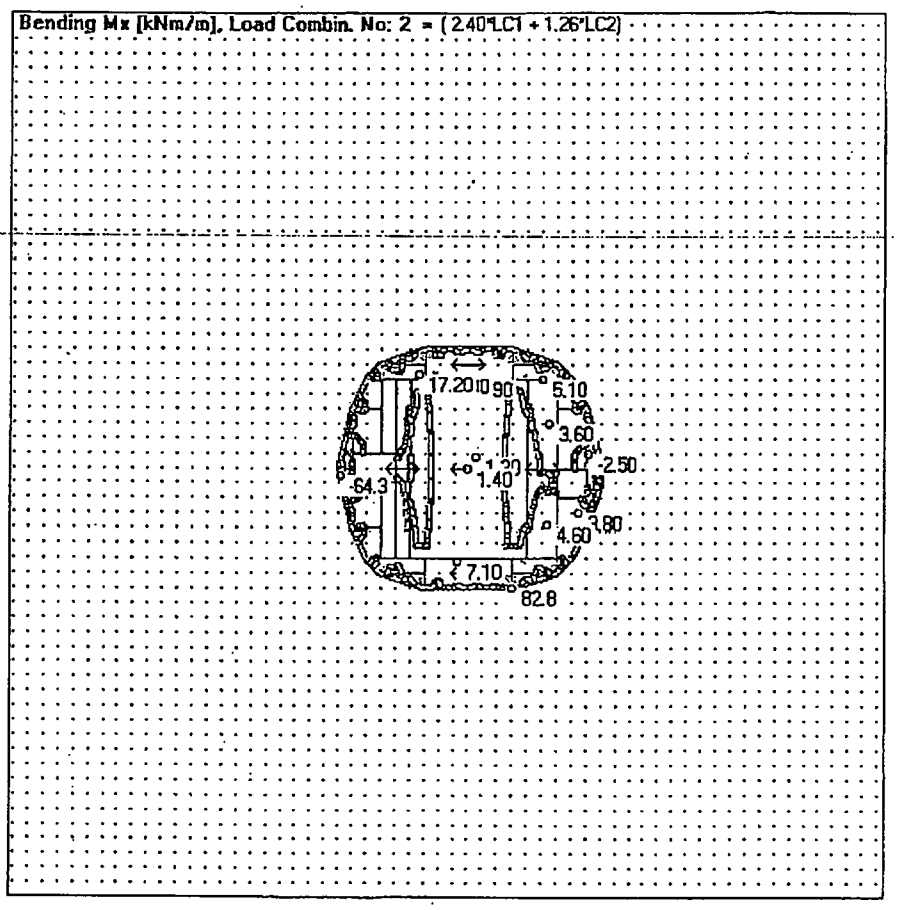
with M = 155 as highest in a 200 wide strip

for the strip $\frac{M}{bd^2} = 4.2$ M = 76

A_s = 900 (3N20 additional)


3475
4400
655
750
600
700
N16-200 T&B
B/W
SWITCHBOARD
PUMP WELL
1
1350
1350
CABLE TRENCH
3N20
T&B
3N20B
&
T
add.
Add 3N20B
2 N16
Trimer
bars
T&B (1.5m long)
LAYOUT PLAN
1:25
5850
400 THICK VOID FORMER
2650
300
3600 dia.
300
925
450
2400
5
R.L.2.75
350
500
R.L.2.75
HUMES PRECAST
"PUMPWELL" SECTI
PRECAST BOTTOM
ALVE PIT
PUMP WELL
150
GRIT
COLLECTOR MH

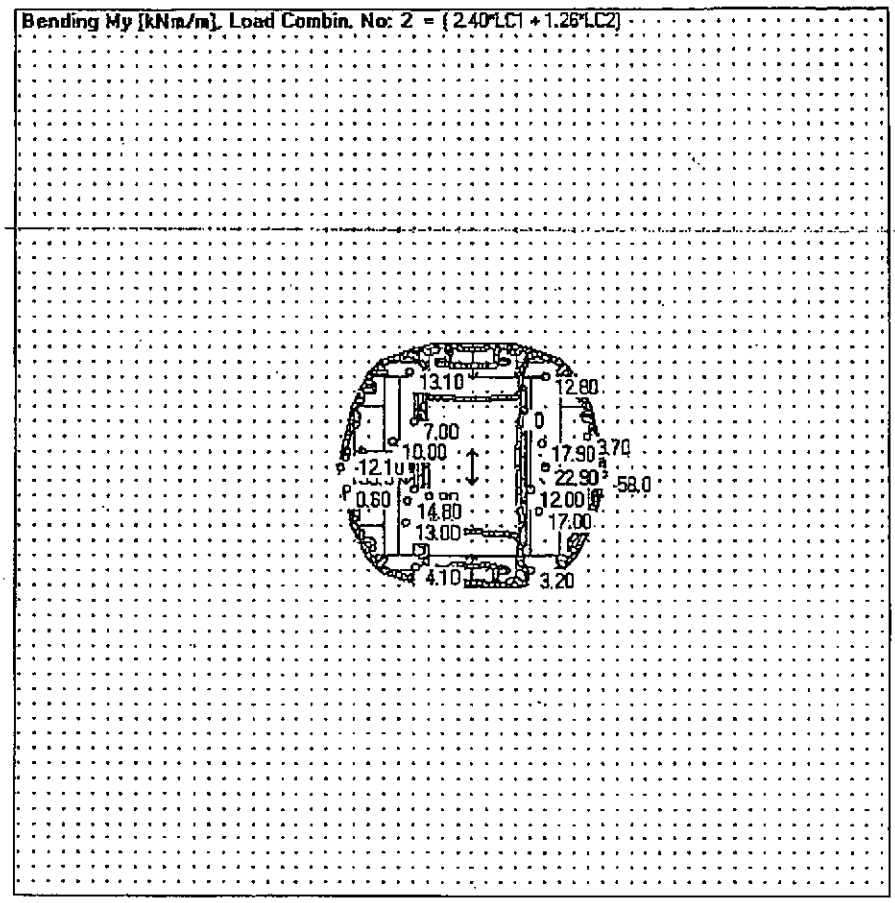
SLABS 3.00, Analysis and Design of Reinforced Concrete Slabs
Company: Cardno MBK
File: c:\slabs\data\4.5diaslab .dat, 28/05/2004, 10:14
Job:
Project:
Location:
Client:



Bending Mx

Bending Mx [kNm/m] min:
-64.28
-34.86
-5.44
23.98
53.40
max: 82.82

SLABS 3.00, Analysis and Design of Reinforced Concrete Slabs
Company: Cardno MBK
File: c:\slabs\data\4.5diaslab .dat, 28/05/2004, 10:16
Job:
Project:
Location:
Client:



