BRISBANE CITY COUNCIL
BRISBANE WATER

Australia Trade Coast Sewer Project

SP300

Serpentine Rd Pump Station

Operation & Maintenance Manual

Contract No. BW30137-02/03

Volume No. 5

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

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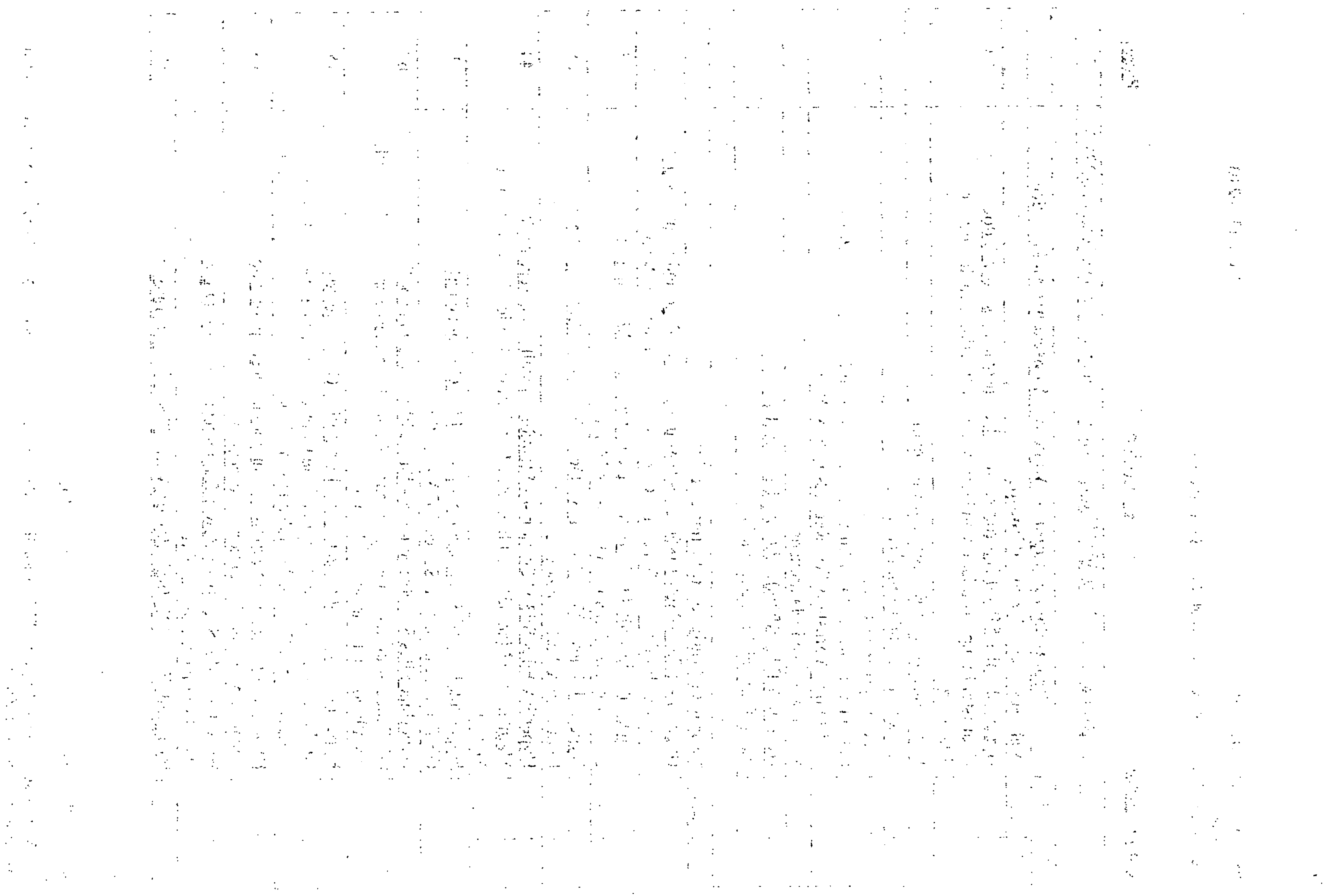

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1 Introduction

2 Description of Equipment and Process

3 Design Details

Section 1

1 Introduction

Parsons Brinckerhoff Design Report Separable Portion No. 2 – SP300

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

Revised Developed Design Report Separable Portion No. 2
Serpentine Road Pump Station SP300

April 2005

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
>$10 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-RPT019Fic

PARSONS BRINCKERHOFF

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Signed:	....
Approved by:	Ian Cameron, Design Manager
Signed:	....
Date:	20 April 2005, Revision F
Distribution:	Brisbane Water

PARSONS BRINCKERHOFF

Australia Trade Coast Sewer Project
Contract No. BW30137-02.03
Revised Developed Design Report
Separable Portion No. 2
Serpentine Road Pump Station SP300

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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 Serpentine Road SP300 pump station and associated rising mains.

Separable Portion 2 consists of:

- Design and construction of SP298 Lytton Road pump station;
- 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 *Revised Developed Design Report Separable Portion No. 2 Lytton Road Pump Station* and *Separable Portion 2 Pipelines Developed Design* Report respectively. The following SP2 works are described in this report.

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

- Serpentine Road SP300 pump station works.

It should be noted that a separate design report has been prepared for the proposed Lytton Road SP298 pump station.

This report supersedes the previous Developed Design Reports dated 30 July 2004, and 12 August 2004, 23 September 2004 and 10 November 2004.

This report includes updated information on the odour control system.

2. Design summary

2.1 Serpentine Road SP300

2.1.1 Pump station

The flow required to be pumped by SP300 (348 L/s) was nominated by BW in the tender documentation.

2.1.2 Construction access

For the construction of SP300 and associated rising mains connecting to the existing Luggage Point rising mains, construction access will be available from Lomandra Drive and Serpentine Road.

2.1.3 Operations and maintenance access

Permanent access to SP300 will be maintained off Lomandra Drive for post-construction traffic.

The proposed roadworks associated with SP300 have been designed for articulated trucks as instructed by BW.

2.2 Associated rising mains

The Separable Portion 2 rising main pipelines associated with the Serpentine Road SP300 may be summarised as follows:

Section	Length	Pipe Materials
SP300 to DN1370RM	21.5 m	DN500 PN12.5 PE100/DN500 DICL
SP300 to DN1840RM	31.5 m	DN500 PN12.5 PE100/DN500 DICL
Total	**53.0 m**	

2.2.1 SP300 to Luggage Point Rising Mains

The rising mains will be constructed within the existing easement ("C") across Lot 1 RP844114, owned by the Commonwealth and which is controlled by BACL, as detailed on SUR040313-02 (see Appendix G).

One of proposed rising mains will be constructed to join directly to the DN1370 rising main. The other rising main will be constructed under the DN1370 and then over the DN1295 and DN910 rising mains before connecting to the DN1840 rising main.

Magnetic flowmeters will be installed on both of the rising mains.

2.2.2 Connection between rising mains

The SP300 rising mains will connect into both the existing DN1370 and DN1840 Luggage Point rising mains.

Actuated control valves at the SP300 pump station will control which of the existing Luggage Point rising mains SP300 will discharge to.

Manual valves will be constructed on the tee branch of the DN1370 and DN1840 rising mains. The manual valves will be left open except for maintenance activities. The "live cut-ins" to the DN1370 and DN1840 rising mains will be constructed by BW.

Manual air valves will be constructed adjacent to the connections to the DN1370 and DN1840 rising mains. These manual air valves will normally be closed, and only opened to allow draining and/or commissioning of the rising mains from SP300.

2.2.3 Pressure limitations DN1840 rising main

The DN1840 rising main bifricates into two DN1295 prestressed concrete mains just downstream of the connection points for the SP300 rising mains, and the existing surge vessels.

Based on previous investigations in 1997, into the condition of the DN1295 concrete mains, we understand BW has adopted a maximum operating head of 12 m (to be confirmed) for these mains, at a maximum flow of 3200 L/s in the DN1840 main.

Further comments on water hammer impacts are provided in Section 5.1.11 of this report, in relation to the DN1840 main.

3. Drawings

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

Serpentine Road SP300

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486/5/7-TR201/023	General Arrangement
486/5/7-TR201/024	Roof Cover Plan
486/5/7-TR201/030	Typical Section
486/5/7-TR201/031	Sections (Sheet 1 of 2)
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486/5/7-TR201/047	Not used
486/5/7-TR201/048	Miscellaneous Details
486/5/7-TR201/049	Scour and Air Valve Pit Details
486/5/7-TR201/050	Tube for the Vega Level
486/5/7-TR201/051	Power Distribution Schematic Diagram
486/5/7-TR201/052	Pump 01 Schematic Diagram
486/5/7-TR201/053	Pump 02 Schematic Diagram
486/5/7-TR201/054	Motorised Valve 01 Schematic Diagram
486/5/7-TR201/055	Motorised Valve 02 Schematic Diagram

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Drawing No	Description
486/5/7-TR201/056	Generator Control Schematic Diagram
486/5/7-TR201/057	PLC/RTU Schematic Diagram
486/5/7-TR201/058	MITS RTU Digital Input
486/5/7-TR201/059	MITS RTU Digital Input
486/5/7-TR201/060	MITS RTU Digital Output
486/5/7-TR201/061	MITS RTU Analogue Input
486/5/7-TR201/062	PLC Digital Inputs Slot 3
486/5/7-TR201/063	PLC Digital Inputs Slot 4
486/5/7-TR201/064	PLC Digital Inputs Slot 5
486/5/7-TR201/065	PLC Digital Inputs Slot 6
486/5/7-TR201/066	PLC Analogue Inputs Slot 7
486/5/7-TR201/067	PLC Analogue Inputs Slot 8
486/5/7-TR201/068	PLC Analogue Output Slot 9
486/5/7-TR201/069	Switchboard General Arrangement
486/5/7-TR201/070	Switchboard Construction Notes
486/5/7-TR201/071	Equipment List
486/5/7-TR201/072	Switchboard Construction Details
486/5/7-TR201/073	Label Schedule Diagram
486/5/7-TR201/074	Electrical Site Layout Diagram
486/5/7-TR201/075	Cabling Block Diagram
486/5/7-TR201/076	Cable Schedule
486/5/7-TR201/077	Not used
486/5/7-TR201/078	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 and Construction Details
486/5/25-SE002/1	Standard Overflow Flap Type 2 Chamber Details
486/5/25-SE002/2	Standard Overflow Flap Type 2 Top Slab and Flat Details
486/5/25-SF002/1	Maintenance Hole Cover Sewer Class B – Conc Infill Cover 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-SF004/1	Maintenance Hole Cover Sewer – Class D Frame Details
486/5/25-SF004/2	Maintenance Hole Cover Sewer – Class D Rising Ring Details
486/5/25-SF004/3	Maintenance Hole Cover Sewer – Class D Cover Details
486/5/25-SF004/4	Maintenance Hole Cover Sewer – Class D Cover Details
486/5/25-SF009	Standard M.S. Ladders and Associated Fittings
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-S47	Grit Collector Maintenance Hole Inlet Valve General Arrangement
486/5/25-S48	Grit Collector Maintenance Hole Inlet Valve Spindle Shaft Details
486/5/25-S49	Grit Collector Maintenance Hole Inlet Valve Bearing Support Details
486/5/25-WC002/4	General Arrangement Tapping Points Options For 25 mm Copper Services
JC50/116	Castings Vent Inserts
JS56/101	Sewerage Pump Stations Sump Pump Delv. Details
JV53/102	Vent Cowl

IPWEAQ Standard Drawings

G-0030	Electrical Cable Drawing Pits
G-0041	Fencing Chain Wire Security Fencing
G-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

BCC Standard Drawings

UMS211	Kerbs and Channels Profiles

4. Input design data

4.1 Survey

Brisbane Water (BW) provided topographic survey in the vicinity of SP300 which was supplemented by topographic survey provided by Brisbane Airport Corporation Limited (BACL). Additional survey has also been carried out by Leighton Contractors to validate the survey provided by BW and BACL, 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 Serpentine Road SP300

Details of existing PUP in the vicinity of Serpentine Road SP300 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 Leighton Contractors 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, Brisbane Water 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 SP300 works were the following:

- *Australia Trade Coast North Viola Street to Serpentine Road Geotechnical Investigation.* BCC, November 2002. Note: Two boreholes to 32 m (August 1994).
- *Geotechnical Data Report, Australia Trade Coast Sewerage Project, Brisbane River Crossing, Lytton to Pinkenba*, BCC, City Design, March 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 SP300 Serpentine Road pump station site, and to review the sheet pile design of the sub-contractor.

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 SP300 based upon previous Brisbane Water 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 SP300, the project team recommended that a settlement analysis be completed to determine likely long term settlement rates.

Parsons Brinckerhoff (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. The preliminary analysis completed in August 2004, was followed by a more comprehensive investigation including a test pit and two cone penetrometer test investigations resulting in the report dated 14 September 2004. (See copy in Appendix E1.)

Filling of the SP300 site has been limited to a maximum depth of 1 m adjacent to the SP300 value pit in order to minimise differential settlement of the site.

Coffey Geosciences completed a geotechnical assessment of the SP300 site to determine predicted differential settlement of the site. (See Appendix E1.)

Settlement contours have been prepared for SP300 site which indicate the maximum differential settlements in the area of inlet to the wet well and the outlet for the rising mains and the scour pit location.

Anticipated Primary Settlement	Anticipated Primary and Secondary Settlement	Location
30 mm	45 mm	Edge of Fill
30 mm	60 mm	Chemical Storage Tank
40 mm	70 mm	Inlet Pipework and Wet Well
50 mm	80 mm	Outlet Pipework at Scour Pit

As a response to the differential settlement issue, the following responses have been recommended.

1. Preload site to a depth of 1 m for 30 days around the sheet piling (for use as working platform).
2. Install "rocker" pipes between SP300 wet well and steel main connected to DN1370 MSCL main to be used as overflow storage chamber system using DN1295 concrete pipe.
3. Provide polystyrene packing around the HDPE rising mains where the rising mains penetrate the sheet piling.
4. Oversize the penetration through the sheet piling to accommodate future settlement.

It should also be noted that Leighton Contractors are de-watering the SP300 excavation using spears which will also accelerate the settlement of underlying layers.

4.5 Land and property issues

4.5.1 Introduction

There are a number of land and property issues which have impacted upon the design and construction of the proposed SP300 works, as detailed below:

- existing easement "C" Lot 1 RP844114 has been expanded to provide additional area for construction of the proposed SP300. (Refer to SUR PLAN in Appendix G.)
- long term access to SP300 off Lomandra Drive will be available via the existing easement "C" Lot 1 RP844114.

For the proposed works associated with SP300, the following approvals needed to be obtained:

Development and Planning Approval: The *Airports Act 1996* Section 67 prescribes that each airport has an approved Airport Master Plan and Major Development Plans for significant developments at airports. Consequently, any development on Airport land must be consistent with an approved Airport Master Plan and Major Development Plan.

Building Approval: Building activities on airport sites require approval under airport regulations prior to commencement.

Certificates of Compliance: Buildings and structures on airport sites must be certified as complying with regulations. Section 98 of the Act defines building works as including constructing buildings or other structures earthworks and/or engineering works An airport-lessee company for an airport must not permit a building, structure, earthworks, engineering works, electrical works, hydraulic works or eligible alteration on the airport site to be occupied or used without a certificate of compliance.

After discussions with BACL officers on 20 May 2004, the following applications were made:

- Development Consent Application to BACL dated 8 June 2004 (refer Appendix A1); and
- Building Approval Application to Airport Building Controller, Airport Environmental Protection and Building Control office dated 8 June 2004 (sent 11 June 2004).

4.5.2 Airport building controller

A subsequent fax from Airport Building Controller was received on 23 June 2004, with a request to provide additional information.

Additional information was compiled and submitted under cover of PB letter dated 19 July 2004 and an approval was issued. (See Appendix A2)

4.5.3 Brisbane Airport Corporation Limited (BACL)

A subsequent letter from the BACL dated 13 July 2004, requested that additional information be submitted and clarified that Approval to commence work is issued by BACL. Additional information was submitted to BACL in response to the letter dated 13 July 2004, and an approval was issued (see Appendix A1). A subsequent change to right turn only from SP300 to Lomandra Drive was approved by BACL by e-mail dated 19 October 2004 (see Appendix A1).

4.6 Existing assets

4.6.1 Actuated valves

The existing actuated valves and associated switchboard and existing overhead power supply will be maintained during the construction phase of the project. The power supply will be transferred from the overhead supply to the new Energex transformer based power supply when the SP300 switchboard is commissioned.

4.6.2 Existing rising mains

Introduction

There are a number of existing rising mains which traverse the SP300 site and the proposed driveway connecting to Lomandra Drive which need to be protected from traffic loads. Cardno MBK completed structural design work which is detailed in Appendix K2.

DN1370 MSCL (At pump station)

A 175 mm thick reinforced concrete relieving slab is recommended to protect the main.

DN1370 MSCL (Across driveway)

Concrete relieving slab as detailed above to be constructed

DN1370 MSCL (Lomandra Drive)

Concrete relieving slab as detailed above to be constructed.

The existing DN1370 rising main will be protected by a relieving slab under the access road as detailed on the design drawings.

DN1295 Concrete (Lomandra Drive)

The existing DN1295 concrete pipes were assessed by Cardno MBK and box culverts bridging was recommended to provide protection from traffic loads. Following a review of this protection method, it was decided that the box culverts would be expensive and difficult to construct adjacent to the existing DN1370 MSCL main.

The intersection alignment to Lomandra Drive was subsequently revised to avoid placing traffic loads on the DN1295 concrete mains. The revised alignment was approved by BACL.

DN1295 Concrete (At pump station)

A reinforced concrete bridging slab 350 mm thick will be constructed to minimise traffic loads upon the existing mains, based upon a design provided by PB (Refer to Appendix L2).

DN910 MSCL (At pump station)

The DN910 MSCL mains have approximately 2.7 m cover and are located under the existing DN1370 main. Analysis has indicated that no protection is required for these mains.

A 200 mm thick driveway slab has been adopted to spread traffic loads on the DN1370 and DN910 MSCL mains adjacent to existing valve pits.

Temporary works

Leighton Contractors will use steel plates to protect the existing DN1370 and DN910 MSCL rising mains from construction traffic loads, based upon a design provided by PB. (Refer to Appendix L.)

4.6.3 Private rising main

The existing DN80 UPVC Class 9 private rising main which services buildings fronting Lomandra Drive traverses the SP300 site. (As constructed information for the rising main was provided by BACL (Colin Stewart) from Commonwealth Department of Housing and Construction Dwg No QCB 83/0234/03/B1).

5. Developed design

5.1 Serpentine Road SP300

5.1.1 Site

The Serpentine Road SP300 pump station is located on easement "C" Lot 1 RP844114 which is part of the Brisbane Airport site owned by the Commonwealth, administered by the Brisbane Airport Corporation Limited (BACL).

Construction access to the site is available either from Lomandra Drive or from Serpentine Road, Pinkenba.

5.1.2 Structures

The structural design for the SP300 pump station was completed by Cardno MBK. See Appendix K1 for Structural Report.

Structures will include:

- combined wet well/dry well/valve pit structure;
- overflow (without screen) to Boggy Creek;
- inlet structure with air valve/breather in pit at RL2.25m AHD; and
- scour pit for rising mains.

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.

The following information has been extracted from the Cardno MBK Design Report included in Appendix K.

Geotechnical Assessment by Coffey Geosciences

A preliminary 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 and associated works.

The assumed subsurface profile consists of fill to a depth of 1.9m underlain by very loose sands clayey sands to 11.0m in depth followed by soft to firm clay to 27.5m in depth.

Elastic settlements of the upper level loose sands are likely to occur under applied loadings, however, these settlements are likely to occur rapidly during construction.

Combined primary and secondary consolidation settlements of the underlying clays are potentially in the order of 200mm per 10kPa of applied loading. The extent of settlement of structures founded on high-level footings will be determined by magnitude of the applied loading relative to the foundation area.

The current effective stress levels in the soil are unlikely to be exceeded by the construction of the pump station therefore consolidation settlements are unlikely to occur.

Settlement

It was realised that settlement of the hardstand areas and associated pump station structures was inevitable as the additional surcharge loadings applied to the site in the placement of fill materials, and in the construction of the pavements, building structures etc. would 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 pump station is unlikely to be affected by long-term consolidation issues, as the effective vertical stress on the underlying soils is unlikely to be exceeded in the construction of the pump station. Piling of the pump station structure is not considered a viable solution due to potential problems caused by the differential movements between the rigid pump station structure and connecting pipework.

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. The sheet piling is to be left in place permanently and anchored laterally during construction by horizontal screw anchors or an equivalent approved method to be proposed by the building contractor.

Due to a high water table there is a net buoyancy effect on the pump station structure. A false floor will be adopted in the dry well to help counteract the buoyancy effect. The wet well is considered as permanently wet with a minimum water level of RL-0.54.

Leighton Contractors are responsible for determining the sheet piling requirements and the method of additional anchorage against buoyancy forces for the structure based on design information supplied by Cardno MBK.

General Arrangement

The design process considered two possible 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. It was determined that the structure would not be constructed with a stepped wet well and that the valve pit and wet well would be combined in a single structure.

The other structures, including the ferric chloride dosing area slab, odour scrubber pad, transformer base, and generator slab 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.

A 3.2 tonne SWL monorail crane has been designed in accordance with the design brief supplied by Parsons Brinckerhoff. The monorail crane and hoist system is to provide a minimum hook clearance above the valve pit top slab of 4.7m. The monorail is to cantilever beyond the immediate supporting structure by a minimum of 2.0m to facilitate loading and unloading of the pumps and associated pipework.

The design of the structural steelwork is in accordance with the requirements of both AS4100 – Steel Structures and AS1418.1,.2 and .3 – SAA Crane Code. The monorail beam and supporting structure have been designed for factored vertical hoisted loads as well as lateral loads and longitudinal end buffer impact loads. The lateral and buffer loads have conservatively been adopted as 20% of the factored hoisted load.

Structural Details

All major structures were detailed in reinforced concrete. These 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 200mm concrete slab and 200mm 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 in ground concrete structures should be protected against potentially aggressive groundwater attack.

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 2.0m.

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

A hot dip galvanised coating in accordance with AS1650 is recommended to all external structural steelwork. A minimum coating thickness of 85 microns is recommended.

Bouyancy

The main design issue for the in-ground pump station is considered to be:

- *Provision of sufficient mass in the structure and additional anchorage to counteract buoyancy forces under high water table conditions. It is considered that the design should conservatively allow for the water table to be located at the ground surface.*

Any assessment of buoyancy effects for the SP300 pump station depends upon the adopted water level for groundwater surrounding the site.

It is of interest to note the following relevant levels:

Highest Astronomical Tide (HAT)	*= 1.53 m AHD*
Q50 Storm Surge	*= 2.2 m AHD*
Q100 Storm Surge	*= 2.5 m AHD*
Groundwater Level (BCC 2002)	*= RL 0.3 m AHD (BH1)*
	= RL -0.1 m AHD (BH2)

A number of buoyancy assessments have been completed for the SP300 based upon the following adopted ground water levels:

- *RL 1.5 m AHD (August 2004)*
- *RL 2.0 m AHD (October 2004)*
- *RL 2.5 m AHD (October 2004)*

For the most conservative groundwater level of 2.5 m AHD which coincides with the Q100 storm surge and flooding level for the Brisbane River at Pinkenba, the following comments are provided:

- *dry well includes 850 mm thick false floor*
- *wet well benching 35.7 cu.m*
- *ignoring skin friction between pump station*

  Buoyancy = 4280 kN

  Total mass = 5041 kN

  FS = 1.18 • ·1.10

The above case is considered to be an extremely rare event.

Additionally, a further buoyancy calculation has been completed in accordance with AS1170.1, with the following results:

- *Q50 storm surge = 2.20 m AHD*

Fgw Buoyancy	*= 4839 kN (1.2 x 4033 kN)*
Total mass	*= 5041 kN*
Stabilising Mass	*= 0.9 x 5041 kN*
	= 4536 kN

Therefore, N_G AS1170 not satisfied

If skin friction between sheet pile and concrete structure is allowed.

Skin friction = 450 kN

0.9 x (5041 + 450) = 4940 kN • •4839 kN

Therefore, meets AS1170 requirements.

(Note: refer calculations dated 1/11/04 in Appendix K3).

5.1.3 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 be required for construction of the pump station. Horizontal screw anchors may be used to help hold the sheetpiling in place.

The construction of a false floor in the dry well to counter buoyancy forces has been adopted.

5.1.4 Duty points

348 L/s at 40.8 m with one pump operating (peak) pumping into the DN1370 rising main. (See Appendix C for additional information.)

5.1.5 Pumps

Two Hidrostal I10K–M02R 200 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 adjacent to the access road to the pump station.

5.1.6 Starters

Two Danfoss VLT8000 variable speed drives.

5.1.7 Discharge system

DN450 DICL discharge pipework connected to two DN500 PE100 PN12.5 rising mains with direct buried magnetic flowmeters installed on both rising mains at the edge of the hardstand area.

Concrete pathways have been designed to provide pedestrian access to the sluice valves which will isolate the SP300 rising mains at the tee pieces which connect to the DN1370 and DN1840.

The concrete pathway to the DN1370 sluice valve will be accessed via a locked access gate through the security fence around SP300.

Locked security cages have also been designed to ensure that the manual DN25 air bleed valves adjacent to the sluice valves on SP300 rising mains are protected from operation by vandals or unauthorised personnel.

5.1.8 Power supply

Negotiations with Energex–Geebung have resulted in a commitment to provide an underground power supply to the Serpentine Road SP300 site from Serpentine Road.

The underground power supply to SP300 will be constructed in conduits terminating at a pad mounted transformer (750 kVA) constructed on the eastern side of the access driveway, to be provided by Energex.

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

SP300 will incorporate a 600 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 chemical dosing and control gear.

5.1.9 Controls and instrumentation

The following equipment is proposed:

- one "multitrode" digital level switch;
- one vega analogue level transmitter;
- one ABB Magmaster magnetic flow transmitter;
- one Vega D84 analogue pressure transmitters;
- PLC to be free-issued by BW; and
- telemetry equipment to be free-issued by BW.

5.1.10 Control philosophy

The incoming flows to SP300 will come from the following two rising mains:

- SP298 Lytton Road (under the Brisbane River then to SP300 with a common trench, with the following rising main from McBride Street to SP300 up Serpentine Road); and
- SP146 Kingsford Smith Drive/SP136 Hugh Street/SP131 McBride Road (with a common trench with the above rising main from McBride Street to SP300 up Serpentine Road).

The wet well/dry well pump station will be fitted with variable speed drives with feedback control based on level. The electromagnetic flowmeters on the discharge lines will be used for monitoring purposes and will not have any control function.

Hydrotec have recommended a daily cleaning cycle be included in the control philosophy for SP300, as detailed in the Function Specification included in Appendix H.

The SP300 pump station will pump into either of the pressurised existing DN1370 or DN1840 Luggage Point rising mains.

The control philosophy for the SP300 pump station is included in Appendix H.

5.1.11 Water hammer analysis

SP300 Rising Mains

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 SP300 and associated rising main Separable Portion 2 works is included in Appendix F, and the following conclusions were reached:

- transient pressures are within the nominal design rating of the pipe material and do not exceed the fatigue derated values given in WSA 01;
- compliance with WSA 01 has been met;
- check valves do not require counterweights; and
- the use of variable speed drives for the pumps will reduce fatigue damage of pipeline components or the pumps.

A Supplementary Investigation was completed was completed by Design Detail and Development in response to concerns raised by BW in relation to the pressure capability of the two DN1295 concrete mains downstream of the DN1840 rising main connection.

With an optimum ramp time of 30 seconds from rest to 348 L/s the resultant transient head is 18 m. (Refer to Appendix F for copy of report.) Note: Not allowing attenuation from existing surge vessels downstream of SP300.

The following conclusions were reached from the supplementary review of the system:

- *transient pressures exceed the recently specified design rating of the concrete pipe material;*
- *the steady state head in the concrete pipe is outside the recently advised rating of the concrete pipe hence the surge pressure cannot possibly meet this criteria;*
- *the existing surge mitigation devices on the DN 1840 rising main were not taken into account as they are designed to protect the existing asset; and*
- *the transient pressures introduced into the concrete mains by SP300 will be very much smaller than those which must emanate from the Eagle Farm pumping station, given that the flow from SP300 is less than 10% of the existing flow in the main. The existing surge controlling devices should be more than adequate to cope with the surges introduced from SP300, if they are functioning properly at present.*

SP298 to SP300 Rising Main

An elevated inlet with a top water level of RL 2.25 m AHD and a drop tube connecting to the wet well was considered for construction at SP300.

BW has a preference for not using air valves due to odour and maintenance concerns.

Water hammer analysis has been completed for the SP298 to SP300 rising main based upon changing the control philosophy for SP298 so that the wet well volume is used rather than air valves to control water hammer and momentum issues.

The results of the network analysis have confirmed the need for an elevated inlet at SP300 at RL2.25 m AHD when air valves are removed from the SP298 to SP300 rising main to control the momentum of the water column in the SP298 to SP300 rising main under both pump stop and power failure conditions.

5.1.12 Odour and septicity equipment

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

The need for odour scrubbing and/or septicity control was investigated following BW review of the report from The Odour Unit. (See Appendix D).

Odour control

There are a range of odour control measures which could be constructed at SP300 depending on the control philosophy being based upon either the number of air changes per hour or constant negative pressure in the wet well. (See information included in Appendix D).

The BW recommendation is to provide a Purafil — 1000 air scrubber system to aid dispersion of odours (refer to details in Appendix M). A VSD fan will ensure a negative pressure is maintained in the wet well for a maximum inflow of 250 L/s.

The VSD fan for the odour control unit will be controlled by Danfoss VLT - 6000 series VF drive in a separate enclosure.

The VSD fan will operate continuously and maintain a negative pressure in the wet well.

The VF drive will receive a 4-20 mA signal from the RTU. The drive will run a set minimum speed under normal operating conditions. When the wet well level is rising the drive will run at an increased speed.

The wet well will be vented via the Purafil - 1000 air scrubber system at all times.

Refer to Appendix M for additional technical information and correspondence in relation to the odour control system.

Appendix M also includes a drawing of the Purafil - 1000 installation.

Septicity control

Following a review of the recommendations provided by The Odour Unit, BW directed that the following works be constructed under the current contract:

SP299 (for information)

- provide no civil works for chemical dosing.

SP298 (for information)

- provide bunded slab (for possible future chemical dosing).

SP300

- provide no civil works for chemical dosing

5.1.13 Noise impact assessment

PB commissioned an in-house noise assessment study for the proposed SP300 pump station.

Ambient background noise levels were measured in the range of 42–49 L_{A90} (15 min) dB(A). The predicted noise level for the noise sources at SP300 were predicted to be in the range of 10–40 dB(A) with total of 44 dB(A). A copy of the noise assessment report is included in Appendix J, and the report provided the following recommendations.

1. It is recommended that the Emergency Diesel Generator be enclosed in an acoustic enclosure which conforms to Brisbane Water's Standard Specifications.
2. It is recommended that the noise emissions of the pumps/motors in the drywell be acoustically treated by reducing the reverberant noise level within the drywell. This can be achieved with the installation of sound absorptive panels on at least two of the drywell's walls. Suitable pre-fabricated sound absorptive panels would be to sound-absorptive type of roadside noise barriers obtainable from FENCO ph. (07) 3277 8990; www.fenco.com.au. The dimensions of the standard FENCO sound-absorptive panels are 4 m x 650 mm x 125 mm.
3. It is recommended that an earth mound be constructed at the perimeter of the site to shield the line-of sight from the nearest affected noise-sensitive receptors to the noise sources shown in Table 5. (See report in Appendix J.)

Based upon the fact that noise emissions may be at or below ambient background noise levels, it is recommended that during commissioning of SP300 noise monitoring be completed and of acoustic panels be installed in the dry well as required.

5.1.14 Vactors

Following a review of the proposed wet well arrangement, it has been agreed that three vactors will be provided in the wet well, as detailed below:

- inlet (upstream of baffle wall);
- sump under pump suction No. 1; and
- sump under pump suction No. 2.

Vactor pipework for the inlet will terminate in an access hole which can be serviced by a vactor truck with maximum 2500 mm reach for the vactor boom.

Vactor pipework for the pump suctions will be terminated above the top slab with a locked Kamlok coupling.

An additional access bay has been provided beside the pump station to provide access to the vactor pipework.

The vactor pipework will allow grit and raw sewage to be removed from the wet well structure during operations and maintenance visits by BW personnel.

5.1.15 Overflow

The overflow system for SP300 which has been developed collaboratively by the project team includes the following components:

1. Low level overflow to existing DN1295 concrete rising main, with the capacity to drain back to the SP300 wet well (RL 0.91 m).
2. High level overflow to Boggy Creek (RL 1.88 m).

It should be noted that the use of the existing DN1295 concrete rising main as a storage vessel forms part of BW's contingency planning for overflow management for SP300. Valving will be provided to isolate the DN1295 concrete mains from the SP300 wet well.

Red valves will be fitted to the interconnecting pipework between the SP300 wet well and the DN rising main to prevent gas attack of the upstream DN1295 concrete rising main.

5.1.16 Scour pit

A scour pit has been provided to allow the two SP300 rising mains to be drained for maintenance purposes into a common pump out pit.

5.2 Associated rising mains

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 mains from the Serpentine Road SP300 to will be DN500.

5.2.2 Pipe material

All rising mains will be constructed from PE100 PN12.5 pipe, and DICL for the above ground sections.

5.2.3 Pigging receival

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

5.3 Physical modelling

Hydrotec UK was commissioned as a sub-consultant to PB to complete the physical modelling for the SP300 pump station. Close liaison has been maintained during the physical modelling period and a number of value adding comments were provided by Hydrotec which have resulted in the depth of the pump station being reduced, with an associated reduction in construction cost.

The Hydrotec Final Report (see Appendix I) contains a number of recommendations, as follows:

- inlet baffle wall;
- stepped inlet flume;
- benching in accordance with Hydrotec drawings; and
- installation of vanes to prevent vortices forming.

Additionally, Hydrotec have recommended a cleaning pumping cycle be implemented each day, as follows:

In order to minimise potential problems, such as pump clogging etc, resulting from such solids accumulations, a cleaning cycle is to be implemented at least once a day. This will entail operating one of the pumps, at high speed (348 l/s) down to a minimum draw down level (defined as a point immediately prior to the onset of any detrimental hydraulic condition such as vorticity, pump snore, increased pre-swirl etc) in order to clear as much accumulated debris as possible. This is covered in more detail in Section 4.5.

To be effective the cleaning cycle should be undertaken when the inflow to the station is just below the pumped outflow. This will ensure that maximum turbulence is generated in the sump. The cleaning cycle will be initiated when the sump level is at or below the modulating level and will over ride the normal pump control.

On initiation of the cleaning cycle the duty pump will run up from base speed until the inflow is beaten (up to a maximum flow of 348 l/s). If the inflow is below the pumped outflow, and the sump level reduces, the cleaning cycle will start. The cycle time for the cleaning period will depend on the inflow to the pumping station and the available sump volume. At the end of the cleaning cycle the duty pump will stop to allow the sump to fill and revert back to normal operation.

If the inflow to the sump is at or above the pumped outflow at the start of the cleaning cycle, and no reduction in sump level is recorded, the cleaning cycle will be overridden and normal operation will resume.

The duty or lead pump selection should be alternated to minimise accumulation of grit debris around the non-operative or standby pump. To help minimise blockages within the pump it is recommended that the lead pump is alternated after running for a set period of say, one hour. However, we would recommend that further advice on running times is sought from the pump supplier.

The operating range available for pump control will be defined by the maximum permissible start level and the minimum permissible stop or draw down level. In this instance the maximum start or modulating level has been defined by the client. Minimum stop or draw down levels were defined in the model by the point immediately prior to the onset of a marked deterioration in pump intake conditions due to air entrainment. The minimum operating or draw down level with one pump operating at full or base pump speed (200 to 348 l/s) was determined as minus 1.00 m.

The above cleaning cycle, will need to be programmed by BW as part of the commissioning process for the SP300 pump station.

The Hydrotec Final Report also contains the following conclusion:

With the modifications in place the proposed final arrangement of the pumping station allowed for a satisfactory pump environment to be achieved across the anticipated operating range. The sump is materially self-cleansing in terms of grits and gross floating solids so long as the cleaning cycle is adopted as part of the control strategy.

Modifications have been kept as simple as possible and no alteration to the structure or pump positions was required.

5.4 Changes since tender design

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

General arrangement

- Access off Lomandra Drive rather than Serpentine Road.
- Need for modified access to in Lomandra Drive.

Inlet works

- Elevated air valve pit at RL2.25m AHD prior to inlet works (to assist with minimising momentum issue from SP298).

Pumps

- Change to Hidrostal pumps — 216 kW (from Flygt pumps — 215 kW).

Pigging receival point

- Pigging receival point recommended and included in inlet design.

Level of top of pump station

- Top of slab set at RL3.00.

Floor of pump station

- Common floor level adopted.

Electricity supply

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

Access bay

- Additional access bay provided for vactor access.

Overflow

- Overflow to Boggy Creek designed.
- Interconnection to existing DN1295 concrete main provided to minimise impact pump station overflow events.

Odour control

- Purafil - 1000 unit approved by BW.

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 sand layers likely to be water bearing;
- the presence of acid sulphate soils;
- the presence of high groundwater levels; and
- declared Fire Ant area.

7. Permits and approvals

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

- Brisbane Airport Corporation Limited (BACL)
- Airport Building Controller
- BCC/DRS

Appendix A

Permits and approvals
A1. BACL/Communications
A2. Airport Building Controller/Communications

A1. BACL

Cameron, Ian

From: Colin Stewart [colin.stewart@bne.com.au]
Sent: Tuesday, 19 October 2004 3:25 PM
To: Cameron, Ian
Subject: RE: 20041015105216.pdf-----SP300 SERPENETINE ROAD / ACCESS OFF LOMANDRA DRIVE

Ian,

This proposal is acceptable to BAC and does not require any additional approval processes.

Regards,

Colin Stewart
Project Manager Operations
Brisbane Airport Corporation
Tel: +61 7 3406 3056 Fax: +61 7 3860 8612
Mobile: 0402 427 490
Email: colin.stewart@bne.com.au

From: Cameron, Ian [mailto:ICameron@pb.com.au]
Sent: Friday, 15 October 2004 11:02
To: Colin Stewart
Cc: James.Whybrow@leicon.com.au; pm13bw@brisbane.qld.gov.au; ec1psbw@brisbane.qld.gov.au
Subject: 20041015105216.pdf-----SP300 SERPENETINE ROAD / ACCESS OFF LOMANDRA DRIVE

Colin,

See attached sketch of modified access off Lomandra Drive , as discussed this morning.

The proposed modified roadworks , minimise the need to protect existing concrete mains from traffic loadings , near Lomandra Drive.

A "No turn Left " sign will be erected , with a " Give Way" sign and roadworks will not promote a left turn.

We seek your review comments before we make a formal submission to modify your previous approval dated 18 August 2004.

Regards,

Ian Cameron
PB

this message in error, or you are not an authorised recipient, please either return e-mail to sender or telephone PB immediately on +61 2 9743 0333, and delete this message from your email system, and destroy any printed copies.

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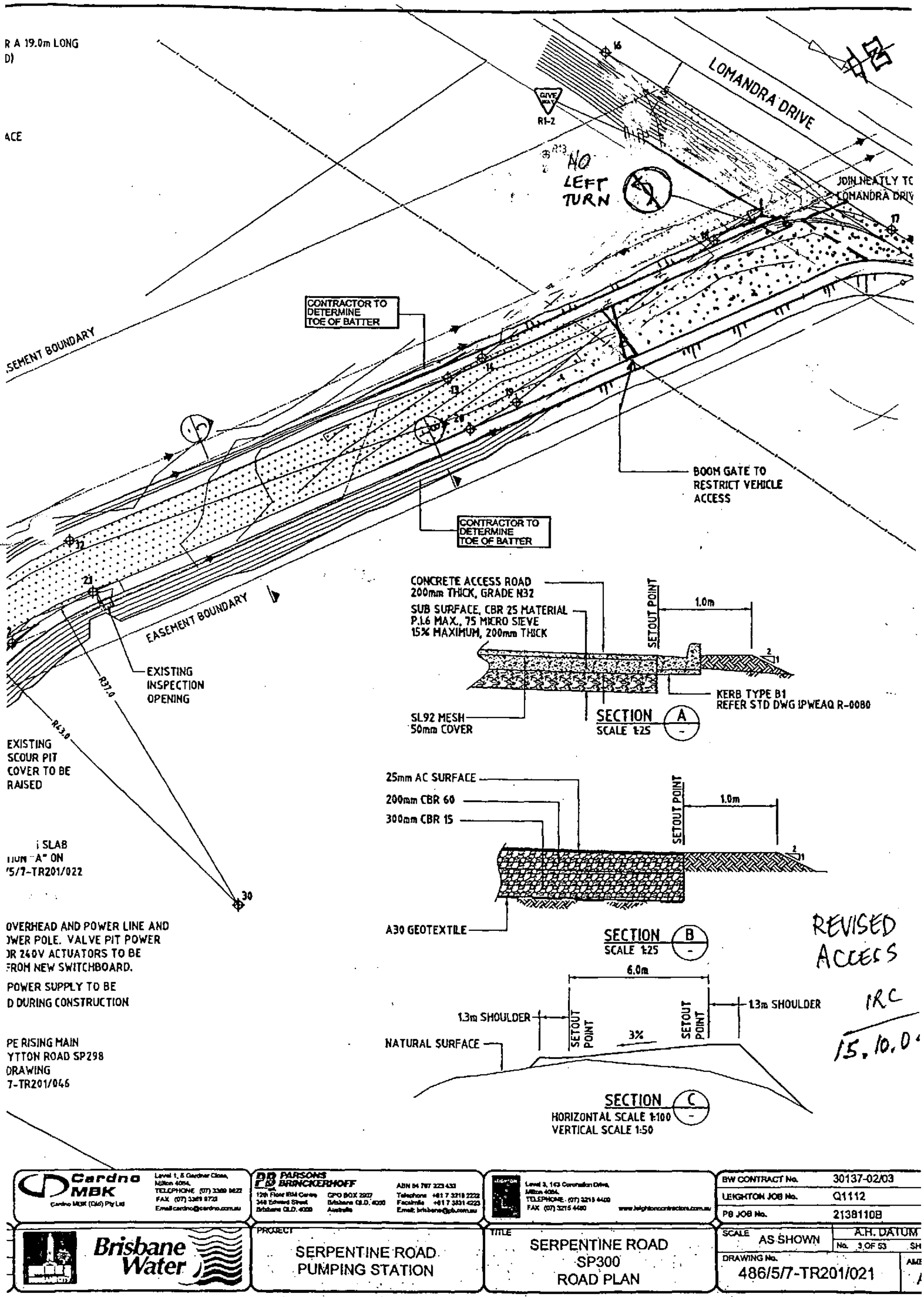
BAC Australia
Brisbane Airport Corporation Ltd

Confidential Communication


R A 19.0m LONG
D)
ACE
LOMANDRA DRIVE
GIVE WAY
R1-2
NO LEFT TURN
JOIN NEATLY TO LOMANDRA DRIV
CONTRACTOR TO DETERMINE TOE OF BATTER
EASEMENT BOUNDARY
BOOM GATE TO RESTRICT VEHICLE ACCESS
CONTRACTOR TO DETERMINE TOE OF BATTER
EASEMENT BOUNDARY
EXISTING INSPECTION OPENING
R37.0
R43.0
EXISTING SCOUR PIT COVER TO BE RAISED
CONCRETE ACCESS ROAD 200mm THICK, GRADE N32
SUB SURFACE, CBR 25 MATERIAL P.I.6 MAX., 75 MICRO SIEVE 15% MAXIMUM, 200mm THICK
SETOUT POINT
1.0m
KERB TYPE B1
REFER STD DWG IPWEAQ R-0080
SL92 MESH 50mm COVER
SECTION A
SCALE 1:25
25mm AC SURFACE
200mm CBR 60
300mm CBR 15
SETOUT POINT
1.0m
A30 GEOTEXTILE
SECTION B
SCALE 1:25
REVISED ACCESS
IRC
15.10.0
i SLAB
TION "A" ON
/5/7-TR201/022
OVERHEAD AND POWER LINE AND
OWER POLE. VALVE PIT POWER
OR 240V ACTUATORS TO BE
FROM NEW SWITCHBOARD.
POWER SUPPLY TO BE
D DURING CONSTRUCTION
PE RISING MAIN
YTTON ROAD SP298
DRAWING
7-TR201/046
6.0m
1.3m SHOULDER
SETOUT POINT
3%
SETOUT POINT
1.3m SHOULDER
NATURAL SURFACE
SECTION C
HORIZONTAL SCALE 1:100
VERTICAL SCALE 1:50
Cardno MBK
Cardno MBK (Qld) Pty Ltd
PARSONS BRINCKERHOFF
BW CONTRACT No. 30137-02/03
LEIGHTON JOB No. Q1112
PB JOB No. 2138110B
Brisbane Water
PROJECT
SERPENTINE ROAD PUMPING STATION
TITLE
SERPENTINE ROAD SP300 ROAD PLAN
SCALE AS SHOWN
A.H. DATUM
No. 3 OF 53
DRAWING No.
486/5/7-TR201/021

BAC Australia
Brisbane Airport Corporation Ltd
Make the most of life.

FAXED 18/8/04

JRb
2138110B
Recd 23/8/c

18 August 2004

Parsons Brinckerhoff Australia Pty Ltd
GPO Box 2907
Brisbane Qld 4001

Attention: Mr Ian Cameron

Dear Sir

Development Consent Approval
Re: Proposed Australia Trade Coast Sewer Project

TF Colin 2:15pm 23/8/04 JRb

Development Consent No. 2004/061

Project Registry No 2004/94

I write on behalf of Brisbane Airport Corporation as the Airport Lessee Company that in accordance with the Airports (Building Control) Regulations 1996, Development Consent for this project is granted.

The purpose of this document is to set out the conditions of consent by Brisbane Airport Corporation limited to the development identified above as contemplated by Regulation 2.03 and 2.04 of the Airports (Building Control) Regulations1996 made under the Airports Act 1996.

Yours faithfully

Colin Stewart
Project Manager - Operations

Encl.

cc:	Mr Willie Tait	Airport Building Controller Department of Transport and Regional Development
	Stephen Goodwin	General Manager Operations
	Brad Bowes	Company Secretary

Banksia Place, Brisbane Airport, Qld 4007 | PO Box 61, Hamilton Central, Queensland 4007 Australia | Telephone: +61 7 3406 3000 | Fax: +61 7 3406 3111
email: info@bne.com.au | www.brisbaneairport.com.au | www.flydirect.com.au

DEVCON 2004/061

BRISBANE AIRPORT CORPORATION LIMITED
CONDITIONS FOR DEVELOPMENT CONSENT

PROPOSAL: Proposed Australia Trade Coast Sewer Project

PROPOSED BY: Parsons Brinkerhoff on behalf of BCC

LOCATION: Serpentine Road and Viola Place Brisbane Airport

---

1. Description of Proposed Building Activity

This proposal is to construct and install rising sewer mains and pump stations at Viola Place and Serpentine Road. Brisbane Airport as part of the larger Australia Trade Coast Sewer Project.

2. Consistency with the 2003 Master Plan

This project is located in a precinct of the Airport master planned for General Industry. BAC has consented to provide land for the BCC to construct these works. These works form part of the BCC infrastructure. It is the responsibility of the BCC to negotiate an easement for these works with the DoTARS.

3. Major Airport Development

This project does not form part of a Major Development Plan as described in Section 89 of the Airports Act 1996.

4. Consistency with the 2004 Airport Environment Strategy

I refer to the development application for the abovementioned project and provide a statement describing how the proposed building activity is consistent with the approved final Airport Environment Strategy (AES) for Brisbane Airport in accordance with the requirement of the Airport (Building Control Regulations 1996, Regulation 2.05 (1)(d).

Section 14 of the 2004 AES addresses environmental management of "Development Projects" in general and the following refers to how the abovementioned project is consistent with the AES:

- Comprehensive environmental impact assessment studies have been undertaken predominantly by Brisbane City Design on behalf of Brisbane Water between 2001 and 2003.
- Long term performance and design standards have been incorporated into the final design; and

- A Construction Environmental Management Plans (CEMP) has been supplied as part of the Development Consent process which addresses satisfactorily all BAC requirements in this matter.

5. Planning Objectives

I confirm that this project is consistent with the intent of the latest edition of the Brisbane Airport Corporation Limited Planning Procedures and Guidelines.

6. Documentation

The approval is not a design check, and all design aspects of the project remain the responsibility of Brisbane City Council and their design team.

This consent relates to the development as described in the following documents.

7. Building Approval by Airport Building Controller

This consent is subject to Building Approval for the works being obtained by Parsons Brinckenhoff from the Airport Building Controller. A copy of the submission to and approval from the Airport Building Controller is to be provided to Brisbane Airport Corporation Limited as soon as it is available and before any work commences.

8. Site Development

Consent is conditional on the proposed development complying with the following:

1. Noise and dust to be controlled within airport Environmental Protection Regulations during constructions.
2. All work which may cause a disruption to the effective operation of the airport to be carried out in non peak periods.
3. Demolition not to affect any base airport services.
4. Provision of all trade and statutory certificates to the Airport Building Controller on completion of works.
5. Compliance with the Brisbane Airport Corporation does not indicate compliance with the DDACT.
6. All workmanship and materials to comply with the relevant Australian Standards.
7. The contractor shall be responsible for disconnecting and terminating any existing water, drainage, sewerage and electrical services and the works are to be carried out in accordance with the relevant codes.
8. The contractor shall comply with the State Workplace Health & Safety Act and Occupational Health & Safety Act, 1989 and 1991 respectively and any associated regulations and amendments.
9. The contractor shall be responsible for damages to any airport property and existing services and the contractor is to advise the

Corporation immediately of any damage. The contractor shall be held responsible for making good any damage caused to airport property and services as a result of their activities.

10. The contractor should manage the site to prevent any environmental impacts contrary to the Airports (Environment Protection) Regulations, such as acid sulfate soil disturbance, runoff to surface drains, sediment loads in stormwater runoff from the site, soil contamination, dust and other air quality issues, excessive noise, ecology and cultural heritage.

9. Site Requirement

The site shall be kept free of rubbish and debris and be maintained in a tidy condition at all times. Access to the site will be as directed by BAC.

10. Services

All services are to be located and protected within the surrounding works area.

11. Occupational Health and Safety

The Contractor is responsible for Occupational Health and Safety requirements throughout the duration of the total site works.

12. Insurances

The Contractor is to provide to BAC a copy of their contractor's insurance.

- Contractors All Risks
- Public Liability ($10,000,000 Landside) ($20,000,000 Airside).
- Workers Compensation

13. Security

The Contractor is to maintain full site security and public safety throughout the duration of the works.

14. Signage

Any proposed signage shall be submitted to BAC for context and graphic approval. Appropriate barriers and public warning shall be maintained at all times.

15. Development Guidelines

The developer shall adopt and comply with the latest edition of the BAC Development Guidelines.

16. Permit to Commence Work

A Permit to Commence work must be obtained from the BAC before any work commences on site.

The Permit to Commence work will be issued on the supply of the following:

- Name of Contractor and telephone number
- Name of Contractors Project Officer and contact for 24 hours access.
- Copies of all insurances
- Copy of the submission to and approval of the Airport Building Controller
- Safe Work Plan
- Approval Environmental Management Plan for Construction
- Method of Work Plan

The Permit to Commence Work must be signed by the Contractor to acknowledge acceptance of the permit conditions before any work commences on site.

17. Occupancy

Upon the completion of the project, design and compliance certificates will be required to show that all work has been completed in accordance with the requirements of the Building Code of Australia and the relevant Australian Standards. Occupancy of the area can not be permitted until the Airport Building Controller has issued a Certificate of Compliance.

18. Protection of Persons and Property

In order to protect against damage to property and persons and injury resulting thereof from the new works, the following will be engaged during construction.

a) Provide for adoption of a safe work plan for the building/works activity.

b) Ensure the Qld state legislation relative to workplace health and safety is adopted and enforced during the operations.

c) Provide safety fences, boarding and barricades around the work area to prevent public access and confine the contractor to works in the nominated area.

d) Provide appropriately qualified and experienced staff to ensure there is no unauthorised entry to the work site.

19. Clean up/Rehabilitation

a) Provision is to be made in the documents for the contractor's debris and rubbish/dust/dirt and the like to be removed from the site and disposed in a suitable licensed dumping area.

b) And that all building fabric and or landscaping to be enhanced as part of the project or at least returned to a condition at least equivalent to its prior condition.

20. Development Consent Approval

This Development Consent Approval is dependant upon Brisbane Airport Corporation Limited receiving payment of the development Consent fee. Our tax invoice is included in this approval.

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 9(

Our Reference: 2138110B-LTR037Aic:rmk

29 July 2004

Colin Stewart
Project Manager Operations
BACL Australia
PO Box 61
HAMILTON CENTRE QLD 4007

Dear Colin

Development Consent Application — Australia Tradecoast Sewer Project Additional Information Submission

Further to our submission dated 8 June 2004, and subsequent response from BAC dated 13 July 2004, we are pleased to provide the following information.

1. We note that BAC will issue the Approval to Commence Work for the works on Brisbane Airport land.

2. The odour control system for the SP300 Serpentine Road pump station has yet to be finalised. The pump station will include an odour scrubber with an estimated air flow rate of 525 m^3/hour (based upon six changes of air volume per hour). This equates to 0.15 m^3/sec which is well below the 4.3 m^3/sec stipulated by BAC.

3. The access road will be constructed from Lomandra Drive to the pump station in flexible pavement with a concrete pavement at the pump station as detailed in the attached Drawing No. 486/5/7-TR201/021

4. Viola Place SP299 pump station overflow is to be connected to the nearby open drain. The pump station will be equipped with the following equipment:

   - dual pumps (duty and standby);
   - standby generator;
   - SCADA alarm system.

   Brisbane Water has supplied the attached information in relation to pump station overflows at the Viola Place pump station.

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2138110B-LTR037Aic:rmk

5. Line marking and signage for the access road connection to Lomandra Drive will be provided as detailed in the attached drawing, to comply with Queensland Main Roads design and construction requirements. It should be noted that a deceleration lane is not required due to the low volume of traffic visiting the pump station.

The proposed intersection works for the access road and Lomandra Drive have been designed by PB Senior Civil Designer, Brian Keller who is a Main Roads Queensland Certified Senior Road Safety Auditor.

We trust that the additional information provided is sufficient to enable assessment of the project for consistency with the objectives of the approved airport master plan. If further information or clarification is required please contact Ian Cameron on 07 3218 2644.

Yours sincerely

Ian Cameron

Ian Cameron
Water Executive
Parsons Brinckerhoff Australia Pty Limited

Encl. Brisbane Water Fax
Dwg No. 486/5/7–201/021

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BAC Australia

Brisbane Airport Corporation Ltd

Make the most of life.

FAXED 13/7/04

13 July 2004

Noted JRb 16/7/04.

RECEIVED 16 JUL 2004

Mr Ian Cameron
Water Executive
Parsons Brinckerhoff Australia Pty
GPO Box 2907
Brisbane Qld 4001

Dear Ian

Re: Australia Trade Coast Sewer Project

I refer to your application for Development Consent for the above project. Before consent can be issued from BAC the following issues need to be clarified.

Clause 1.2 The report incorrectly states that the Airport Building Controller issues Approval to Commence Work, this however is the responsibility of BAC.

Clause 2.1.2 Please confirm that the discharge from the Serpentine Road pump station stack will be less than $4.3m^3$.

Clause 2.1.2 The report specifies that the proposed new 190m long access road from Lomandra Drive to the Serpentine Road pump station would be spray sealed bitumen, however on drawing No 486/5/7 TR201/021 Amendment P1 the road is shown as concrete with a kerb edge, please clarify.

Please provide drawings and certification to indicate the appropriate line marking and traffic signage for the connection of your access road to Lomandra Drive.

It is noted that from conversations between yourself and Helen Clarke from BAC that the overflow pipe from the Viola Place pump station discharges directly into the airport open unlined drainage system. Could you please document the remediation process in place for dealing with possible discharges in to our system. The documentation should indicate the expected frequency of any overflow and the method of response including time frames for remediation.

Please contact me directly on 3406 3056 if further clarification is required.

Yours faithfully

Colin Stewart
Project Manager - Operations

cc: Stephen Goodwin
Karyn Rains
Alex MacDowell

G:\Operations\Engineering Services\Engineering Correspondence\Eng Correspondence 2004\CSB406 Ian Cameron Australia Trade Coast Sewer Project 13.7.04.doc

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Parsons Brinckerhoff

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Facsimile +61 7 3831 4223
Email brisbane@pb.com.au

ABN 84 797 323 433
NCSI Certified Quality System ISO

Our Reference: 2138110B-LTR030A1ic:syg

8 June 2004

Colin Stewart
Project Manager Operations
BACL Australia
PO Box 61,
HAMILTON CENTRE QLD 4007

Dear Colin

Development Consent Application — Australia Tradecoast Sewer Project

Please find enclosed an application for development consent, on behalf of Brisbane Water, for construction of components of the Trade Coast Sewer Project on airport land controlled by BACL. The scope of works on airport land includes rising mains connecting to a new pump station (SP299) at Viola Place and construction of a new pump station (SP300) Serpentine Road including access from Lomandra Drive.

In support of this application, please find enclosed two copies of a report with appended documentation supporting the application.

We trust that the information provided is sufficient to enable assessment of the project for consistency with the objectives of the approved airport master plan. If further information or clarification is required please contact Mike Hall on (07) 3218 2206 or Kate Robbins on (07) 3218 2260.

Yours sincerely

Ian Cameron

Ian Cameron
Water Executive
Parsons Brinckerhoff Australia Pty Limited

Encl.

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Engineering Excellence

A2. Airport Building Controller

Parsons Brinckerhoff

12th Floor, IBM Centre
348 Edward Street
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Facsimile +61 7 3831 4223
Email brisbane@pb.com.au

ABN 84 797 323 433
NCSI Certified Quality System ISO 90

Our Reference: 2138110B-LTR029A1ic:syg

8 June 2004

Mr Willie Tate
Airport Building Controller
Airport Environmental Protection and Building Control Office
PO Box 137,
HAMILTON CENTRE QLD 4007

Dear Mr Tate,

Building Approval Application — Australia Tradecoast Sewer Project

Please find enclosed an application for Application for Building Permit, on behalf of Brisbane Water, for construction of components of the Trade Coast Sewer Project on airport land controlled by BACL. The scope of the proposed works on airport land includes rising mains connecting to a new pump station (SP299) at Viola Place and construction of a new pump station (SP300) Serpentine Road including access from Lomandra Drive.

In support of this application, please find enclosed two copies of the following documentation:

- Application for Building Permit;
- Report in Support of Application to BACL and Airport Building Controller with appended supported drawings and documentation;
- Cheque to the value of $2,100.00 to cover the Building Application fee.

We trust that the information provided is sufficient to enable assessment of the application for consistency with regulations. If further information or clarification is required please contact Mike Hall on (07) 3218 2206 or Kate Robbins on (07) 3218 2260.

Yours sincerely

Ian Cameron

Ian Cameron
Water Executive
Parsons Brinckerhoff Australia Pty Limited

11/6/04

Encl.

Over a Century of Engineering Excellence

10. MAR. 2004 15:48 BCC INFRASTRUCT MGT 07 3403 9087 NO. 904 P. 4

Airport Environment Protection and Building Control Office

Application for Building Permit

Airports Act 1996

Airports (Building Control) Regulations 1996

To Airport Building Controller

Applicants Details

Name: Brisbane Water

Postal Address: T.C. Beirne Centre, 315 Brunswick St Mall, Fortitude Valley Postcode: 4006

Contact Person: Arnold Crowe

Phone No: 3403 9608 Fax No .... E-Mail AOPC5@brisbane.qld.go

Description of Building Activity

Location of Works: • SP 299 Viola Place
Accurate address must be provided. • SP300 Serpentine Road

Description of Works: Two Sewerage pump stations

Value of Works: $460,000.00

Duration of Works: July to December 2004.

Building Contractor: Leighton Contractors

ABN. 84 797 323 433 Registration Number: ....

Postal Address: Level 3, 143 Coronation Drive Milton Postcode: 4064

Project Manager: James Whybrow

Phone No: 3907 8500 Fax No .... E-Mail james.whybrow@leicon.com.au

Applicant

Signature: [signature] Date of Application: 9/06/04

Note

Fees in accordance with Regulation 2.02 of the Airports (Building Control) Regulations must be paid on lodgement of the application.

Airport Environmental Protection and Building Control Office
PO Box 137, Hamilton Central Qld 4007 (Unit 7, 35 Qantas Drive, Eagle Farm QLD 4009)
Tel 07 3216 3040 ~ Fax 07 3216 3100

PB 100 YEARS

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ABN 84 797 323 433
NCSI Certified Quality System ISO 9001

Our Reference: 2138110B-LTR033Aic:rmk

19 July 2004

Mr Willie Tate
Airport Building Controller
Airport Environmental Protection and Building Control Office
PO Box 137
HAMILTON CENTRE QLD 4007

Dear Mr Tate

Building Approval Application — Australia Trade Coast Sewer Project Additional Information Submission

Further to our Building Approval Application dated 8 June 2004 (despatched 11 June 2004) and the subsequent fax from the Airport Environmental Protection and Building Approval Control office dated 23 June 2004, we are pleased to provide the additional information as requested.

Peter Czerkaski on 29 June 2004, provided a copy of the Design Certificate required to be submitted as part of the additional information requested by your office.

In response to the additional information request, we have provided the following information.

1. Additional design drawings for SP300 Serpentine Road pump station.
2. The project is being designed in accordance with Brisbane Water Specifications which are contained in the tender documents (five volumes).
3. Marked up SUR Plans clearly detailing the boundary of the Brisbane Airport.
4. Design certificates for following:
   - hydraulic installation;
   - structural design; and
   - civil design (carparks and roadworks).
5. A current CV for Design Manager Ian Cameron (RPEQ 2241), and Structural Engineer Malcolm Pound (RPEQ 2408).
6. Copy of CEMP Appendices 1 (Q1112–MN–412 System Documentation Schedule) and 2 (Hot Spot Map).

We are currently providing additional information to BACL in response to a request dated 13 July 2004. We will forward a copy of the BACL letter of consent when it is received.

We trust that the information provided is sufficient to enable assessment of the application for consistency with regulations. If further information or clarification is required please contact Ian Cameron on (07) 3218 2644 or 0401 148 142.

Yours faithfully

Ian Cameron
Water Executive
Parsons Brinckerhoff Australia Pty Limited

Encl. Additional Information

Over a Century of Engineering Excellence

Airport Environmental Protection and Building Control Office
Appointed by the Australian Government Department of Transport and Regional Services

Facsimile Transmission

To	cc	Company	Attention	Fax No.
✓		**Parsons Brinckerhoff**	**Mike Hall** **Kate Robbins**	**07 3831 4223**

Project	Australia Trade Coast Sewer Project	Ref	BNE 04 B0032
From	**Willie Tait**	Date	23 June 2004
Subject	Technical Assessment	Pages	5

Ian,

The project documentation forwarded for the above project have been assessed and attached is a technical report in relation to the requirements of the Airports (Building Control) Regulations and other relevant legislation as they relate to the proposed work.

On receipt of the report please give me a call to discuss the issues raised.

Regards

Willie Tait
Airport Building Control Office

If you have problems receiving this correspondence, please contact this office immediately

Airport Environment Protection and Building Control Office *PO Box 137, Hamilton Central QLD 4007* *(Unit 7, 35 Qantas Drive, Eagle Farm Qld 4009)*	*Contact 07 3216 3040 (tel)* *07 3216 3100 (fax)* *0417 757 695 (mob)*

TECHNICAL ASSESSMENT - PROPOSED AUSTRALIA TRADE COAST SEWER PROJECT

1 INTRODUCTION

Thank you for forwarding the design documentation for the Building Approval for the above project. An assessment of the documentation has been undertaken and the following matters are raised for consideration and discussion to allow the Permit to issue.

1.1 Scope of Report

1. The object of this report is to
   - provide an assessment of the proposal against the requirements of the Airports Act 1996, the Airports (Building Control) Regulations and associated legislation as they relate to the proposed works
   - detail the documentation required to allow issue of a Permit for the project

Review documentation

Report in Support of Application to Brisbane Airport Corporation Limited and the Airport Building Controller dated June 2004

1.2 Information Request

1. Please forward two copies of the design documentation for the project including
   - Drawings detailing the works proposed
   - Specifications.

   Please note, not all drawings referenced in Section 2.1 of your report were included in appendix C

2. For clarification purposes please forward drawings clearly indicating the Airport site boundaries and clearly detailing the extent of works proposed on Federal leased airport land.

2 ADMINISTRATION / OTHER ISSUES

2.1 Airport (Building Control) Regulations

The following should be sought from Brisbane Airport Corporation Limited and forwarded to this office

- A letter of consent for the operations and
- Confirmation the proposal is consistent with the final master plan
- Confirmation the proposal is consistent with the final environment strategy

2.2 Environment Controls

The application has been referred to the Airport Environmental Officer (AEO). The AEO has responded and attached is a copy of letter dated 21 June 2004.

Please arrange for the information requested to be forwarded and if any clarification is required please contact the Airport Environmental Officer Sue Hogg directly on 07 3216 3083.

2.3 Other Issues

1. Design certificates will be required for the following

Item	Notes
Hydaulic installation	
Structural design	
Civil design (carparks, roadworks)	

Note each certificate must

- Have an **original** signature.
- Reference design standards.
- Be accompanied by a current CV.
- Include professional qualifications/affiliation details/registration details.

Airport Environment Protection and Building Control Office

Appointed by the Australian Government Department of Transport and Regional Services

Brisbane Airport Building Controller
Unit 7
35 Qantas Drive
Eagle Farm Qld 4009

Our Reference: BNE04/0001
Your Reference: BNE 04 B0032

21 June 2004

Dear Willie

Re: Building Application – Stage Installation of Sewerage Pumps and Associated Infrastructure at Viola Place and Serpentine Roads, Brisbane Airport for Brisbane Water

Thank you for your letter dated 18 June 2004 requesting advice on the environmental requirements, restrictions or conditions in relation to the above development.

The Environmental Management Plan (Construction) prepared by Leighton Contractors does not include the *Airports Act, 1996* nor the *Airports (Environment Protection) Regulations, 1998* for those parts of the project to be constructed on the Airport. Please advise the client that subsequent revisions of the CEMP should be amended accordingly.

In addition, The copy of the CEMP referred to me is missing the content of Appendices 1 (Q1112-MN-412 System Documentation Schedule) and 2 (Hot Spot Map). Please request the client to provide this information for my review.

Notwithstanding the above comments, the CEMP is of a high standard and includes appropriate strategies for managing construction risks to the environment. So, to further this application I make the following comments and look forward to receiving the above mentioned information in due course:

1. Construction activities must comply with the ***Airports (Environment Protection) Regulations 1997***. The Regulations deal with issues such as runoff to surface drains, sediment loads in stormwater runoff, soil contamination, noise, dust and other air quality issues, excessive noise, ecology and cultural heritage.

2. The contractor(s) and / or agent(s) must comply with the terms and conditions of the Construction Environmental Management Plan (CEMP) prepared by Leighton Contractors referenced Q1112 dated 27 May 2004 and any subsequent revisions.

Airport Environment Protection and Building Control Office
PO Box 137 Hamilton Central Qld 4007 (Unit 7 35 Qantas Drive Eagle Farm, Qld 4009)
Tel 07 3216 3083 ~ Mob 0414 932 202 ~ Fax 07 3216 3100 ~ email sue.hogg@ane.com.au

Airport Environment Protection and Building Control Office

Appointed by the Australian Government Department of Transport and Regional Services

3. Particular attention should be paid to management of stomwater runoff, erosion and sediment controls, acid sulphate soils and red imported fire ants.

4. Any environmental incident, complaint, audit, monitoring and / or inspection records produced as a result of carrying out the requirements of the CEMP mentioned above must be provided to the Airport Environment Officer by fax (07 3216 3100) as soon as possible after receipt of the information.

5. Appropriate permits should be obtained from the Queensland Department of Primary Industries should the proposed works require the removal of mangroves.

6. The contractor or agent must comply with the requirements under the Regulations for reporting any discovery of possible cultural heritage significance to the Brisbane Airport Corporation and the Airport Environment Officer, and the proposed management of such discoveries.

Please do not hesitate to contact me if you would like to discuss these issues.

Yours Sincerely

Sue Hogg
for Air Noise Environment Pty Ltd
Airport Environment Officer, Brisbane Airport
Appointed by the Australian Govemment Department of Transport and Regional Services

Airport Environment Protection and Building Control Office
PO Box 137 Hamilton Central Qld 4007 (Unit 7 35 Qantas Drive Eagle Farm, Qld 4009)
Tel 07 3216 3083 ~ Mob 0414 932 202 ~ Fax 07 3216 3100 – email sue.hogg@ane.com.au

Appendix B

Communications
B1 — Energex

B1. Communications — Energex

2138/10
27/5/04

POWER SUPPLY END OF OCT 2004 - Energex

RECEIVED
27 MAY 2004

energex

Attention	Ian Cameron
Company	Parsons Brinkerhoff
Fax Number	(07) 3831 4223
Date	25 May 2004 **Number of Pages** 2
Subject	Serpentine Rd, Eagle Farm - Pump Station Supply

Copy to Andrew Bau... 1-6-04 IRC (Cameron)

Dear Ian

With regard to your request for supply to a new pump station at the end or Serpentine Rd, Eagle farm, I advise the following:

ENERGEX works required:
- Replace 1 LV pole with a 12.5m 11kV pole.
- Extend 11kV from P627 to new 11kV pole.
- Trench from new 11kV pole to new transformer site.
- Install 4 x 125mm Conduit along trench route.
- Install 1 x 750kVA padmounted transformer
- Install 1 x 95mm 11kV cable from termination on new 11kV pole to RMU termination in new padmount.
- Install 1 x 70mm earth cable from new 11kV pole to earth grid in new padmount

Customer works required:
- You are required to prepare the substation site in accordance with ENERGEX requirements and specifications located on the ENERGEX website at:

www.energex.com.au/service_providers/technical_docs/asp/technical_documents.asp

As part of these works you are required to pay a capital contribution of

$49,379 + $4,937.90 GST Capital Contribution
$4,400 + $440 GST Transformer Surcharge

$59,156.90 TOTAL

Actual Costs Wether More Or Less Apply.

INTERNATIONAL QUALITY MANAGEMENT SYSTEM

Enquiries
Chris Allan
Telephone
(07) 3407 5808
Facsimile
(07) 3407 5853
Email
chrisallan@energex.com.au

Asset Services
524 Bilsen Road
Geebung Qld 4034

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

<u>Pre-payment is required before work is scheduled.</u>

To proceed with this project, please complete the attached customer acceptance form, Proposed Electricity Supply Arrangements form (2226) and forward with payment to:

ATT: Chris Allan
ENERGEX
524 Bilsen Rd.
Geebung Qld. 4034

Please note that the Proposed Electricity Supply Arrangements form (2226) and the customer acceptance form are not attached to this fax. It is a requirement of ENERGEX that the original form 2226 is to be mailed.

At present a lead time of approximately 20 weeks from the receipt of payment may be required before construction is commenced, however every effort will be made to minimise this timeframe where possible.

Please note that this offer is valid for a period of sixty days only. ENERGEX reserves the right to withdraw this offer should approvals from statutory authorities to complete the work be withheld and/or the offer period lapses.

If you have any other questions regarding this matter, please call me on (07) 3407 5808.

Yours sincerely

Chris Allan
Design Technical Officer

for General Manager Asset Services

energex

2226 06.05.200
Page 1 of :

Proposed Electricity Supply Arrangements
Industrial and Commercial Customers requiring a Substation Site

Project		
Reference Numbers	ENERGEX - C0054000	Location – METRO NORTH
Project Name	INSTALL 750kVA Padmount Transformer & 11kV UG Cables	
Location of Project	Serpentine Rd, Pinkenba	
Real Property Description		
Customer Details		
Name of Customer (please print)	Brisbane City Council	
Customer's Representative	Parsons Brinckerhoff	
Telephone Number	(07) 3218 2644	**Facsimile Number** (07) 3831 4223
ddress		
Contact Person (please print)	Ian Cameron	
Existing Account No.(s)		

Supply Information				
Type of Industry or Purpose of Building	Sewerage Pump Station			
AS 3000 Calculated Demand	750A		**Agreed Estimated Demand**	750A
Castell key interlocks required on customer's LV switchboard to prevent multiple transformers being paralleled.				
Size of Largest Motor / Special Apparatus	2 x 216kW Sewerage Pump			
Location of Substation	On Site			
Type of Substation	Padmount Transformer			
Major ENERGEX Equipment and Rating	Initially	750kVA		
High Voltage Method of Supply	From	11kV Fdr MDH4A	To	RMU of PMT
ow Voltage Circuits	To Customer	TWO		
	To ENERGEX Network	Up to three (3) low voltage circuits. NONE		
Metering Type	☐ High Voltage	☒ Low Voltage		
Customer to install/uprate metering CT's	☒ Yes	☐ No		
Customer's Point of Supply (Customer's Terminals) **is** LV BOARD OF NEW PMT				
Possible Fault Level at Customer's Point of Supply	20.8kA at 433 V			
Customer to Carry Out	Preparation of Substation site as per ENERGEX specifications			
Customer to Bear Cost of	All works required to prepare the padmount site, and any costs associated with work required outside normal working hours.			

	Type	Name	Telephone No.	Facsimile No.
ENERGEX Contacts	Design	CHRIS ALLAN	3407 5808	3407 5853
	Metering/Inspection of Customer's Installation	EDWARD DADIC	3407 5858	3407 6907
	Construction and Transformer Delivery	CHRIS ALLAN	3407 5808	3407 5853

Relevant Drawings	*Previously Supplied / Enclosed		
Application Form	*Lodged / To be lodged	**Date Lodged**	/ /
Date Supply Required	31 / 10 / 2004 (To be confirmed by Customer)		

* 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: Before electricity supply can be connected to the property, the customer is required to apply for electricity supply and provide the relevant security deposit. The Account may be established by calling ENERGEX on 13 12 53. Please quote the ENERGEX project number C0054000 when making an application for supply.

Information contained within this Arrangement and/or associated drawing(s) does not absolve the customer from obtaining Building Approval for the proposed substation construction. The customer is required to obtain necessary Building Approvals, as required, 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 nominated date and is required to notify ENERGEX to arrange a site inspection. Failure of the site to pass inspection or to be ready by the required date may delay the supply availability date.

Details of the time and date of delivery for the transformer 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.

Following the installation of the transformer on site, the customer's electrician will be allocated 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) CHRIS ALLAN

Position (please print) DESIGN TECHNICAL OFFICER

Signature (for Chief Executive) [signature] **Date** 25 / 05 / 2004

PROPERTY OWNER

I, 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 30 / 09 / 2004. Taking into account the lead times required by ENERGEX, I also confirm that the "Date Supply Required" is 31 / 10 / 2004. The customer has been advised that should the expected or future load requirement for the aforementioned premises exceed the agreed estimated demand of 540 kVA, as specified in this Arrangement, a separate application is to be submitted to ENERGEX for the increased capacity requirement.

Name (please print)

Position (please print)

Organisation

Signature **Date** / /

energex

2226 06.05.2004
Page 1 of 2

Proposed Electricity Supply Arrangements
Industrial and Commercial Customers requiring a Substation Site

Project

Reference Numbers	ENERGEX - C0054000	Location – METRO NORTH
Project Name	INSTALL 750kVA Padmount Transformer & 11kV UG Cables	
Location of Project	Serpentine Rd, Pinkenba	
Real Property Description		

Customer Details

Name of Customer (please print)	Brisbane City Council		
Customer's Representative	Parsons Brinckerhoff		
Telephone Number	(07) 3218 2644	**Facsimile Number**	(07) 3831 4223
ddress			
Contact Person (please print)	Ian Came		
Existing Account No.(s)			

Your Copy

Supply Information

Type of Industry or Purpose of Building	
AS 3000 Calculated Demand	**ated Demand** 750A
Castell key interlocks required on custo	**eing paralleled.**
Size of Largest Motor / Special Apparatu	
Location of Substation	
Type of Substation	
Major ENERGEX Equipment and Ratin	
High Voltage Method of Supply	o RMU of PMT

ow Voltage Circuits	To Customer	
	To ENERGEX Network	Up to three (3) low voltage circuits. NONE

etering Type ☐ High Voltage ☒ Low Voltage

Customer to install/uprate metering CT's ☒ Yes ☐ No

Customer's Point of Supply (Customer's Terminals) **is** LV BOARD OF NEW PMT

Possible Fault Level at Customer's Point of Supply 20.8kA at 433 V

Customer to Carry Out	Preparation of Substation site as per ENERGEX specifications
Customer to Bear Cost of	All works required to prepare the padmount site, and any costs associated with work required outside normal working hours.

	Type	Name	Telephone No.	Facsimile No.
ENERGEX Contacts	Design	CHRIS ALLAN	3407 5808	3407 5853
	Metering/Inspection of Customer's Installation	EDWARD DADIC	3407 5858	3407 6907
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Relevant Drawings	*Previously Supplied / Enclosed		
Application Form	*Lodged / To be lodged	**Date Lodged**	/ /
Date Supply Required	31 / 10 / 2004	(To be confirmed by Customer)	

* Cross out where not applicable

● ENERGEX Limited ● 150 Charlotte Street Brisbane 4000 ● GPO Box 1461 [illegible]

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: Before electricity supply can be connected to the property, the customer is required to apply for electricity supply and provide the relevant security deposit. The Account may be established by calling ENERGEX on 13 12 53. Please quote the ENERGEX project number C0054000 when making an application for supply.

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Name (please print) CHRIS ALLAN

Position (please print) DESIGN TECHNICAL OFFICER

Signature (for Chief Executive) Chris Allan **Date** 25 / 05 / 2004

PROPERTY OWNER

I, 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 30 / 09 / 2004. Taking into account the lead times required by ENERGEX, I also confirm that the "Date Supply Required" is 31 / 10 / 2004. The customer has been advised that should the expected or future load requirement for the aforementioned premises exceed the agreed estimated demand of 540 kVA, as specified in this Arrangement, a separate application is to be submitted to ENERGEX for the increased capacity requirement.

Name (please print)

Position (please print)

Organisation

Signature **Date** / /

energex

1299 11.02.2003

Return Completed form to –
Chris Allan, Project Manager
524 Bilsen Rd
Geebung, Qld 4034
Telephone – (07) 3407 5808

Customer Acceptance – Payment Arrangements
(to be included with Letter of Offer)

ENERGEX Project Details

Project Reference Number	C0054000
ENERGEX Location/s	
Project Name	INSTALL 750kVA PADMOUNT & EXTEND 11 KV CABLES
Location of Project	SERPENTINE RD
	PINKENBA
Other Details	

Customer Details

	Customer Contact	Tax Invoice Recipient
Name/s		
Address		
Suburb/Postcode		
Telephone No.		
Facsimile No.		
Email		
ABN Number		

Comments

Customer Acceptance of Payment Arrangements

I/we hereby accept the payment arrangements as outlined in the Letter of Offer.

Name (please print)	Signature	Date
		/ /
		/ /

Appendix C

Design Calculations SP300

Parsons Brinckerhoff Australia ABN. 84 797 323 433

REVISION RECORD

Document Type:	PB Document Name:	Page
DESIGN CALCULATIONS	SP 300 Design	Cover

Document Title:	Rev.:
SP 300 (Serpentine Rd) DESIGN CALCULATIONS	**1.12**

Rev No.	Prepared Initials & Date	Verified Initials & Date	Approved Initials & Date (Effective Date)	Description
0.0	MB 22-May-03			Initial issue
0.1	MB 1-Jun-03			Flotation calcs added
0.2	Not Used			Not used
0.3	MB 23-Jun-03			For Tender
1.0	MB 28-Jan-04			Start of Detailed Design
1.1	MB 9-Feb-04			Hydraulic algorithm standardised
1.2	MB 10-Feb-04			Pumps changed to CT3312 / 250kW
1.3	MB 4-Mar-04			Issue for Pump Selection Report
1.4	MB 31-Mar-04			Reduced size delivery calcs added
1.5	MB 12-Apr-04			Surface levels lowered
1.6	MB 14-Apr-04			BW control levels implemented
1.7	MB 12-May-04			Hydrotec sump mods included
1.8	MB 25-Jun-04			Manufacturer's pump curves added
1.9	IC 11-Aug-04			Pump station slab levels changed
1.10	IC 22-Sep-04			Pump station slab levels changed
1.11	IC 23-Sep-04			Pump station slab levels changed
1.12	IC 4-Nov-04			Overflow level changed

Project Use

Notes:

Client: **Brisbane Water**	Client Project No:	Client Rev.:
Plant Area: **SP 300 - Serpentine Rd Pinkenba**	Client Doc No:	
Superintendent: Rod Richards	Project Name: **Australia Trade Coast Sewerage Project**	
PB Project Manager: Ian Cameron		
The information contained in this document is subject to Copyright and may not be copied or otherwise used without the express authority of PB	PB Project No.: **2138110B**	

I:\2138110B Trade Coast Sewerage post-Award\WORK\Pumping Stations\SPS 300 Serpentine Road\[SP 300 Design Rev 1.12.xls]SPS Dimensions and Levels

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

20/05/2003
Pump selection using FLYPS 2.1
Using single pump developing 400L/s / 40m static / 41m dynamic
CT3306 / 215kW - good curve coverage, adequate power, high NPSHr
CT3312 / 250kW - excellent curve coverage, needs overspeeding, good NPSHr
CT3351 / 290kW - poor curve coverage, good power, good NPSHr
CT3400 / 310kW - excellent curve coverage, good power, good NPSHr
CT3531 / 340kW - poor curve coverage, adequate power, good NSPHr

28/01/2004
As dry mounted pumps are used, NPSH calculations should be included.

10/02/2004
With SP299 now pumping directly into the EFPS rising mains, the duty flow from SP300 can be reduced. Refer J.Bower email XXXX Jan 2004. Pipework and civils to be designed for ultimate flow (378 L/s) with pumps to be installed for the year 2031 duty.
Pump selection is now different, as the CT3312 / 250kW, which needed to be oversped to meet the tender duty point can now be considered. It has a slightly larger motor than the tendered pump (CT3306 / 215kW) but has much better NPSH characteristics and a better turn down flow. Flygt recommended the CT3312 at the tender stage instead of the CT3306 because of their concerns with NPSH for the CT3306. Now that it does not need to be oversped to meet the duty it is probably a better choice than the CT3306.

16/02/2004
Control philosophy needs to ensure the PS can deliver enough flow to cut out against high static head during low flow conditions. We do not want the PS to be spinning away for hours with no flow going through it because it is not spinning fast enough to overcome the static head.