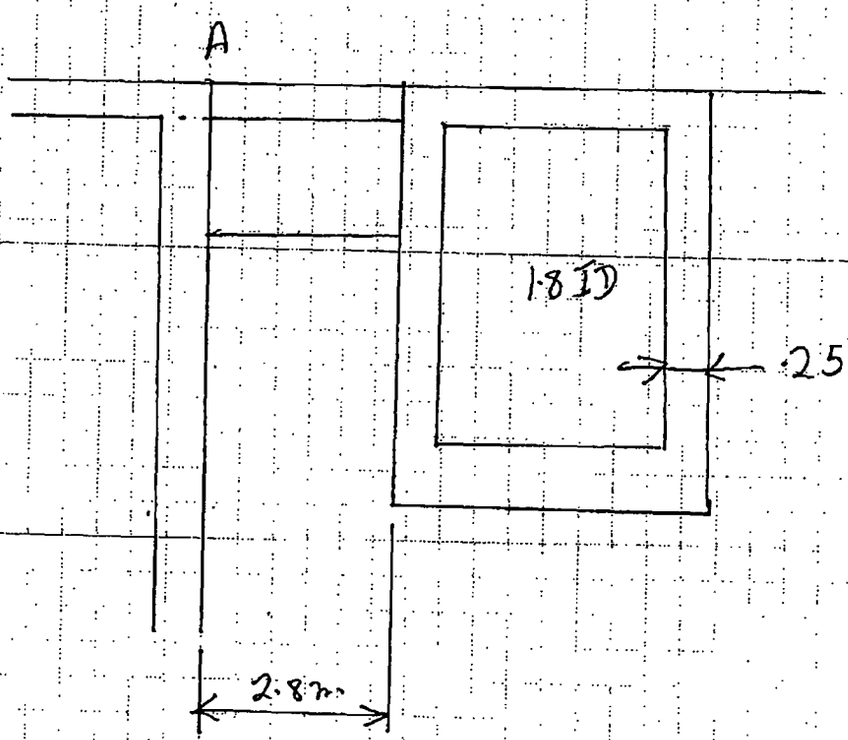
Bending My

Bending My [kNm/m] min:
-57.99
-15.22
27.65
70.32
113.09 max: 155.86

Cardno

PROJECT Lytton Road PS Connection to Grit Collector

PROJECT NO. 7519/02-3
Designed
Date 28-6-4 **Sheet** 1 **of**



M_A = top slab	$2.9 \times 2.9 \times .35 \times 25 \times 3.9$		287
annulus slab	$2.5 \times 4.2 \times .35 \times 25 \times 1.25$		115
grit collector wall	$(2.3^2 - 1.8^2)\frac{\pi}{4}$	$2.8 \times 25 \times 3.9$	439
" " floor	$2.3^2 \frac{\pi}{4} \cdot 3 \times 25 \times 3.9$		122
" " contents	$1.8^2 \frac{\pi}{4}$	$2.8 \times 10 \times 3.9$	278
annulus (3t)	$3 \times 9.81 \times 1.35$		40
walls	$.25 \times .95 \times 2 \times 3.15 \times 1.55 \times 25$		58
			1339

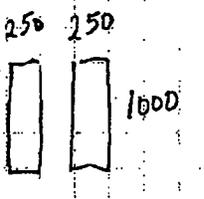
Roof load.

top slab	$2.9 \times 2.9 \times 3.9 \times 5$	164
annulus slab	$2.5 \times 4.2 \times 1.25 \times 5$	66
		230

$\therefore M_U = 1339 \times 1.25 + 230 \times 1.5 = 2019$

Cardno

PROJECT	PROJECT NO. ..... Designed ..... Date ..... Sheet 2 of .....



$f'_c = 40\ MPa$

$$\frac{M_x}{bd^2} = \frac{2019 \times 10^6}{500 \times 1000^2}$$

$$= 4.038$$

$$\therefore \frac{A_s}{bd} = .0137$$

$$A_s = .0137 \times 500 \times 1000 = 6850\ mm^2$$

$\therefore$ 15 - N24 N24-452

$\therefore$ 11 - N28 N28 - 615

assume the ground supports will ~~not~~ always carry 5.0 t load

$\therefore$ max $M_U = 1010\ kNm$

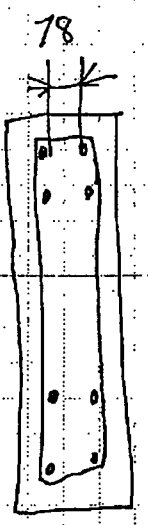
$\therefore \frac{M_x}{bd_2} = 2.019$ $\therefore \frac{A_s}{bd} = .0067$

$A_s = 3350 = 8\ N24 / 6\ N28$

Cardno

PROJECT	PROJECT NO. .....
	Designed .....
	Date ..... Sheet 3 of .....

adapt 8 N 24 T v B



ULTIMATE SLABS

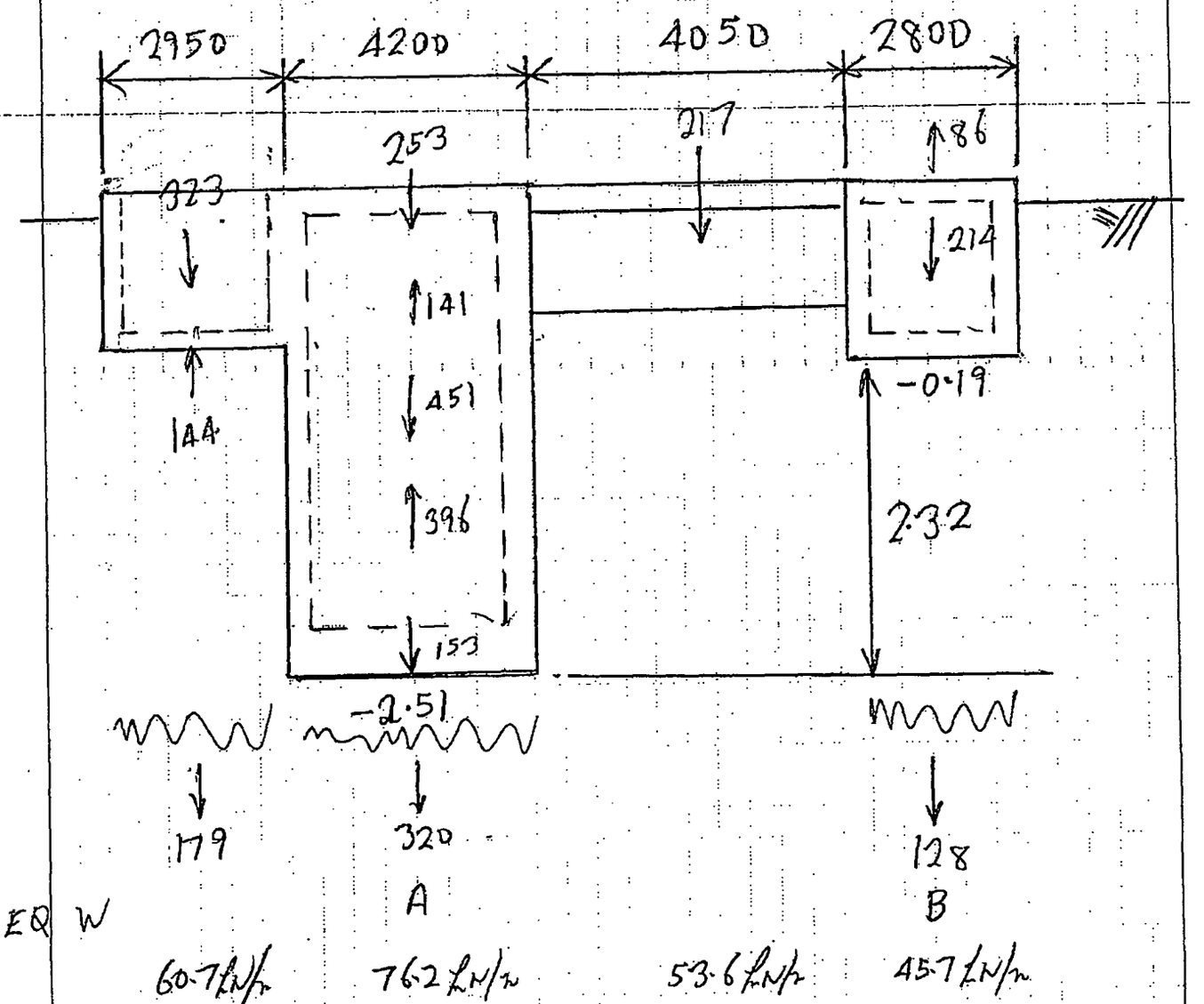
D	300	mm
cover	50	mm
cross reo dia	0	mm
main dia	16	mm
main reo spacing	200	mm
fsy	400	Mpa
fc	40	MPa
d	242	mm
Area steel	1005	mm/m
p	0.0042	
q	0.0415	
phi	0.8	
Ku	1.30	
Mu	75.9	nNm/m

Cardno

PROJECT Lytton Rd PS
Link Wet Well – Sth Collector

PROJECT NO. 7519/02-3
Designed MP
Date 14-7-0 Sheet 1 of

Spacing increased by Brisbane Water



$\Sigma M_A = -179 \times 3.57 + 217 \times 2.12 + 128 \times 7.55 - F_B\ 7.55$

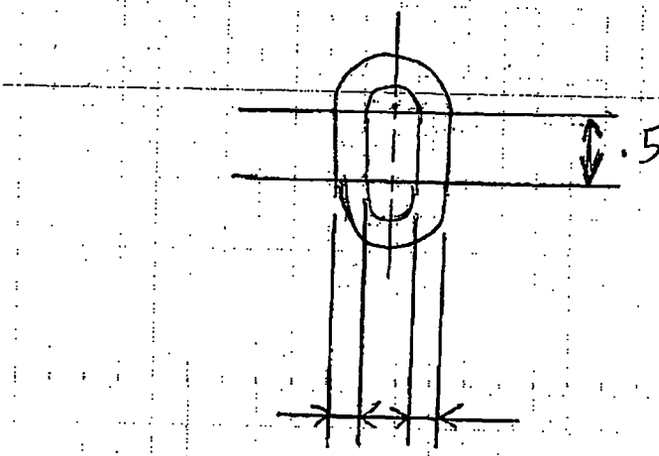
$\therefore F_B = 104.3 \quad \checkmark\ 37.2\ kN/m$

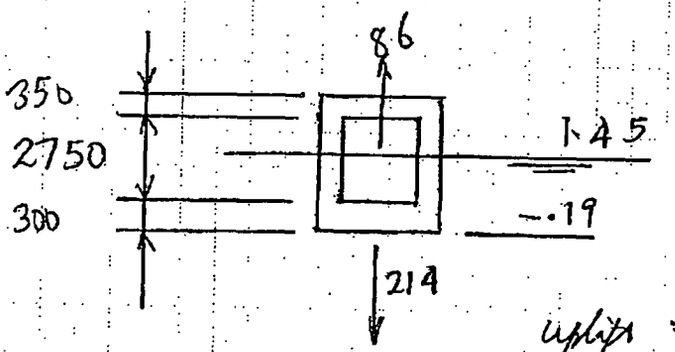
$\therefore F_A = \frac{\cancel{522}}{739.7} \quad \checkmark\ \frac{\cancel{124.5}}{176}\ kN/m$

Cardno

PROJECT	PROJECT NO. 7519/2-3
	Designed
	Date Sheet 2 of

Gas Collection Manhole





1.43
2.70

mass = $\left[\left(2.3^2 - 1.8^2\right)\frac{\pi}{4}\ 2.75\right.$

$\left.2.3^2\frac{\pi}{4}\ .65\right]\ 25$

= 178 kN

$+ .5 \times 3.4 \times 2.3 \times 25$

$- .5 \times 2.75 \times 1.8 \times 25$

= 178 + 98 − 62

= 214 kN

uplift = $2.3^2 \times \frac{\pi}{4} \times 1.64 \times 9.81$

$+ 2.3 \times .5 \times 1.69 \times 9.81$

= 67 + 19

= 86 kN

slab $\left(4.2 \times .35 \times 4.05 + 2 \times .25 \times 1.35 \times 4.05\right)\ 25$

= 217 kN

3

LYTTON ROAD PUMP STATION

GEOMETRICAL DESIGN

No Footing allowed Ground water 1m below ground level

Pump well diameter	3.60	m
Pump well wall thickness	0.30	m
Valve pit length	2.65	m
Valve pit width	3.70	m
Valve pit wall thickness	0.25	m
Dividing wall thickness	0.30	m
Switchboard slab length	4.05	m
Pump well floor thickness	0.60	m
Valve pit floor thickness	0.30	m
Footing length	0.00	m
Footing thickness	0.00	m
Pump well hatch location	1.00	m
Pump well hatch length	1.10	m
Pump well hatch width	2.30	m
Pump well roof thickness	0.35	m

Top level	2.75	m
Ground level	2.45	m
Water table level	1.45	m
Pump well floor level	-1.91	m
Valve pit floor level	0.71	m

Concrete density	25.00	kN/m3
Ground density	19.00	kN/m3
Water density	9.81	kN/m3
Top surcharge	5.00	kPa

Side shear	5.00	kN/m2

Pump station mass

Pump well floor	6.11 m3	5.00 m	Inside wall
Pump well wall	18.05 m3	5.00 m	Foundation to U/S of roof
solid block	0.00	6.05	
wet well cutout	0.00	5.89	
Wet well footing	0.00 m3	0.00 m	
solid block	49.14	2.50	to C/L of pump well
valve pit hole	20.00	1.58	
pump well hole	16.21	4.11	
valve pit hole	12.93 m3	1.91 m	
square slab	8.60	7.93	
pump well half	2.42	4.11	
pump well hatch	0.89	4.75	
Pump well roof	10.14 m3	7.29 m	
Total concrete	**47.22 m3**	**4.65 m**	
	1181 kN		
Moment on Centreline		417 kNm	

Buoyancy

Assumes water level is above underside of valve pit

Pump well lower	40.45 m3	5.00 m
Pump well upper	14.41 m3	5.00 m
valve pit solid	21.84	2.50
pump well hole	7.20	3.86
Pump pit	14.64 m3	1.83 m
Total buoyancy	**69.50 m3**	**4.33 m**
	-682 kN	
Moment on Centreline		-455 kNm

Soil on Footing

solid block	0.00	6.05

4

wet well cutout	0.00	5.89
Soil on footing	**0.00 m3**	**0.00 m**
	0 kN	
Moment on centreline		0.00 kNm

Side Shear

Neglect side friction on top equivalent to depth of slab		
Pump well lower	38.53 m2	5.00 m
Pump well upper	15.83 m2	6.34 m
Valve pit sides	46.10 m2	2.50 m
Valve pit end	8.36 m2	0.00 m
Total shear	**108.82 m2**	**3.75 m**
	544 kN	
Moment on Centreline		679 kNm

Buoyancy Calculations	With shear	No shear
Down force factored	1552 kN	1062 kN
Up force factored	-818 kN	-818 kN
Ratio	-0.53	-0.77
	OK	

Roof Loading

Roof area	45.57 m2		
Roof live load	447 kN	5.43 m	
Moment on centreline		-190 kNm	

Equipment Loading

Valve pit pipework	45 kN	2.50 m	assumption
Pump well pumps	120 kN	5.60 m	assumption
Benching	66 kN	5.00 m	estimate
Pump well contents	220 kN	6.25 m	estimate
Total equipment	**451 kN**	**5.52 m**	
Moment on centreline		-235 kNm	

			e		
				Base A	13.85 m2
Maximum loading	1397 kN	-462 kNm	-0.33	Base Z	7.27 m3
Minimum loading	499 kN	-38 kNm	-0.08		
Normal case	950 kN	-272 kNm	-0.29		

Stresses on Pump Well Base

	Compression	Bending	Max	Min	
Maximum loading	101 kPa	-64 kPa	37	164 kPa	
Minimum loading	36 kPa	-5 kPa	31	41 kPa	
Normal loading	69 kPa	-37 kPa	31	106 kPa	No go

Stresses on Pump Well Base + Valve Pit Base

	Bending	e	New e	New M
Maximum loading	-462 kNm	-0.33	-1.99	-2779
Minimum loading	-38 kNm	-0.08	-1.78	-865
Normal loading	-272 kNm	-0.29	-1.95	-1848

					Total L	7.10 m
					Pit width	4.20 m
					Pit length	5.00 m
					Well dia	4.20 m
					Centroid	3.34 m
					I	78.05 m4
					c1	3.34
					c2	3.76
					Z1	23.36 m3
					Z2	20.77 m3
					Area	27.93 m2

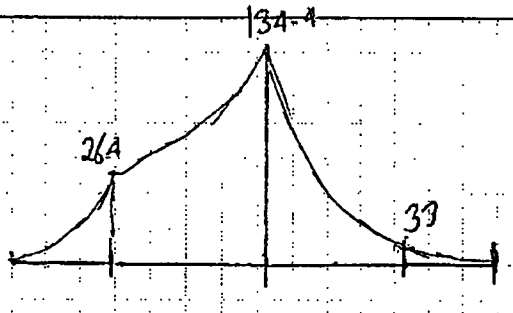
	Compression	Bending		Max	Min	
		C1	C2	C1	C2	
Maximum loading	50 kPa	-119	134	-69	184 kPa	
Minimum loading	18 kPa	-37	42	-19	60 kPa	
Normal loading	34 kPa	-79	89	-45	128 kPa	

Effective Ground Stress

Pump well floor	45.58 kPa
Valve pit floor	18.75 kPa

Cardno

PROJECT	PROJECT NO. .....
	Designed .....
	Date ..... Sheet 5 of .....



OK for current walls.

Assumes that load is shared between pump wet well and grit collector based on stiffness.