4/03/2004
All head loss calcs checked against ITT Flygt Colebrook White calculator in FLYPS.
Check the minimum speed from Flygt for the turndown minimum

22/09/2004
Pump station levels changed

23/09/2004
Pump station Levels revised

4/11/2004
Overflow Levels revised

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

Entered
Calculated

SUMMARY OF DUTY FOR SP 300

SP 300 - Serpentine Rd

Design PWWF (Tender Docs)	348.0 L/s	per duty pump
Total Flow (Tender Docs)	348.0 L/s	maximum duty flow
Static Head	39.7 m	from Pump Calcs
Total Head	40.8 m	from Pump Calcs

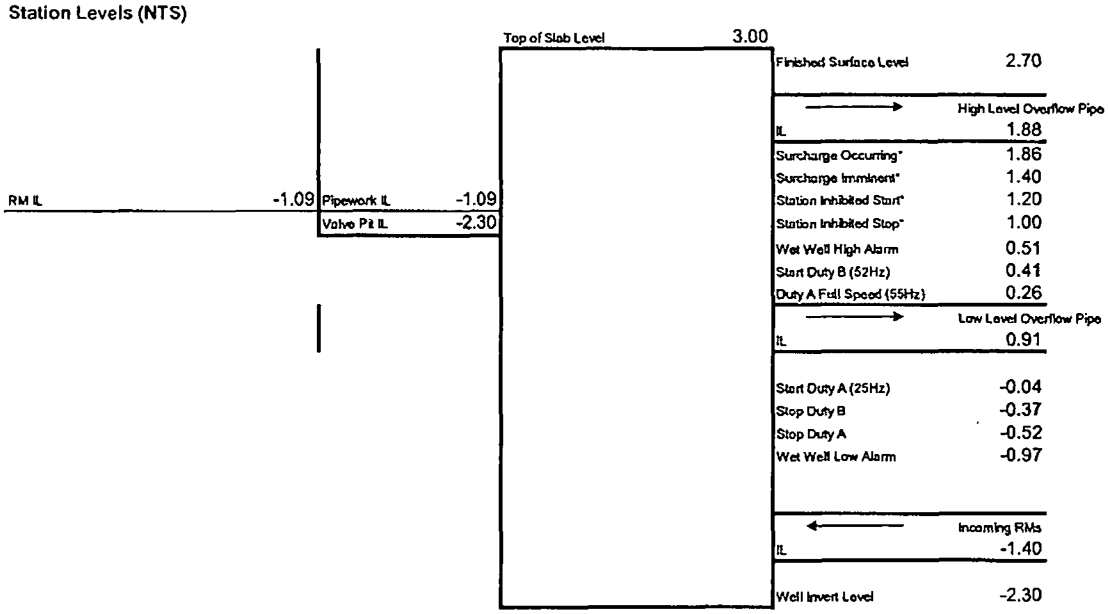
Parsons Brinckerhoff - Brisbane Office
Client: Brisbane Water
Project: Australia Trade Coast Sewerage Project
PB Job Code: 2138110B

Entered
Calculated

SP 300 DIMENSIONS AND LEVELS (Datum is AHD)

Proposed SP 300	Source	Design Values
Wet Well Length (internal)	PB	4.60 m
Wet Well Width (internal)	PB	5.00 m
Wet Well Area	calc	23.00 m2
Max Water Depth: OF Level to SPS Floor	calc	4.00 m
Incoming Sewer Diameter - Lytton Road PS	OD450 PE100	450 mm
Incoming Sewer Diameter - Kingsford Smith Drive PS	OD315 PE100	315 mm
Rising Main Diameter	OD500 PE100	500 mm
Discharge Pipe and Valve Diameter	velocity < 3m/s at max flow from single pump (400L/s)	450 mm
Switchgear Level	150mm above top slab	3.15 RL
Roof Slab - Finished Level		3.00 RL
Roof Slab - Underside	assume 250mm thick	2.75 RL
Finished Surface Level	Access road - 300 below top slab	2.70 RL
Flood Level	assume Q100 storm surge	2.50 RL
Air Vent - Obvert Level (horizontal section)	allow 100 above slab	3.10 RL
Physical Overflow Level (OF)		1.70 RL
Surcharge Occurring Level	25 below OF	1.68 RL
Surcharge Imminent Alarm Level	300 below OF	1.40 RL
Wet Well High Alarm (TWL)	250 above Duty A Full Speed	0.51 RL
Station Inhibited Start Level	200 below Surcharge Imminent	1.20 RL
Start Duty B (52Hz)	150 above Duty A Full Speed	0.41 RL
Station Inhibited Stop Level	200 below Station Inhibited Start	1.00 RL
Valve Pit Floor - Invert Level		-2.30 RL
Duty A Full Speed (52Hz)	Hydrotec	0.26 RL
Incoming RMs to Inlet Chamber - Invert	PB	-1.40 RL
Start Duty A (25Hz)	300mm below Duty A Full Speed	-0.04 RL
Stop Duty B	150 above Stop Duty A	-0.37 RL
Stop Duty A	GOAL SEEK THIS TO GIVE 10 STARTS PER HOUR ON DUTY PUMP	-0.52 RL
Wet Well Low Alarm (BWL)	150 below Stop Duty A	-0.67 RL
Available Pump Submergence	Hidrostal I10K-M - CHECK!	1.78 m
Wet Well - Invert Level	Hydrotec	-2.30 RL

Station Levels (NTS)



		Water Height (mAHD)	Stored Volume (m³)	Remaining Storage Capacity [m³]	Comments	% Level	% Volume
Wet Well Low	1	-0.97	0.0	65.6	BWL	0%	0%
Stop Duty A	2	-0.52	10.3	55.3		16%	16%
Stop Duty B	3	-0.37	13.7	51.8		21%	21%
Start Duty A	4	-0.04	21.4	44.2		33%	33%
Duty A Full Speed	5	0.26	28.3	37.3		43%	43%
Start Duty B	6	0.41	31.7	33.8		48%	48%
Station Inhibited Stop	7	1.00	45.3	20.2		69%	69%
High Level Alarm	8	0.51	34.0	31.5	TWL	52%	52%
Station Inhibited Start	9	1.20	49.9	15.6		76%	76%
Surcharge Imminent Alarm	10	1.40	54.5	11.0		83%	83%
Surcharge Occurring Alarm	11	1.86	65.1	0.5		99%	99%
Overflow Level	12	1.88	65.6	0.0		100%	100%

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DYNAMIC LOSS CALCULATION — DN500 DICL K12
Pump Suction Pipework (DN500 sections)

Flow rate	1,252.8	m3/hr	0.35	m3/s	Flowrate 348.0 L/s
Pipe internal diameter	**518.0**	mm	0.52	m	single pump flow (year 2031)
Surface area	0.211	m2	20	inch	pipes for Ultimate (378 L/s)
Water velocity	1.651	m/s	0.0006	m	
Reynolds Number	850,279.33				
Roughness coefficient	**0.600**	mm	1.01E-06	m2/s	
Equivalent length of pipe	**1**	m			
Temperature	20	deg. C			
Kinematic viscosity	1.006	m2/s			
Hydraulic gradient	5.55	m/km			
Pipe dynamic loss	**0.01**	m			

Component fitting losses:	k value	fitting loss		
bellmouth inlet	0.05	0.01	m	check formulae when inserting rows
90 degree bend R=1D	0.75	0.10	m	
		0.00	m	
		0.00	m	
		0.00	m	
Total component losses		**0.11**	m	
Total dynamic loss in section		**0.12**	m	

DYNAMIC LOSS CALCULATION — DN450 DICL K12
Pump Suction Pipework (DN450 sections)

Flow rate	1,252.8	m3/hr	0.35	m3/s	Flowrate 348.0 L/s
Pipe internal diameter	**467.0**	mm	0.47	m	single pump flow
Surface area	0.171	m2	18	inch	
Water velocity	2.032	m/s	0.0006	m	
Reynolds Number	943,136.39				
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	9.53	m/km			
Pipe dynamic loss	**0.00**	m			

Component fitting losses:	k value	fitting loss		
500 / 450 taper	0.03	0.01	m	check formulae when inserting rows
gate valve (John Fig 694)	0.10	0.02	m	
		0.00	m	
		0.00	m	
		0.00	m	
Total component losses		**0.03**	m	
Total dynamic loss in section		**0.03**	m	

DYNAMIC LOSS CALCULATION — OD406 MSCL 5 wall 12 CML
Pump Suction Pipework (DN400 sections)

Flow rate	1,252.8	m3/hr	0.35	m3/s	Flowrate 348.0 L/s
Pipe internal diameter	**372.0**	mm	0.37	m	single pump flow
Surface area	0.109	m2	15	inch	
Water velocity	3.202	m/s	0.0006	m	
Reynolds Number	1,183,991.11				
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	31.35	m/km			
Pipe dynamic loss	**0.00**	m			

Component fitting losses:	k value	fitting loss		
450 / 400 taper	0.03	0.02	m	check formulae when inserting rows
90 degree bend R=1D	0.75	0.39	m	
		0.00	m	
		0.00	m	
		0.00	m	
Total component losses		**0.41**	m	

Total dynamic loss in section **0.41** m

DYNAMIC LOSS CALCULATION — DN300 DICL K12
Pump Discharge Pipework (DN300 sections) [DN250 for Hidrostal]

Flow rate	1,252.8	m3/hr	0.35 m3/s	Flowrate	348.0 L/s
Pipe internal diameter	**313.0**	mm	0.31 m	single pump flow	
Surface area	0.077	m2	12 inch		
Water velocity	4.523	m/s	0.0006 m		
Reynolds Number	1,407,171.54				
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	77.60	m/km			
Pipe dynamic loss	**0.00**	m			

Component fitting losses:	k value	fitting loss	
300 / 450 taper	0.04	0.04 m	check formulae when inserting rows
		0.00 m	
		0.00 m	
		0.00 m	
		0.00 m	
Total component losses		**0.04** m	

Total dynamic loss in section **0.04** m

DYNAMIC LOSS CALCULATION — DN450 DICL K12
Pump Discharge Pipework (DN450 sections)

Flow rate	1,252.8	m3/hr	0.35 m3/s	Flowrate	348.0 L/s
Pipe internal diameter	**467.0**	mm	0.47 m	single pump flow	
Surface area	0.171	m2	18 inch		
Water velocity	2.032	m/s	0.0006 m		
Reynolds Number	943,136.39				
Roughness coefficient	**0.600**	mm	1.01E-06 m2/s		
Equivalent length of pipe	**5**	m			
Temperature	20	deg. C			
Kinematic viscosity	1.006	m2/s			
Hydraulic gradient	9.53	m/km			
Pipe dynamic loss	**0.05**	m			

Component fitting losses:	k value	fitting loss	
check valve (John Fig. 404)	0.63	0.13 m	pipe take off is for the most hydraulically disadvantaged configuration
gate valve (John Fig 694)	0.09	0.02 m	check formulae when inserting rows
tee - line to branch	0.80	0.17 m	
tee - branch to line	0.80	0.17 m	
knifegate valve	0.00	0.00	
check valve (John Fig. 404)	0.63	0.13	
450 / 500 taper	0.03	0.01 m	
Total component losses		**0.63** m	

Total dynamic loss in section **0.68** m

DYNAMIC LOSS CALCULATION — OD500 PE100 PN12.5
Pump Discharge Pipework (DN500 PE sections)

Flow rate	1,252.8	m3/hr	0.35 m3/s	Flowrate	348.0 L/s
Pipe internal diameter	**424.0**	mm	0.42 m	single pump flow	
Surface area	0.141	m2	17 inch		
Water velocity	2.465	m/s	0.0002 m		
Reynolds Number	1,038,784.65				
Roughness coefficient	**0.150**	mm	1.01E-06 m2/s		
Equivalent length of pipe	**20**	m			
Temperature	20	deg. C			
Kinematic viscosity	1.006	m2/s			
Hydraulic gradient	11.76	m/km			
Pipe dynamic loss	**0.24**	m			

Component fitting losses:	k value	fitting loss	
90 degree bend R=1D	0.75	0.23 m	check formulae when inserting rows
tee - line to branch	1.20	0.37 m	
		0.00 m	
		0.00 m	
		0.00 m	
Total component losses		**0.60** m	

Total dynamic loss in section	**0.84**	m	

DYNAMIC LOSS CALCULATION — OD508 MSCL 5 wall 12 CML
Pump Discharge Pipework (DN500 cut in section)

Flow rate	1,252.8	m3/hr	0.35 m3/s	**Flowrate**	**348.0** L/s
Pipe internal diameter	**474.0**	mm	0.47 m	single pump flow	
Surface area	0.176	m2	19 inch		
Water velocity	1.972	m/s	0.0006 m		
Reynolds Number	929,208.21				
Roughness coefficient	**0.600**	mm	1.01E-06 m2/s		
Equivalent length of pipe	**2**	m			
Temperature	20	deg. C			
Kinematic viscosity	1.006	m2/s			
Hydraulic gradient	8.82	m/km			
Pipe dynamic loss	**0.02**	m			

Component fitting losses:	k value	fitting loss		
90 degree bend R=1D	0.75	0.15	m	check formulae when inserting rows
gate valve (John Fig 694)	0.11	0.02	m	
tee - branch to line - sharp	1.20	0.24	m	
		0.00	m	
		0.00	m	
Total component losses		**0.41**	m	
Total dynamic loss in section		**0.43**	m	

PUMP DUTY CALCULATION — SP300 Serpentine Road Pinkenba

BWL in SPS	**(0.5)**	RL	Stop Duty A level in SPS Dimensions and Levels
Residual HGL in discharge main	**39.2**	RL	check latest version of EFPS 1370RM Hydraulics
Static head	**39.7**	m	
Total dynamic loss in suction	**0.6**	m	
Total dynamic loss in discharge	**0.5**	m	
Pump duty head	**40.8**	m	
Pump efficiency	67	percent	
Pump shaft power	**208**	kW	
Selected pump	Flygt CT3312 / 580mm / 250kW		

NPSH CALCULATION — SP300 Serpentine Road Pinkenba

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	**(0.6)**	RL	nominally 100mm below Stop Duty A
BWL on suction side	**(0.5)**	RL	Stop Duty A
Surface pressure head	**10.3**	m	normal atmospheric pressure 10.34m
Temperature	20	deg. C	
Vapour pressure	**0.2**	m	
Loss in suction	**0.6**	m	from block above
NPSH Available	**9.6**	m	
NPSH Required	**3.0**	m	from pump curve at the operating point
Safety Margin	**6.6**	m	positive is OK (prefer >1)

High System Curve

Single Pump Flow L/s	Duty Head m
	40.8
1	39.7
20	39.7
50	39.7
100	39.8
150	39.9
200	40.1
250	40.3
300	40.5
320	40.6
340	40.8
347.5	40.8
360	40.9
400	41.2
420	41.3

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PB Job Code: 2138110B

DYNAMIC LOSS CALCULATION — DN500 DICL K12
Pump Suction Pipework (DN500 sections)

Flow rate	1,252.8	m3/hr	0.35	m3/s	Flowrate 348.0	L/s
Pipe internal diameter	**518.0**	mm	0.52	m	single pump flow (year 2031)	
Surface area	0.211	m2	20	inch	pipes for Ultimate (378 L/s)	
Water velocity	1.651	m/s	0.0006	m		
Reynolds Number	850,279.33					
Roughness coefficient	**0.600**	mm	1.01E-06	m2/s		
Equivalent length of pipe	**1**	m				
Temperature	20	deg. C				
Kinematic viscosity	1.006	m2/s				
Hydraulic gradient	5.55	m/km				
Pipe dynamic loss	**0.01**	m				

Component fitting losses:	k value	fitting loss		
bellmouth inlet	0.05	0.01	m	check formulae when inserting rows
90 degree bend R=1D	0.75	0.10	m	
		0.00	m	
		0.00	m	
		0.00	m	
Total component losses		**0.11**	m	
Total dynamic loss in section		**0.12**	m	

DYNAMIC LOSS CALCULATION — DN450 DICL K12
Pump Suction Pipework (DN450 sections)

Flow rate	1,252.8	m3/hr	0.35	m3/s	Flowrate 348.0	L/s
Pipe internal diameter	**467.0**	mm	0.47	m	single pump flow	
Surface area	0.171	m2	18	inch		
Water velocity	2.032	m/s	0.0006	m		
Reynolds Number	943,136.39					
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	9.53	m/km				
Pipe dynamic loss	**0.00**	m				

Component fitting losses:	k value	fitting loss		
500 / 450 taper	0.03	0.01	m	check formulae when inserting rows
gate valve (John Fig 694)	0.10	0.02	m	
		0.00	m	
		0.00	m	
		0.00	m	
Total component losses		**0.03**	m	
Total dynamic loss in section		**0.03**	m	

DYNAMIC LOSS CALCULATION — OD406 MSCL 5 wall 12 CML
Pump Suction Pipework (DN400 sections)

Flow rate	1,252.8	m3/hr	0.35	m3/s	Flowrate 348.0	L/s
Pipe internal diameter	**372.0**	mm	0.37	m	single pump flow	
Surface area	0.109	m2	15	inch		
Water velocity	3.202	m/s	0.0006	m		
Reynolds Number	1,183,991.11					
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	31.35	m/km				
Pipe dynamic loss	**0.00**	m				

Component fitting losses:	k value	fitting loss		
450 / 400 taper	0.03	0.02	m	check formulae when inserting rows
90 degree bend R=1D	0.75	0.39	m	
		0.00	m	
		0.00	m	
		0.00	m	
Total component losses		**0.41**	m	

Total dynamic loss in section		**0.41** m			

DYNAMIC LOSS CALCULATION — **DN300 DICL K12**
Pump Discharge Pipework (DN300 sections) [DN250 for Hidrostal]

Flow rate	1,252.8 m3/hr	0.35 m3/s	Flowrate	348.0 L/s
Pipe internal diameter	**313.0** mm	0.31 m	single pump flow	
Surface area	0.077 m2	12 inch		
Water velocity	4.523 m/s	0.0006 m		
Reynolds Number	1,407,171.54			
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	77.60 m/km			
Pipe dynamic loss	**0.00** m			

Component fitting losses:	k value	fitting loss	
300 / 450 taper	0.04	0.04 m	check formulae when inserting rows
		0.00 m	
		0.00 m	
		0.00 m	
		0.00 m	
Total component losses		**0.04** m	
Total dynamic loss in section		**0.04** m	

DYNAMIC LOSS CALCULATION — **DN450 DICL K12**
Pump Discharge Pipework (DN450 sections)

Flow rate	1,252.8 m3/hr	0.35 m3/s	Flowrate	348.0 L/s
Pipe internal diameter	**467.0** mm	0.47 m	single pump flow	
Surface area	0.171 m2	18 inch		
Water velocity	2.032 m/s	0.0006 m		
Reynolds Number	943,136.39			
Roughness coefficient	**0.600** mm	1.01E-06 m2/s		
Equivalent length of pipe	**5** m			
Temperature	20 deg. C			
Kinematic viscosity	1.006 m2/s			
Hydraulic gradient	9.53 m/km			
Pipe dynamic loss	**0.05** m			

Component fitting losses:	k value	fitting loss	pipe take off is for the most hydraulically disadvantaged configuration
check valve (John Fig. 404)	0.63	0.13 m	check formulae when inserting rows
gate valve (John Fig 694)	0.09	0.02 m	
tee - line to branch	0.80	0.17 m	
tee - branch to line	0.80	0.17 m	
knifegate valve	0.00	0.00	
check valve (John Fig. 404)	0.63	0.13	
450 / 500 taper	0.03	0.01 m	
Total component losses		**0.63** m	
Total dynamic loss in section		**0.68** m	

DYNAMIC LOSS CALCULATION — **OD500 PE100 PN12.5**
Pump Discharge Pipework (DN500 PE sections)

Flow rate	1,252.8 m3/hr	0.35 m3/s	Flowrate	348.0 L/s
Pipe internal diameter	**424.0** mm	0.42 m	single pump flow	
Surface area	0.141 m2	17 inch		
Water velocity	2.465 m/s	0.0002 m		
Reynolds Number	1,038,784.65			
Roughness coefficient	**0.150** mm	1.01E-06 m2/s		
Equivalent length of pipe	**20** m			
Temperature	20 deg. C			
Kinematic viscosity	1.006 m2/s			
Hydraulic gradient	11.76 m/km			
Pipe dynamic loss	**0.24** m			

Component fitting losses:	k value	fitting loss	
90 degree bend R=1D	0.75	0.23 m	check formulae when inserting rows
tee - line to branch	1.20	0.37 m	
		0.00 m	
		0.00 m	
		0.00 m	
Total component losses		**0.60** m	

Total dynamic loss in section		**0.84**	m		

DYNAMIC LOSS CALCULATION — OD508 MSCL 5 wall 12 CML
Pump Discharge Pipework (DN500 cut in section)

Flow rate		1,252.8	m3/hr	0.35	m3/s	Flowrate 348.0 L/s
Pipe internal diameter		**474.0**	mm	0.47	m	single pump flow
Surface area		0.176	m2	19	inch	
Water velocity		1.972	m/s	0.0006	m	
Reynolds Number		929,208.21				
Roughness coefficient		**0.600**	mm	1.01E-06	m2/s	
Equivalent length of pipe		**2**	m			
Temperature		20	deg. C			
Kinematic viscosity		1.006	m2/s			
Hydraulic gradient		8.82	m/km			
Pipe dynamic loss		**0.02**	m			
Component fitting losses:	k value	fitting loss				
90 degree bend R=1D	0.75	0.15	m	check formulae when inserting rows		
gate valve (John Fig 694)	0.11	0.02	m			
tee - branch to line - sharp	1.20	0.24	m			
		0.00	m			
		0.00	m			
Total component losses		**0.41**	m			
Total dynamic loss in section		**0.43**	m			

PUMP DUTY CALCULATION — SP300 Serpentine Road Pinkenba

BWL in SPS	**(0.5)**	RL	Stop Duty A level in SPS Dimensions and Levels
Residual HGL in discharge main	**7.3**	RL	static level at inlet to LPWWTP with no flow down DN1840
Static head	**7.8**	m	
Total dynamic loss in suction	**0.6**	m	
Total dynamic loss in discharge	**0.5**	m	
Pump duty head	**8.9**	m	
Pump efficiency	67	percent	
Pump shaft power	**45**	kW	
Selected pump	Flygt CT3312 / 580mm / 250kW		

NPSH CALCULATION — SP300 Serpentine Road Pinkenba

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	**(0.6)**	RL	nominally 100mm below Stop Duty A
BWL on suction side	**(0.5)**	RL	Stop Duty A
Surface pressure head	**10.3**	m	normal atmospheric pressure 10.34m
Temperature	20	deg. C	
Vapour pressure	**0.2**	m	
Loss in suction	**0.6**	m	from block above
NPSH Available	**9.6**	m	
NPSH Required	**3.0**	m	from pump curve at the operating point
Safety Margin	**6.6**	m	positive is OK (prefer >1)

Low System Curve

Single Pump Flow L/s	Duty Head m
	8.9
1	7.8
20	7.8
50	7.9
100	7.9
150	8.0
200	8.2
250	8.4
300	8.7
320	8.8
340	8.9
347.5	8.9
360	9.0
400	9.3
420	9.4

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Client: Brisbane Water
Project: Australia Trade Coast Sewerage Project
PB Job Code: 2138110B

MAXIMUM PUMP STARTS CALCULATION - SP 300

Duty Pump Rate	200	L/s	use maximum turned down flow - from pump performance curves
Inflow rate	100	L/s	worst case inflow = half duty pump discharge rate
Wet well diameter	[illegible]	m	not used for rectangular wells
Wet well benching width	[illegible]	m	Hydrotec
Wet well benching length	[illegible]	m	Hydrotec
Effective wet well area	[illegible]	m2	calculated
Start Duty A [illegible]	[illegible]	m	from SPS dimensions and levels
Stop Duty A	[illegible]	m	from SPS dimensions and levels

Wet well plan area	[illegible]	[illegible]	from wet well dimensions above
Duty Pump Pumping Rate	200	[illegible]	from above
Time for one pumping cycle	[illegible]	min	goal seek this to 6 minutes by changing the normal pump cut out level on SPS dimensions and level
[illegible]	[illegible]	starts per hour	Weir: "adopt 10 starts per hour" although cut out will occur at min speed
Total average pump running time	[illegible]	minutes per hour	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.

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Client: Brisbane Water
Project: Australia Trade Coast Sewerage Project
PB Job Code: 2138110B

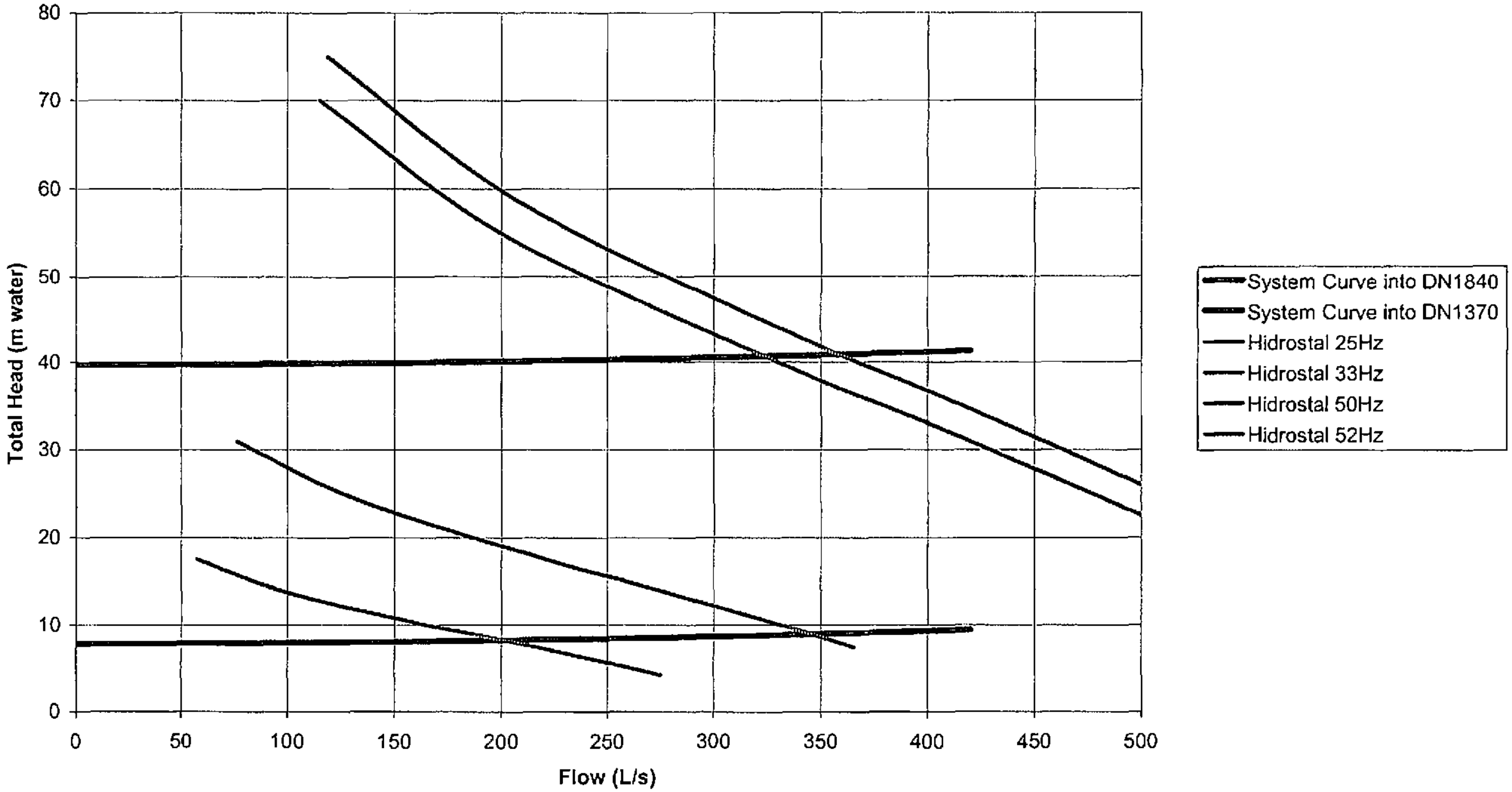
PUMP PERFORMANCE DATA
SP 300 - Serpentine Rd

Pump Type	Hidrostal I10K-M
Curve No.	84-K3183b
Imp. Diameter.	
Rated Power	216 kW

derived from spreadsheet provided by Weir

Hidrostal 25Hz		Hidrostal 33Hz		Hidrostal 50Hz		Hidrostal 52Hz	
L/s	Total Hd	L/s	Total Hd	L/s	Total Hd	L/s	Total Hd
57.5	17.5	76.40411	30.89839	115	70	118.9384	74.87662

SP 300 (Serpentine Rd) - Performance Curves - One Hidrostal I10K-M / 216kW



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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.

PARSONS BRINCKERHOFF

Appendix D

Odour and Septicity Study

independent Sewer Consulting Services Pty Ltd

THE ODOUR UNIT

PARSONS BRINCKERHOFF

AUSTRALIA TRADE COAST SEWER PROJECT

ODOUR AND SEPTICITY STUDY

FINAL REPORT

SEPTEMBER 2004

PROJECT: 1180

independent sewer consulting services

THE ODOUR UNIT

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Project Number: 1180

Report Revision

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The Odour Unit Pty Ltd and Independent Sewer Consulting Services Pty Ltd	
Prepared By: D. Bentink and G. Chipman	Approved By: T. Schulz
Parsons Brinckerhoff – Australia Trade Coast Sewer Project: Odour and Septicity Study	

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THE ODOUR UNIT

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THE ODOUR UNIT

1.0 INTRODUCTION

The Odour Unit Pty Ltd (TOU) was commissioned by Parsons Brinckerhoff (PB) to provide a review of odour and septicity information with respect to planned upgrades to the sewage network for the Australian Trade Coast Sewer Project in Brisbane, Queensland.

PB requested that the odour and septicity study include:

- A review of liquid and gas phase test results provided by Brisbane Water.
- Determination of odour generation for the three proposed pump stations – Lytton Road (SP298), Viola Place (SP299) and Serpentine Road (SP300).
- Air dispersion modelling of predicted odour emissions from SP300.
- Recommendations to reduce odours at the three proposed pump station sites.
- A review of PB nominated odour control measures and recommendations on preferred equipment.

Due to the preliminary nature of the data collected, detailed recommendations on chemical dosing rates were considered beyond the scope of this study.

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2.0 GAS PHASE TESTING RESULTS

It should be noted that the following review is solely based on the data provided. No information has been supplied on calibration or response testing of the equipment used to collect the data reviewed. All gas phase testing and monitoring data is contained in **Appendix A**.

2.1 KINGSFORD SMITH DRIVE PUMP STATION SP146

Hydrogen sulphide (H_2S) monitoring data was logged over a 7-day period from 28/6/04 to 5/7/04 inclusive. **Table 2-1** provides a 24 hour breakdown of maximum, minimum and average H_2S concentrations as well as the percentage of H_2S readings less than 1ppm recorded during each 24 hour period.

Two major peaks dominate with H_2S levels recording 160.4ppm and 203.9ppm. The peak of 160.4ppm was recorded at approximately 6:30pm on 2/7/04. Hydrogen sulphide levels began increasing above background levels at approximately 5:15pm up to a peak of 55.6ppm just after 5:20pm, before falling below average levels for the day at 6:00pm. Shortly after, H_2S levels again began to increase rapidly at 6:15pm before reaching the peak of 160.4ppm at 6:30pm. Levels again then gradually decreased to below average concentrations for the day by 7:45pm. This would indicate a sudden influx or evolution of hydrogen sulphide from an odorous effluent source, rather than a gradual increase associated with generation by biological action within the pump station wet well.

On days not experiencing the two high peaks, maximum H_2S levels ranged from 8.0ppm to 27.2ppm while average H_2S levels ranged from 0.7ppm to 1.7ppm. Levels on these days were less than 1ppm for between 49.8% and 85.6% of the time.

With the exception of the days experiencing the two high peaks, it could be expected that occasional odour complaints would be experienced due to the maximum hydrogen sulphide levels recorded. It would be desirable to achieve a level of H_2S of less than 1ppm for 90% of readings during any 7 day monitoring period. The two days experiencing high H_2S levels recorded in SP146 would likely result in significant odour complaints and are of concern with respect to Occupational Health & Safety of personnel working in and around the pump station. Exposure standards for H_2S as reported in Sydney Water Corporation confined spaces training manual (August 2001) are a Time Weighted Average (TWA) of 10ppm, a Short Term Exposure Limit (STEL) of 15ppm and an Immediately Dangerous to Life or Health (IDLH) level of 100ppm. In addition to odour issues, corrosion of assets would be of concern within SP146. It is advised that the sources of odorous effluent generating the high peaks be identified and measures taken to eliminate or treat these sources prior to discharge into the sewage network. Gas phase treatment at SP146 and/or liquid phase dosing upstream of SP146 would also be required to reduce concentrations of H_2S associated with domestic sewage loads.

Table 2-1: Hydrogen Sulphide Monitoring Data Kingsford Smith Drive Pump Station SP146				
24hr Period	Max. (ppm)	Min. (ppm)	Avg. (ppm)	% ≤ 1ppm
28/6/04 08:01 - 29/6/04 08:00	27.2	0.0	1.2	72.5%
29/6/04 08:01 - 30/6/04 08:00	18.6	0.0	1.7	60.8%
30/6/04 08:01 - 1/7/04 08:00	18.5	0.0	1.5	64.4%
1/7/04 08:01 - 2/7/04 08:00	8.0	0.0	0.7	85.6%
2/7/04 08:01 - 3/7/04 08:00	160.4	0.1	6.6	52.3%
3/7/04 08:01 - 4/7/04 08:00	203.9	0.6	15.8	12.8%
4/7/04 08:01 - 5/7/04 08:00	22.3	0.3	1.7	49.8%

2.2 PRITCHARD STREET PUMP STATION SP85

As for SP146, H_2S was also logged at Pritchard Street Pump Station SP85 over a 7-day period from 28/6/04 to 5/7/04 inclusive. **Table 2-2** provides a 24 hour breakdown of maximum, minimum and average H_2S concentrations as well as the percentage of H_2S readings less than 1ppm recorded during each 24 hour period.

There appears to be a relatively low presence of hydrogen sulphide at SP85 with a maximum H_2S level recorded of 2.0ppm approximately 10 minutes after commencement of the logging period. Concentrations then quickly decreased to 0.0ppm within approximately 15 minutes of the peak being recorded. Another peak of 1.4ppm was recorded at 10:40am on 2/7/04 with low H_2S levels being recorded for approximately 1 hour. H_2S was again recorded between 11:45pm on 2/7/04 and approximately 6:00am on 3/7/04, however levels recorded peaked at 0.5ppm during this period. Based on the monitoring data provided, it would be considered unlikely that significant odour complaints or high rates of corrosion would be observed at SP85. It should be noted that while H_2S is typically used as an indicator for problematic sewage odours, an absence of H_2S does not mean there will not be other odorous compounds present or which may develop at some future date with expansion or changes to the sewage network. It may be advisable to provide space for and include a gas phase treatment system (eg. small biofilter).

Table 2-2: Hydrogen Sulphide Monitoring Data Pritchard Street Pump Station SP85				
24hr Period	**Max. (ppm)**	**Min. (ppm)**	**Avg. (ppm)**	**% ≤ 1ppm**
28/6/04 09:07 - 29/6/04 09:06	2.0	0.0	0.0	99.4%
29/6/04 09:07 - 30/6/04 09:06	0.0	0.0	0.0	100.0%
30/6/04 09:07 - 1/7/04 09:06	0.1	0.0	0.0	100.0%
1/7/04 09:07 - 2/7/04 09:06	0.1	0.0	0.0	100.0%
2/7/04 09:07 - 3/7/04 09:06	1.4	0.0	0.1	99.3%
3/7/04 09:07 - 4/7/04 09:06	0.1	0.0	0.0	100.0%
4/7/04 09:07 - 5/7/04 09:06	0.0	0.0	0.0	100.0%

2.3 KIANAWAH ROAD PUMP STATION SP49

Kianawah Road Pump Station SP49 also had continuous H_2S data recorded from 28/6/04 to 5/7/04 inclusive. **Table 2-3** provides a 24 hour breakdown of maximum, minimum and average H_2S concentrations as well as the percentage of H_2S readings less than 1ppm recorded during each 24 hour period.

The monitoring data shows a regular diurnal pattern of H_2S with maximums ranging from 33.1ppm to 50.1ppm during the monitoring period while average H_2S levels ranged from 11.7ppm to 15.4ppm. Typically, H_2S levels recorded lows from approximately 8:00am to 10:00am each day while maximum levels were recorded during late afternoon and overnight periods. Were significant emission rates of odorous air to be released from SP49, the levels of H_2S recorded would be expected to result in regular ongoing odour complaints from nearby receptors while the relatively constant presence of H_2S would be expected to lead to significant corrosion of assets in and around SP49.

Table 2-3: Hydrogen Sulphide Monitoring Data Kianawah Road Pump Station SP49				
24hr Period	**Max. (ppm)**	**Min. (ppm)**	**Avg. (ppm)**	**% ≤ 1ppm**
28/6/04 06:10 - 29/6/04 06:09	39.5	0.0	12.9	0.7%
29/6/04 06:10 - 30/6/04 06:09	33.1	1.9	13.3	0.0%
30/6/04 06:10 - 1/7/04 06:09	48.2	2.7	13.9	0.0%
1/7/04 06:10 - 2/7/04 06:09	50.1	3.2	15.4	0.0%
2/7/04 06:10 - 3/7/04 06:09	33.1	2.6	12.8	0.0%
3/7/04 06:10 - 4/7/04 06:09	37.7	2.0	12.2	0.0%
4/7/04 06:10 - 5/7/04 06:09	35.5	2.3	11.7	0.0%

3.0 LIQUID PHASE TESTING RESULTS

A review of liquid phase testing data (SAS Laboratory Reports – Batch No 04/05294 04/05297 and 04/05317) noted that the analysis reported results for Kianawah Road SP49 wet well and Kingsford Smith Drive SP49 wet well. For the purposes of this review, it is assumed that the labelling of Kingsford Smith Drive SP49 is an error and should read Kingsford Smith Drive SP146. Temperature and pH results for the 30/6/04 (Batch No 04/05297) also appear to have a transposing error. As was the case for gas phase sampling, the liquid phase sampling methods and handling are not reported in the following discussion.

Three sets of grab samples were each taken from six locations on 28/6/04, 30/6/04 and 2/7/04. The liquid phase data is appended as **Appendix B.**

3.1 KIANAWAH ROAD PUMP STATION SP49 AND SCOUR

28 JUNE 2004

Samples taken at 6:00am and 7:20am from the SP49 wet well and the downstream scour indicate alkaline sewage with pH of 8.0 and 8.1 recorded respectively. Sewage temperatures were recorded as 20.7°C and 19.9°C respectively. Low to average domestic sewage BOD levels of 150mg/L and 180mg/L were recorded and COD levels of 420mg/L and 470mg/L recorded respectively. As would be expected, total and soluble sulphide levels increased from the wet well to the scour, however the levels reported are not considered high. Sulphate levels in domestic sewage are typically less than 100mg/L, however levels reported from the wet well and the scour were 310mg/L and 330mg/L respectively, which appears higher than normal for domestic sewage. Sulphate is generally not the rate limiting step in sulphide generation, however for long residence times and high BOD loads, it is possible for the sulphate to be exhausted. Dimethyl sulfide (DMS) was also measured at the wet well with 1ppm recorded.

Samples taken at 11:15am and 12:00pm indicate a slight reduction in sewage pH from the earlier samples with 7.8 recorded at both locations. Sewage temperatures were higher with 23.6°C and 23.3°C reported respectively. BOD levels reported were similar to the earlier samples with 190mg/L reported at both locations and COD was reported as 500mg/L and 520mg/L respectively. Total sulphides at both locations and soluble sulphides at the wet well had (approximately) doubled from the earlier samples while soluble sulphide measured at the scour was similar to the earlier sample. Sulphate levels reported were higher than earlier samples with 340mg/L and 470mg/L recorded. DMS measured at the wet well increased from the earlier sample to 7.5ppm and represents a similar increase in H_2S logged at SP49.

Samples taken at 4:00pm and 4:45pm have similar sewage pH to the samples taken at midday with 7.8 and 7.7 recorded respectively. Sewage temperatures were slightly lower than the midday samples, however were still elevated from the early morning samples. BOD levels were similar to earlier samples with 220mg/L and 180mg/L reported while COD was reported as 550mg/L and 440mg/L.

Total sulphide levels measured were found to have increased from the midday samples with 0.91mg/L and 1.1mg/L reported respectively while soluble sulphide levels at both sites had also significantly increased from the earlier samples with 0.94mg/L and 0.92mg/L reported. Sulphate levels recorded were lower than midday samples with 360mg/L and 370mg/L recorded. DMS measured at the wet well was significantly higher with >15ppm recorded which again correlates well with similar increases in H_2S levels recorded at the wet well.

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Samples taken at 7:45am and 8:35am were similar to samples taken on the 28/6/04 with alkaline sewage pH's in the morning recording 8.3 and 8.2 respectively. Sewage temperatures were also within the range reported from 28/6/04 with 19.5°C and 20.8°C recorded. BOD levels were slightly higher (290mg/L and 210mg/L respectively) as were COD levels (670 mg/L and 540mg/L). Similarly, total sulphide and soluble sulphide levels were higher than the morning samples from 28/6/04. Sulphate levels reported were significantly lower with 80mg/L and 79mg/L recorded respectively at the SP49 wet well and the scour. A DMS concentration from the wet well was recorded as 3ppm.

Samples taken at 1:00pm and 1:45pm follow a similar trend to the samples on 28/6/04 with sewage pH decreasing to 7.7 for both samples while sample temperatures increased slightly to 21.5°C and 20.9°C. BOD levels were similar to the morning samples with 280mg/L and 230mg/L reported respectively. COD levels were recorded as 570mg/L and 560mg/L. Total sulphides were similar to morning samples while soluble sulphide levels were slightly lower recording 0.48mg/L and 0.77mg/L respectively. Sulphates measured were again considerably lower than the 28/6/04 with 54mg/L and 90mg/L reported. DMS was recorded as >15ppm.

Samples taken at 5:45pm and 6:45pm reported a further decrease in sewage pH with 7.3 reported at both sites. Sewage temperatures were similar to earlier samples with 20.5°C and 20.7°C reported. BOD levels reported are again typical of domestic sewage with 290mg/L and 230mg/L reported while COD was reported as 540mg/L and 440mg/L respectively. Total sulphides were similar to earlier samples while soluble sulphides were slightly higher than the midday samples with 0.66mg/L and 0.93mg/L reported. Sulphates were noted to be significantly lower than recorded on 28/6/04. DMS was again measured at >15ppm.

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Samples taken during the morning of 2/7/04 follow a similar pattern to the two earlier days with alkaline sewage pH recorded as 8.3 and 8.0 respectively. Sewage temperatures were recorded as 21.9°C and 21.8°C respectively. BOD was similar to earlier samples at the wet well but slightly higher at the scour with 240mg/L and 390mg/L reported respectively. Similarly, COD was recorded as 600mg/L at the wet well and 910mg/L at the scour. Total sulphides were similar to the morning samples taken on 30/6/04 but higher than morning samples taken on 28/6/04 with 0.82mg/L and 1.2mg/L recorded. Soluble sulphides were similar to earlier samples with 0.35mg/L and 0.71 mg/L recorded. Sulphate levels were again lower than samples taken on 28/6/04 with 61mg/L and 54mg/L recorded respectively. DMS measured from the wet well was recorded as 7ppm.

Samples taken approximately at midday follow a similar trend to earlier samples with sewage pH decreasing to 7.8 and 7.5 respectively while sewage temperatures were similar with 21.4°C and 21.2°C reported. BOD samples were significantly lower than morning samples with 190mg/L and 210mg/L reported while COD was also lower with 450mg/L and 440mg/L recorded. Total sulphides were higher than morning samples with 0.96mg/L and 1.5mg/L recorded respectively. Soluble sulphides were recorded as 0.5mg/L and 1.2mg/L at the SP49 wet well and scour respectively. Sulphates were again low with 60mg/L and 52mg/L recorded. DMS from the wet well was recorded as >15ppm.

Samples taken in the afternoon follow similar patterns to earlier samples with sewage pH continuing to decrease to levels of 7.6 and 7.4 respectively. Temperatures also decreased with 20.5°C and 19.7°C recorded. BOD was recorded as 230mg/L for both samples while COD was recorded as 430mg/L and 450mg/L respectively. Total sulphides were similar to earlier samples with 0.54mg/L and 1.2mg/L recorded while soluble sulphides at SP49 were low with <0.1mg/L recorded. Soluble sulphides at the scour were recorded as 0.77mg/L. Sulphates were slightly higher than earlier samples at the SP49 wet well with 120mg/L recorded while 50mg/L was reported from the scour. DMS was recorded as >15ppm.

KIANAWAH ROAD SUMMARY

Sewage pH tended to be higher earlier in the morning with readings typically higher than 8.0 which then decreased during the course of the day at both SP49 and the scour to levels of approximately 7.4. As expected, sewage temperatures increased during the day before typically holding or falling during the afternoon. BOD and COD levels were relatively consistent with the exception of the sample taken at the scour at midday on the 2/7/04, which was slightly higher than typical domestic sewage BOD loadings. Sulphates were higher than what would be expected from typical domestic sewage for the samples taken on 28/6/04, however these levels were found to have decreased significantly when recorded from the subsequent sampling days which followed. Total and soluble sulphides levels tended to increase during the day with higher levels found at the scour than at the pump station. DMS levels also tended to increase during the day which correlates well with the continuous H_2S profiles recorded during the period.

Hydrogen sulphide monitoring at SP49 and the liquid phase testing results suggests that sewage entering the network upstream of SP49 has become anaerobic and generated sufficient soluble sulphides to cause hydrogen sulphide release upstream and into the SP49 wet well. It would be expected that downstream of SP49 and the scour, sulphide generation and H_2S release would be of concern. Chemical dosing upstream of SP49 would be expected to reduce sulphide levels in sewage and hydrogen sulphide generation in the network, at SP49 and also downstream of the pump station. Alkali dosing may be required to ensure the sewage pH is maintained at levels greater than 7.0 which would assist in reducing the potential for H_2S evolution and consequently protect those assets in contact with sewage.

3.2 KINGSFORD SMITH DRIVE PUMP STATION SP146 AND SCOUR

28 JUNE 2004

Samples taken at 8:00am and 8:35am from the SP146 wet well and the downstream scour indicate an alkaline sewage with pH of 8.8 and 8.9 recorded respectively. Sewage temperatures were recorded as 21.3°C and 21.5°C respectively. Low BOD levels of 77mg/L and 61mg/L were recorded while COD of 270mg/L and 240mg/L were recorded respectively. Total and soluble sulphide levels were low at both the wet well and the downstream scour. Conversely, sulphate levels reported from the wet well and the scour were very high recording 1500mg/L and 1600mg/L respectively indicating the influence of an industrial load on the sewage at SP146.

Samples taken at 1:00pm and 1:45pm show a decrease in sewage pH from the earlier samples with 7.6 and 7.9 recorded respectively. Sewage temperatures were slightly higher with 22.7°C and 23.1°C respectively. BOD levels were again low with 82mg/L and 71mg/L recorded while COD was slightly higher with 350mg/L and 280mg/L recorded respectively. Total sulphides were higher than the earlier samples with 0.74mg/L and 0.33mg/L recorded. Soluble sulphides were negligible with 0.11mg/L and <0.10mg/L reported. Significantly, sulphate levels reported from the wet well and the scour were again very high with 1200mg/L and 1500mg/L reported. DMS at SP146 was reported as 1ppm.

Samples taken at 5:45pm and 6:30pm show similar pH to the midday samples with 7.5 and 7.6 recorded respectively. Sewage temperatures were also similar measuring 21.8°C and 21.2°C respectively. BOD levels remained low with 53mg/L and 50mg/L recorded while COD was slightly higher at SP146 measuring 410mg/L but lower at the scour with 260mg/L recorded. Total sulphides were slightly higher with 0.87mg/L and 0.98mg/L recorded. Soluble sulphides were also higher at SP146 but remained low at the scour with <0.10mg/L reported. Sulphate levels reported from the wet well and the scour maintained high levels with 1300mg/L and 1400mg/L reported. DMS at SP146 increased from the morning sample with 5ppm recorded.

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Samples taken at 6:00am and 7:10am indicate significantly lower sewage pH with 7.8 and 6.9 recorded respectively. Sewage temperatures were recorded as 22.3°C and 20.6°C respectively. BOD levels were similarly low to those taken on 28/6/04 with 56mg/L and 31mg/L recorded while COD levels of 200mg/L and 180mg/L were recorded respectively. Total and soluble sulphide levels were low at both the wet well and the downstream scour. Sulphate levels reported from the wet well and the scour again reported high levels of 1,700mg/L and 1800mg/L.

Samples taken at 11:15am and 12:15pm reported sewage pH's of 7.3 at both sites. Sewage temperatures were similar to earlier samples with 22.4°C and 22.0°C respectively. BOD levels were lower with 37mg/L and 33mg/L recorded while COD was similar with 200mg/L recorded for both samples. Total sulphides and soluble sulphides were again low reporting <0.10mg/L. Sulphate levels reported from the wet well and the scour were again very high with 1500mg/L reported for both samples. The data suggests that there is negligible change

in sewage conditions between SP 146 and the downstream scour. DMS at SP146 was reported as 5ppm.

Samples taken at 4:00pm and 4:45pm show slightly lower pH than the midday samples with 7.2 and 7.1 recorded respectively. Sewage temperatures were also slightly lower measuring 20.5°C and 21.2°C respectively. BOD levels were higher recording 65mg/L and 100mg/L while COD was similar when compared to the midday sample for SP146 (200mg/L) however higher at the scour where 460mg/L was recorded. Total sulphides were recorded as 0.66mg/L and 0.68mg/L respectively. Soluble sulphides remained low at the wet well and scour with <0.10mg/L reported. Sulphate levels were higher with 2000mg/L and 1400mg/L reported respectively. DMS at SP146 decreased from the earlier sample with 3ppm reported.

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Samples taken in the morning reported sewage pH's of 8.5 and 8.6 respectively. Sewage temperatures were recorded as 23.0°C and 23.3°C respectively. BOD levels were again low with 84mg/L and 67mg/L recorded while COD of 180mg/L and 240mg/L were recorded respectively. Total and soluble sulphide levels were low at both the wet well and the downstream scour with <1.0mg/L reported for both sites. High sulphate levels were still present with the wet well and the scour recording 1500mg/L and 1700mg/L. DMS measured at SP146 was high recording >15ppm.

Samples taken at midday reported lower sewage pH's than the morning samples with 7.0 and 7.4 recorded. Sewage temperatures were slightly higher measuring 24.3°C and 23.2°C respectively. BOD levels were recorded as 130mg/L and 62mg/L while COD levels were 220mg/L and 300mg/L. Total sulphides were slightly higher than the morning samples with 0.39mg/L and 0.53mg/L recorded while soluble sulphides remained low at <0.10mg/L for both sites. Sulphates were again high measuring 1500mg/L and 1400mg/L and DMS at SP146 was also high reporting >15ppm.

Samples taken in the afternoon show slightly higher pH's than the midday sample with 7.4 and 7.5 recorded respectively. Sewage temperatures measured 25.0°C and 23.1°C respectively. BOD levels were similar to the midday samples with 100mg/L and 95mg/L recorded while COD was recorded as 190mg/L and 210mg/L. Total sulphides were recorded as 0.73mg/L and 0.45mg/L respectively. Soluble sulphides were higher at SP146 with 0.73mg/L recorded while at the scour <0.10mg/L was reported. Sulphate levels reported from the wet well and the scour were higher at 1700mg/L and 1600mg/L respectively. DMS measured at SP146 was again recorded at >15ppm.

KINGSFORD SMITH DRIVE SUMMARY

Sewage pH's were found to be high at times, primarily for the early morning samples while BOD and COD levels were typically very low. Soluble and total sulphides were typically found to be very low during the early morning but appeared to increase throughout the day.

SP146 appears to have a strong influence of industrial effluent with very high sulphate levels recorded for all samples. DMS levels tended to be typically higher with numerous readings greater than 15ppm recorded. While sulphate levels are very high, the relatively low BOD and COD levels may help reduce the formation of sulphides, however, where significant detention times occur within rising mains and/or BOD levels are increased, problematic levels of sulphide generation would be expected.

3.3 PRITCHARD STREET PUMP STATION SP85 AND SCOUR

28 JUNE 2004

The sample taken at 9:30am from the SP85 wet well indicates low sewage pH with 5.6 recorded. The sample taken at the downstream scour at 10:20am indicates a slightly alkaline sewage with pH of 7.4. Sewage temperatures were recorded as 20.2°C and 19.4°C respectively. BOD levels were recorded as 190mg/L and 420mg/L while COD of 670mg/L and 870mg/L were recorded respectively. Total sulphides were recorded as 0.77mg/L and 2.3mg/L at the wet well and scour respectively. Soluble sulphide levels were low at the wet well with <0.1mg/L reported and 0.42mg/L reported at the downstream scour. Sulphate levels reported from the wet well and the scour varied with 430mg/L reported at the wet well and 720mg/L reported at the scour. It is likely that the elevated sulphate levels are due to an industrial trade waste load received by SP85.

The sample taken from SP85 wet well at 2:15pm reported an increased sewage pH of 9.4 while the pH at the downstream scour decreased to 7.1 at 3:15pm. Sewage temperatures were reported as 21.0°C and 21.4°C which were slightly higher than the morning samples. BOD at SP85 was significantly higher than the morning sample with 5,500mg/L reported while the scour was similar to the morning sample, recording 460mg/L. This indicates a sudden influx of high BOD effluent, likely to be due to an industrial load received by SP85. COD measured at SP85 was similarly high with 10,000mg/L reported while the sample from the scour reported 1,200mg/L. Total sulphides at SP 85 were low with <0.1mg/L reported while the sample at the scour was recorded as 0.62mg/L. Soluble sulphides at both locations were low measuring 0.14mg/L and <0.1mg/L. Sulphates recorded 74mg/L and 390mg/L at SP85 and the scour respectively. DMS sampled at SP85 was reported as 2ppm.

The third set of samples taken at 7:30pm and 8:30pm showed pH levels to have decreased to 8.5 at SP85 from the earlier samples but increased at the scour to 8.4. Sewage temperatures were similar to the afternoon samples with 20.4°C and 19.7°C recorded respectively. BOD reported at SP85 was significantly lower than the afternoon sample and similar to the morning sample with 180 mg/L recorded while the sample at the scour recorded 3,400mg/L. Similarly, COD was lower at SP 85 with 530mg/L reported while 6,600mg/L was reported at the downstream scour. Total sulphides at SP85 was recorded as 0.43mg/L and was negligible at the scour. Soluble sulphide both at the scour and SP85 were reported as <0.1mg/L. Sulphates were reported as 580mg/L and 130mg/L respectively. DMS at SP85 measured the same as the earlier sample with 2ppm reported.

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Samples taken at 9:30am and 10:45am from the SP85 wet well and downstream scour indicate high sewage pH's with 8.9 and 10.8 recorded respectively. Sewage temperatures were recorded as 18.7°C and 19.5°C respectively. BOD levels were higher than domestic loads however were not as high as two days earlier, recording 2,600mg/L and 2,500mg/L respectively. Similarly, COD levels of 4,300mg/L and 3,900mg/L were recorded respectively. Total sulphides were low at both sites with 0.23mg/L and <0.1mg/L recorded. Soluble sulphide levels were also low with 0.19mg/L and <0.1mg/L reported respectively. Sulphate levels were 130mg/L and 90mg/L and DMS sampled at SP85 was reported as 1ppm.

The sample taken at SP85 wet well at 2:15pm reported a slight decrease in sewage pH with 8.6 recorded while the pH at the downstream scour decreased abnormally to 6.3. Sewage temperatures were similar to morning samples with 19.3°C and 20.5°C reported. BOD levels were higher than morning samples at both SP85 and the scour with 4,500mg/L reported at both locations. COD measured at SP85 was unusually low for this sample compared to typical trends with 270mg/L recorded while the sample from the scour reported 6,800mg/L. Total sulphides and soluble sulphides at both locations were very low with <0.1mg/L reported. Sulphates were reported as 200mg/L and 87mg/L at SP85 and the scour respectively. DMS sampled at SP85 was slightly higher than the morning sample with 2ppm reported.

Samples taken at 7:30pm and 8:40pm showed sewage pH at SP85 to be significantly lower than the afternoon sample with 6.5 recorded while the sample from the scour increased markedly with 10.2 reported. Sewage temperatures were similar to the afternoon samples with 19.5°C reported for both samples. BOD reported at both SP85 and the scour were significantly lower than earlier samples with 590mg/L and 1,100mg/L reported respectively. COD was reported as 1,300mg/L and 2,000mg/L respectively. Total sulphides and soluble sulphides at both locations were again very low with <0.1mg/L reported. Sulphates were reported as 600mg/L and 270mg/L and DMS at SP85 again increased slightly with 3ppm reported.

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Samples taken in the morning from the SP85 wet well and the downstream scour indicate neutral sewage pH's with 7.0 and 7.1 recorded respectively. Sewage temperatures were recorded as 17.7°C and 18.1°C. BOD levels were higher than expected domestic sewage loads and were recorded as 1,800mg/L and 2,600mg/L respectively. Similarly, COD levels of 3,000mg/L and 3,900mg/L were recorded. Total sulphides and soluble sulphides at both locations were again very low with <0.1mg/L reported. Sulphate levels were reported as 140mg/L and 190mg/L and DMS sampled at SP85 was reported as 1ppm.

Afternoon samples from the SP85 wet well and the downstream scour indicated lower sewage pH's than the morning samples with 6.5 and 6.8 recorded respectively. Sewage temperatures were slightly higher than morning samples with 18.8°C and 21.3°C reported. BOD levels were lower than morning samples with 910mg/L and 1,300mg/L reported respectively. COD was reported as 1,600mg/L and 2,200mg/L and again total sulphides and soluble sulphides at both locations were very low with <0.1mg/L. Sulphates were reported as 290mg/L and 250mg/L respectively. DMS was not reported for SP85.

Samples taken in the early evening showed sewage pH's were slightly higher than the afternoon samples with 6.9 and 7.1 recorded respectively. Sewage temperatures were recorded as 19.5°C and 19.8°C. BOD reported at both SP 85 and the scour were significantly lower than the afternoon and morning samples and were more representative of domestic sewage conditions with 160mg/L and 290mg/L reported respectively. Similarly, COD was reported as 530mg/L and 730mg/L. Total sulphides were reported as 0.19mg/L and 0.34mg/L while soluble sulphides at both locations were again very low with <0.1mg/L reported. Sulphates were higher with 830mg/L and 490mg/L reported while DMS sampled at SP85 was reported as 1ppm.

PRITCHARD STREET SUMMARY

Sewage received at SP85 shows significant variation within short periods of time that range from typical domestic sewage conditions to those characteristic of high strength industrial loads. This indicates that SP85 is subjected to short duration surges of industrial discharges. The high BOD levels reported would be expected to result in significant generation of sulphides at downstream locations. Moreover, where sewage becomes anaerobic, and considering the pattern of discharge, this would be likely to result in short term high levels of hydrogen sulphide at the proposed downstream pump stations SP298, SP300 and possibly at Luggage Point Waste Water Treatment Plant depending on dilution within the sewage network.

There appears to be no strong diurnal correlation with pH, BOD and COD loads varying significantly at different times. Low soluble and total sulphides reported at SP85 would indicate a low likelihood of H_2S at SP85 which is supported by the H_2S wet well data described earlier. While there would appear to be no significant problems with odour generation at SP85, sewage conditions and residence times would indicate a high potential for the generation of H_2S at downstream locations for the aforementioned reasons. It is unlikely that gas phase treatment at SP85 is required, however chemical dosing to prevent sulphide generation downstream would be advised. Prior to implementing any chemical dosing regime it is advised that continuous sewage pH monitoring be conducted at SP85 and at downstream pump stations to determine the variation in sewage pH.

Although an increased pH tends to reduce the potential for evolution of hydrogen sulphide from sewage containing soluble sulphides, turbulence is the major factor which contributes to the stripping of H_2S. Therefore, under highly turbulent conditions, H_2S may still evolve from alkaline sewage conditions.

4.0 HYDROGEN SULPHIDE GENERATION POTENTIAL

In-lieu of any site-specific odour concentration data, sulphide generation potential has been calculated as a means of evaluating the odour generation potential for the three proposed pump stations Lytton Road (SP298), Viola Place (SP299) and Serpentine Road (SP300). It should be noted that while H_2S is typically used as an indicator for problematic sewage odours, an absence of H_2S does not mean there will not be other odorous compounds present.

Sulphide generation has been calculated for the expected worst case of average dry weather flow with intermittent operation of pumps. For parallel rising mains from Eagle Farm to Luggage Point Waste Water Treatment Plant it is understood that a single rising main is used during dry weather flow with the second rising main operating during wet weather flows. For the purposes of identifying sulphide generation, it has been assumed that a single rising main is utilised.

Table 4-0 illustrates both worst and best case scenarios for H_2S levels based on typically accepted generation rates which vary between 20% and 1% respectively.

Table 4-0: Hydrogen Sulphide Generation Potential

From	To	Detention Time (hours)	Soluble Sulphide (mg/L)	Worst Case H_2S Levels 20%* (ppm)	Best Case H_2S Levels 1%* (ppm)
SP49	SP298	2.3	6.6	191	10
SP85#	SP298	1.1	2.5	877	44
SP298	SP300	2.5	4.3	124	6
SP146	SP136	0.8	2.2	63	3
SP136	SP131	1.9	7.3	212	11
SP131	SP300	1.9	6.2	180	9
Eagle Farm PS	CH1210	0.4	0.3	7	0
SP299	CH1210	6.6	6.7	195	10
CH1210	CH3444	0.6	0.5	13	1
SP300	CH3444	0.1	0.1	2	0
CH3444	Luggage Point WWTP	1.7	1.2	34	2

Notes:

* Worst and best case H_2S generation based on typically accepted theoretical generation rates of 20% and 1% respectively.

\# Worst case calculated using high intermittent BOD loads reported by Brisbane Water.

4.1 LYTTON ROAD PUMP STATION SP298

It is proposed that SP298 is to receive sewage from SP85 and SP49. Based on the data reviewed, sewage from SP85 contains intermittent industrial loads that increase BOD levels which would result in a high potential for sulphide generation at SP298.

BOD levels were reported as high as 5,500mg/L, while sewage pH varied from a reported low of 5.6 to as high as 10.8. The low sewage pH is of concern in relation to the corrosion of sewage assets resulting from an increased potential to release hydrogen sulphide gas where soluble sulphides are present. It is expected that short periods of high sulphide loads may be experienced at SP298. Prudent chemical dosing at SP85 would include the use of an alkali to buffer sewage pH into the range of at least 7.0 – 7.5 and preferably greater than 7.5. While alkali dosing would reduce the tendency for release of H_2S, additional chemical dosing would be recommended at SP298 to prevent the formation of sulphides in the first instance. Gas phase treatment in the form of an activated carbon filter, biofilter or chemical scrubber may also be required to remove odorous compounds not addressed by chemical dosing.

4.2 VIOLA PLACE PUMP STATION SP299

A proposed rising main from SP299 is to discharge into the rising main from Eagle Farm Pump Station and then to Luggage Point WWTP. While this rising main is relatively short, the detention time within the main is relatively long (>6 hours). Sulphide generation within this rising main is expected to be significant, however, as the sewage volume is low when compared to the Eagle Farm flow and is discharged under pressure into the rising main, it is expected to be diluted considerably and therefore not likely to present a high contribution of problematic odours generated downstream at Luggage Point WWTP.

It is advisable to provide contingency for the introduction of chemical dosing at SP299 to provide additional treatment of sewage discharging into the rising main from Eagle Farm to Luggage Point WWTP. Additional space for the future installation of a gas phase treatment system (activated carbon, biofilter or chemical scrubber) is also advised to enable treatment of foul air that may be generated at SP299 or from influent to SP299.

4.3 SERPENTINE ROAD PUMP STATION SP300

SP300 is designed to operate normally as a flow-in/flow-out station, however when sewage inflow is less than sewage outflow (ie. less than 200 L/s) it will operate as a fill and drain station. For the purposes of calculating potential sulphide generation, this effectively means that the rising mains will operate as continuously flowing rising mains during higher flows and intermittently flowing rising mains during low flow periods (typically overnight). Actual sewage flow during continuous operation will vary due to the sewage pump control arrangement.

Sewage received at SP300 is expected to have hydrogen sulphide levels ranging from 6ppm up to an expected worst case of 180ppm. This will vary depending upon sewage pH, temperature and turbulence.

Sewage from SP146 contains relatively low BOD levels with the reviewed data reporting less than 100mg/L BOD. This would have the effect of reducing the potential for sulphide generation from this rising main, however it would be considered likely that BOD levels may increase due to contributions from SP136 and SP131.

High BOD loads received from SP85 via SP298 may also affect sulphide generation at SP300 and generate occasional high peaks of H_2S.

It is advised that chemical dosing be introduced upstream of SP300 to ensure sewage pH is controlled and sulphide generation is minimised. Gas phase treatment is recommended to control potential high H_2S peaks. Control options may include activated carbon filters, biofilters and wet chemical scrubbers. If appropriately sized, the activated carbon scrubber as described in the Functional Specification (21 June 2004) would be expected to be suitable as an odour control measure for this pump station. It is recommended that PB liase with an Australian distributor such as Airepure Australia who partner with Purafil Inc. in air filtration systems to determine the most appropriate treatment unit for SP300.

Where upstream chemical dosing is not introduced, chemical dosing would be recommended in the inlet chamber prior to the wet well, however this would not be expected to completely prevent H_2S generation at SP300.

Some conflicting data in the documents reviewed were noted, primarily the sewage flow from Eagle Farm Pump Station was indicated to be 8000L/s in the schematic dated 19/2/04 whilst the functional specification dated 21 June 2004 indicates the flow to be 4200L/s.

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5.0 ATMOSPHERIC DISPERSION MODELLING

5.1 AUSPLUME DISPERSION MODELLING

Odour dispersion modelling was performed for the proposed Serpentine Road SP300 Pump Station using the dispersion model AUSPLUME Version 5.4 (Ausplume). Ausplume, developed by the Victoria Environment Protection Authority (Vic EPA), is based on and similar to the United States Environment Protection Agency (USEPA) Industrial Source Complex Model (ISC).

The modelling was undertaken in accordance with the Queensland Environmental Protection Agency (Qld EPA) Draft Odour Impact Assessment Guideline '*A Procedure to Assess the Risk of Odour Nuisance from Proposed Developments*'. The Guideline states that modelled odour concentrations at the "most exposed existing or likely future off-site sensitive receptors" should be compared against the criteria of 1 odour unit, 3-minute average and 99.5^{th} percentile.

In general terms, the dispersion model takes into consideration various factors such as:

- Odour emissions data;
- Site specific meteorology; and
- Geophysical impact (topography).

The odour emissions data used in the model looked at the impact from best and worst case odour emissions as well as a mean case odour emission all based on the theoretical hydrogen sulphide generation rates for SP300 depicted in **Table 4-0**. As H_2S was considered the sole odorant for problematic emissions, the predicted H_2S concentrations were converted to odour units (ou) using the typically accepted odour threshold value (1ou = 0.5ppb H_2S).

Table 5-1 shows the modelled odour emission scenarios assuming that no odour control system was implemented at SP300. For the purposes of this modelling, it was assumed that a standard 12.5m high vent pole of diameter 200mm would vent untreated sulphide emissions from the wet well. As described in Section 4.3, problematic emissions are most likely to occur during low flow periods (ie. overnight) when the pump station would operate as a fill and drain station as opposed to continuous flow. Under these conditions, it was assumed that a flowrate of 200L/s would displace 0.2 m^3/s of problematic emissions.

Table 5-1: Modelled Odour Emission Scenarios for SP300 (No Odour Control System Implemented)

Odour Emission Scenario	Predicted H_2S Concentration (ppm)	Derived Odour Concentration (ou)	Foul Air Flowrate (m^3/s)
Worst Case	180	360,000	0.2
Best Case	6	12,000	0.2
Mean Case	93	186,000	0.2

The supplied meteorological data was provided by the Queensland Department of Environment and uses meteorological data recorded at Brisbane Airport. The supplied meteorological data was collected over a period of at least three decades and the most representative months were used to generate a 12 month meteorological file.

Topographical impacts were not considered to be a significant factor due to the topographical relief being <5m for the modelled area. The grid spacing used was 1000m. An example of an Ausplume Output File is included as **Appendix C**.

5.2 ODOUR DISPERSION IMPACT

The results of the modelling are depicted as odour impact maps in **Appendix D**. For the odour emission scenarios modelled and assuming that no odour control system was implemented at SP300 the findings were as follows:

- A Best Case Emission Scenario (1% theoretical H_2S generation) resulted in no odour impact.
- A Worst Case Emission Scenario (20% theoretical H_2S generation) resulted in adverse impact in the suburbs of Pinkenba and Meeandah.
- A Mean Case Emission Scenario also showed significant impact on nearby receptors.

Although there is considerable difficulty in quantifying definitive odour impacts from a proposed Sewage Pump Station, the results of the modelling support the Functional Specification provision for gas phase treatment of emissions by way of an activated carbon scrubber or similar to be installed adjacent to the wet well of SP300. As previously mentioned, liaison with an Australian distributor such as Airepure Australia who partner with Purafil Inc. in air filtration systems would be required to determine appropriate sizing for a gas phase treatment unit at SP300. Similarly, Wallace and Tiernan Pty Ltd is another company who would provide suitable advice.

6.0 CHEMICAL DOSING

6.1 MAGNESIUM HYDROXIDE

Magnesium hydroxide is a non-dangerous chemical dosed into sewage, primarily to increase sewage pH to minimise the dissociation of soluble sulphides into dissolved hydrogen sulphide gas. Magnesium hydroxide is typically dosed, end of pipe, directly into sewage with normal sewage flows providing mixing in the system. Magnesium hydroxide is also utilised in industrial applications to remove metals from effluent solutions. It would not be expected that magnesium hydroxide be used as the sole odour control technology.

6.2 FERRIC CHLORIDE

Ferric chloride ($FeCl_3$) is classified as a dangerous good (class 8 corrosive) due to the presence of small quantities of hydrochloric acid. The iron present in ferric chloride reacts with soluble sulphides to form an insoluble FeS precipitate, thereby reducing the formation of soluble H_2S and evolution of H_2S into the gas phase. The FeS is a small black precipitate that tends not to settle in sewage networks, however gives the sewage a black appearance (this is generally not a concern where sewage treatment plant operators are aware of the treatment). Ferric chloride is more efficient for odour control where sewage pH is alkaline. Ferric chloride dosing systems should be designed to ensure that ferric chloride does not directly contact concrete or metal assets due to its corrosive nature.

7.0 CONCLUSION AND RECOMMENDATIONS

7.1 EXISTING SEWAGE CONDITIONS AND PROPOSED NETWORK

Based on the liquid and gas phase data reviewed, it is advised that, where sewage pH is acidic (occurring intermittently at SP85) alkali dosing be conducted at upstream locations to ensure the sewage pH is maintained in an alkaline state. Ferric chloride dosing may then be introduced downstream of the alkali dosing, allowing sufficient mixing and reaction time of the alkali prior to dosing of the ferric chloride.

With regard to the locations reviewed, the following is recommended:

- A continuous sewage pH monitoring program to be conducted at SP49 and SP85 in addition to SP298 and SP300 (following commissioning) to determine diurnal trends in sewage pH.

- Contingent upon the above:
  - alkali dosing (magnesium hydroxide) to be introduced upstream of SP85 where suitable.
  - Ferric chloride dosing to be introduced at SP85, SP49, SP299 & SP146 with provision for dosing at SP300.
  - Provision for gas phase treatment systems at SP49, SP298, SP300 and SP299.

7.2 ADDENDUM

Following a PB and Brisbane Water review of the above recommendations, TOU was subsequently advised of additional information which is pertinent when evaluating the feasibility of those recommendations. These issues are discussed in-turn below:

- Pritchard Street SP85 and Kianawah Road SP49 are located on footpaths such that there is limited space to install chemical storage tanks without resuming land. Furthermore, it was advised that there is no current budget for chemical dosing works at either location. These issues are acknowledged but it is emphasised that significant odour problems may arise downstream at SP298 due to an absence of chemical dosing upstream.

- As outlined in Section 7.1 a continuous sewage pH monitoring program is recommended at SP298 following commissioning. This would determine the preferred chemical dosing treatment. For sewage pH primarily <7, magnesium hydroxide dosing directly into the Pump Station would be recommended to buffer the pH to an alkaline state. Conversely, if sewage pH was >7, ferric chloride dosing into the rising main from SP298 would be more efficient. Dosing both chemicals together is **not** recommended unless sufficient mixing and reaction time of the alkali dosing is allowed to occur before ferric chloride is introduced. This is due to the fact that the magnesium hydroxide would take up some of the iron salts such that the ferric chloride dosing would be rendered less efficient. In effect, both dosing treatments would work against each other.

- It is emphasised that chemical dosing at SP298 would not alleviate the likely odour impacts arising from sulphide generation at this location. It would instead have beneficial impacts on odour generation further downstream. For this reason, if chemical dosing measures were not implemented upstream (ie at SP85 and SP49), additional capacity for gas phase treatment would be required at SP298.

- Based on the liquid phase data review, ferric chloride dosing at SP146 would be preferred to SP300 as it would provide better protection for that part of the network as well as assisting in minimising odours generated from sewage conditions downstream at SP300. Notwithstanding this, it is also recommended that provision be made for dosing at SP300. As mentioned, liaison with an Australian distributor such as Airepure Australia who partner with Purafil Inc. in proven air filtration systems would be required to determine appropriate sizing for a gas phase treatment unit at SP300. Similarly, Wallace and Tiernan Pty Ltd is another company who would provide suitable advice.

- It has been advised that chemical dosing facilities for SP299 will not be built at this time due to the current absence of a contributing catchment and likely future domestic type loads. This is noted, however it is emphasised that a detention time of >6 hours from SP299 is likely to result in sulphide and H_2S generation which may be of concern downstream at Luggage Point WWTP.

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Appendix A :

Gas Phase Testing Data

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Appendix B :

Liquid Phase Testing Data

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Appendix C :

Ausplume Output File

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Appendix D :

Ausplume Odour Impact Maps

Appendix E

Geotechnical Information
E1. Coffeys Reports
E2. PB Report

E1. Coffeys Reports

29-JUL-2004 16:59 FROM COFFEY TO 038314223 P.01

Coffey Geosciences Pty Ltd ACN 056 335 516

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Coffey

Facsimile Transmission

To	**Parsons Brinckerhoff Australia Pty Ltd**	From	**DAN ABOOD**
Attention	**MR IAN CAMERON**	Date	**28 JULY 2004**
Facsimile number	**3831 4223**	Our Reference	**B17928/2-B**
cc		Number of pages including this page	**2**
Subject:	**AUSTRALIA TRADE COAST SEWER - SP300 PUMP STATION**		

Based on the structural loadings supplied by Cardno MBK (Qld) Pty Limited (Cardno) (ref: 7519/02-03) dated 26 July 2004, the supplied Brisbane City Council (BCC) Investigation Report 93038 dated August 1994 and the supplied design drawings (drawing numbers 486/5/7-TR201/020 to 486/5/7-TR201/043 amendment P2), the following comments are made with respect to potential settlement issues at the above site:-

- BH2 of BCC report is the closest borehole to the pump station. The subsurface profile encountered in BH2 has been adopted for the settlement estimates. The subsurface profile described comprises an upper layer of medium dense gravely clayey sand fill to 1.9m in depth, underlain by very loose sands and clayey sands to 11m in depth, followed by soft to firm clay to 27.5m in depth.
- Based on the subsurface profile described in BCC BH2, the alluvial clays appear to be normally consolidated; hence, any additional increase in vertical effective stress resulting from fill or structural loads will result in potential consolidation settlements.
- Loadings supplied by Cardno indicate that the pump station structure will be buoyant, assuming groundwater level is at the current ground level. However the weight of the pumps, pipes, fittings etc. and water level in the pump well has not been considered as we have no information in this regard. It is estimated that provided the combined loading from the pumps, pipes, fittings etc. and water in the pump well does not exceed 4500kN, then the current effective stress levels in the underlying soils will not be exceeded, hence consolidation settlement of the pump station should not occur.
- Supplied drawing ref 486/5/7 – TR201/020 indicates that approximately 0.5m of fill is to be placed for the new access road and turning bay. It is estimated that consolidation settlements of the underlying clay (primary and secondary) resulting from the placement of this fill may be of the order of 200mm (120mm primary and 80mm secondary).
- The supplied drawings also indicate a number of additional structures surrounding the pump station. It is considered likely that settlement of these structures will occur. The magnitude of such settlements will be determined by the size of the foundation area and the magnitude of the imposed loads.
- The upper level loose sands described in BCC BH2 could be expected to settle when additional loads are applied however it is considered that these settlements would occur rapidly during construction.

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Coffey Geosciences Pty Ltd ACN 056 335 516

B17928/2-B 2
28 JULY 2004

These settlement estimates are based on consolidation parameters derived from empirical correlations and from experience of nearby sites. It is recommended that additional investigations and consolidation testing be carried out to confirm the assumed consolidation parameters and soil profile and a more accurate estimate of the potential structural loads be carried out.

If you have any questions regarding this matter please contact Dan Abood or the undersigned at our Brisbane office on 3274 4411.

For and on behalf of
COFFEY GEOSCIENCES PTY LTD

IAN SHIPWAY

B:\BRISBANE\B17928-02 PB Aust Trade Coast Sewer (DA)\Correspondence\B17928-2-B.Doc

TOTAL P.02

E2. PB Report

MEMORANDUM

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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/m³)
	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.

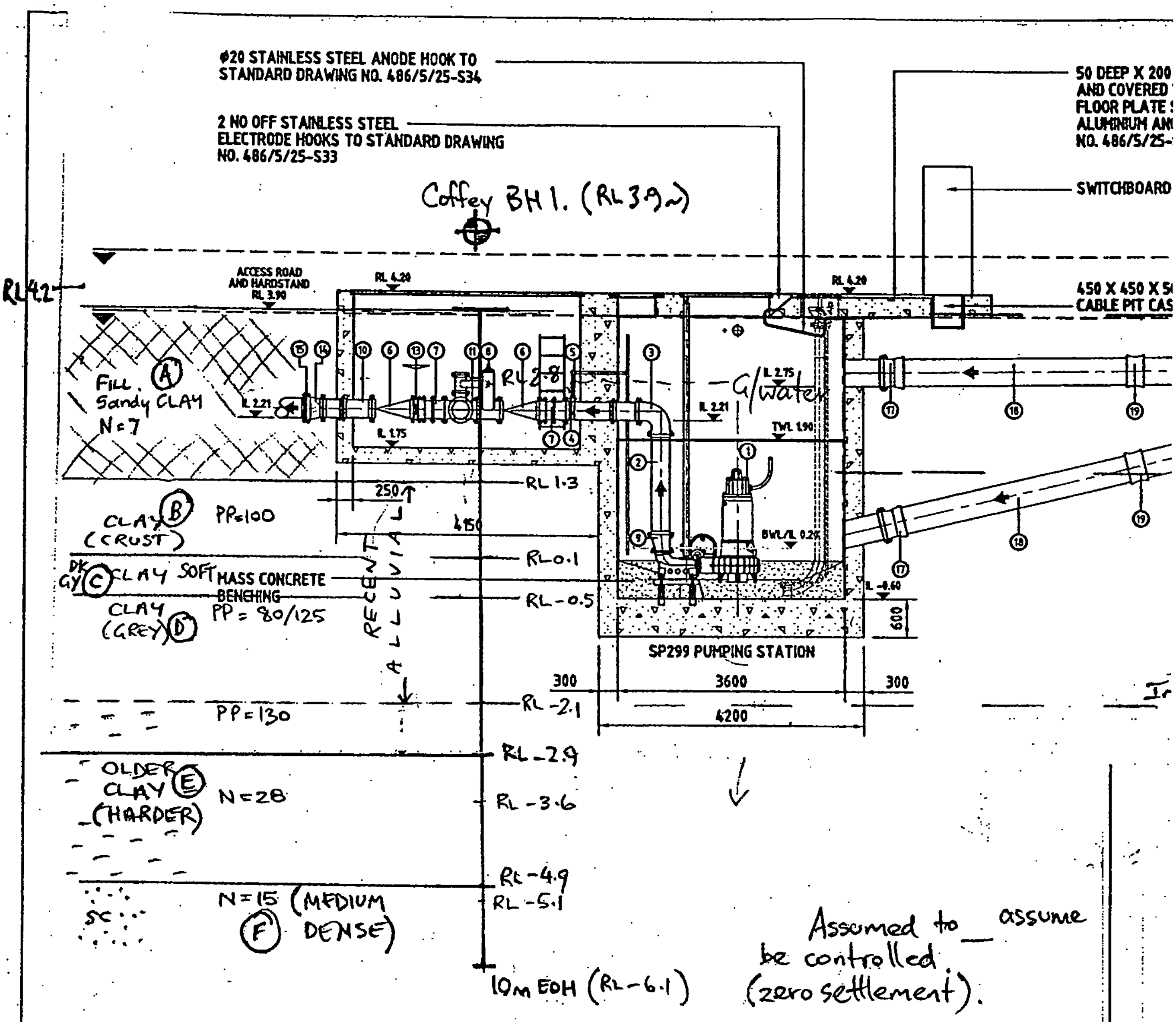
Attachment A. Ground Model Sketches

PB 100 YEARS

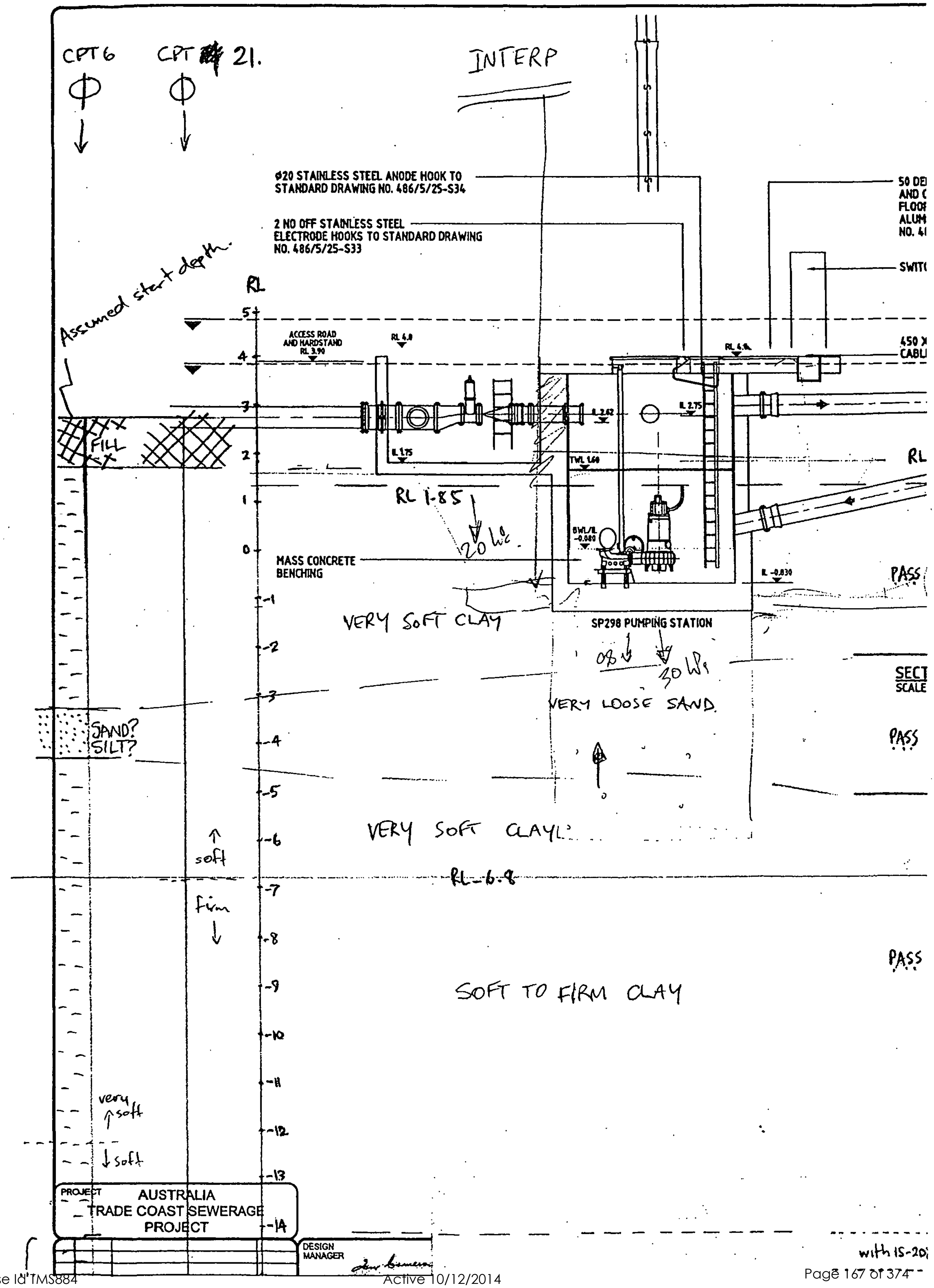
Job TRADE COAST SEWER
VIOLA - PUMP STATION

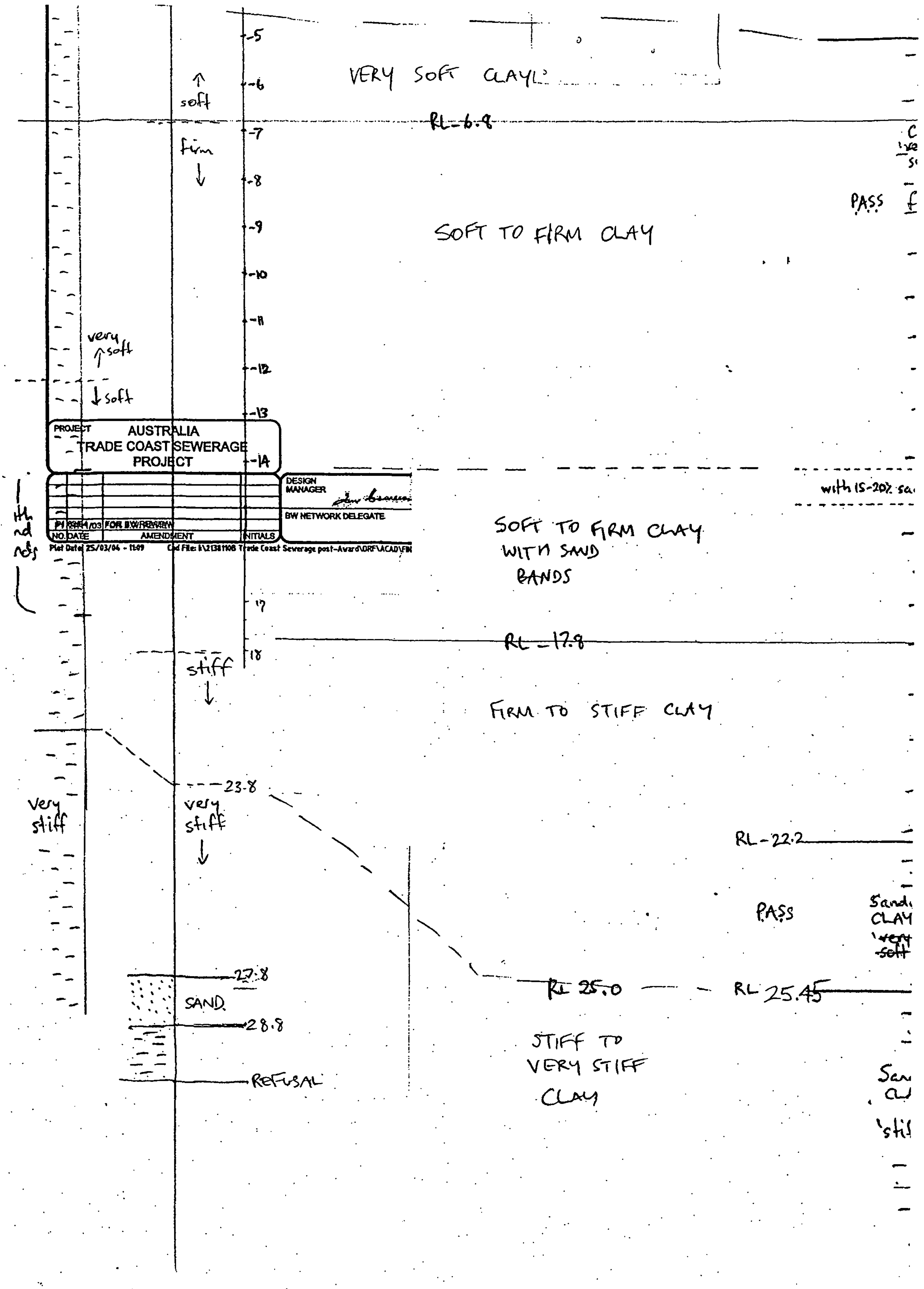
Design IAW
Date
Checked
Date 31/3/04

Office PB - BRIS
Job No. 2138110B/
Page No.