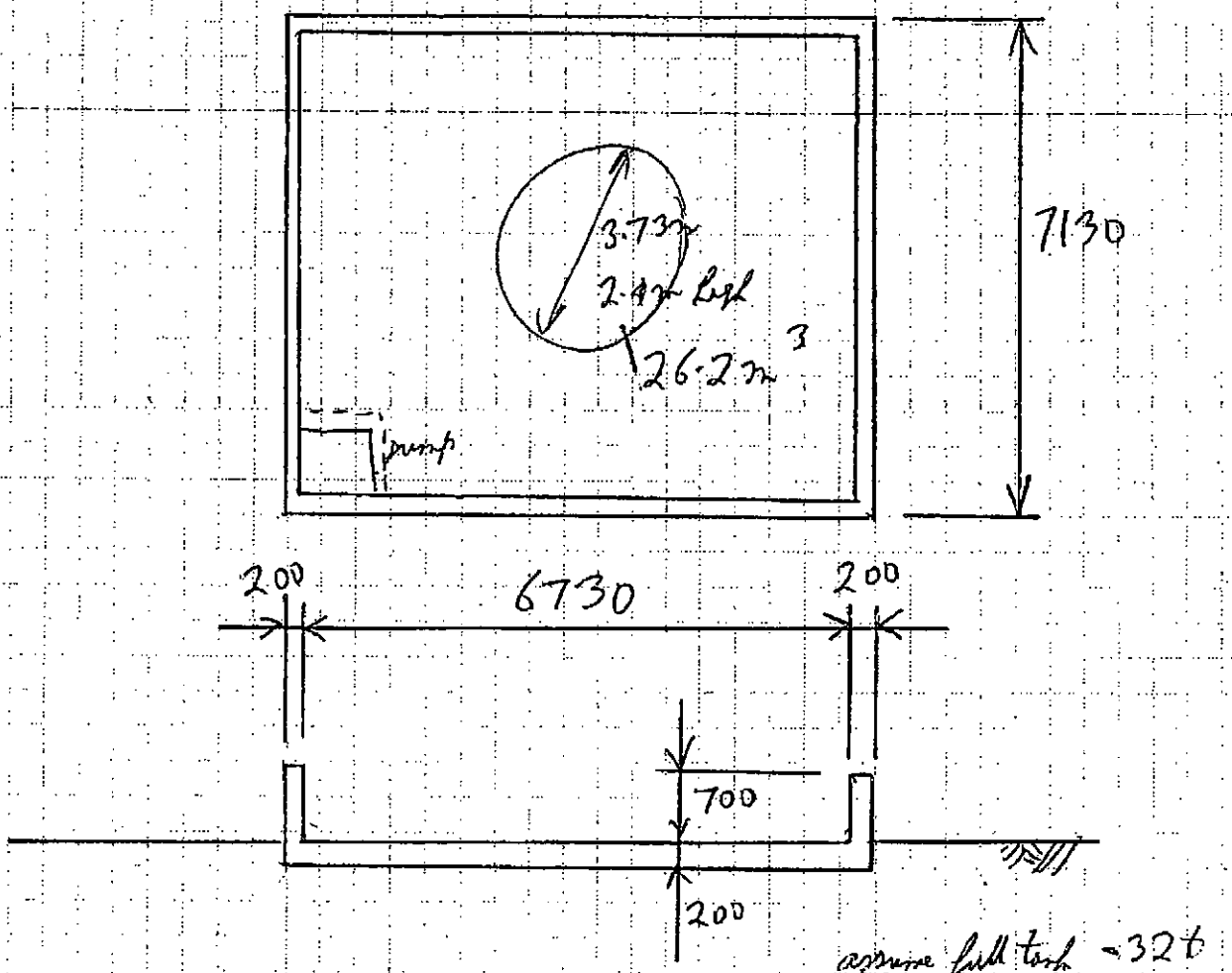
Likely in order of 14 m length of the structure.

Spare capacity in connection if foundations under grit collector is softer than under pump well.

Cardno

PROJECT	Lytton Rd PS	PROJECT NO.	7519/2
		Designed	MP
		Date	13-5-01 Sheet 1 of

Ferric Chloride Dosing System



assume full tank = 32t

Bearing pressure under slab

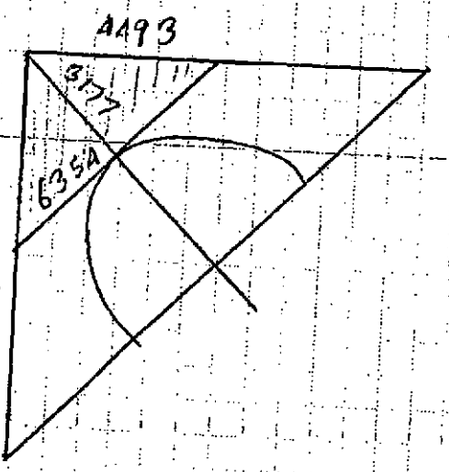
$$= \frac{7.13 \times 7.13 \times .2 \times 25 + 27.72 \times .7 \times .2 \times 25 + 32 \times 9.81}{7.13^2}$$

$$= 13.1 \text{ kPa}$$

PROJECT

PROJECT NO.
Designed
Date Sheet 2 of

Slab Moment



$$W = \frac{32 \times 9.81}{6.73^2} = 6.93\ kP_a$$

$$M = 6.93 \times \frac{4.493^2}{2} \quad \frac{3.177}{3} = 74.1\ kN_m$$

$L = 6.354$

$$\therefore M_u = \frac{74.1}{6.354} \times 1.5 = 17.5\ kN_m/m.$$

$D = 200$

$d = 126$

N16@150 $A_s = 1340$

$F'_c = 32$

More than adequate.

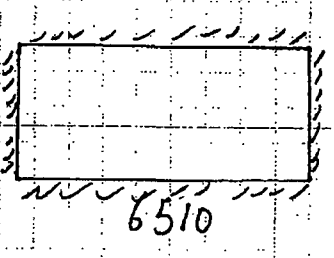
∴ Same design as Viola Place.

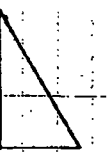
Cardno

PROJECT	Lytton Road PS Rig Lauriston	PROJECT NO. 7519/02-3 Designed MP Date 26-6-09 Sheet 1 of

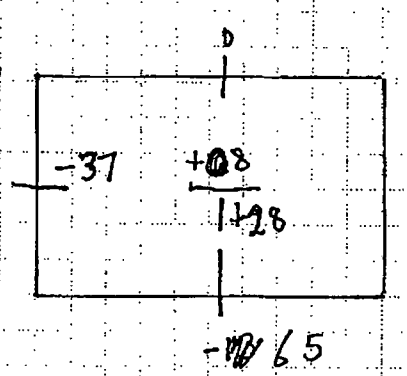
Longest wall:

$\frac{b}{a} = \frac{6510}{2530} = 2.57$





Case 4



T = 10

$M_V = 65 \quad 25.3 \quad 2.53^2 \quad \frac{1}{1000} = 10.6 \text{ kNm/m}$

$M_H = 37 \quad " \quad " \quad " = 6.0 \text{ kNm/m}$

assume restrained 12mm res res = 0.48%

wall 250 thick = 1200 mm² N12 = 113mm²

∴ 2 layers / Y12 @ 188

→ Y12 @ 150 = 753mm²/m

base 300 thick = 1440 mm² ∴ also N12 @ 150

Concrete Serviceability analysis

	Hor		Ver		
Case	1		2	3	4
D	250	mm	250		
Cover	50	mm	50		
Outer Reo Dia	0	mm	12		
Stress Reo Dia	12	mm	12		
Stress Reo Spacing	150	mm	150		
Concrete strength	40	MPa	40		
Concrete mass	2500	kg/m3	2500		
Reinforcement strength	500	MPa	500		
Moment	6	kNm/m	10.6		
d	194	mm	182	0	0
Area of reinforcement	754	mm2	754	#DIV/0!	#DIV/0!
p	0.0039		0.0041	#DIV/0!	#DIV/0!
E concrete	33994	MPa	33994	0	0
E reinforcement	2.00E+05	MPa	2.00E+05	2.00E+05	2.00E+05
n	5.9		5.9	#DIV/0!	#DIV/0!
pn	0.023		0.024	#DIV/0!	#DIV/0!
k	0.192		0.198	#DIV/0!	#DIV/0!
j	0.936		0.934	#DIV/0!	#DIV/0!
Allowable concrete stress	16.0	MPa	16.0	0.0	0.0
Allowable reo stress	150.0	MPa	150.0		
Mc	54.2	kNm/m	48.9	#DIV/0!	#DIV/0!
Ms	20.5	kNm/m	19.2	#DIV/0!	#DIV/0!
	OK		OK	OK	OK

Cardno

PROJECT	PROJECT NO. .....
	Designed .....
	Date ..... Sheet 3 of .....