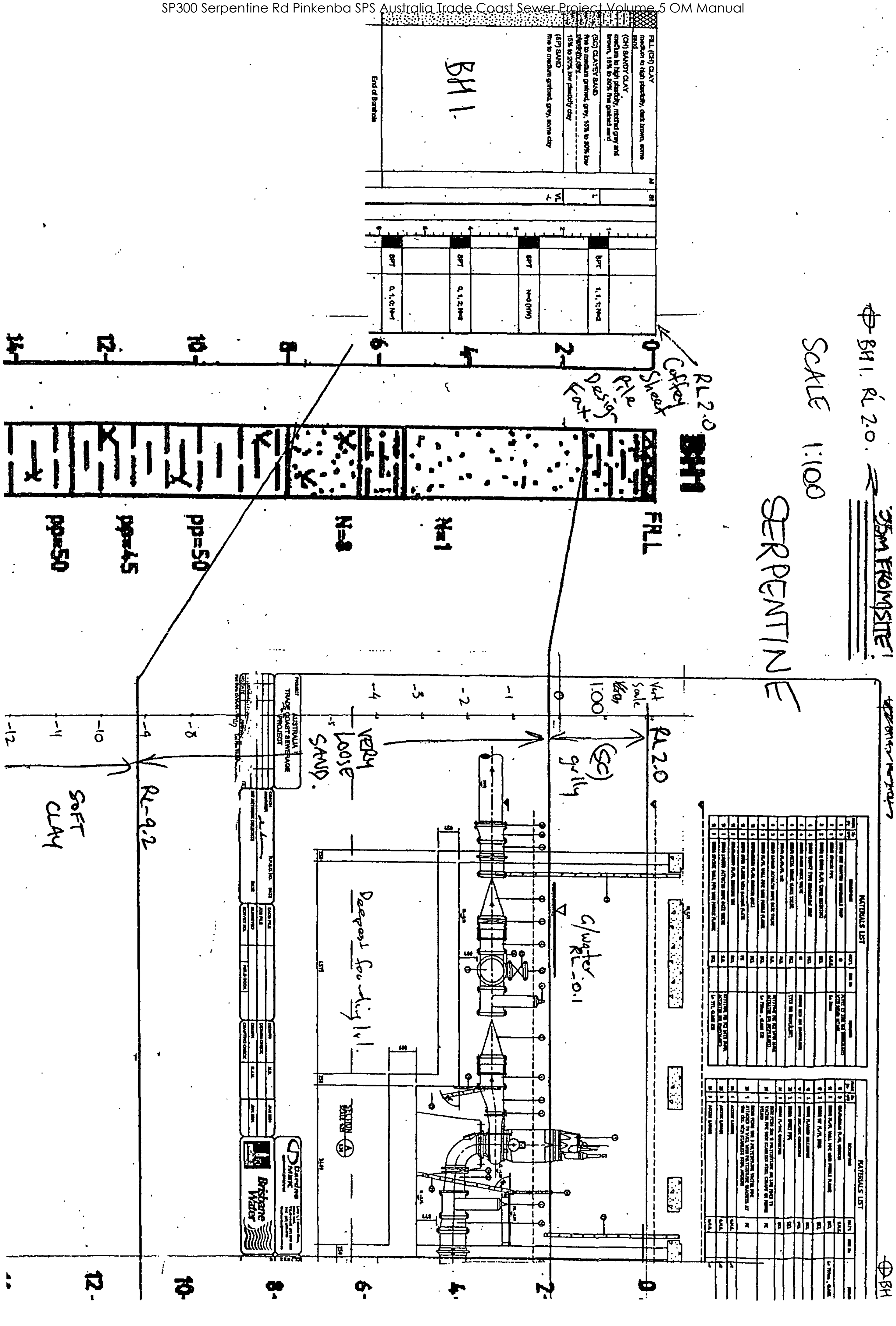


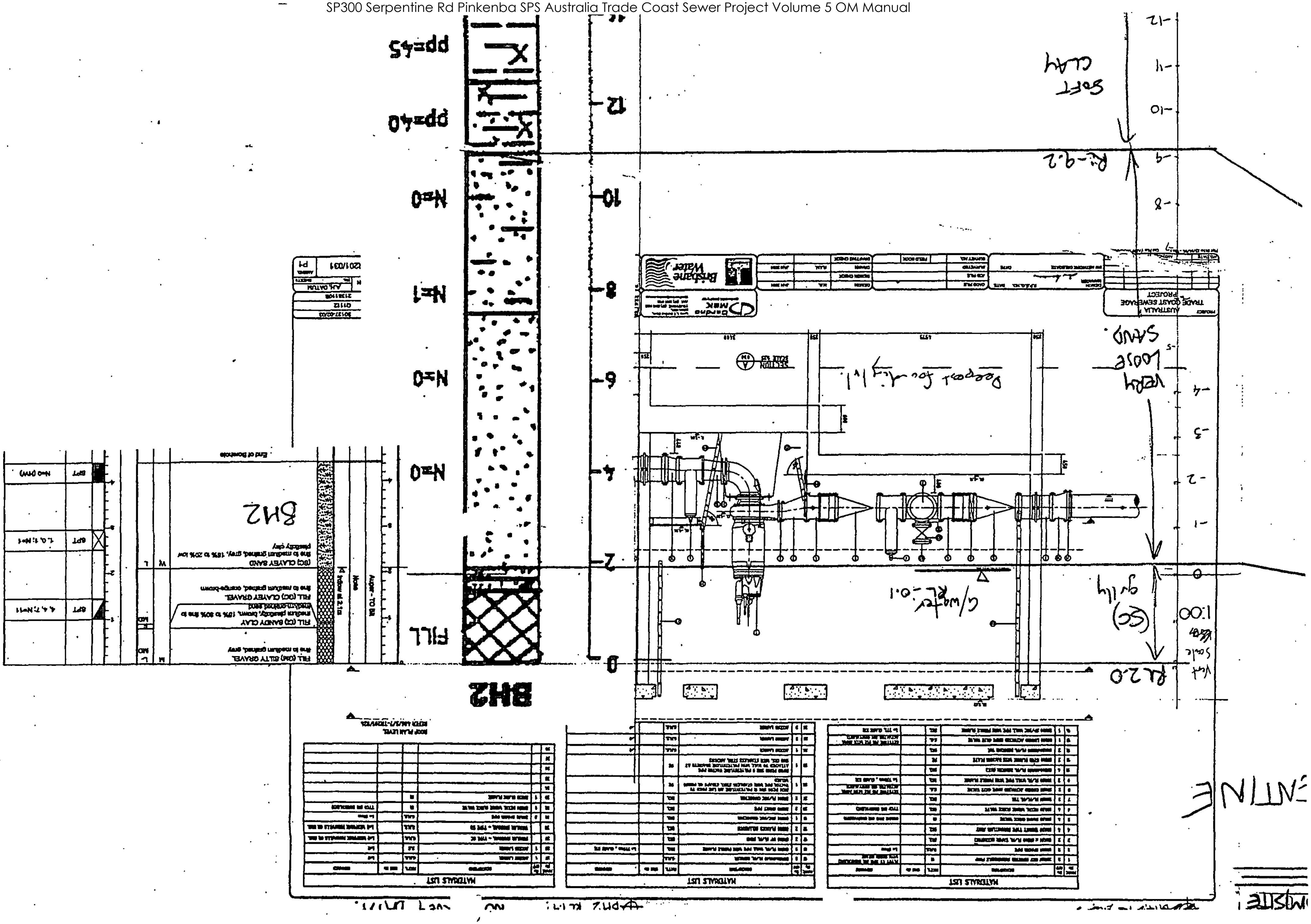
4×4×5 = 80m³ = 800kN
× 1.2 = 960kN.
160kN / 16m² = 10kPa
/ 32m² : 5 kPa. ~6m.





VERY SOFT CLAY
RL-6.8
soft
firm
SOFT TO FIRM CLAY
PASS
very soft
soft
PROJECT AUSTRALIA TRADE COAST SEWERAGE PROJECT
DESIGN MANAGER
BW NETWORK DELEGATE
NO. DATE AMENDMENT INITIALS
with 15-20% sa
SOFT TO FIRM CLAY WITH SAND BANDS
RL-17.8
stiff
FIRM TO STIFF CLAY
23.8
very stiff
very stiff
RL-22.2
PASS
Sandy CLAY
27.8
SAND
28.8
REFUSAL
RL 25.0
RL 25.45
STIFF TO VERY STIFF CLAY


BH1. RL 2.0.
35m FROM SITE
SCALE 1:100
SERPENTINE
RL 2.0 Coffey Sheet Pile Design Fact.
BH1
FILL
N=1
N=8
pp=50
pp=45
pp=50
BH1.
End of Borehole
Vert Scale 1:100
RL 2.0
(SC) gritty
VERY LOOSE SAND.
G/water RL -0.1
Deepest for dig 1:1
RL -9.2
SOFT CLAY
MATERIALS LIST
SECTION A
AUSTRALIA TRADE COAST SEWERAGE PROJECT
Brisbane Water


BH2
FILL
N=0
N=1
N=0
N=0
pp=40
pp=45
SOFT CLAY
VERY LOOSE SAND
RL 2.0
MATERIALS LIST
MATERIALS LIST
MATERIALS LIST
AUSTRALIA TRADE COAST SEWERAGE PROJECT
Brisbane Water

Appendix F

Dynamic Surge Analysis Information

Review

of

Unsteady State Hydraulic Design

Australian Trade Coast Sewerage Project

SPS 300 Serpentine Road PS
to
Existing Rising Mains

Supplement

Commissioned by Parsons Brinckerhoff Australia
Client: Brisbane Water
Prepared by Geoffrey D Stone F I Mech E;C. Eng; F I E Aust C.P. Eng
Date 17th September 2004
Status Initial

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Preamble

Parsons Brinckerhoff Australia (PBA) have undertaken a design for the Australia Trade Coast Sewerage Project for Brisbane Water. This Supplement to the Report covers the steady and unsteady state analysis of the hydraulic design for the SPS 300 Serpentine Road PS to the existing DN 1840 rising main and the impact on the two downstream DN1295 concrete lines. These mains run from Eagle Farm PS to Luggage Point STP. The line from SP300 joins the DN1840 main 34m before it bifurcates into the two DN1295 concrete lines.

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
- Brisbane Water have recently specified a design rating of 12m on the concrete pipes because of their advanced state of decay
- The steady state hydraulics shows that the existing system head exceeds the design rating applied to the concrete pipes
- The modelling was done at a maximum flow of 3800 l/s in the DN 1840 main to provide the worst case scenarios
- The case of 3200 L/s was also examined however provides no relief

Software Used

As per the Report.

Scenarios Modelled

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

- Pump start up with DN1840 flow of 3800 L/s and the SP300 design flow of 348 L/s
- Pump start up with DN 1840 flow of 3800 L/s and the SP300 flow achieved with pump at full speed

System Modelling

The existing DN1840 & DN 1295 system was modelled in steady state with the SP300 pump stopped. The static head from the commencement of the DN1295 concrete mains and the Luggage Point treatment Works is 5.3m. The friction loss in the system at Q=3800 L/s is 7.9m. Hence the calculated head at the inlet of the concrete pipes is 13.2 m. This is without surge in the DN1840 main or from the SP300 pump start up. Thus the HGL exceeds the recently specified design head of the concrete pipes set by Brisbane Water.

In is understood that the DN 1840 main is fitted with a surge chamber or vessels. Insufficient details are available of this system or surges in the main(s) arising from pump start and stop at Eagle Farm to be able to pass an opinion as to their capability. In any event these devices are outside the scope of any investigation related to SP300.

Unsteady state models were carried out of the pump start of SP300 to determine the time to ramp the pump up so that surges transferred to the concrete pipes were minimal in nature. The modelling showed that the minimum head that could be provided by limiting the ramp time was 19m. This arose because of the shape of the DN1840 system curve as seen by the SP300 pump and the characteristics of a centrifugal pump. The system curve has a relatively flat portion.

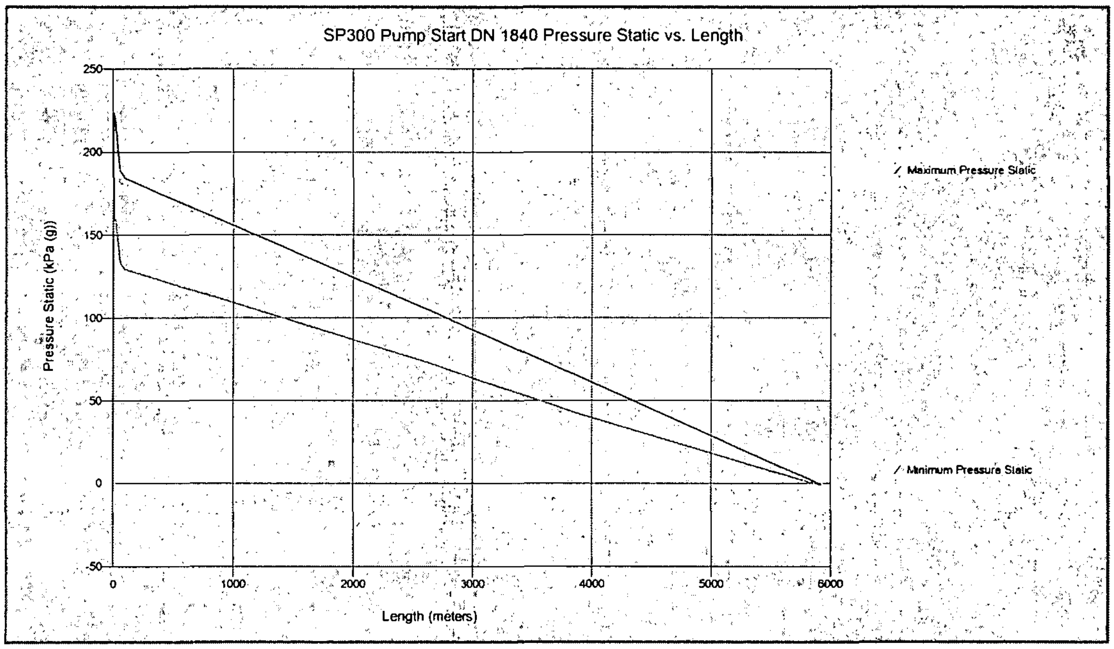
Unsteady State Response Pipelines and Pumps

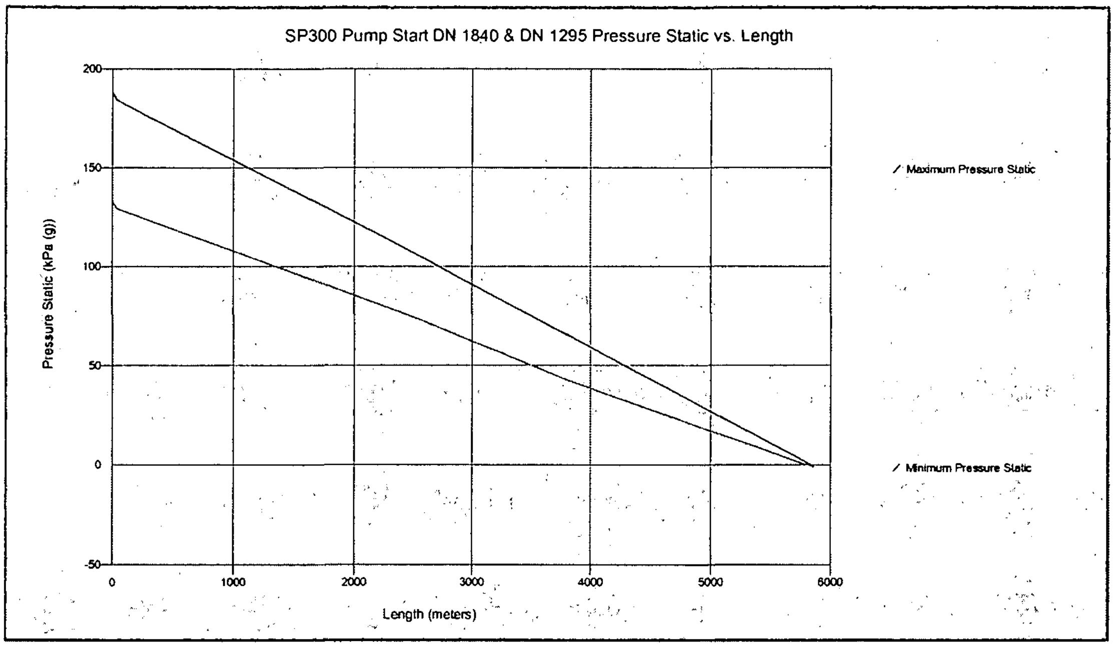
SPS 300 Pumping Station

The modelled pumps for this system are Hidrostal units as detailed in the main report.

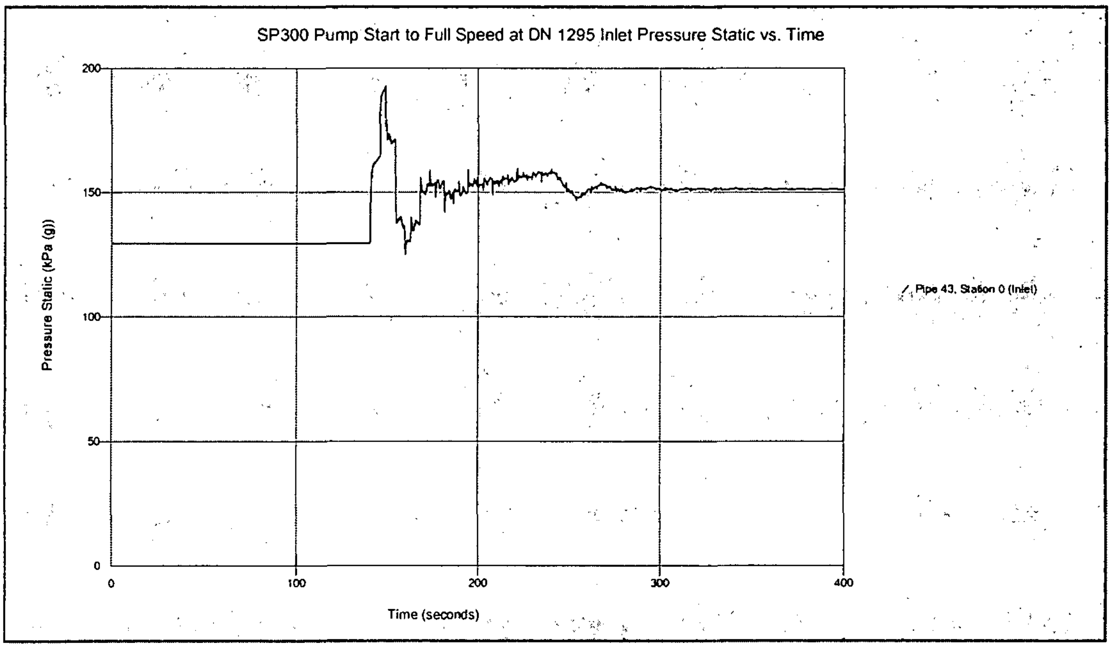
The modelling of the system was based upon the flow in the existing system of DN 1840 steel main bifurcating to the two DN 1295 concrete pipes. The flow rate used was that recently advised by Brisbane Water of 3800 L/s. A flow rate of 3200 L/s that appears in Annexure 4 part 1 Clause 7.3 of the brief was also examined but is not reported herein other than by commentary.

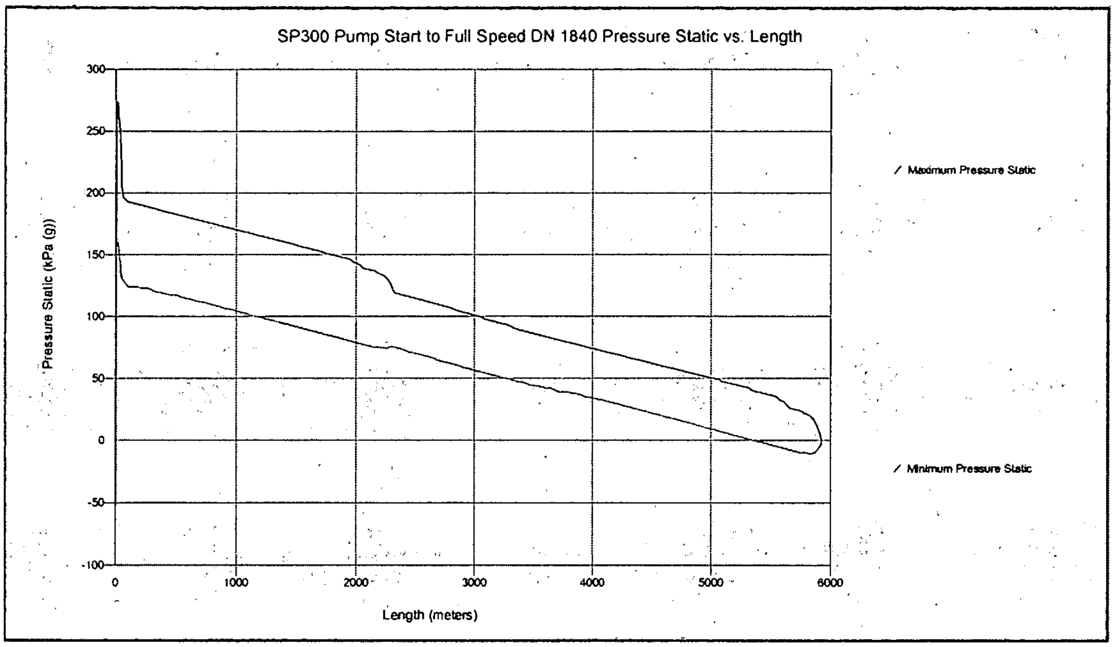
In the first scenario the system was modelled with the pump starting from rest until a flow of 348 L/s was reached. The optimum ramp time was 30 secs. Ramp-up times longer than this did not show any additional benefit in terms of minimising transient pressures. The resultant head in the concrete pipes was 18m. The following graphs show the system from SP300 to Luggage Point Treatment Works and the DN 1295 concrete pipe alone.





In the second scenario the pump was allowed to start until full speed was achieved. . This was designed to replicate an occurrence that may be envisaged in a maintenance scenario. The optimum time before no further benefit was derived was 150 secs The rising speed of the pump when cross plotted with the system curve shows that the system response is a 19m head at the inlet to the concrete pipes. The following graph shows a spike where the pump speed matches the system requirements in the flat portion of the system curve.





Outcomes of the Modelling

The transient pressures are outside the recently specified design rating of the concrete pipe for all the above scenarios. The design rating of the pipe class recently advised is 12m at 20°C.

Conclusions

The following conclusions are drawn from this supplemental review of the system.

- Transient pressures exceed the recently specified design rating of the concrete pipe material
- The steady state head in the concrete pipe is outside the recently advised rating of the concrete pipe hence the surge pressure cannot possibly meet this criteria
- The existing surge mitigation devices on the DN 1840 rising main were not taken into account as they are designed to protect the existing asset
- The transient pressures introduced into the concrete mains by SP300 will be very much smaller than those which must emanate from the Eagle Farm pumping station, given that the flow from SP300 is less than 10% of the existing flow in the main. The existing surge controlling devices should be more than adequate to cope with the surges introduced from SP300, if they are functioning properly at present.

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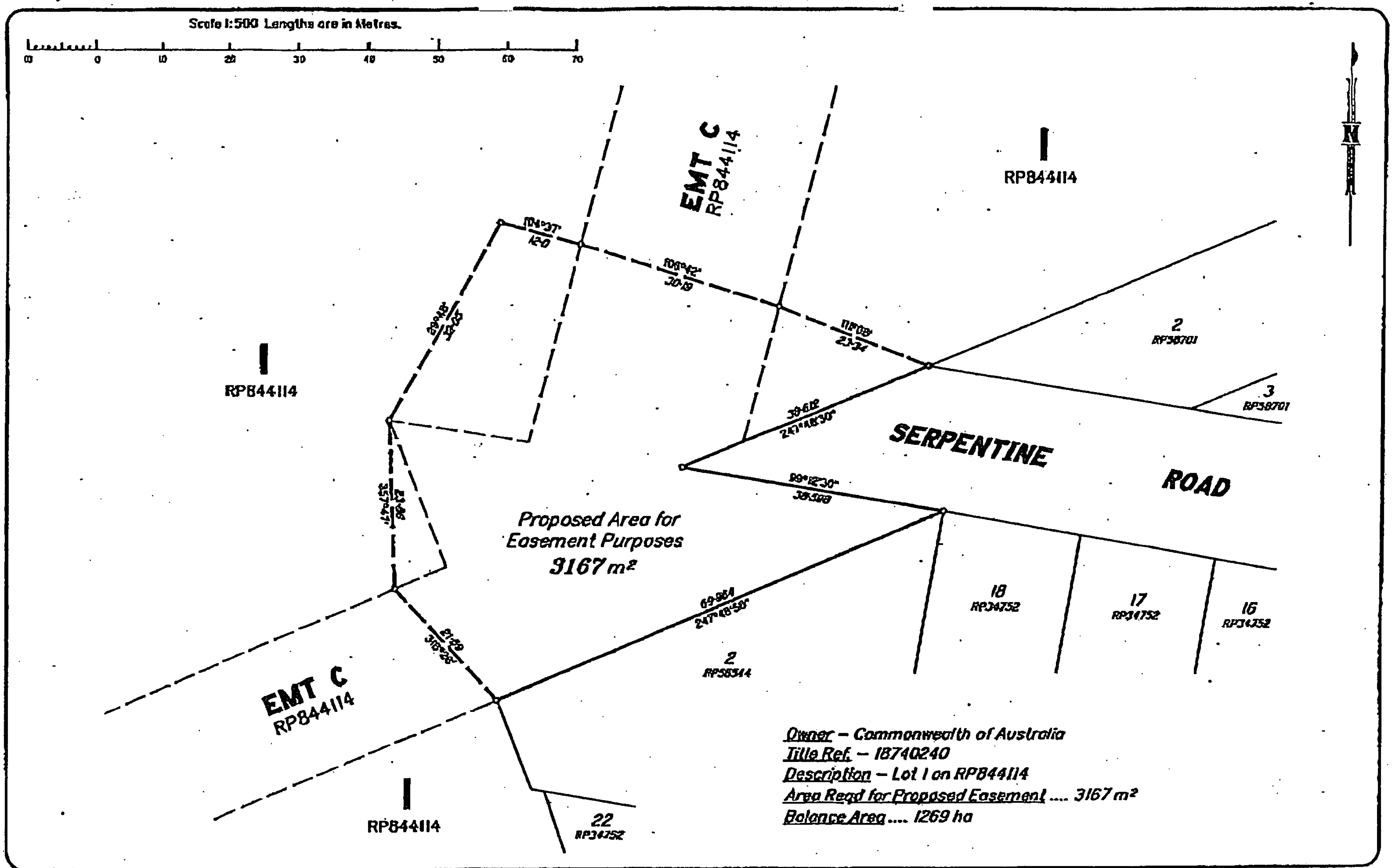
PARSONS BRINCKERHOFF

Appendix G

RP Plan

HDD TO LAYOUT PLAN



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SUR PLAN

showing Area required for Proposed Easement in Lot 1 on RP844114.
Original Portions 428, 433 & 993, Parish of Toombul.
County of Stanley.

Brisbane City

Scale 1:500	
Drawn: AJH 9/9/2003	
Search: 1789	
CAD Ref: SUR040313–03	
Instructions: A.Crowe	
U.M. Infrastructure Mgement	

CITY DESIGN
TECHNICAL SERVICES
3rd Floor, T.C.Beirne Centre
315 Brunswick St Mall, 4006.

Project / Plan number	Amend
SUR040313–03	

PARSONS BRINCKERHOFF

Australia Trade Coast Sewer Project
Contract No. BW30137-02.03
Revised Developed Design Report
Separable Portion No. 2
Serpentine Road Pump Station SP300

Appendix H

Control Philosophy

PARSONS BRINCKERHOFF

LEIGHTON

BRISBANE CITY

Brisbane Water

SEWAGE PUMP STATION
SP 300
SERPENTINE ROAD PINKENBA

REVISED FUNCTIONAL SPECIFICATION

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Document Approval

		Signature	Date
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ATTACHMENTS:
SP300 Design Calculations
SP300 Electrical Drawings

1. INTRODUCTION

1.1 Scope of Document

This document outlines the functional requirements for control, monitoring and telemetry at sewage pump station SP300 at Serpentine Road Pinkenba.

1.2 Organisations Involved

The design, construction and commissioning of SP300 were components of Brisbane Water's Australia Trade Coast Sewer Project. The project was awarded to Leighton Contractors Pty Ltd (LCPL) in late 2003.

SP300 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 SP300

SP300 is a 13 m x 5.5 m reinforced concrete pump station incorporating two variable speed driven 216 kW dry mounted submersible pumps operating in a duty/standby arrangement. SP300 is located in a Brisbane Water pipeline easement at the western end of Serpentine Road Pinkenba.

SP300 discharges a maximum of 348 L/s of raw sewage through one of two OD500 PE100 rising mains into the existing Eagle Farm to Luggage Point sewage rising mains. The system operators can remotely select either the high pressure DN1370 MSCL rising main or the low pressure DN1840 MSCL rising main to take the flow from SP300.

2. FUNCTIONAL REQUIREMENTS

2.1 Pump Station Duties

SP300 is required to deliver a maximum of 348 L/s into either the high pressure DN1370 Eagle Farm to Luggage Point rising main, or the low pressure DN1840 Eagle Farm to Luggage Point rising main. Both the large diameter rising mains are connected to variable speed pumps at the Eagle Farm Pump Station (EFPS) and hence the sewage flows in each main are variable.

The EFPS actually consists of two pump stations:

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

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

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

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

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

It should be noted that BW has concerns about the allowable pressures in the DN1295 concrete mains downstream of the SP300 rising main connection to the DN1840 rising main. We understand a 12 m operating head has been nominated (to be confirmed).

System curves, pump performance curves and duty calculations for SP300 are presented in the Attachments.

2.2 Equipment Installed

2.2.1 Pumps

Two Hidrostal I10K submersible pumps with 216 kW four pole electric motors are installed in the dry 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.

2.2.4 Flowmeters

Two direct buried DN500 ABB Magmaster electromagnetic flowmeters are installed in the DN500 PE100 discharge mains downstream of the valve chamber.

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

Two Vega D84 pressure transmitters are installed on the discharge pipework in the valve chamber.

2.2.7 Actuated Valves

Two DN450 Keystone Figure 951 knifegate valves with 415 V Rotork actuators are installed in the discharge pipework in the valve chamber.

2.2.8 Dosing Pumps

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

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 SE Power 500 kVA diesel powered backup generator is installed on a slab adjacent to the valve chamber. The generator includes its own GE FANUC PLC mounted in a dedicated control panel inside the generator housing.

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.

2.2.13 Pump Controls

It is recommended that the PLC for pump controls is programmed and interlocked to ensure that when the pumps are pumping into the DN1840 rising main that operational pressure limitations are not exceeded for the DN1295 concrete mains.

2.3 Pump Station Operating States

SP300 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 feedback control of the wet well level. The PLC calculates the deviation between the measured well level (from the hydrostatic transmitter) and the level setpoint (in the PLC software) and manipulates the speed of the operating pump(s) through the VFDs.

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;
- VFD speed control shall be set to the required speed depending on control being Local or Remote;

- 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 not registered a flow of at least 20 L/s after the time delay has expired, then the run/stop relay remains energised;
- the status indicator lights turns on.

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 ten 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

2.6.1 Normal Operation

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

SP300 is designed to discharge into one of two Eagle Farm to Luggage Point rising mains — a low pressure DN1840 steel rising main and a higher pressure DN1370 steel rising main. Pressure transmitters are installed in the discharge pipework leading to each main to advise the control system which main is in use.

Motorised knifegate valves with proximity switches are installed in the discharge pipework to allow automatic switching between the discharge mains. SP300 is not designed to discharge to both mains simultaneously.

During normal operation, SP300 operates on level control. The electromagnetic flowmeters on the discharge lines are for monitoring only, and flow setpoints are not used to control the station. The proposed level control philosophy is described below.

Level control is used in order to operate the pump station as a "flow-in/flow-out" transfer station as opposed to a "fill and drain" station. SP300 will, however, operate in "fill and drain" mode if the inflow is less than the minimum flow from the station (ranging from 0 L/s to 200 L/s, depending on the rising main in use and the residual pressure in the main).

The control system attempts to maintain a steady level in the pump station by adjusting the output of the operating pump(s). The control loop uses an analogue level signal (from the hydrostatic level transmitter) as the measured variable and manipulate the pump speed through the VFDs.

The PID control loop should be configured at commissioning to provide Proportional-only control action. That is, the integral time constant should be set to a very large number and the derivative constant should be set to zero.

Proportional Control (PC) manipulates the pump speed in response to the deviation between the measured level and a nominal level setpoint. PC will not maintain the level exactly at the setpoint but will allow it to vary around the nominal setpoint within a range called the Proportional Band (PB). The amplitude of the PB can be set arbitrarily by changing the Proportional Gain (Kp) of the feedback controller. **The Proportional Gain should be set to a value of 90** at commissioning to give a PB of +/- 0.15 m around the nominal setpoint, allowing for a pump speed range of 25 Hz to 52 Hz. **The nominal setpoint should be RL0.41 mAHD.**

At the start of an operating cycle, the level in the wet well will be at Cut Out and all pumps will be off. As sewage enters the station the level will rise.

When the level reaches Bottom of PB (Cut In) the Duty A pump will start at the minimum speed of 25 Hz. If the inflow is less than the pump output at minimum speed, the level will fall and the pump will cut out at Cut Out. The operating volume between Cut In and Cut Out is sized for a maximum of 10 starts per hour with one pump producing a nominal flow of 200 L/s.

If the inflow is greater than the minimum discharge rate, the level in the wet well will continue to rise after the pump starts. Within the PB, the controller will modulate the speed of the pump in proportion to the level until the pump can stabilise the level. The VFD will ramp the pump supply frequency within a range from a minimum of 25 Hz (at the bottom of the PB) to a maximum of 52 Hz (at the top of the PB) with a linear distribution between the two limits. At 52 Hz a single pump will discharge approximately 348 L/s into the high pressure main when the EFPS is delivering its peak flow of 4200 L/s.

If the well level continues to rise above the Top of PB, the Duty B pump will start. The feedback level control loop will continue to operate as normal and both pumps will operate at the same speed. The Duty B pump will cut out when the level is drawn down to the Stop Duty B level.

During Level Control operation, the discharge flowrate from the pump station will be monitored by the PLC through the magnetic flowmeters. If the discharge flowrate reaches the upper flow limit of 348 L/s, the PLC will not command any further frequency modulation that will drive the flow above this limit. The speed that corresponds to this flowrate will depend on the main in use (DN1370 or DN1840) and the residual pressure in the main at the time. The pump speed required to deliver 348 L/s could be as low at 33 Hz (with the minimum residual in the DN1840 main), or as high as 52 Hz (with the maximum residual in the DN1370 main).

The PLC will also monitor the discharge rate to ensure it does not drop below 75 L/s during steady operation. This flow corresponds to the intersection between the peak DN1370 system curve and the nominal operating region of the pump. This part of the control logic is designed to prevent the pump station operating continuously at low speed against a high residual head and delivering no flow.

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 at maximum speed and run for a predefined time.

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 all 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 five 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.

In the event of a failure of the wet well probe, 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, both pumps start at maximum speed.

SP300 may communicate by telemetry with the EFPS, SP298, SP299, SP146, SP136 and SP131 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.

2.6.2 Daily Cleaning Cycle

Hydrotec Consultants Ltd who completed the physical modelling of the SP300 wet well recommended that a daily cleaning cycle be included in the operating philosophy for the pump station, as detailed below.

On initiation of the cleaning cycle the duty pump will run up from base speed until the inflow is beaten (up to a maximum flow of 348 L/s). If the inflow is below the pumped outflow, and the sump level reduces, the cleaning cycle will start. The cycle time for the cleaning period will depend on the inflow to the pumping station and the available sump volume. At the end of the cleaning cycle the duty pump will stop to allow the sump to fill and revert back to normal operation.

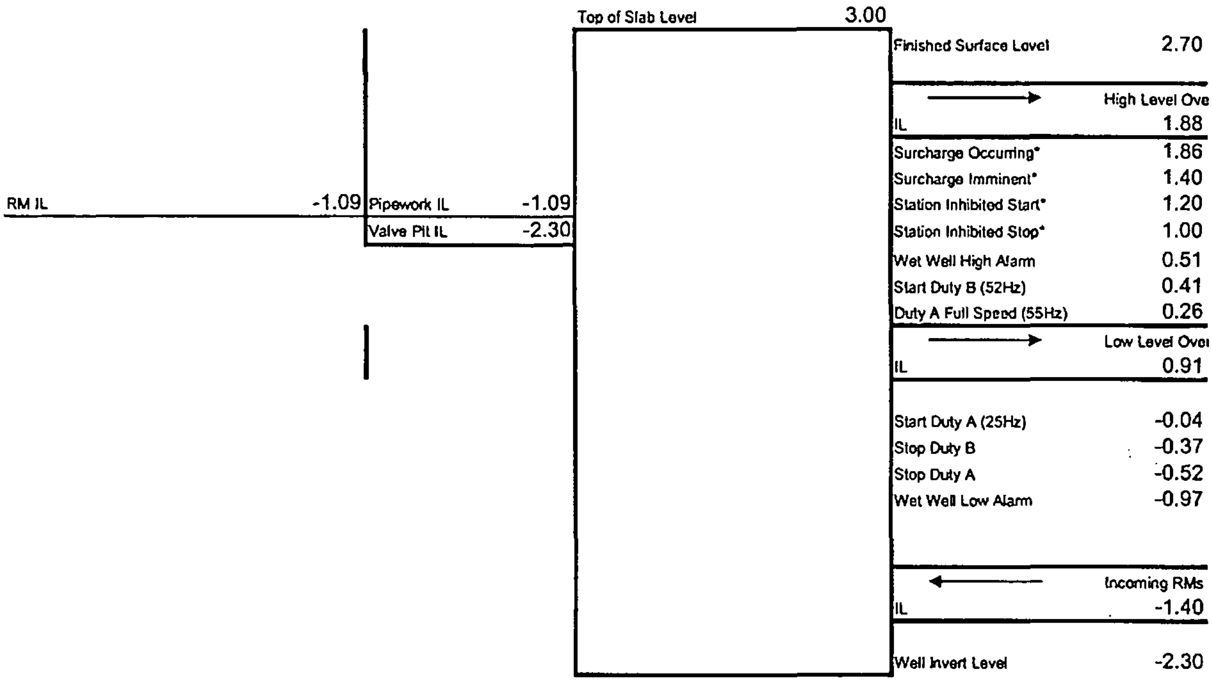
If the inflow to the sump is at or above the pumped outflow at the start of the cleaning cycle, and no reduction in sump level is recorded, the cleaning cycle will be overridden and normal operation will resume.

The duty or lead pump selection should be alternated to minimise accumulation of grit debris around the non-operative or standby pump. To help minimise blockages within the pump it is recommended that the lead pump is alternated after running for a set period of say, one hour. However, we would recommend that further advice on running times is sought from the pump supplier.

It is recommended that the minimum drawdown level for the daily cleaning cycle be set during commissioning. Hydrotec have determined a minimum drawdown level of -1.30 m for one pump operating at full or base speed (200 to 348 L/s).

Operational Diagram

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



Note: *Based upon DN1295 concrete pipe being isolated.

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

MITS SCADA Details		
Plant	**Quantity**	**Alarm Description**
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
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	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

MITS SCADA Details		
Plant	**Quantity**	**Alarm Description**
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; and
- 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.

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 conditions becomes active.

- While being in PID minimum flow control, the VFD speed is above pump blockage minimum flow rate VFD speed setpoint for that delivery pressure for longer than the time period determined by the pump blockage minimum flow rate VFD speed timer.
- Flow rate less than the pump blockage flow rate setpoint for that delivery pressure and the VFD speed is above the pump blockage flow rate VFD speed setpoint for that delivery pressure for longer than the time period determined by the pump blockage 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.

Pump Availability

The pump available flag will only be set when all of the available conditions occur and either 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.

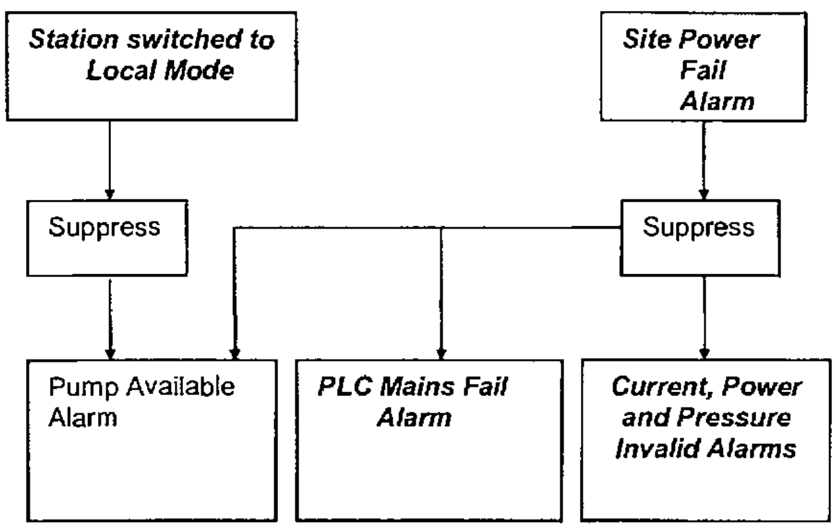
If site power fails, the following secondary alarms are suppressed:

- pump unavailable;
- PLC power fail;
- motor current invalid;
- motor power invalid; and
- site pressure invalid.

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



No Suppression

Wet well
- Level invalid
- Wet well high
- Surcharge imminent
- Surcharge occurring

PLC
- PLC stopped
- PLC failed
- PLC Battery low

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 (metres) + 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 level 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.

Note: The wet well volumes are calculated on the basis that DN1295 concrete overflow pipe is isolated. Once BW commissions the DN1295 concrete pipe overflow system, the set points will need to be adjusted.

		Water Height (mAHD)	Stored Volume (m^3)	Remaining Storage Capacity [m^3]	Comments	% Level	% Volume
1	Wet Well Low	-0.97	0.0	46.3	BWL	0%	0%
2	Stop Duty A	-0.52	7.3	39.0		16%	16%
3	Stop Duty B	-0.37	9.8	36.5		21%	21%
4	Start Duty A	-0.04	15.1	31.2		33%	33%
5	Duty A Full Speed	0.26	20.0	26.3		43%	43%
6	Start Duty B	0.41	22.4	23.9		48%	48%
7	High Level Alarm	0.51	24.0	22.3	TWL	52%	52%

		Water Height (mAHD)	Stored Volume (m^3)	Remaining Storage Capacity [m^3]	Comments	% Level	% Volume
8	Station Inhibited Stop	1.00	32.0	14.3		69%	69%
9	Station Inhibited Start	1.20	35.3	11.0		76%	76%
10	Surcharge Imminent Alarm	1.40	38.5	7.8		77%	77%
11	Surcharge Occurring Alarm	1.86	46.0	0.3		99%	99%
12	Overflow Level	1.88	46.3	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.

ATTACHMENTS

PARSONS BRINCKERHOFF

Appendix I

Physical Modelling — Hydrotec Ltd UK

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SERPENTINE ROAD PUMPING STATION
PHYSICAL HYDRAULIC MODEL TEST
for
PARSONS BRINCKHOFF AUSTRALIA PTY.LTD.

FINAL REPORT

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Report 04-07, June 2004

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SUMMARY

This report covers the testing and development undertaken on a physical hydraulic model of the proposed Serpentine Road Pumping Station. The model was constructed to a scale of 1 to 4 full size and operated on the basis of Froude law similarity.

Initial testing showed that while the conceptual design of the pumping station was essentially sound, modifications were required to eliminate submerged vorticity and improve pump intake conditions. Minor infill benching was required to reduce potential low velocity areas that may be subject to long term deposition and in addition, improvements to the inlet arrangement were required to promote grit and solids transportation through to the main sump.

The inlet area benching was profiled to promote the transport of solid matter through to the main sump. In addition, corner fillets were added to each individual pump trough to eliminate low velocity areas that may lead to long term deposition.

Profiled flow straightening vanes were located beneath each suction intake in addition to profiled vertical rear and side wall deflector vanes. These modifications eliminated the formation point for submerged vorticity and improved suction intake conditions. Pre-swirl rotation was reduced to within acceptable limits. It is also recommended that the flange on the intake bend is removed to eliminate stranding of solid particles.

Final testing showed that, with the modifications in place, the pumps could operate in a hydraulically sound environment free from vorticity, air entrainment and with pre-swirl rotation within acceptable limits. The sump was also materially self-cleansing with the adoption of a defined cleaning cycle to be initiated following each cycle.

Director

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1. INTRODUCTION

1.1 Description of scheme

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

Flow will be delivered into the station from a 450 mm diameter rising main from New Lytton Road pumping station (SP298) and from a 315 mm diameter inlet from three existing pumping stations (SP146, SP136 and SP131), all of which are located to the south and south west of the SP300.

The proposed Serpentine Road Pumping Station (SP300) will consist of a rectangular concrete station which will be equipped with two variable speed dry well mounted pump units.

The pumps will operate on a duty/standby basis, drawing flow through 450 mm diameter suction intakes, to deliver between a minimum outflow of 200 l/s and a maximum capacity of 348 l/s of raw sewage through one of two Eagle Farm rising mains. One is a low pressure 1870 mm diameter steel rising main and the second a higher pressure 1340 mm diameter steel rising main.

Pressure transmitters will be installed on the connection branches to each main to instruct the pump control system software which main is in use. Actuated knife gate valves with proximity switches will be installed inside the valve chamber upstream of each connection branch to allow isolation of the main that is not in use. The rising mains will transport the effluent directly into the Eagle Farm rising mains for delivery to Luggage Point WWTP.

Figure 1.0 (overleaf) shows the overall plan arrangement of the station and Figure 1.1 that follows show section A - A of the pumping station and the general terminology used during the testing programme.

The detailed general arrangement drawings of the pumping station are presented on Drawing 01 and 02 in Appendix 2.

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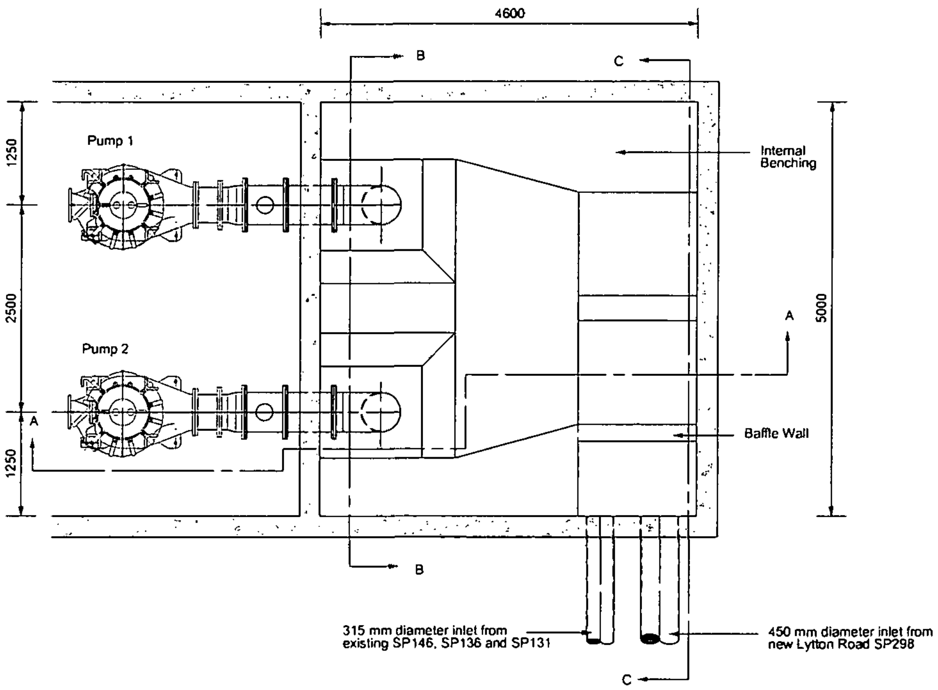
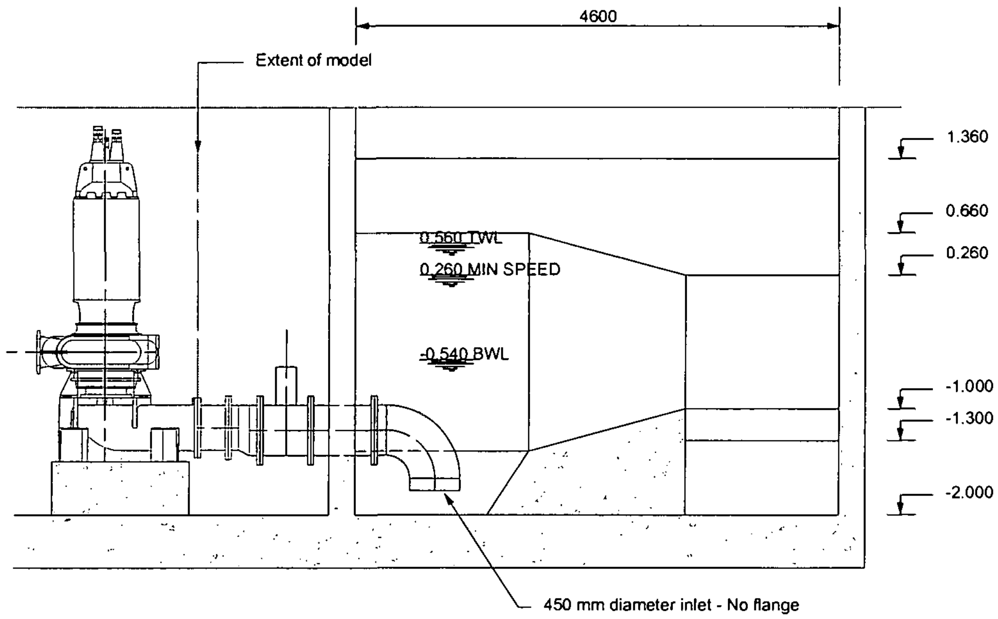


Fig 1.0 Plan on station



SECTION A-A

Fig 1.1 : Section A – A

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1.2 Purpose of testing

The purpose of the model study was to verify the pumping station arrangement and, if necessary, develop modifications that will ensure suitable operation. The pumps must operate in an environment where:-

- Flow presentation to the suction intakes is acceptable.
- No entrained air is drawn into the suction intakes.
- Free surface and submerged vorticity are absent.
- Pre-swirl rotation is within acceptable limits.
- The sump is materially self-cleansing.

More specifically this comprises the following:-

- Study the proposed wet well arrangement under all potential levels, flow rates and pump combinations.
- Develop any necessary modifications to the inlet baffle and benching to provide satisfactory flow conditions and assist the transportation of grits and gross solids.
- Study the conditions at the pump intakes under all potential operating levels, flow rates and pump combinations.
- Confirm the minimum acceptable pump operating levels.

1.3 Description of model

The model was constructed in accordance with details shown in the general arrangement drawings presented in Appendix 2, and comprised the following elements:-

- The 450 mm diameter inlet rising main from New Lytton Road (SP298).
- The 315 mm diameter inlet from pumping stations SP146, SP136 and SP131.
- The proposed baffle structure.
- The pump sump and all internal benching complete with two 450 mm suction pipe assemblies for the dry well mounted pump units, modelled as far as the prototype pump impeller position. Note, the pumps were tested with and without the flange on the intakes.

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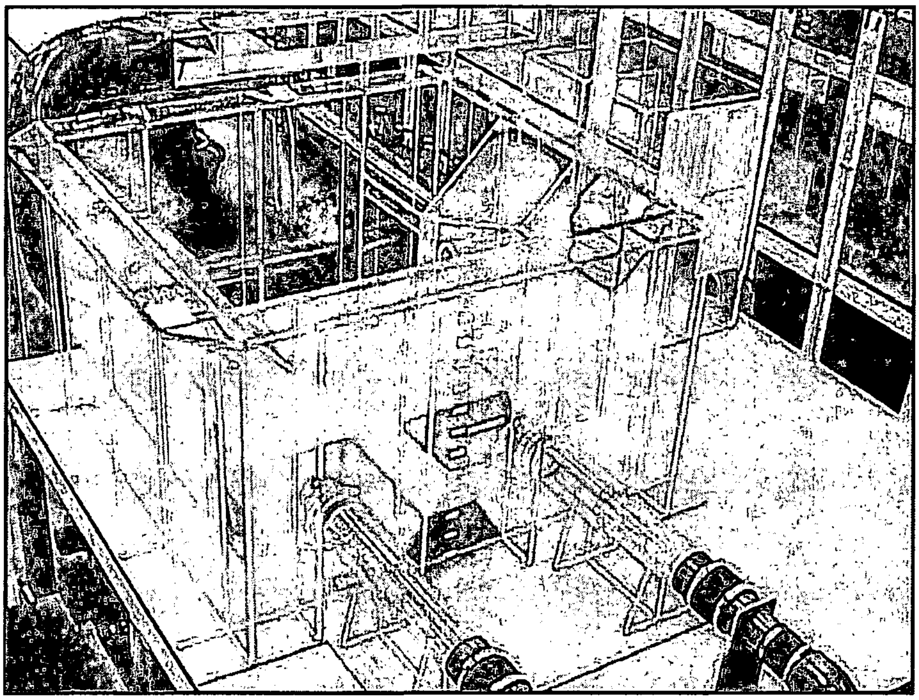
Each pump suction assembly included a swirl-meter located at the position of the prototype impeller to measure the intensity of pre-swirl rotation. A description of the swirl-meter device is presented in Appendix 1.

The model was constructed from clear acrylic material on a substantial timber frame with internal benching and infill fabricated in opaque plastic. The use of acrylic material ensured dimensional stability with the benefit of uninterrupted viewing. This can be of particular importance when studying, for example, vorticity local to pump intakes.

Flow was drawn through the model pump units using individual circulating pumps and was delivered, via control valves and orifice plates, into an inlet stilling chamber which was located at the head of the model.

Flow patterns were observed by dye tracing, various water levels were achieved by adjusting the volume of water retained within the model and testing was undertaken at steady state conditions with inflow equal to outflow. Velocity measurements were undertaken using a miniature propeller meter.

General views of the model are shown in the images that follow.



Overall view of the model.

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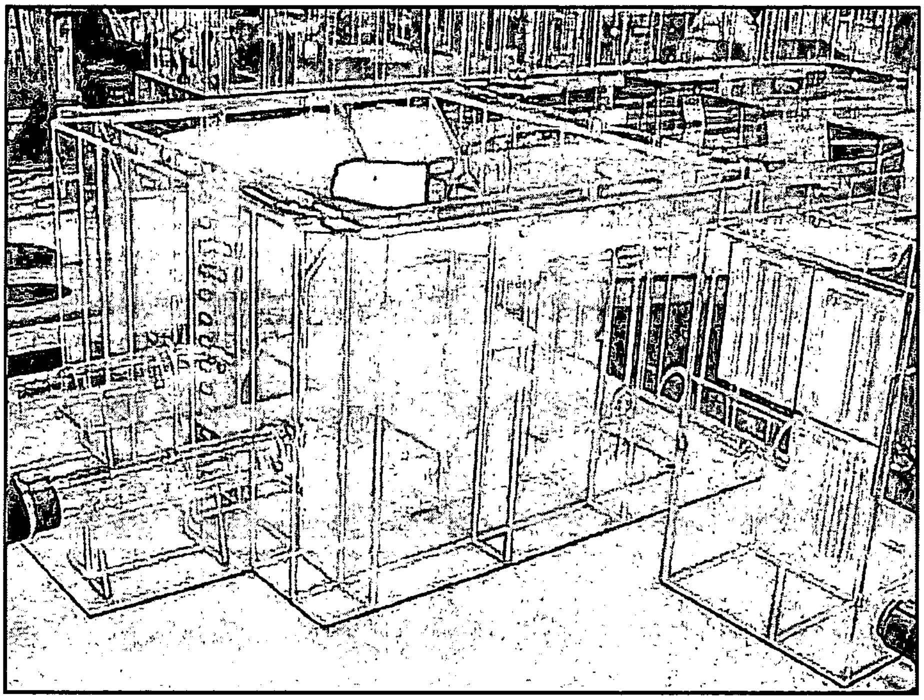
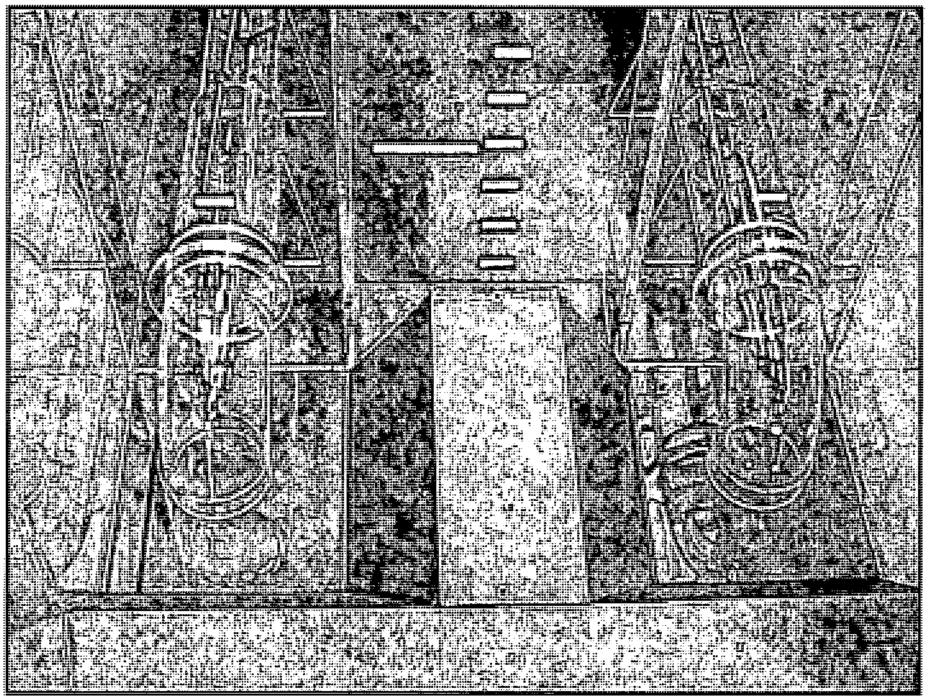


Overall view of the model.



The main pump sump.

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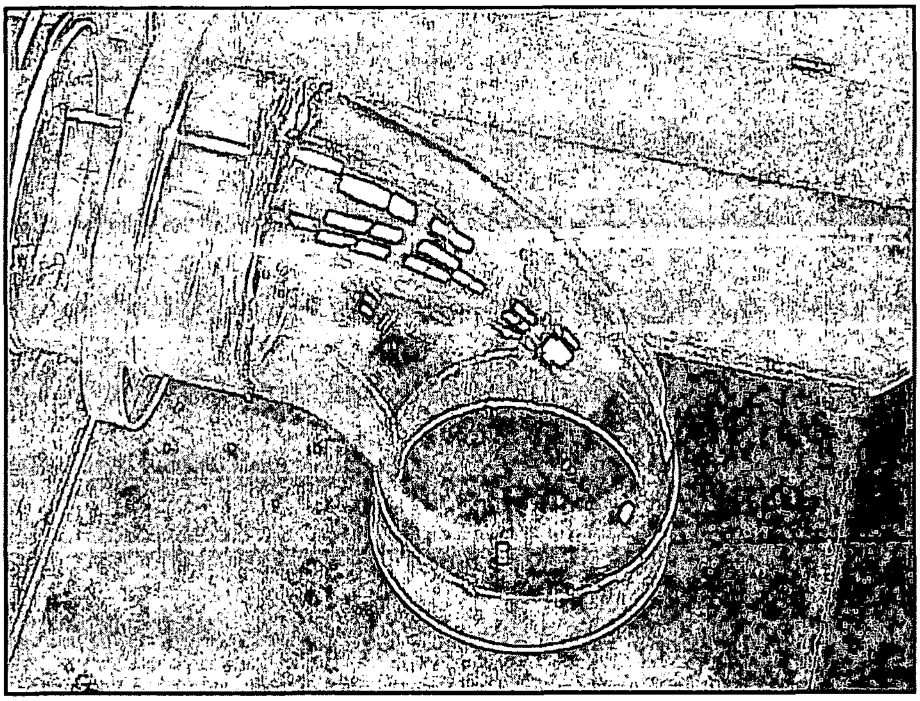
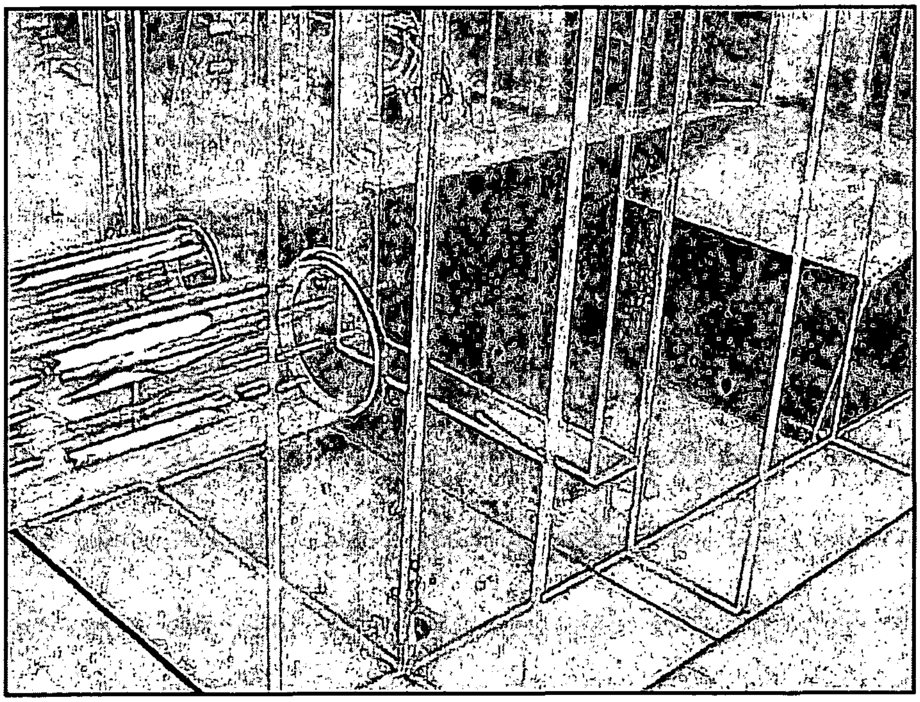


Close up of the suction arrangement.



The inlet and baffle arrangement.

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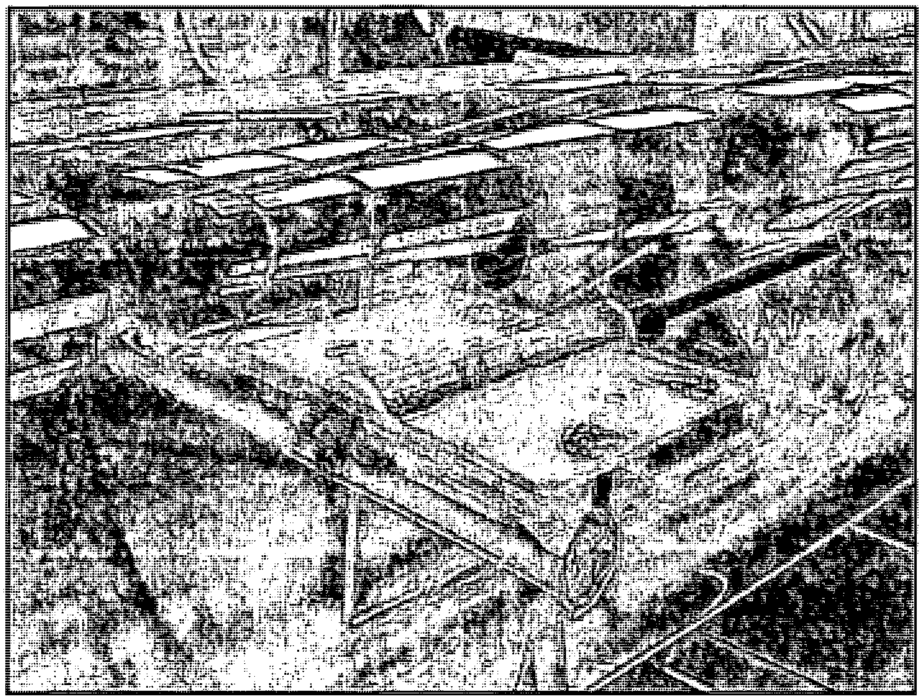
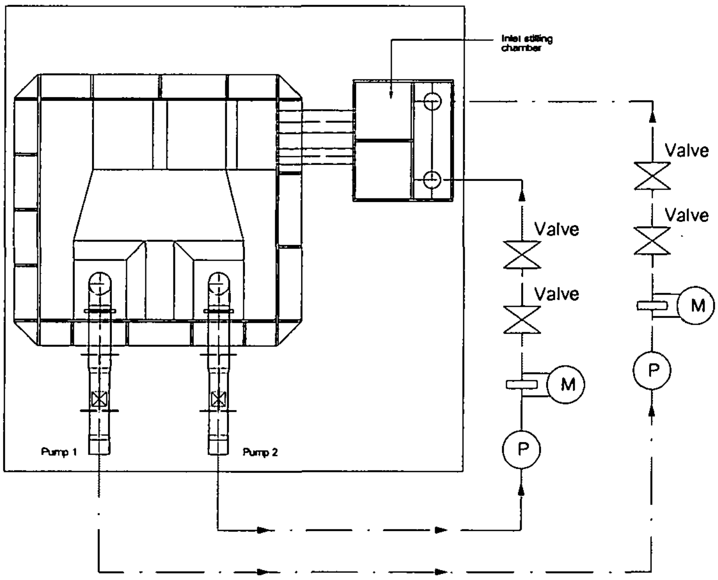


Swirl meter vane located at the position of the prototype impeller

A schematic layout of the model testing rig is shown below.



Schematic layout of the model testing rig

1.4 Proposed operating scenario

Level control will be used to operate the pumping station as a "flow in/flow out" transfer station as opposed to a "fill and drain" station. SP300 will, however, operate in fill/drain mode in the event that the inflow is less than the minimum flow from the station (approximately 200 l/s into the 1840 mm diameter main). The control system is programmed to ensure the pumping station will cut out at low flows when high residual pressures are present in the 1370 mm diameter main.

The control system will maintain a steady level in the pumping station by adjusting the output of the operating pump. The control loop will use an analogue level signal as the measured variable and will manipulate the pump speed through the variable speed drives.

Proportional control is the means by which the level will be controlled. The proportional control will manipulate the pump speed in response to the deviation between the measured level and a nominal level set point. The level will not be maintained at an exact level but will be allowed to vary around a set point level within a range called the proportional band (300 mm). For the purposes of model testing the proportional band was set at plus or minus 0.15 m.

At the start of an operation cycle, the level in the wet well will be at "cut out" and the pumps will not be operating. As the sewage enters the station the level will rise. When the level reaches the bottom of the proportional band (known as cut in) the first pump will be initiated at minimum speed (0.260 m). If the inflow is less than the pumped outflow at minimum speed, the level in the pumping station will fall and the pump will be stopped at the "cut out" level of minus 0.540 m. The operating volume between "cut in" and "cut out" is proportioned for a maximum of 15 starts per hour with one pump producing a nominal flow of 200 l/s.

If the inflow is greater than the minimum discharge rate, the level in the wet well will continue to rise after the pump starts. The sump water level will now be within the proportional band and the pump controller will modulate the speed of the pump in proportion to the level until the pump can stabilise the level between 200 and 348 l/s.

On cessation of the storm event the inflow will reduce and the level will start to fall. The pump will ramp down to 200 l/s at a level of 0.26 m and assuming the inflow is below 200 l/s the level will continue to fall. The duty pump will continue to draw the sump water level down at base speed until the proposed bottom water level of minus 0.540 m is reached at which point the pump will stop.

Three digital level float switches will provide emergency backup for the analogue transmitter and are located to protect against the level drawing too low (suction safety), too high (alarm top water level) and overtopping the station (overflow level).

The station will also communicate by telemetry with the Eagle Farm Pumping Station, SP298, SP146, SP136 and SP131 through Brisbane Water's Cullen Avenue Control Centre. This will enable the system to be controlled as a whole, minimising the chance of sewage overflows in the event of a breakdown or malfunction.

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2.0 INITIAL TESTING

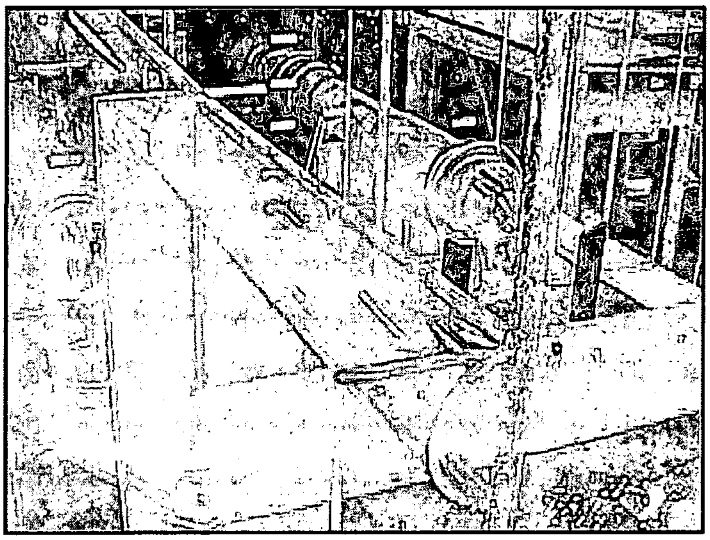
2.1 Introduction

The purpose of the testing programme was to study the pump intake conditions and to determine what modifications, if any, were required to improve operating conditions over the full range of pump flows and pump combinations, as defined in the specification.

2.2 Initial testing

For the purposes of testing the model was initially operated at the top water level of 0.56 m with the duty pump at full speed (348 l/s). The sump water level was reduced with the duty pump operating at full speed to a level of 0.26 m (the lower boundary of the modulating band). The pump speed was then reduced to base speed (200 l/s) and the sump water level reduced further to the bottom water level of minus 0.540 m.
Flow entered the station from the 350 mm and 450 mm diameter inlet sewer into the reception chamber immediately upstream of the baffle wall.

The baffle wall design consisted of a standard "L" shaped baffle and was elevated to a level of 0.260 m. This level corresponds to the pump cut in level at the bottom of the proportional band and allows floating solids, previously trapped behind the baffle wall, to be released into the main sump. This will ensure there is no long term build up behind the baffle. In addition, the top edge of the baffle plate was fitted with a half round section to ensure that any rags passed into the sump, rather than stranding on the top of the baffle wall (see image below).



Half round section on top of baffle wall reduces stranding of rags.

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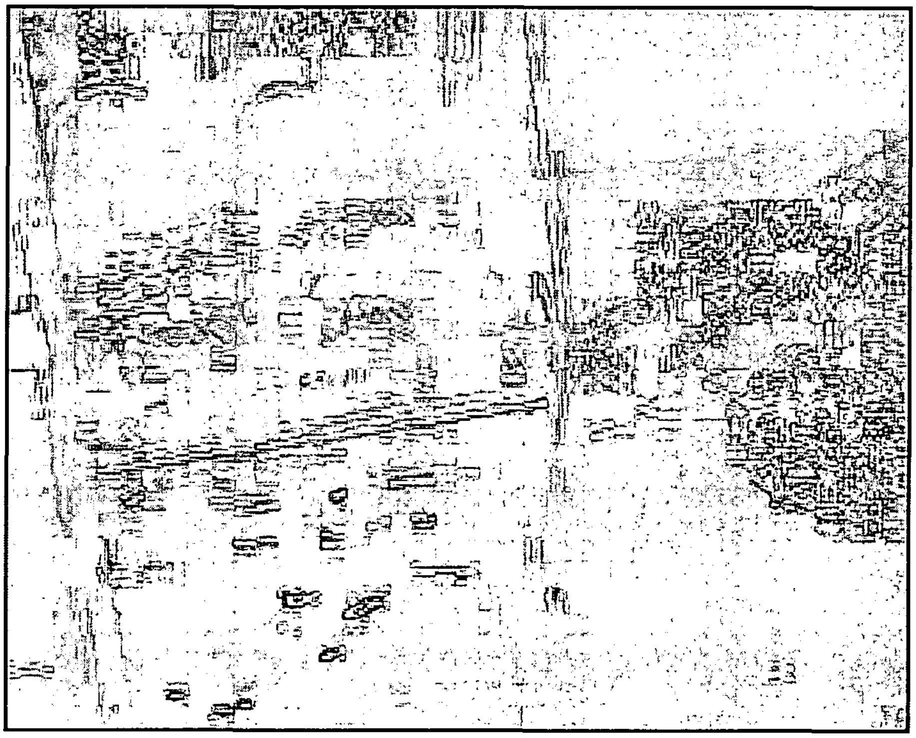
Floating matter passing over the top of the baffle structure...



...and into the main sump.

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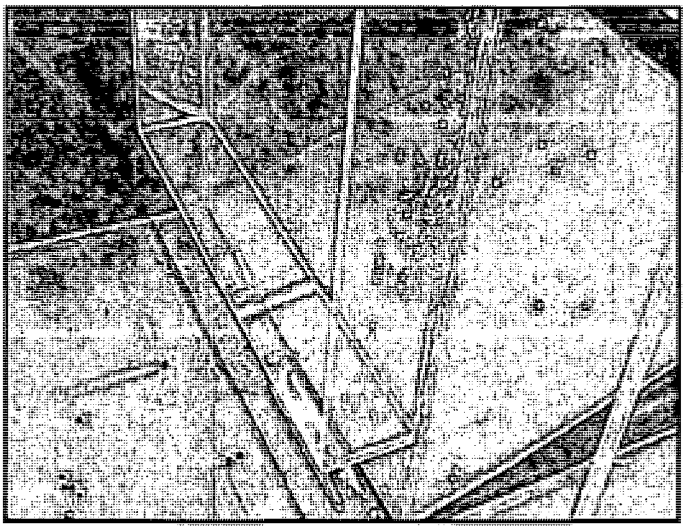
The horizontal plate fitted on the base of the baffle wall was effective at dissipating a proportion of the energy generated at the inlet, eliminated jetting and directed flow uniformly into the reception chamber, immediately downstream of the baffle wall. This plate would also add stiffening to the baffle structure.



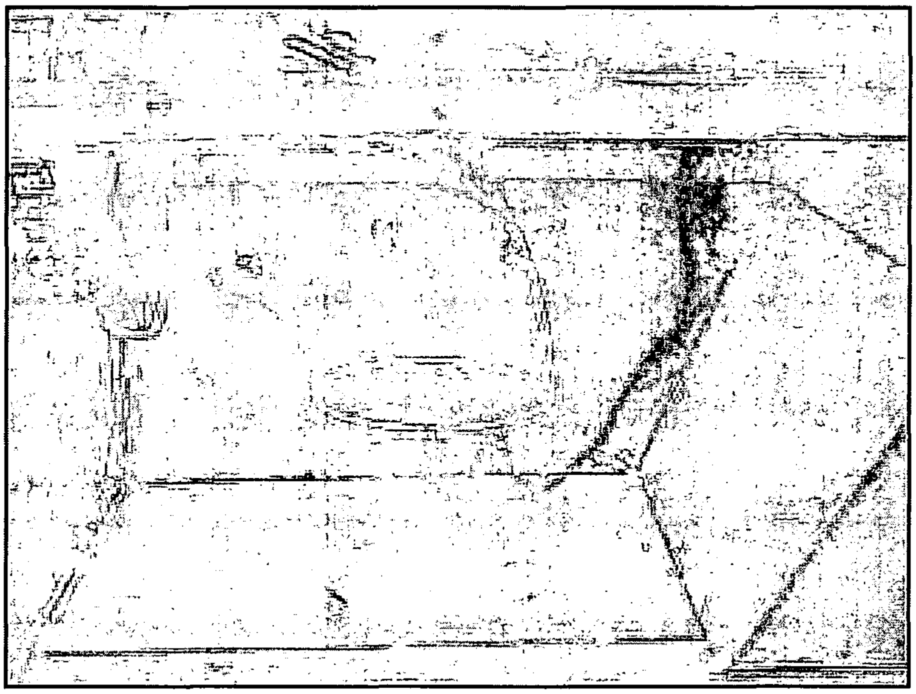
The horizontal plate fitted to the base of the baffle

From the reception chamber flow lifts into the main sump over the baffle wall. As the inlet sewer is set perpendicular to the weir plate, flow is forced to turn through 90 degrees. As a result there was a minor bias to the right hand side of the sump (when looking downstream), particularly at high inflows (348 l/s). Despite this, the utilisation of the station width was considered acceptable when operating across the specified flow and level range.

While a bottom water level has been defined by the client as minus 0.540 m (to allow for 15 starts per hour to be achieved and to provide adequate submergence to prevent loss of prime) it was considered that the water level could be reduced further without causing detriment to intake conditions. This would result in a significant improvement in grit transport towards the pump troughs and a general improvement in the self-cleansing characteristics of the sump. While it may not be necessary to run the sump so low following each cycle, it may be prudent to draw the sump down as low as possible on a regular basis as part of a cleaning cycle.

The sump water level was reduced to the point immediately prior to the ingestion of entrained air. Testing showed that the minimum sump operating level with the duty pump at base speed (200 l/s) was minus 1.00 m. Allowing the sump to reduce below this level resulted in the ingestion of air entrained air. Air entrainment can be very detrimental to pump performance and is therefore a main concern on pumping stations such as this where flow freely discharges into the sump at lower operating levels. While there is little published data on the changes in pump performance due to air entrainment, it is known that air in quite small quantities leads to a reduction in discharge and loss in efficiency. Industry guidelines (Reference : M.J. Prosser – The Hydraulic Design of Pump sumps and Intakes) states that in the case of a centrifugal pump, the intake of 3.0 % by volume of free air showed a drop in efficiency of 15.0%. It is therefore important that the minimum operating level/cleaning cycle draw down level is adhered to.