∴ walls + floor OK.

Roof: 5kPa

Strip 1.5m wide, supports 2.9m width, span 4.7m

DL .3m slab $M = \frac{.3 \times 25 \times 2.9}{1.5} \frac{4.7^2}{8} 1.25$

$= 14.5 \quad 2.76 \quad 1.25$

$M_{UDL} = 50 \text{ kNm/m}$.

$D = 300 \quad d = 300 - 50 - 8$

$= 240\text{mm}$ (M6)

Flexure $= 820 \text{ mm}^2/\text{m} \approx$ N16 @ 245 ~~N16 @ 201~~

adopt N16 @ 150 $\rightarrow 1340 \text{mm}^2/\text{m}$

Transverse $= 6 b D \times 10^{-3} = 1800 \text{ mm}^2/\text{m}$ | excessive ∴ not retained

min $= \frac{A_{st}}{bD} = .002$

$A_{sb} = .002 \times 1000 \times 300 = 600 \text{ mm}^2/\text{m}$

Cardno

PROJECT	PROJECT NO. ..... Designed ..... Date ..... Sheet 4 of .....

$DL = 5\ kN/m^2$

$M_{VLL} = 5 \quad \frac{2.9}{1.5} \quad \frac{4.7^2}{8} \quad 1.5$

$= 40\ kN.m$

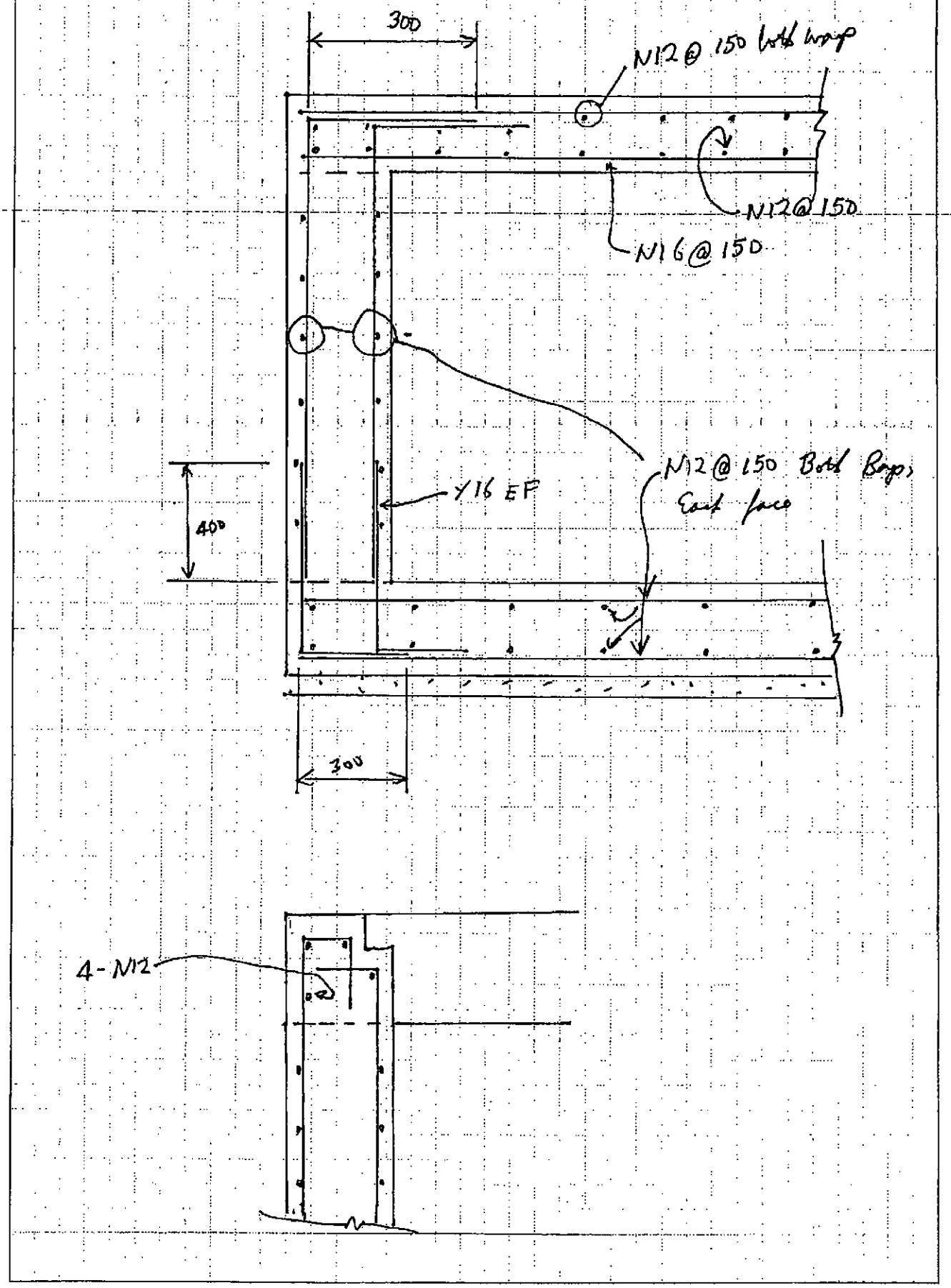
$\therefore M_V = 90\ kN.m/m$

$A_s = 1260\ mm^2/m$

N16 @ 150 = $1340\ mm^2/m$ OK

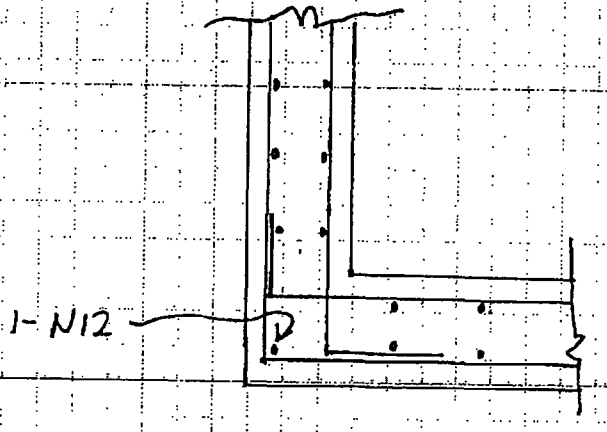
Cardno

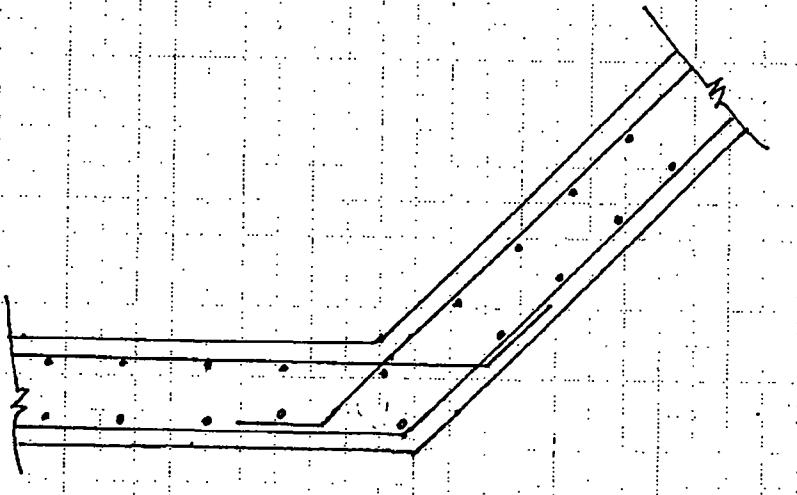
PROJECT	PROJECT NO. .....
	Designed .....
	Date ..... Sheet 5 of .....