While operating conditions were generally acceptable at low level, an area of flow starvation was noted adjacent to Pump 2 between the intake and the side wall. Reverse flow was noted when Pump 2 was operating which did result in the formation of a Type 3-4 vortex when operating below minus 1.05 mAOD. Double click the image below to view video clip of the vortex.



Type 4 surface vortex connecting with Pump 2 at a sump water level of minus 1.05 m with the pump operating at base speed (200 l/s).

Testing showed that the operative pump was subject to strong side wall, rear wall and submerged floor vortices. The intensity of these vortices were in each case related to sump water level with intensity increasing with reducing levels. Double click on the images that follow to illustrate the submerged floor, side wall and rear wall vortices.

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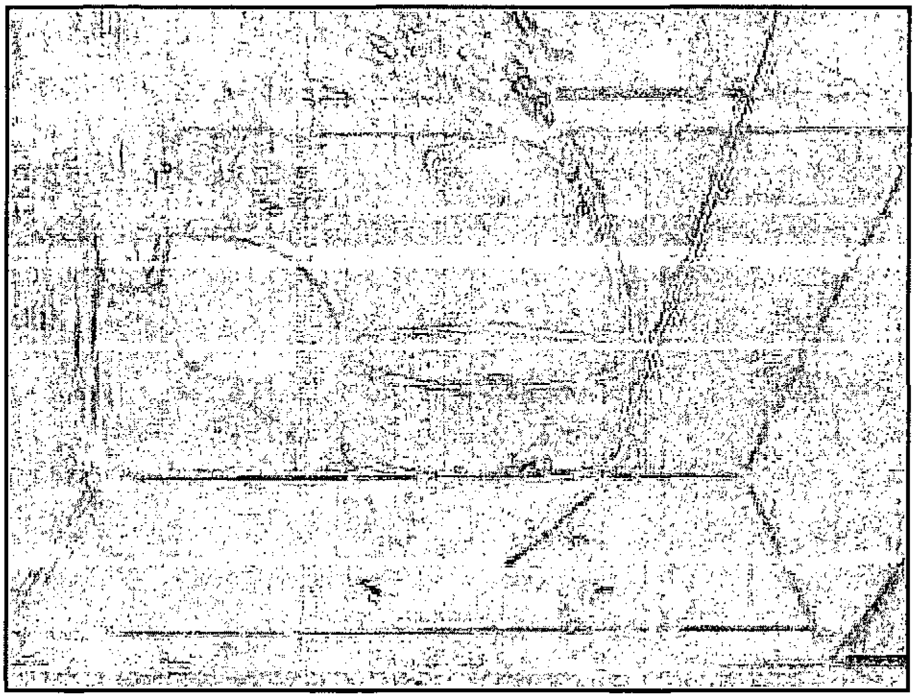
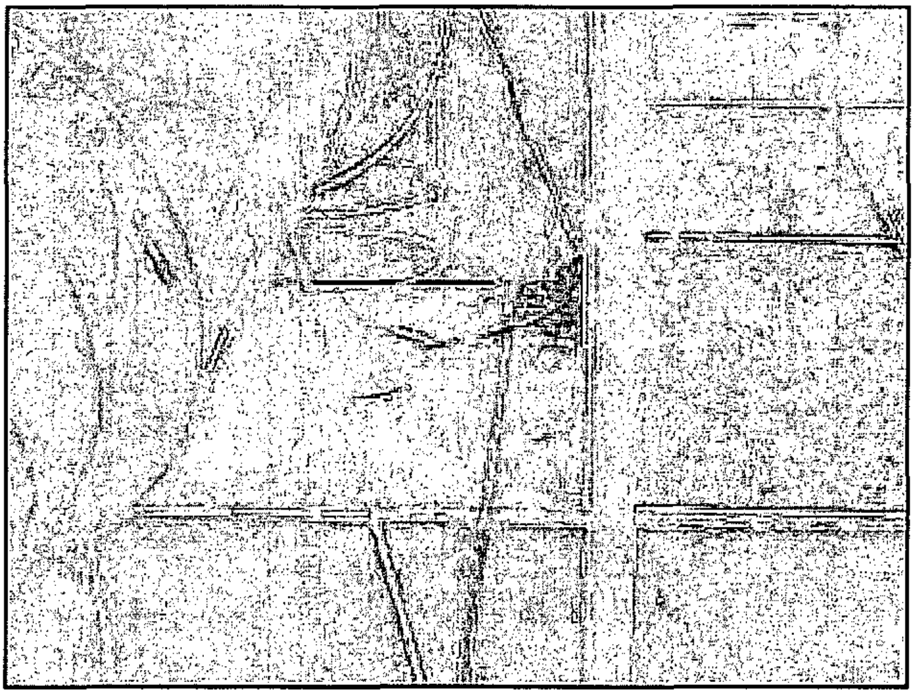


Submerged floor vortex connecting with Pump 2.



Submerged side wall vortex connecting with Pump 2.

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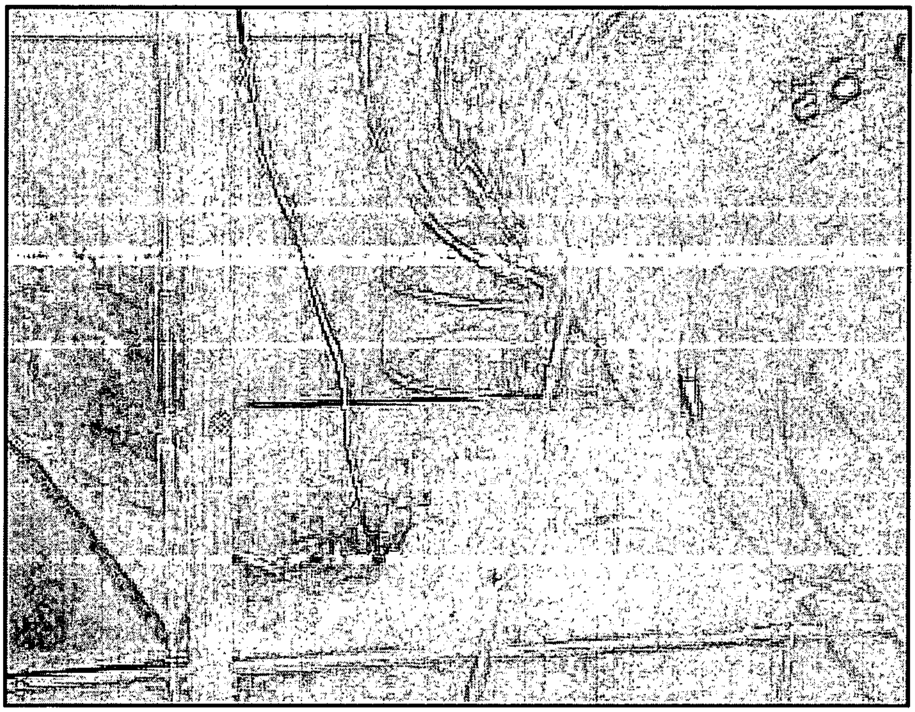

Submerged rear wall vortex connecting with Pump 2.

As a result the swirl meter vanes were, in each case, characterised by relatively intense bi-directional fluttering interspersed by periods of defined rotation. These characteristic were indicative of unstable flow passing the impeller position. Table 2.1 below summarises the intensity of pre-swirl rotation across the anticipated level and flow range.

Table 2.1 Summary of pre-swirl rotation between levels of 0.500 and minus 1.00 m

Sump Level (m)	Pre-swirl (Pump 1) Degrees	Pre-swirl (Pump 2) Degrees	Pump flow (l/s)
0.500	2.8	0.8	348
0.250	4.6	6.0	200
0.000	4.6	5.7	200
Minus 0.250	5.7	3.7	200
Minus 0.500	2.0	2.9	200
Minus 0.750	2.0	0.0	200
Minus 1.000	0.6	2.0	200

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3.0 DEVELOPMENT

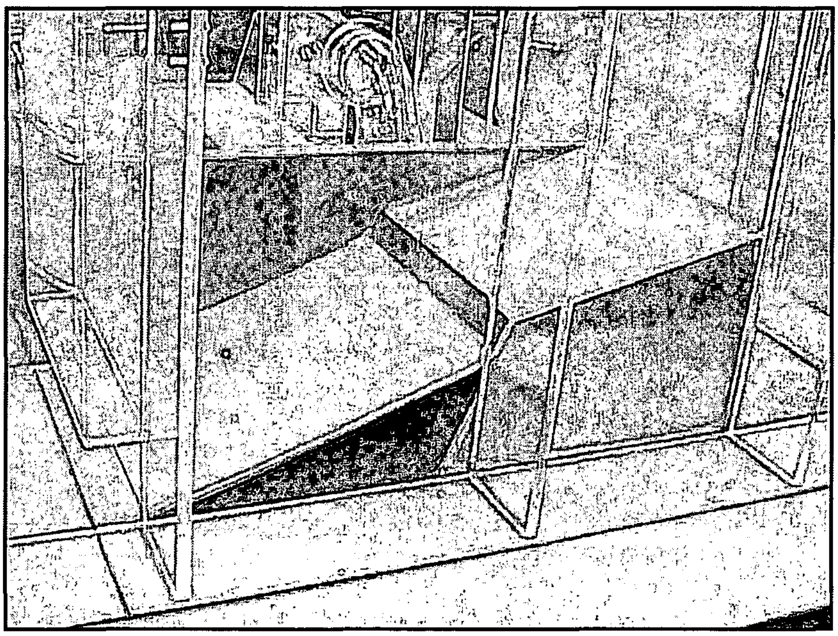
3.1 Introduction

Initial testing showed that while the conceptual design of the pumping station was essentially sound, modifications were required to eliminate submerged vorticity and improve pump intake conditions. Minor infill benching was required to reduce potential low velocity areas that may be subject to long term deposition and in addition, improvements to the inlet arrangement were required to promote grit and solids transportation through to the main sump.

The operating scenario has already been defined by the client although it is proposed that a draw down cycle should be written into the control software to ensure the station remains materially self-cleansing.

3.2 Development

Following confirmation by the client that the inlet arrangement should promote the transport of grits into the sump, rather than operating as a grit trap and retaining them, additional benching was developed. Initial testing showed that the existing arrangement was effective at first turning the flow through 90-degrees and then spreading it to ensure full utilisation of the sumps width. It was therefore important that any modification to the inlet arrangement didn't compromise this flow presentation. The image below illustrates the position and form of the infill benching located within the inlet area.

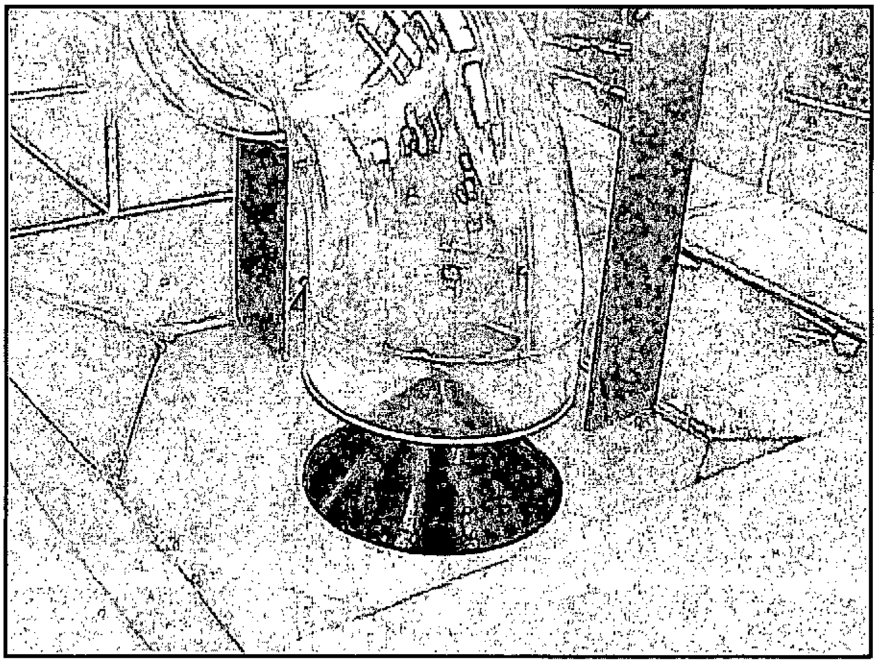


Modified inlet arrangement to promote grit transport into the main sump

Testing showed that the revised inlet arrangement was effective at promoting grit transport into the main sump without compromising flow presentation.

Initial testing showed that submerged side wall and floor vortices were evident across the anticipated flow and level range. The effect of this was noted on the swirl meter vanes which were characterised by intense bi-directional fluttering interspersed by periods of defined rotation or pre-swirl. It is also likely that the efficiency or performance of the operative pump may reduce and a deviation from the pump curve would be notable.

Profiled flow conditioning cones and single element flow straightening vanes were tested, each located beneath and along the centreline of the pump suction. The cones proved effective at breaking the initiating mechanism for submerged floor vorticity and improved the intake conditions by promoting a smooth radial draw into the suction intake. The vanes pre-conditioned flow entering the suction intake, however, a weak submerged floor vortex was still noted to the side of the vane. The vane was profiled which eliminated the formation point and therefore the initiation of the vortex mechanism. While it was considered that both forms of flow pre-conditioning were effective, we would recommend that the profiled vane be utilised on the prototype as it will be easier to form in concrete or steel. The image below illustrates the position and form of the flow conditioning cones and vanes. The image that follows shows the profiled flow straightening vane and vertical vanes.



Position and form of the flow conditioning cone and vane arrangement.

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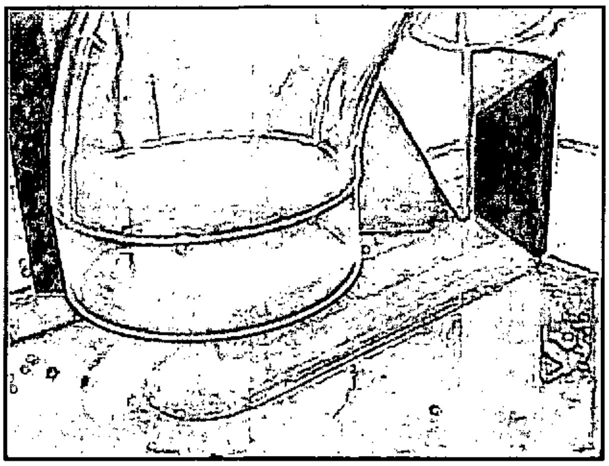
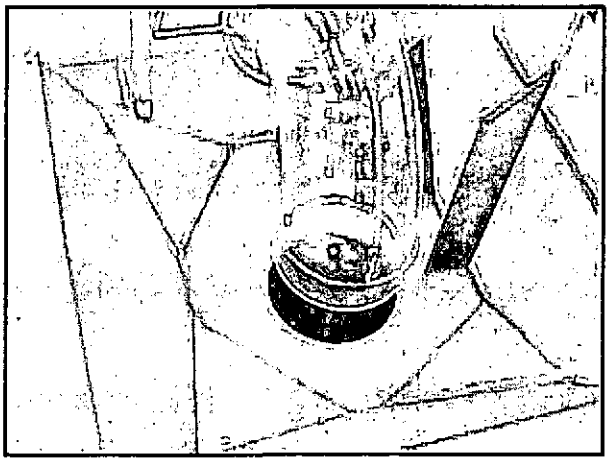


Position and form of the vertical vanes and profiled straightening vane.

While the profiled vanes were successful at eliminating submerged floor vorticity, side wall vortices were also a common feature. Profiled vertical vanes were installed perpendicular to the outside walls along the pump centreline. The vertical vanes eliminated the formation point for rear and side wall vorticity and also reduced passing flow by deflecting a proportion of flow towards the suction intake.
It is recommended that the vertical wall vanes and flow straightening vanes are formed in stainless steel with rounded off edges to reduce any potential ragging. They can be bolted into position once the pumps have been installed to ensure accurate positioning can be achieved.

Low velocity areas were noted in the two pump troughs, during initial testing, that may lead to long term deposition. Corner fillets were added to the two troughs to eliminate the low velocity zone and improve grit transportation through to the pumps. The corner fillets should be cast in concrete. The position and form of the infill fillets is shown below.



Position and form of the infill fillets.

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4.0 FINAL TESTING

4.1 Introduction

Following the definition of the modifications a study of the final arrangement was undertaken to confirm the pumping environment over the proposed operating range established in Section 1.2. The program of testing carried out may be summarised as follows: -

- Operating levels
- Sump inlet conditions
- Pump intake conditions
- Self cleansing of the pumping station

4.2 Operating range and control levels

The sump will be operated using a modulating band. The level will not be maintained at an exact level but will be allowed to vary around a set point level within a range called the proportional band. Section 1.4 of this report defines the operating scenario in detail. Testing showed that the level for the normal operating band could be reduced by up to 300mm without any adverse effect hydraulically.

Operating the sump for extended periods at a relatively high modulating level will generate relatively low levels of turbulence within the sump. It is therefore likely, that under such conditions, a build up of grits and gross solids will be deposited in low velocity regions of the sump and, in addition, the formation of floating "blankets" of buoyant debris will occur.

In order to minimise potential problems, such as pump clogging etc, resulting from such solids accumulations, a cleaning cycle is to be implemented at least once a day. This will entail operating one of the pumps, at high speed (348 l/s) down to a minimum draw down level (defined as a point immediately prior to the onset of any detrimental hydraulic condition such as vorticity, pump snore, increased pre-swirl etc) in order to clear as much accumulated debris as possible. This is covered in more detail in Section 4.5.

To be effective the cleaning cycle should be undertaken when the inflow to the station is just below the pumped outflow. This will ensure that maximum turbulence is generated in the sump. The cleaning cycle will be initiated when the sump level is at or below the modulating level and will over ride the normal pump control.

On initiation of the cleaning cycle the duty pump will run up from base speed until the inflow is beaten (up to a maximum flow of 348 l/s). If the inflow is below the pumped outflow, and the sump level reduces, the cleaning cycle will start. The cycle time for the cleaning period will depend on the inflow to the pumping station and the available sump volume. At the end of the cleaning cycle the duty pump will stop to allow the sump to fill and revert back to normal operation.

If the inflow to the sump is at or above the pumped outflow at the start of the cleaning cycle, and no reduction in sump level is recorded, the cleaning cycle will be overridden and normal operation will resume.

The duty or lead pump selection should be alternated to minimise accumulation of grit debris around the non-operative or standby pump. To help minimise blockages within the pump it is recommended that the lead pump is alternated after running for a set period of say, one hour. However, we would recommend that further advice on running times is sought from the pump supplier.

The operating range available for pump control will be defined by the maximum permissible start level and the minimum permissible stop or draw down level. In this instance the maximum start or modulating level has been defined by the client. Minimum stop or draw down levels were defined in the model by the point immediately prior to the onset of a marked deterioration in pump intake conditions due to air entrainment. The minimum operating or draw down level with one pump operating at full or base pump speed (200 to 348 l/s) was determined as minus 1.00 m.

4.3 Sump inlet conditions

Following confirmation by the client that the inlet arrangement should promote grit movement into the main sump rather than utilising it as a grit trap the benching arrangement was adapted. The initially proposed arrangement was effective at turning the flow whilst retaining full utilisation of the inlet and it was essential that this remained the case following modification. Final testing showed that the full sump width was utilised across the anticipated flow and level range and grits were successfully transported into the main sump. There was no evidence of jetting and turbulence was minimal. The intake arrangement therefore promoted acceptable flow patterns within the sump which in turn contributed to acceptable intake conditions at the pumps.

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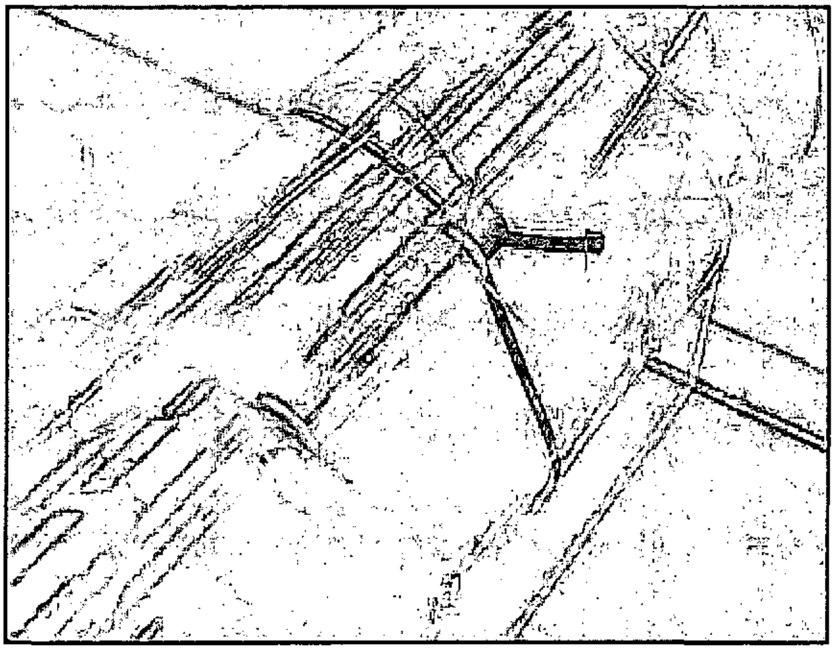
4.4 Pump intake conditions

With the operating range confirmed, a detailed evaluation of the pump intake conditions was undertaken to verify the characteristics of the proposed modified sump. A detailed evaluation of pump intake conditions was undertaken across the anticipated flow and level range to identify any submerged or surface vorticity and to determine the magnitude of pre-swirl rotation.

Testing showed that at low operating levels the pumps were subjected to submerged jetting which in turn initiated submerged vorticity and influenced intake conditions. Despite this pre-swirl rotation was generally below 3.0 degrees, although intense bi-directional fluttering of the swirl meter vanes was notable, which is indicative of unstable flow passing the impeller position. Double click the image below to see the action of the swirl meter vane in the unmodified sump.



The swirl meter vane in the unmodified sump.

The addition of profiled flow straightening vanes ensured that the initiating mechanism for submerged floor vorticity was broken and they also improved the transition of flow into the pump intakes. This reduced the intensity of bi-directional fluttering.

Profiled vertical vanes located on the side and rear wall of the sump along the centre lines of the two pumps were sufficient to break the mechanism for submerged side and rear wall vortices. The vanes also improved flow presentation to the pumps which in turn resulted in a reduction of pre-swirl rotation and instability.

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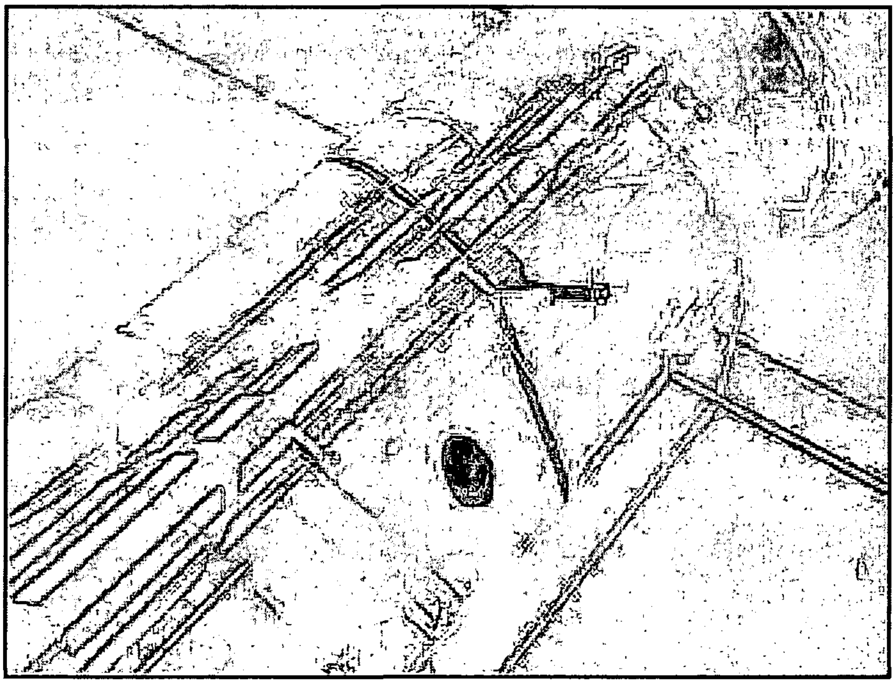
Testing was carried out with a flange on the suction intakes and with the flange removed. There was no difference hydraulically to the suction intake conditions, however, there was concern that there was a potential for solids stranding so it is therefore recommended the flange is removed.

There was no evidence of either surface or submerged vorticity across the defined operating range. Pre-swirl values remained at zero degrees and the swirl meter vanes continued to exhibit mild bi-directional fluttering (double click image below), although this was not considered to be detrimental to intake conditions.



Action of the swirl meter vane on the modified sump.

With the modifications in place it was considered that pump intake conditions were acceptable across the anticipated flow and level range.

4.5 Self cleansing characteristics of the pumping station

One of the major operational problems associated with sewerage pumping stations today is the accumulation of floating debris comprising fibrous waste, fat and plastic material. Increasing quantities of fats and detergents within domestic discharges, and more significantly, within effluent from restaurants and fast food outlets, has exacerbated the problem. Excessive turbulence upstream of the pumping station can cause fats and detergents to foam, increasing their buoyancy. Likewise, rags coated with fats will trap air bubbles and, on rising to the surface, will agglomerate with congealed fats and other floating material to form rafts or mats.

Unless such accumulations are cleared on a regular basis, i.e. at least once a day, the resulting raft formations will increase the risk of impeller clogging during high inflow periods. Due to the orientation of the inlet sewer and the relatively low outflow of the station, it is unlikely that floating matter will be cleared from the surface until low sump water levels are achieved.

As the sump will be operated using a modulating band it is unlikely that the level will reduce sufficiently during a single cycle to transport heavier grit particles through to the pumps. It is therefore imperative that a draw down procedure is implemented on a regular basis to ensure that floating matter can be cleared effectively. In addition, to avoid pump clogging at low level, it will be necessary to implement duty cycling on a regular basis.

In a similar fashion, fine sand, carried through to the station, can accumulate on the sump floor in low velocity areas or when the sump is operating at high level and the general turbulence and flow velocities are reduced. If sediment accumulations are permitted to increase, without periodic clearing, septicity could result. Furthermore, under higher inflow conditions, when such accumulations are de-stabilised, sand/silt can be ingested by the pumps in significant concentrations and start to accumulate in downstream mains, increasing head loss and reducing discharge capacity.

During model testing of any raw sewage pumping installation, the evaluation of solids transport and the development of periodic cleaning cycles as part of the routine level control philosophy are critical areas for optimisation, if the reduced risk of premature failure of the pumps is to be maintained.

The self-cleansing characteristics of the pumping station with respect to grit debris was determined by the introduction of modelled grit particles. In this instance modelled grit representing full-scale particles ranging from 0.3mm to 1.5 mm were used. Using positive and neutral buoyancy particles such as chopped sponge, polystyrene and sawdust simulated indicative behaviour of grease and floating solids. Saw dust acts as an emulsion and also a binding agent to provide a good indicator of composite grease type properties.

The model was tested to ensure it was materially self-cleansing throughout the full range of inflows required. The model was initially run at steady state conditions where inflow is equal to outflow. This allowed the general self-cleansing characteristics of the station to be assessed at any given level. The model also had the capability to run with an increased/decreased inflow to the pumped outflow using an auxiliary reservoir and

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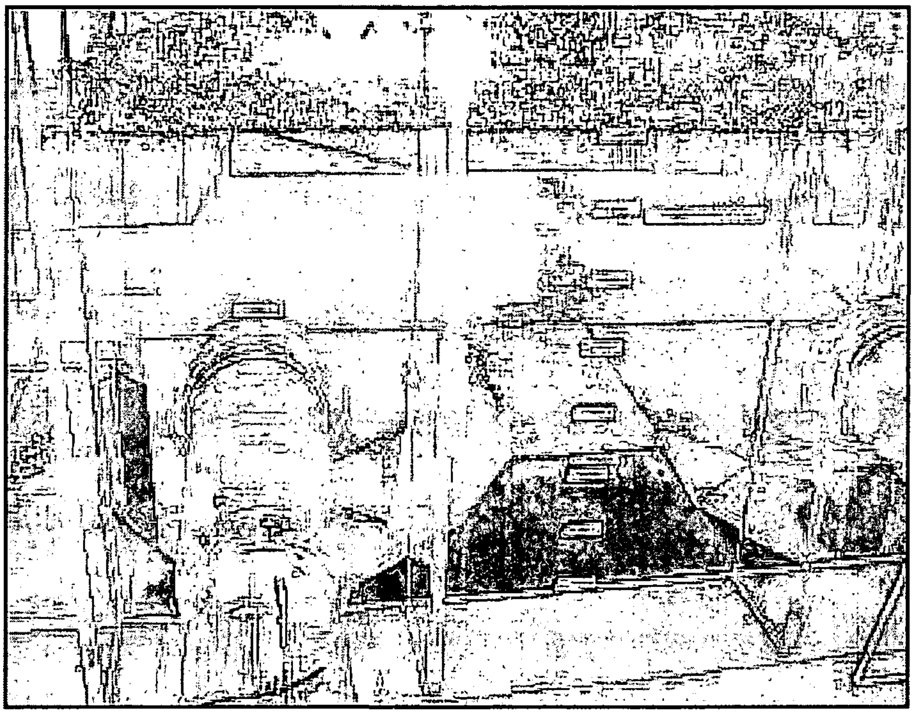
drain line. This allowed conditions to be assessed when the sump water level was either rising or falling. The scale considerations in the modelling of grit and floating solids are defined in Appendix 1.

Grit and gross floating solids

Grits and particles simulating gross floating solids were introduced into the model at a level of 0.260 m (the low speed start level). The bulk of the grits cleared the inlet area and passed straight through to the main sump with a proportion of the more neutrally buoyant particles being drawn directly into the operative pump unit. The bulk of the non- buoyant grit particles settled on the sloping benching and in the non-operative pump trough. Double click on the image below to show areas of primary settlement.



Settlement in the sump at a level of 0.260 m with Pump 2 (right) operating at base speed of 200 l/s.

The sump water level was allowed to rise to the top water level of 0.560 m at which point the model pumps were operating at full speed (358 l/s) to simulate storm conditions. Further grits and buoyant particles were added at regular intervals. Solid particles continued to be transported through to the main sump with only heavier particles remaining. These particles were continually agitated by the inflow and eventually cleared as the sump water level reduced (double click image overleaf).

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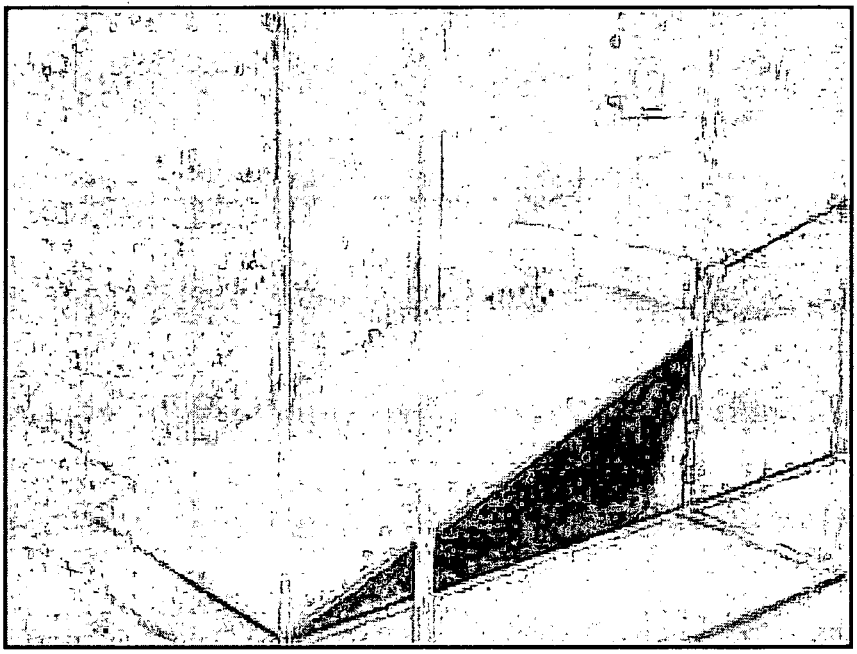
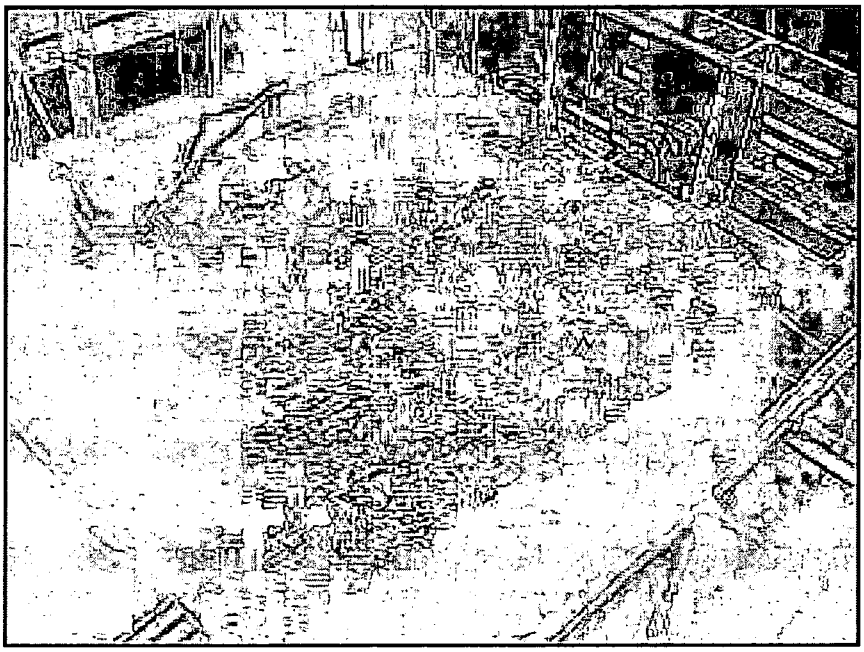


Grits entering revised inlet arrangement at a level of 0.260 m.

As the sump water level increased, the turbulence decreased resulting in further grit settlement. Buoyant particles were pushed to the downstream end of the sump, above the pumps, where they formed a floating mat of debris. Double click the image below to see the extent of floating matter on the sump surface at a level of 0.560 m.



The extent of floating surface matter in the sump at a level of 0.560 m (TWL) with one pump operating at full speed (358 l/s).

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The sump water level was allowed to reduce to simulate the cessation of the storm event. In practice the sump water level would rise and fall within the proportional band for the period of the storm event first. It was considered that during this period there may be a significant build up of solid material within the sump that is deposited across the benching and on the water surface as floating debris and so further grits and floating matter were introduced.

As the sump water level reduced to a level of 0.260 m the pump speed reduced and an outflow of 200 l/s was assumed. Neutrally buoyant and lighter negative buoyancy particles were continually drawn into the suction intake of the operative pump, however, heavier particles remained stranded on the benching. This was still the case at the proposed bottom water level of minus 0.540 m. In addition, floating surface matter was still evident. Double click the image below to see the extent of deposition at the pump stop level of minus 0.540 m.

Extent of deposition at the bottom water level of minus 0.540 m.

Testing showed that while the bulk of the solids particles introduced into the sump were transported through to the pumps and cleared, heavier grits and the more buoyant floating surface matter was left stranded. It will therefore be necessary to implement a cleaning cycle which should be initiated following each cycle or at least on a daily basis. The cleaning cycle involves drawing the sump down to a level of minus 1.00 m

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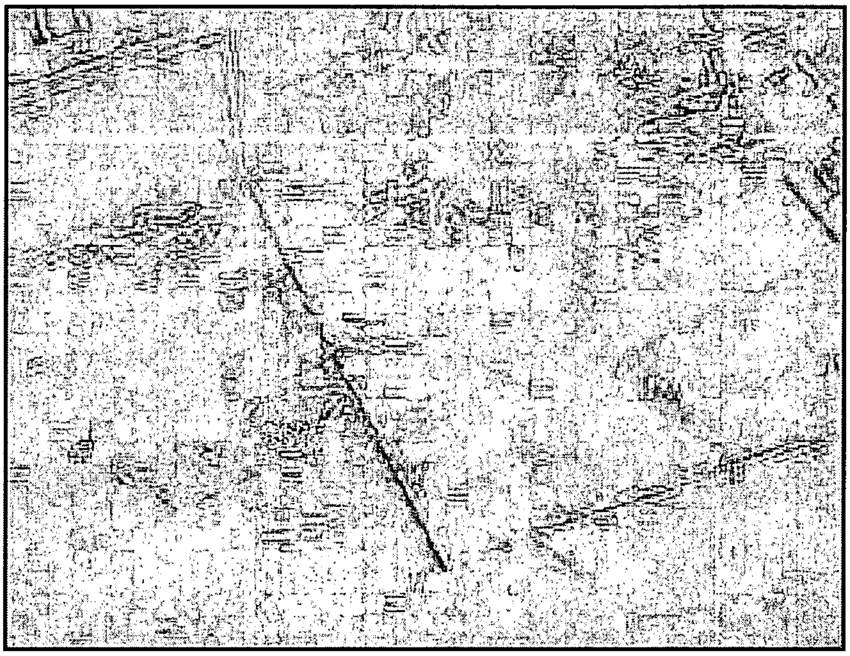
with one pump at full speed of 348 l/s (the procedure is discussed more fully in Section 4.2 of this report).

Testing showed that as the level reduced, sump turbulence increased and the grits were transported into the two pump troughs. The bulk of the floating debris was drawn into the operative pump suction. While there may be some residual floating matter left on the pump surface, it is unlikely that this will build up over time. The image below illustrates the cleared sump at a level of minus 1.00 m.



The cleared sump at a level of minus 1.00 m with Pump 2 operating.

The addition of the corner fillets ensured that all solid particles were drawn into the operative pump suction. Grits entering the non-operative pump trough were deposited beneath the suction intake. It is therefore necessary to ensure duty cycling is implemented on a regular basis. The change over should be implemented following each pump cycle or, during prolonged periods of operation within the proportional band, after a set period of time, say one hour for example. It is recommended that advice from the pump supplier is sought for maximum pump run times.

The adoption of regular sump draw down in accordance with the levels specified and in conjunction with automatic duty changeover of the pumps, should ensure that the bulk of the grits and floating solids are cleared. While testing showed that the sump should remain materially self-cleansing, modelling could not take into account the effects of larger debris such as bricks and sections of timber. As the station does not include a course screening facility we would recommend that periodic inspection is undertaken to ensure the sump remains clear of such debris.

4.6 Conclusion

With the modifications in place the proposed final arrangement of the pumping station allowed for a satisfactory pump environment to be achieved across the anticipated operating range. The sump is materially self-cleansing in terms of grits and gross floating solids so long as the cleaning cycle is adopted as part of the control strategy.

Modifications have been kept as simple as possible and no alteration to the structure or pump positions was required.

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APPENDIX 1 MODEL SIMILARITY

A1.1 Model Scale

The fundamental scale for any hydraulic model is the geometric scale, that is the ratio of a given length in the model to a given length in the full-scale application. Practical considerations such as the circulating pump capacity, depth of model, the floor space utilised and ultimately cost, place limits on the maximum size of a model. Theoretical considerations regarding the correct representation of flow conditions places limits on the minimum size of a model.

The correct representation of flow conditions principally requires that the Reynolds Number to be above a critical value within the model to ensure that, where fully turbulent conditions are present in the prototype, similar turbulent conditions exist within the model. If the model is too small this condition will not be met.

Much has been written concerning the problem of scaling results from a physical model to predict full-size prototype performance. It is apparent that a scaling law for one arrangement may not be appropriate for another and thus no definitive, universally applicable law exists. In areas of the sump remote from the pump intakes it is generally accepted that the Reynolds Number should be at least 2,500 to ensure fully turbulent conditions are present. In studies where vortex formation may occur it is necessary to ensure that the Reynolds Number, at the plane of the pump intake bellmouth, has a value of at least 30,000 to 40,000 to eliminate viscous scale effects.

Some researchers suggest applying a multiplication factor to the Froude Scale model velocities for vortex studies, but there is no general agreement on the actual numerical value to use.

In this instance the dry well mounted pumps have an intake diameter of approximately 450 mm. At a nominal maximum flow of 348 l/s the full scale Reynolds Number will be approximately 890 000. From practical considerations the model the model was constructed to a scale of 1 to 4 full size which will result in a Reynolds Number at the plane of the pump intake of approximately 110, 000. This is well in excess of quoted minimum values and will ensure similarity in pump intake conditions will be maintained.