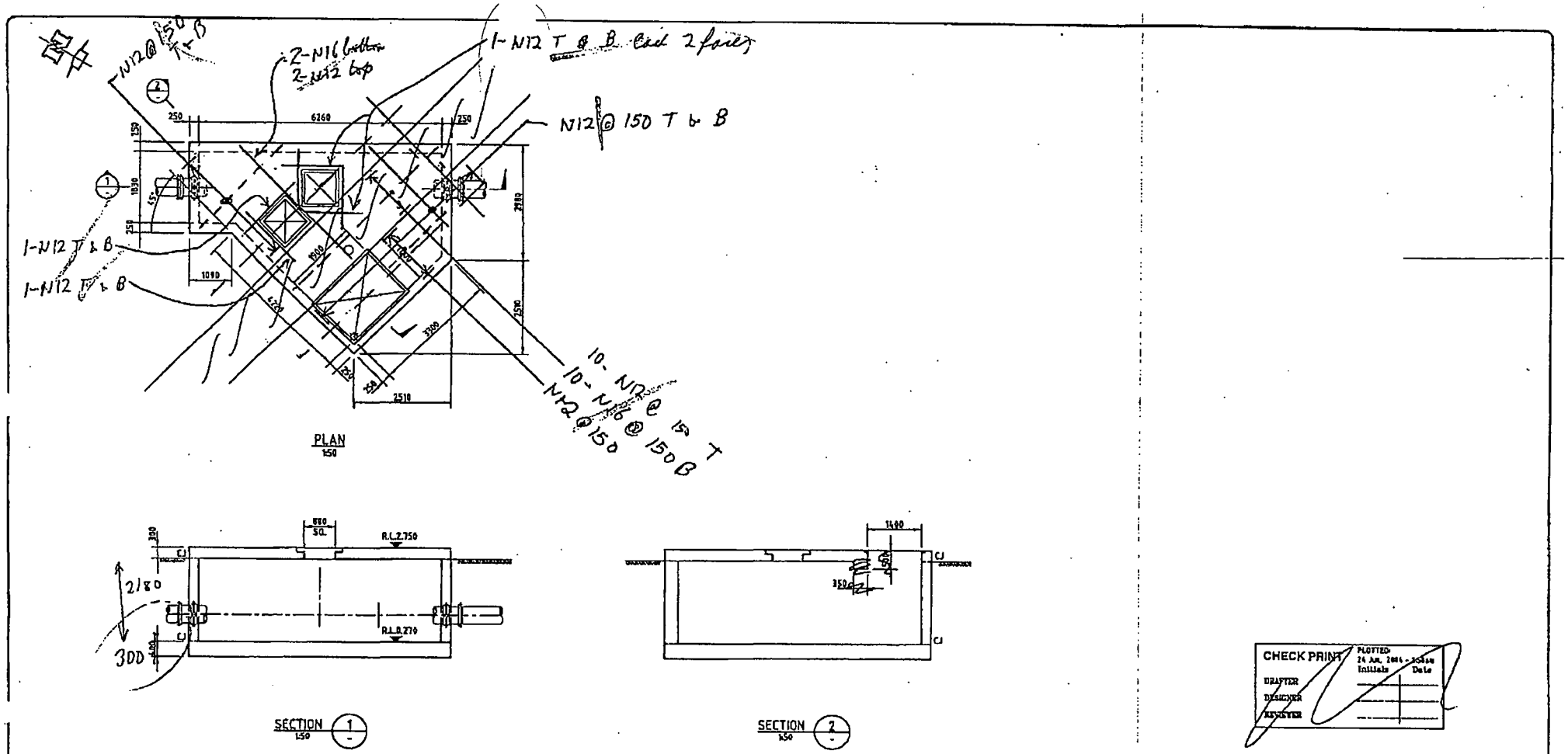


Cardno

PROJECT	PROJECT NO. .....
	Designed .....
	Date ..... Sheet 5 of .....







CHECK PRINT
PLOTTED: 24 JUL 2014 - 13:54
Initials Date
DRAFTER
DESIGNER
REVIEWER

NOTES:
1. FOR GENERAL NOTES REFER TO DWG NO. 486/5/7-WR101/032.
2. CONCRETE QUALITY:
   S40 U.N.O.
3. CLEAR COVER TO REINFORCEMENT NEAREST TO CONCRETE SURFACE SHALL BE, UNLESS NOTED OTHERWISE:
   50mm

SCALE BEFORE REDUCTION
500 0 500 1000 1500 2000 2500mm
1:50

PROJECT: AUSTRALIA TRADE COAST SEWERAGE PROJECT

Cardno MBK 7519/02/03-092

PB PARSONS BRINCKERHOFF

BW CONTRACT No.	30137-02/03
LEIGHTON JOB No.	Q1112
PB JOB No.	21381108

DESIGN MANAGER | BLP.E.O. NO. 2241 | DATE 7/7/2014
BW NETWORK DELEGATE | DATE
CADD FILE | JOB FILE | SURVEYED | SURVEY NO. | FIELD BOOK
DESIGN M.D.P. JUNE 2014 | DESIGN CHECK | DRAWN G.F.B. JUNE 2014 | DRAFTING CHECK

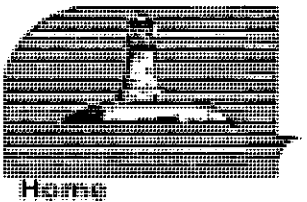
P1 FOR BW REVIEW
NO. DATE AMENDMENT INITIALS

Brisbane Water

PROJECT: LYTTON ROAD PUMPING STATION

TITLE: LYTTON ROAD SP298 - PIG LAUNCHER CONCRETE DETAILS

SCALE: AS SHOWN | A.H. DATUM
DRAWING No.: 486/5/7-WR101/039
No. SHEETS
AMEND. NO.: P1



Home

Rope

Rescue Gear

Mustang

Secure Screen

Life Jackets

Quest Meters

Catalog Index

Request Info

Contact Us

MACHOVEC

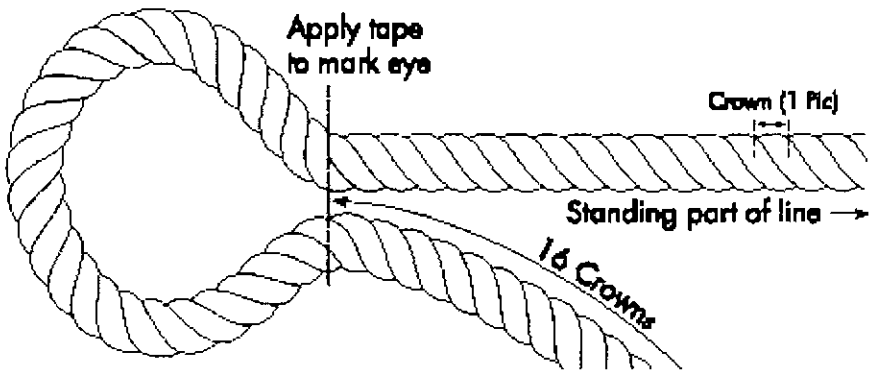
3-Strand Tuck Splic

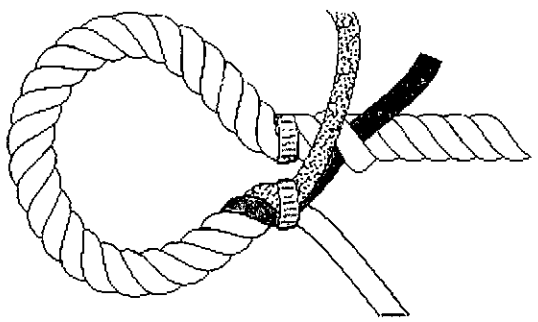
Class 1 3-strand ropes are made from any or all of the followinc

Although the 3-strand splice is the most common splice, and simple to perform, techi Take care that the tucks lie neatly; rope strength can be lost if the strands are twisted

Tools Required: Fid; tape or whipping twine; marking pen, scissors or a sharp knife;

Getting Started: From one end of the rope, count back 16 crowns. Tape this sectior end of each strand. Form the eye and tape the standing part of the rope. To avoid a the rope one-half turn between the pieces of tape.



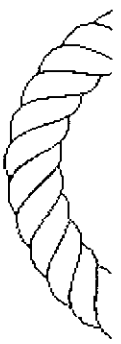


STEP 1 ... TUCKING TH

With a fid or your finger, raise a strar the rope and insert the middle work through. Mark the first tucked strar working strands will help you keep tra

STEP 2 ... TUCKING TH

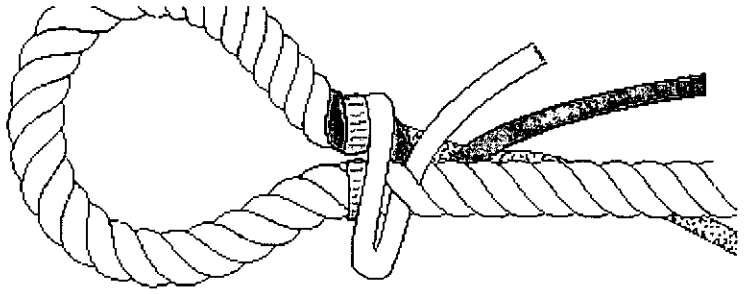
Using the fid to separate strands, tuck the next working strand over the strand you just tucked under and under the strand just below it. Mark this strand with a double hash mark.



STEP 3 ... TUCKING THE THIRD STRAND

Turn the entire piece over. There is one working strand left to tuck and there is one strand left in the standing part of the rope that does not have

a working strand under it. Insert the fid to separate the strands and make this tuck, cc the rope. Mark this strand with a triple hash mark.

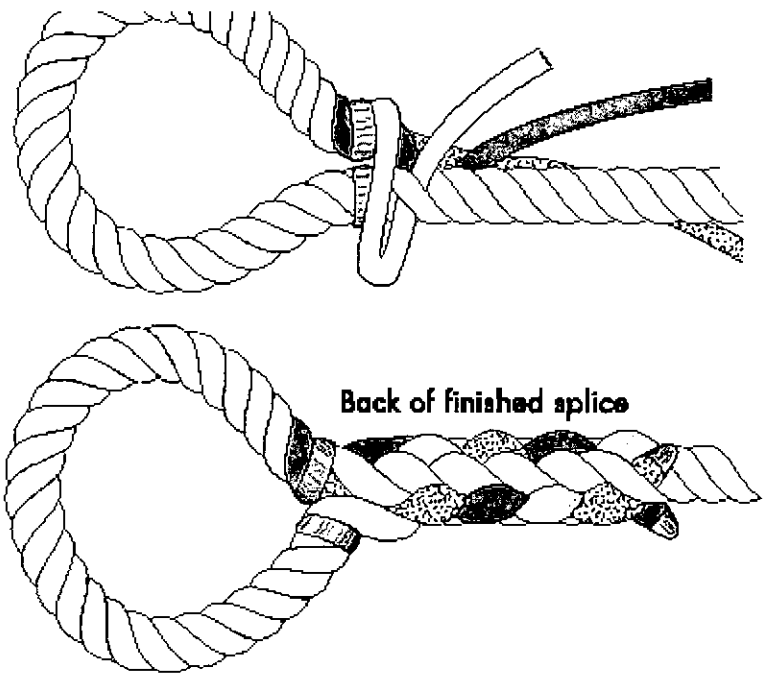


The first round of tucks is complete. Tighten if necessary by pulling on the strand ends

When you tuck, take care to use all three strands in each round and that you tuck u and not under one of your working strands.

STEP 4 ... FINISHING THE SPLICE

Perform four more complete tucks. Tighten tucks if necessary. Both the front and illustrations shown.



**Splicing information is provided by SAMSON Rope Technologies*

SAMSON®
ROPE TECHNOLOGIES
The Strongest Name In Rope

Site questions should l

Please take a moment to view our

MACHOVEC

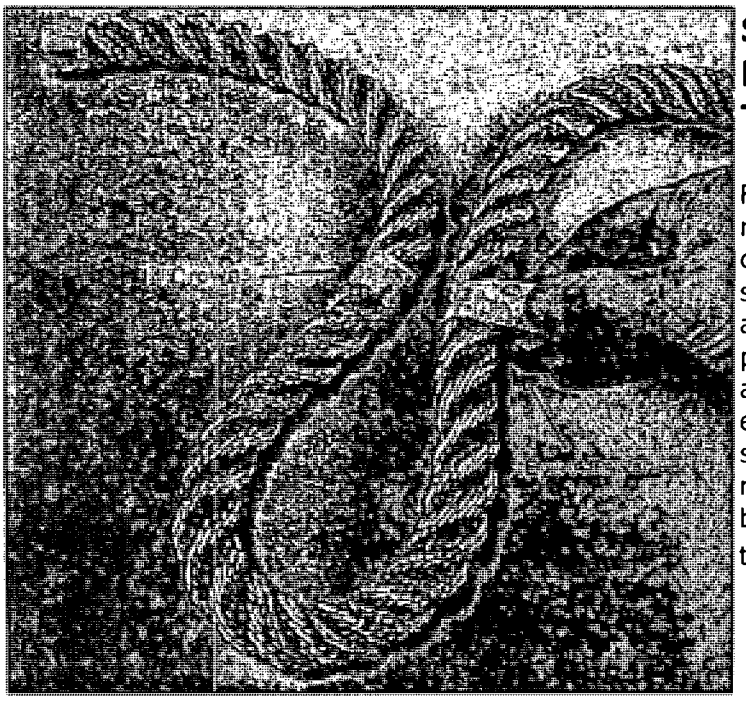
3-Strand Tapered Eye Splice

Home
Rope
Rescue Gear
Mustang
Secure Screen
Life Jackets
Quest Meters
Catalog Index
Request Info
Contact Us

Class 1 3-strand ropes are made from any or all of the following fibers: Olefin, Polyester, Nylon

Although the 3-strand splice is the most common splice, and simple to perform, technique is important to preserve splice strength. Take care that the tucks lie neatly; rope strength can be lost if the strands are twisted incorrectly.

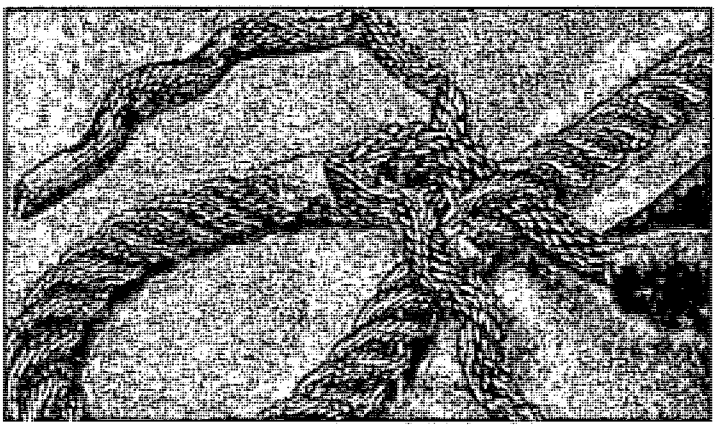
Tools Required: Fid; tape or whipping twine; marking pen, scissors or a sharp knife; hot knife or heat source ☹; ruler.



STEP 1 ... FORMING THE EYE

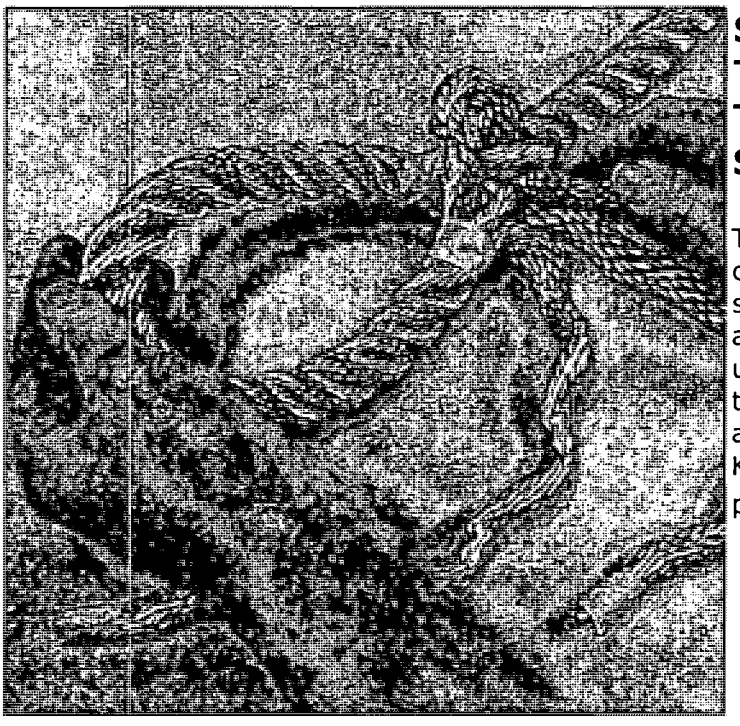
From one end of the rope, count back 14 crowns. Tape this section. Form the eye and tape the standing part of the rope. To avoid a twist in the eye of the finished splice, untwist the rope one-half turn between the pieces of tape.

STEP 2 ... TUCKING THE FIRST STRAND



Unlay the three strands to the first tape and either tape or seal the individual ends.

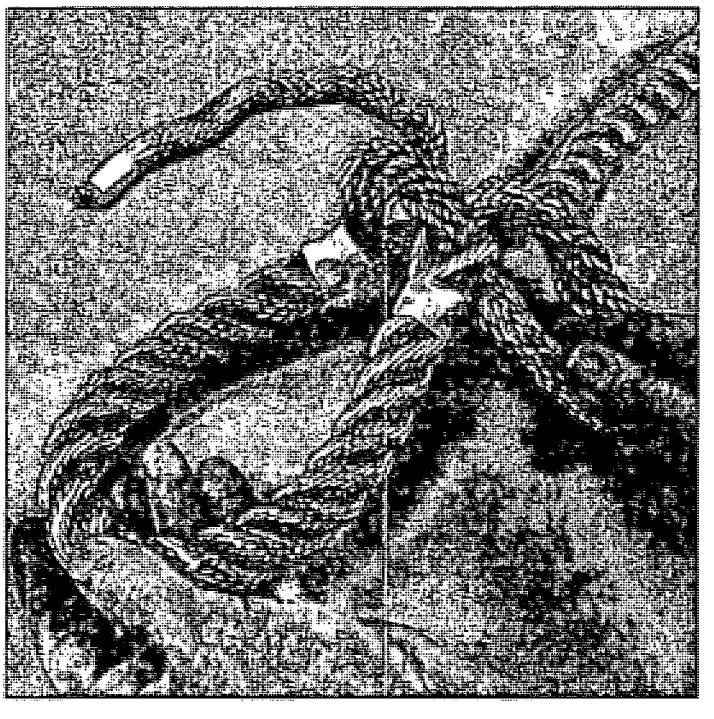
Form the eye from right to left by bringing the two tape marks together. Tuck the center unlayed strand toward you under the top strand in the main body of the line. Pull tight.



STEP 3 ... TUCKING THE SECOND STRAND

Turn the entire piece over. Insert the fid to separate the strands and tuck the left-hand unlayed strand under the next strand in line and pull towards you. Keep the strands pulled tight.

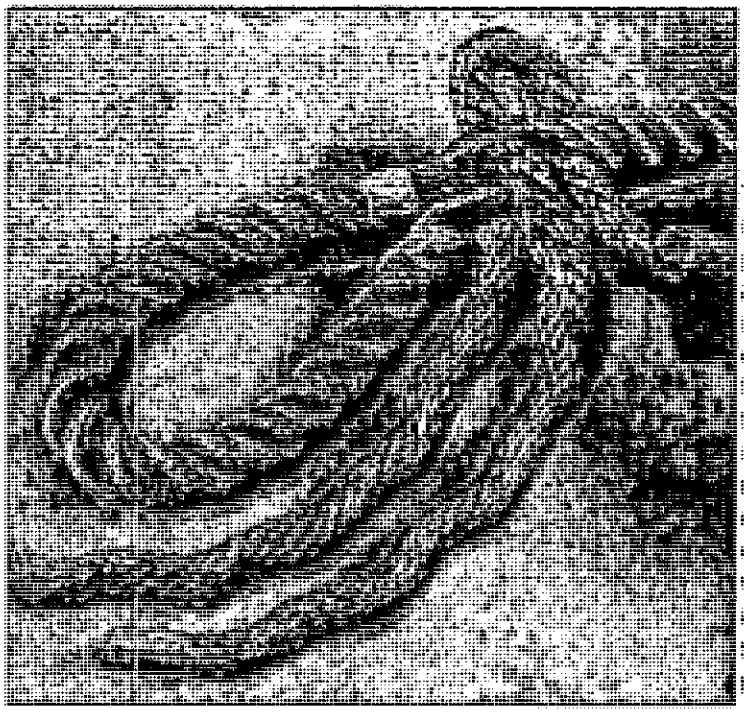
STEP 4 ... TUCKING THE THIRD STRAND



Turn the entire piece over. There is one working strand left to tuck and there is one strand left in the standing part of the rope that does not have a working strand under it. Insert the fid to separate the strands and make this tuck, continuing to work counter to the lay or twist or the rope..

The first round of tucks is

complete. Tighten if necessary by pulling on the strand ends.



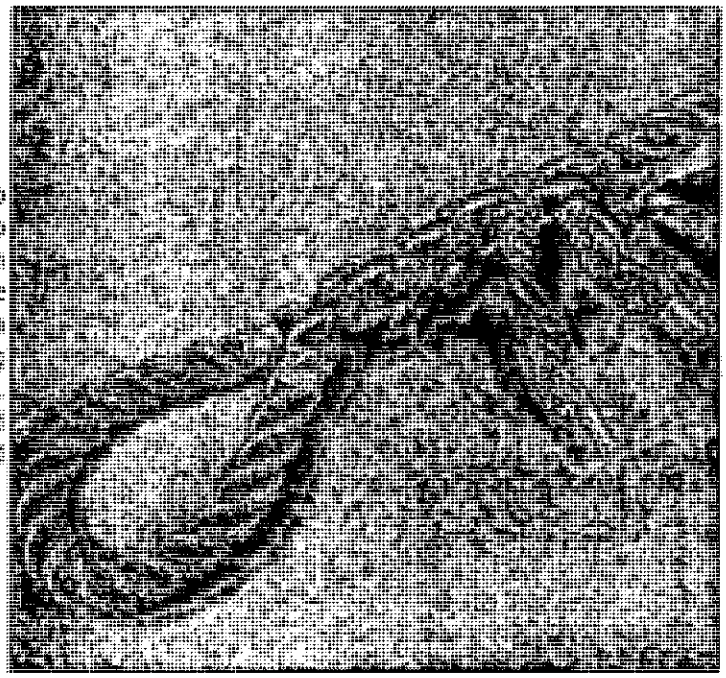
STEP 5 ... CONTINUING ON

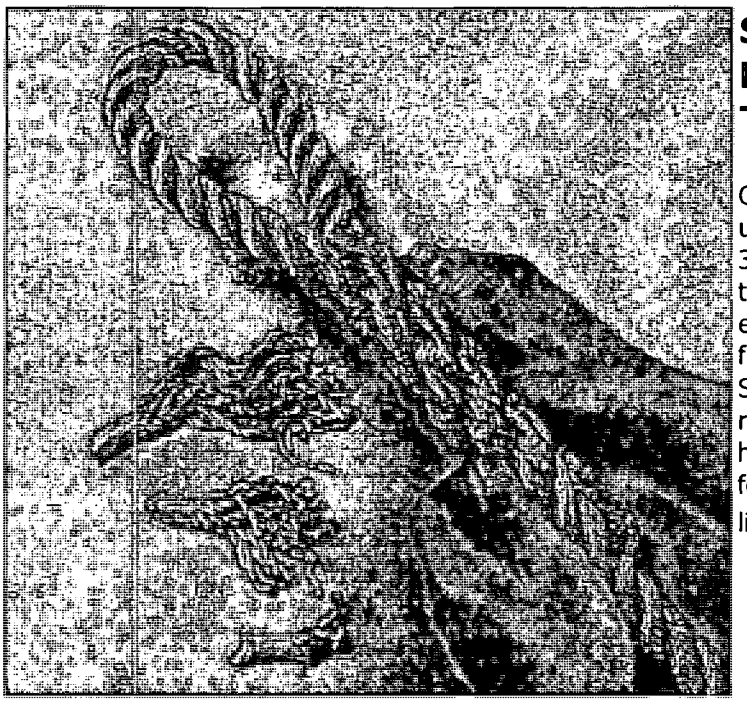
Take one of the unlayed strands and pass it over, around and under the strand next to it. Pull the end of the strand through toward you. Repeat this process with all unlayed strands for a minimum of five tucks each. You will find that each unlayed strand will be forming a twist around one of the strands in the body of the line.

When you tuck, take care to use all three strands in each round and that you tuck under a strand in the standing part of the rope and not under one of your working strands.

STEP 6 ... TAPERING THE SPLICE

To taper the splice into the line, make two additional tucks with one strand and one additional tucks with a second strand leaving the third strand as it is. This will leave a strand between each unlayed strand.





STEP 7 ... FINISHING THE SPLICE

Cut off the remaining unlayed strands about 3/8" from the last tuck. Heat seal the ends to prevent fraying, if desired. Smooth the splice by rolling it between your hands or under foot for large diameter lines.

These splicing instructions were brought to you by www.machovec.com.

**Splicing information is provided by New England Ropes*

NEW ENGLAND ROPES

Site questions should be directed to

Please take a moment to view our Terms of Use and our Privacy Policy.