Following the selection of an appropriate geometric scale, the dynamic scale of for example, velocity and discharge, will be determined according to scaling criteria

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dictated by a particular model law. For free surface flows the governing forces are gravity and inertia, these forces are related by the Froude Scaling Law, which may be stated as:

Froude Number similarity will be achieved if the Froude Number in the prototype (F_p) and model (F_m) are equal, i.e. :

$$F_p = \frac{V_p}{\sqrt{g.L_p}} = F_m = \frac{V_m}{\sqrt{g.L_m}} \qquad 1.1$$

Where V_p and V_m are the velocities in the prototype and model, L_p and L_m are characteristic lengths in the prototype and model and g is the gravitational constant. This will ensure dynamic similarity for flow regimes governed primarily by gravity. Rearrangement of equation 1.1 gives the velocity scale :

$$V_m = V_p \frac{\sqrt{g.L_m}}{\sqrt{g.L_p}} \qquad 1.2$$

For a geometrically similar model the model scale factor may be defined by $S = L_m / L_p$ and the gravitational constant g will be equal, hence

$$V_m = V_p S^{1/2} \qquad 1.3$$

The flow scale may be derived by continuity, whereby

$$Q \propto L^2 V \qquad 1.4$$

Substitution into equation 1.2 gives

$$Q_m = Q_p S^{5/2} \qquad 1.5$$

Similarly, transformation to take account of time is made using

$$V \propto L/T \qquad 1.6$$

so that

$$T_m = T_p S^{1/2} \qquad 1.7$$

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Force scales are based on the ratio of measured force to inertial force and provided these are maintained in equal ratio model similarity of forces will also be achieved:

$$\frac{F_p}{\rho L_p^2 V_p^2} = \frac{F_m}{\rho L_m^2 V_m^2} \qquad 1.8$$

so that assuming the model and full scale application are operated with the same fluid, substitution into equation 1.3 gives

$$F_m = F_p S^3 \qquad 1.9$$

For the application in question a geometric scale of 1 to 4 was selected, hence the appropriate dynamic scales may be calculated as follows :-

Property	Scale Relationship	Model Value
Geometric	$S = L_m / L_p$	1 / 4
Velocity	$V_m = V_p S^{1/2}$	1 / 2
Flow	$Q_m = Q_p S^{5/2}$	1 / 32
Time	$T_m = T_p S^{1/2}$	1 / 2
Force	$F_m = F_p S^3$	1 / 64

A1.2 Pre-swirl at pump intakes

Most pumps are designed for rotation free inflow. Rotational flow will therefore cause the internal flow inside the pump to depart from the design pattern and cause the performance of the pump to deviate from design parameters. Hence pre-swirl rotation should be avoided or kept within limits prescribed by the manufacturer.

Rotational flow usually arises due to an asymmetrical velocity distribution at the entry to a sump which results in the development of rotational momentum which is then amplified as flow converges into the pump intake, as depicted overleaf.

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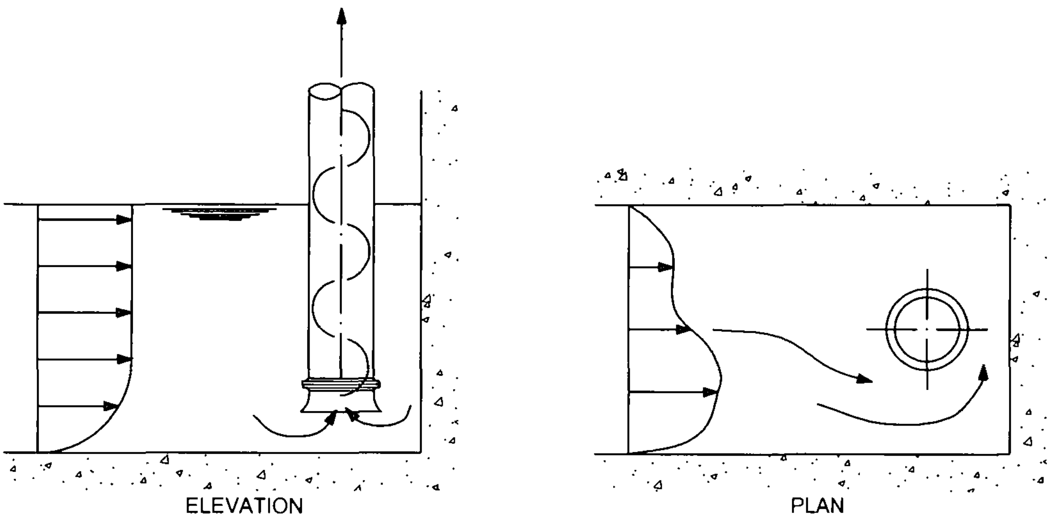
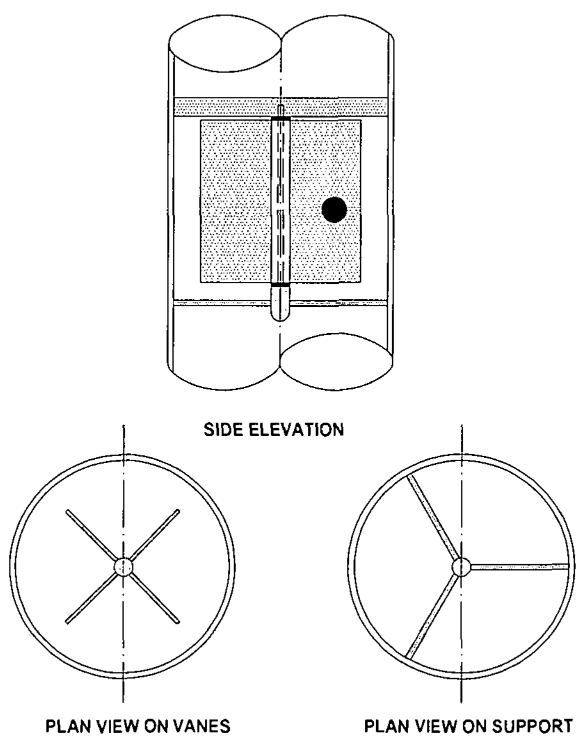


Asymmetrical velocity distribution onto a pump intake.

In a hydraulic model of a pumping station, pre-swirl rotation can be measured directly by a freely pivoted, four vane swirl-meter mounted in the pump inlet at the position of the impeller. The swirl-meter is essentially a propeller with zero pitch, the swirl meter diameter should be not greater than 75 percent of the pipe diameter in order to occupy the 'solid body' rotational flow field. A representation of the swirl-meter used in this model study is shown below.



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The swirl angle θ is defined as

$$\theta = \arctan \frac{V_t}{V_a}$$

where V_t is the tip velocity of the swirl-meter and V_a is the axial velocity.

The effects of pre-swirl on the performance of a pump are primarily dependant on the direction of pre-swirl rotation in relation to that of the impeller rotation and will vary according to pump type. Pre-rotation opposing the impeller increases the developed head and, dependant on pump type, the absorbed power, typically the efficiency is reduced leading to increased energy consumption.

If a pump is subject to counter rotating pre-swirl of sufficient intensity coincident with maximum power uptake, potential motor overload problems could result. Pre-swirl rotation in the same direction as the pump impeller results in a reduction of the pumped flow and typically efficiency and absorbed power. Noisy operation, cavitation and premature bearing wear are all features of excessive pre-swirl.

In general, for a pump operating close to its BEP (Best Efficiency Point) the effect of swirl at the inlet would be (i) to reduce the flow at which BEP occurs with swirl in the direction of impeller rotation, and (ii) to increase the flow at which BEP occurs with swirl in the opposite direction to impeller rotation. In both cases there would also be a change in the pump differential head compared with no-swirl conditions.

A pump may be subject to overlying pre-swirl and cyclic peaks of swirl. Overlying or bulk pre-swirl may be defined as consistent rotation of the flow entering an intake and is registered by relatively constant rotation of the swirlmeter in one direction. Short term rapid rotation of the swirlmeter registers the magnitude of intermittent cyclic peaks in pre-swirl and abrupt changes in the direction of rotation or jerky operation are indicative of unstable flow conditions.

It is generally accepted that to achieve similarity between model and full size magnitudes of pre-swirl requires an approach flow Reynolds Number of not less than 3×10^4, this condition is satisfied at the model scale selected. Operation at Reynolds Numbers below this value results in scale effects to produce an under-estimate of full scale swirl.

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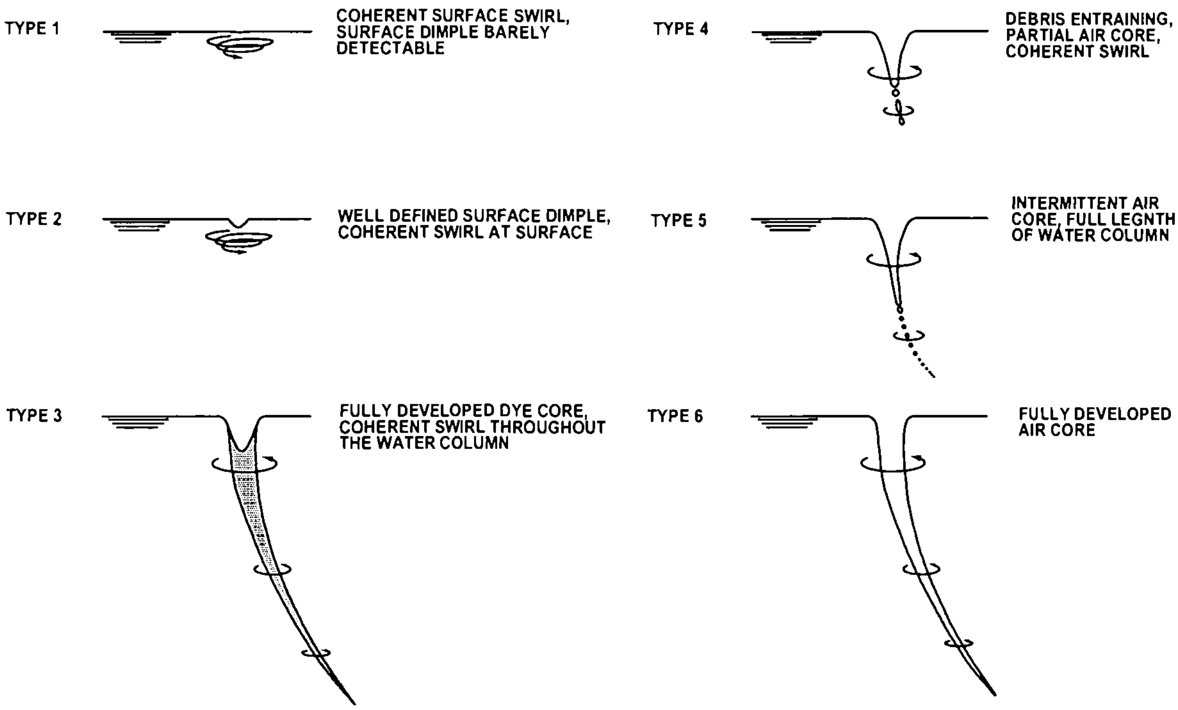
A1.3 Vorticity

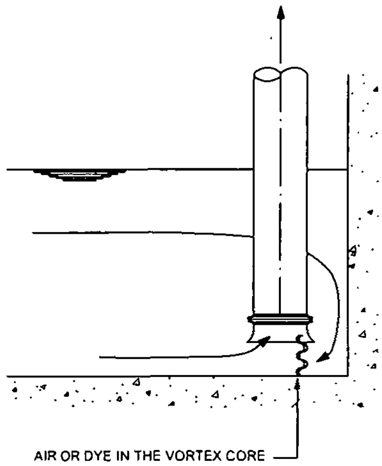
Whereas pre-swirl is a function of bulk rotation at an intake, vorticity is a much more intense form of local rotation which applies shock loadings to the rotating elements of a pump, causing adverse performance and vibration. Vortices may be surface or submerged formations. Surface vortices may be classified as six distinct types as shown below:-



Type 1, 2 and 3 vortices do not entrain air and therefore dye tracing must be used to confirm penetration into an intake. Since only inertial and gravitational forces are involved prototype conditions will be accurately predicted in a model operated on the basis of Froude similarity. Type 4, 5 and 6 vortices are much more readily identifiable owing to the presence of air. In a full size installation due to the absence of scale effects, the transition from a surface dimple and coherent subsurface swirl to an air core will occur more readily than in the model.

Surface vortices may be free or forced. Free surface vortices form due to rotation imposed without influence from the surrounding water environment, for example by rotation imparted at a pump intake or at a submerged reservoir outlet. Forced surface vortices form due to rotation induced by interaction of flow with the surrounding environment, for example in the wake of an obstruction or within a confined region of mass circulation. Surface vorticity may also be formed due to a combination of both free surface and forced influences, particularly within pumping stations where conditions conducive to both mechanisms of vorticity are often present.

Submerged vortices, occurring for example between the sump floor or wall and an intake, may be more detrimental to pump operation than surface vortices. Unlike surface vortices, the pressure in a submerged vortex core can fall below atmospheric pressure and have stronger rotational characteristics. If the pressure is sufficiently low, dissolved gasses will come out of solution, making the vortex core visible. More typically, dye tracing must be used to confirm the presence of submerged vortices



Development of submerged floor vortex.

A1.4 Scale effects

Scale errors occur whereby the laws of dimensional similarity cannot be satisfied simultaneously within a model operating on the basis of one particular law of affinity. This model was operated on the basis of Froude Number similarity, this effectively exaggerates the viscous influence defined by the Reynolds number (for non-turbulent conditions) and also exaggerates surface tensile forces defined by the Weber number. This condition is termed a 'scale effect'.

Under this model application, air was entrained in the flow at the entry to the sump. Due to surface tension effects, air bubbles generated within a model exhibit the same absolute size as those generated within the prototype. As a result, air bubbles apparent in the model will be disproportionately large compared to their boundary scale. The prototype, which operates at a higher Reynolds Number and therefore higher shear rate, will exhibit a larger number of proportionately smaller bubbles.

As a result of this condition, model bubbles will be more buoyant than their prototype full scale counterparts and will therefore exhibit a higher rise velocity. This results in model bubbles approaching the water surface quicker than their prototype counterparts, which will travel further. Hence the rise trajectory of model bubbles will be steeper.

It can be shown that within a Froude scale model, the depth of air bubble penetration is dictated by gravitational and inertial forces, provided flow is fully turbulent. Hence this characteristic will be correctly represented within the model provided the model is operated in excess of the Critical Reynolds Number (Re. of approximately 2000), which will ensure that the flow regime is fully turbulent. Therefore, where prototype operation is critical in relation to the depth of air bubble penetration, conditions will be correctly represented within the model, provided the geometric scale is selected to satisfy Reynolds Number constraints.

The depth of air bubble penetration and subsequent rise trajectory is of importance where the full scale installation has a bearing on the passage of air to say, a pump or transfer pipe, whereby more air may enter the pump or pipe within the prototype than within the model. Hence, where considered critical, an assessment of the relative characteristics of the prototype bubble flow paths and model bubble flow paths must be made. The deviation in bubble rise trajectory cannot be eliminated within a small scale Froude model, however the effect is reduced as the model scale is reduced.

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APPENDIX 2 DRAWINGS

The following drawings form part of this report:-

Title	*Drawing No.*
General Arrangement Drawings	
Serpentine Road – Plan On Station	Drawing 01
Section A – A	Drawing 02
Section B – B and C - C	Drawing 03
Details of Modifications	
Detail of modification – Plan	Drawing 04
Detail of modification – Section A – A	Drawing 05
Detail of modification – Section B – B & C – C	Drawing 06
Detail of modification – Pump cell detail	Drawing 07
Detail of flow straightening vanes	Drawing 08

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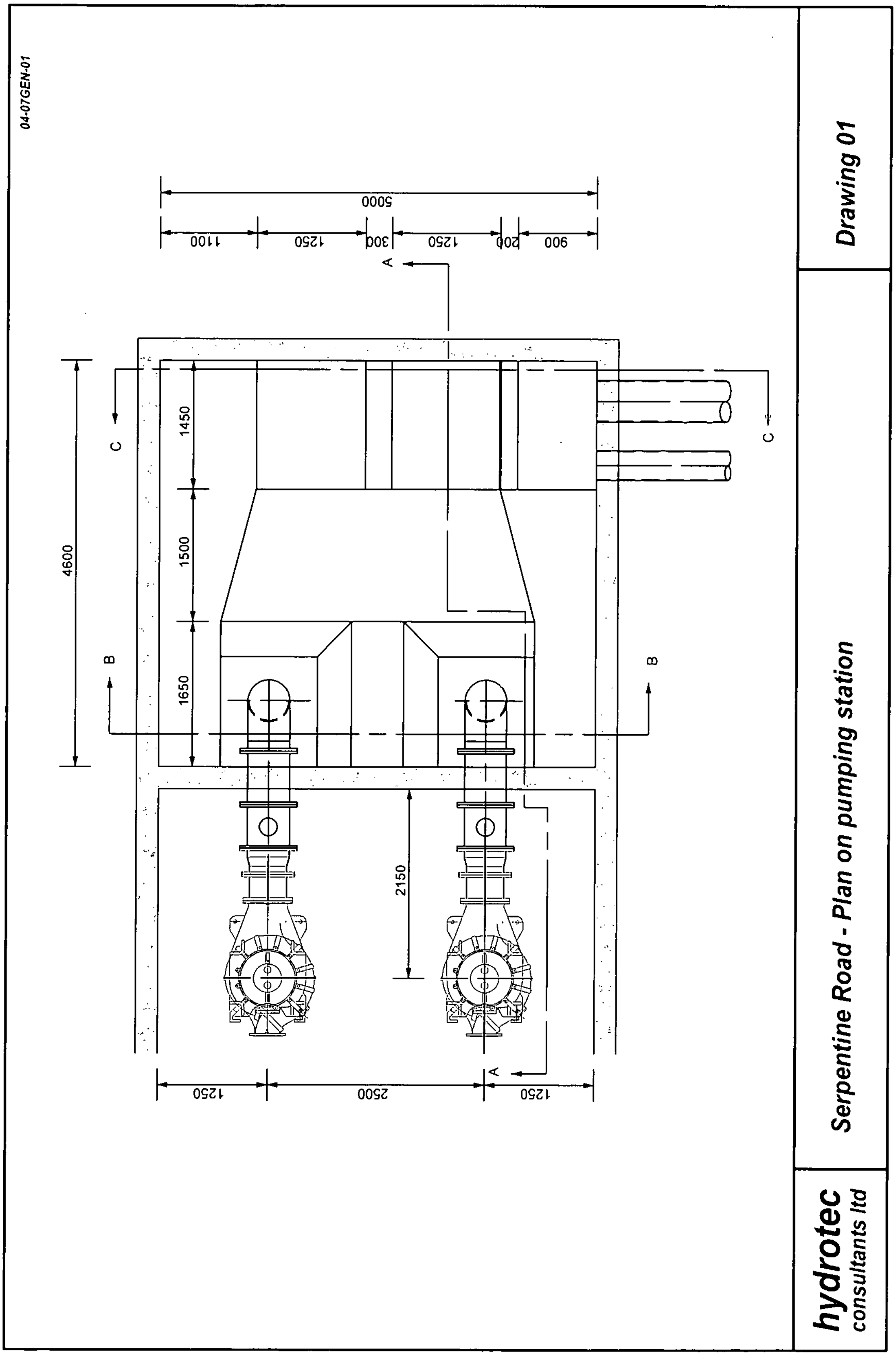
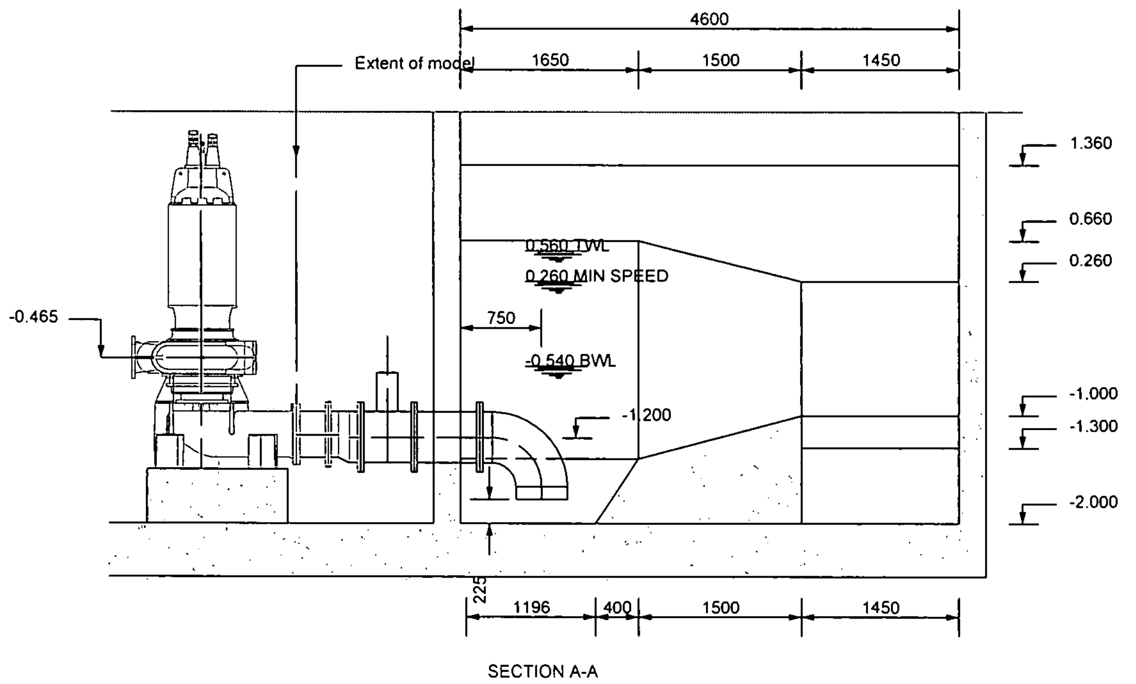
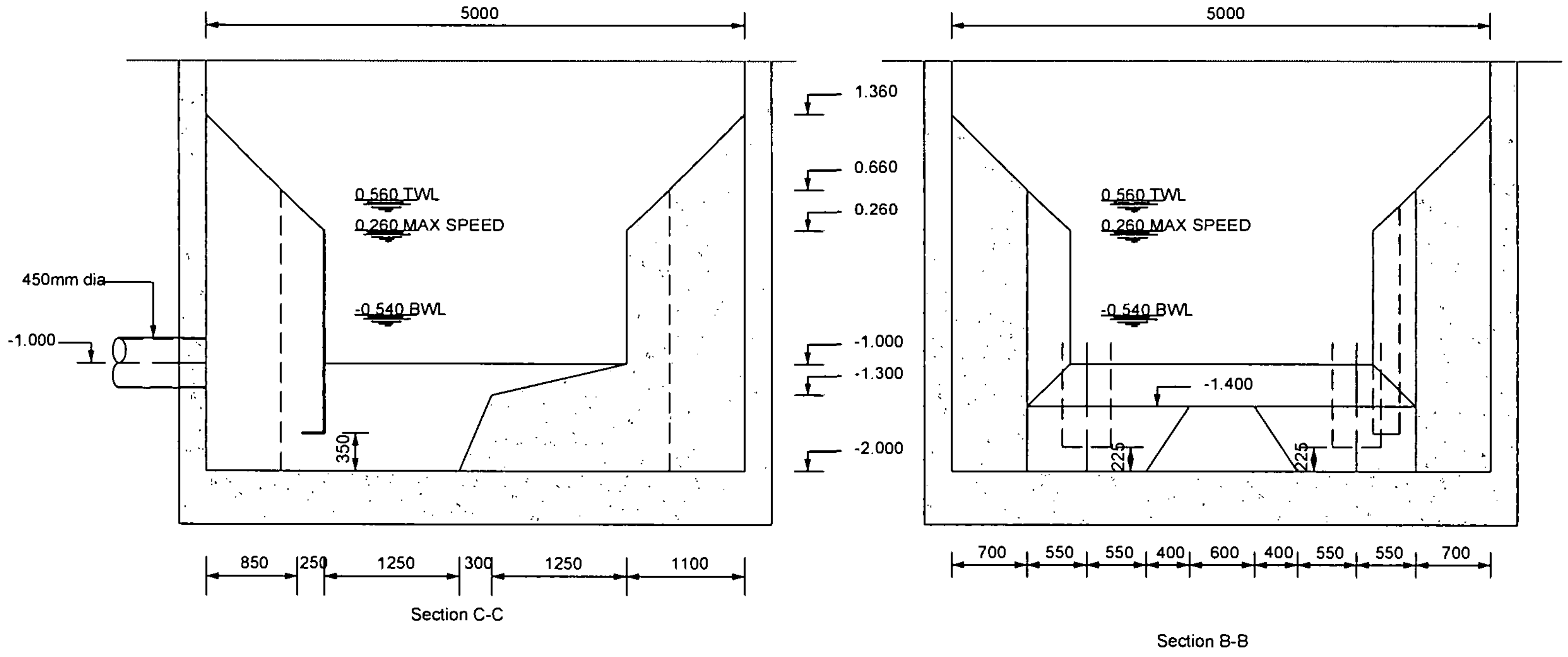


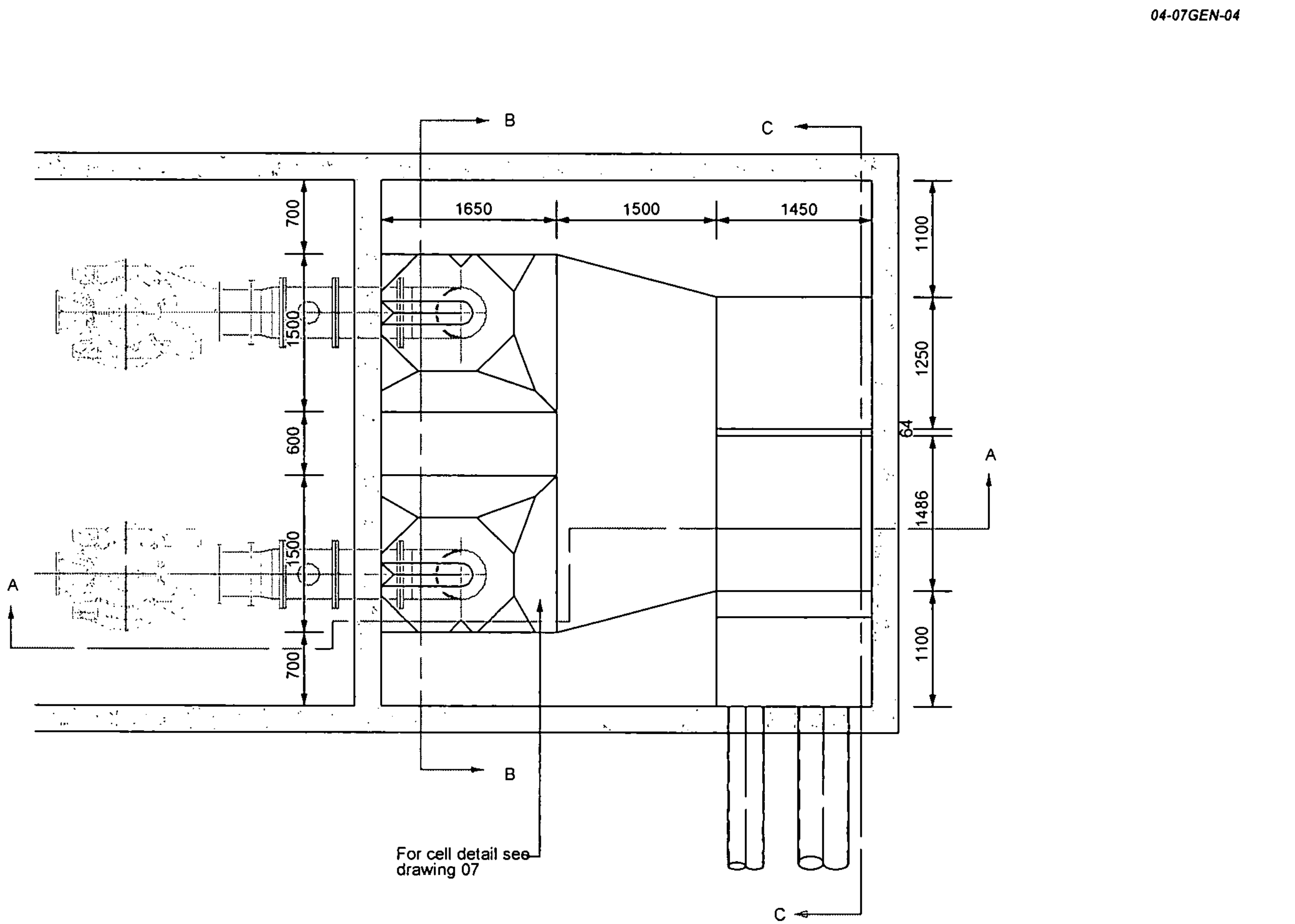


hydrotec consultants ltd	Section A - A	Drawing 02

04-07GEN-03



hydrotec consultants ltd	Section B-B AND C-C	Drawing 03



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Detail of modifications - Plan

Drawing 04

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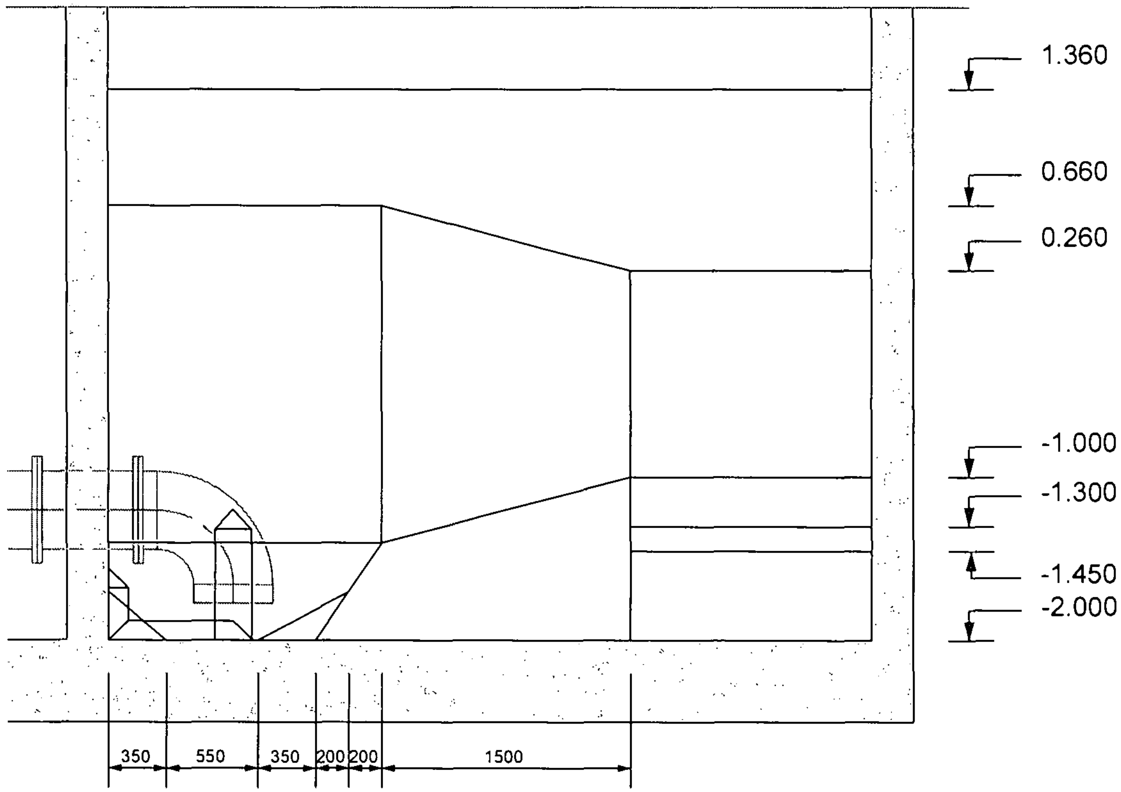
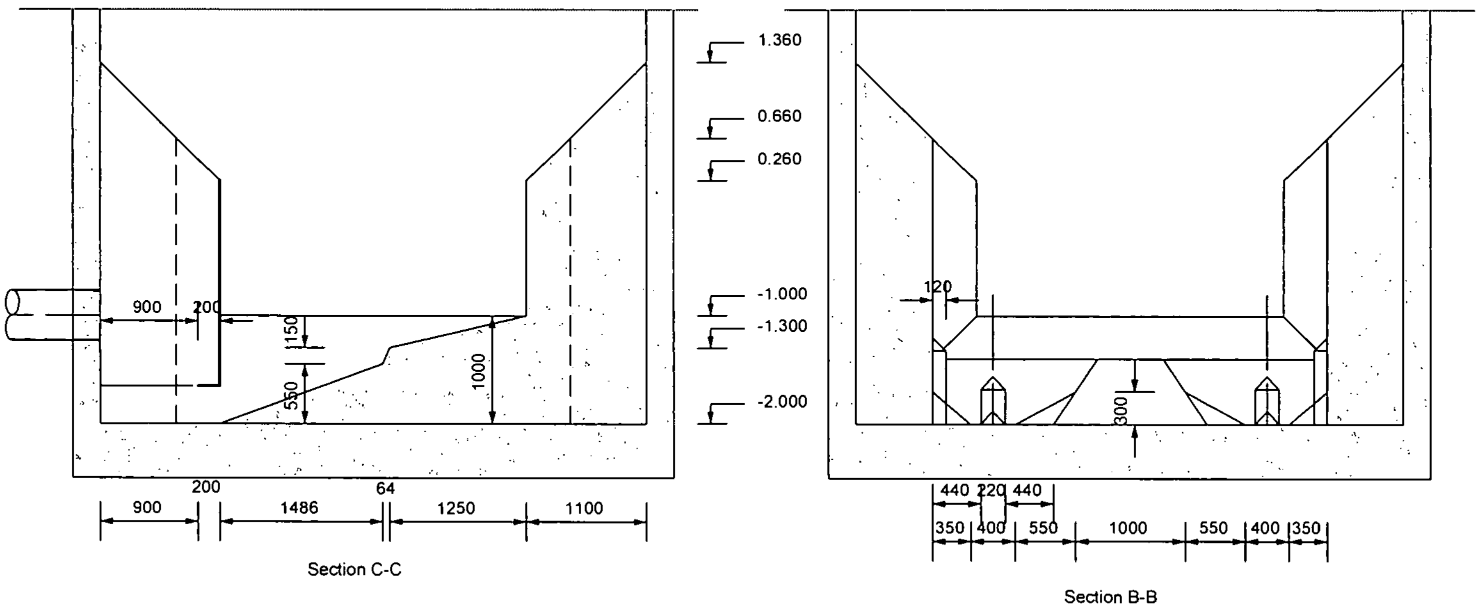
04-07GEN-05



hydrotec consultants ltd	***Detail of modifications - Section A - A***	***Drawing 05***

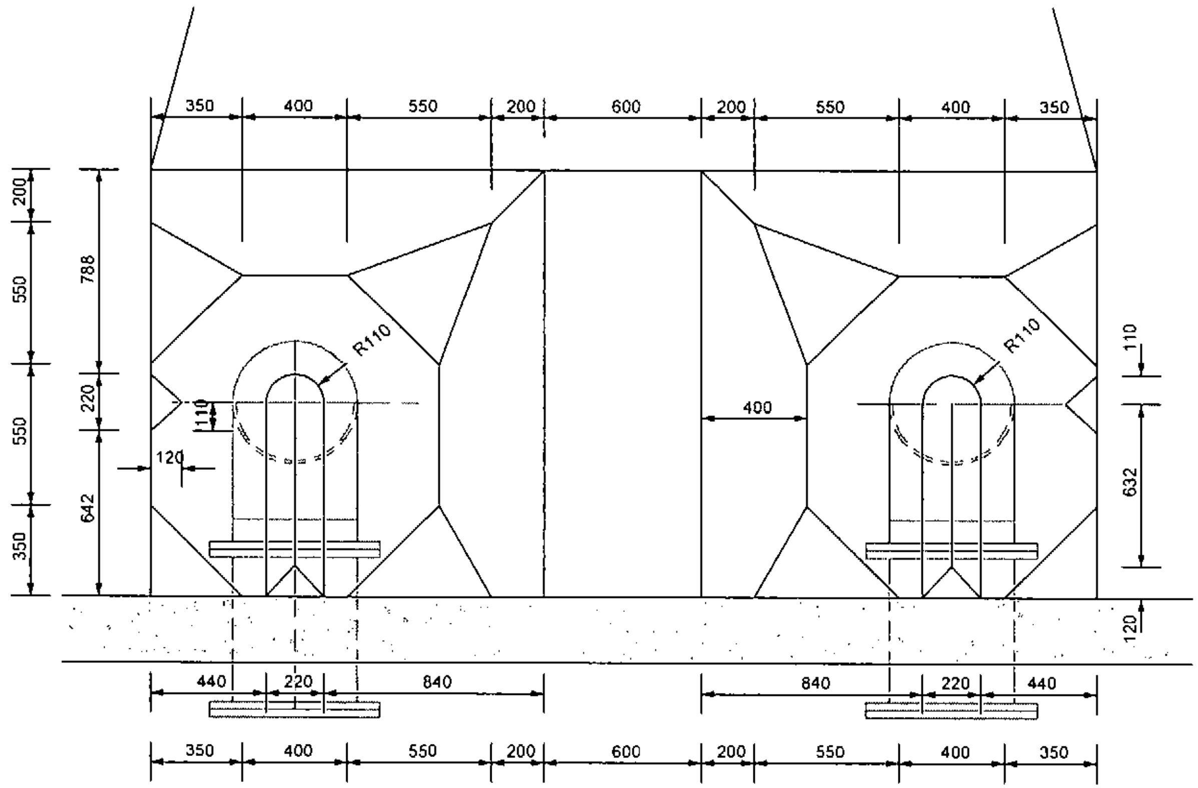
04-07GEN-06



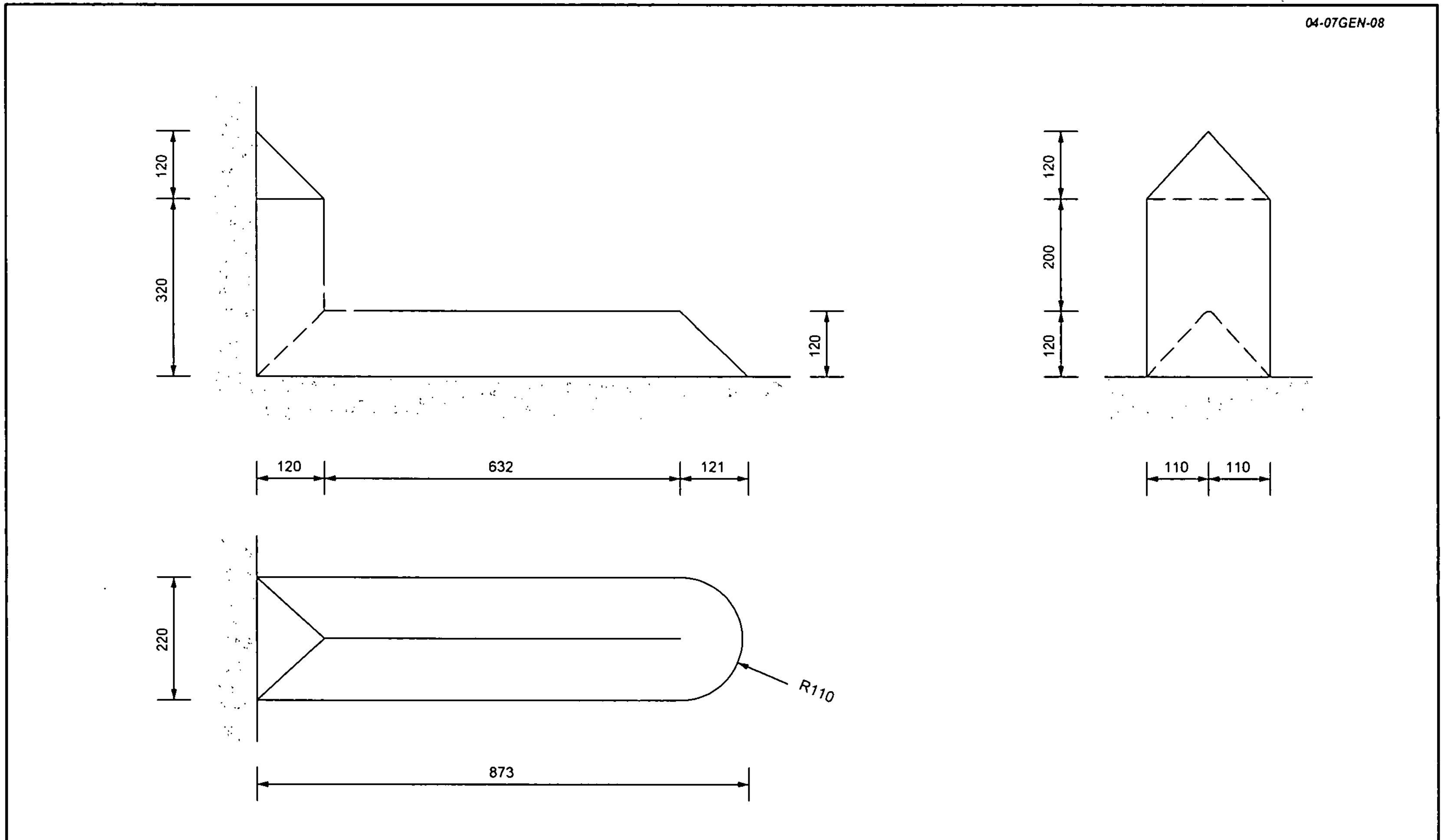
hydrotec consultants ltd

Detail of modifications - Section B - B and C - C

Drawing 06



hydrotec consultants ltd	Detail of modifications - Pump cell detail	Drawing 07



hydrotec consultants ltd	Detail of the flow straightening vanes	Drawing 08

Appendix J

Noise Impact Assessment

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: 18 May 2004

To: Ian Cameron

cc: Michael Brand

From: Dave Davis

Job No: 2138110B-2200

Re: Trade Coast Sewer - Serpentine Rd Noise Impact Assessment

Over a Century of Engineering Excellence

AUSTRALIA TRADE COAST SEWER PROJECT

Serpentine Road Pumping Station

Environmental Noise Impact Assessment & Design Recommendations

Background

As part of the Australia Trade Coast Sewerage Design & Construction project, an environmental noise impact assessment was required for the pumping station located at the north-western end of Serpentine Road, Pinkenba (see Figure 1). This noise impact assessment includes recommendations for noise control treatments to be incorporated in the design to ensure compliance with the requirements of the *Environmental Protection Act 1994*.

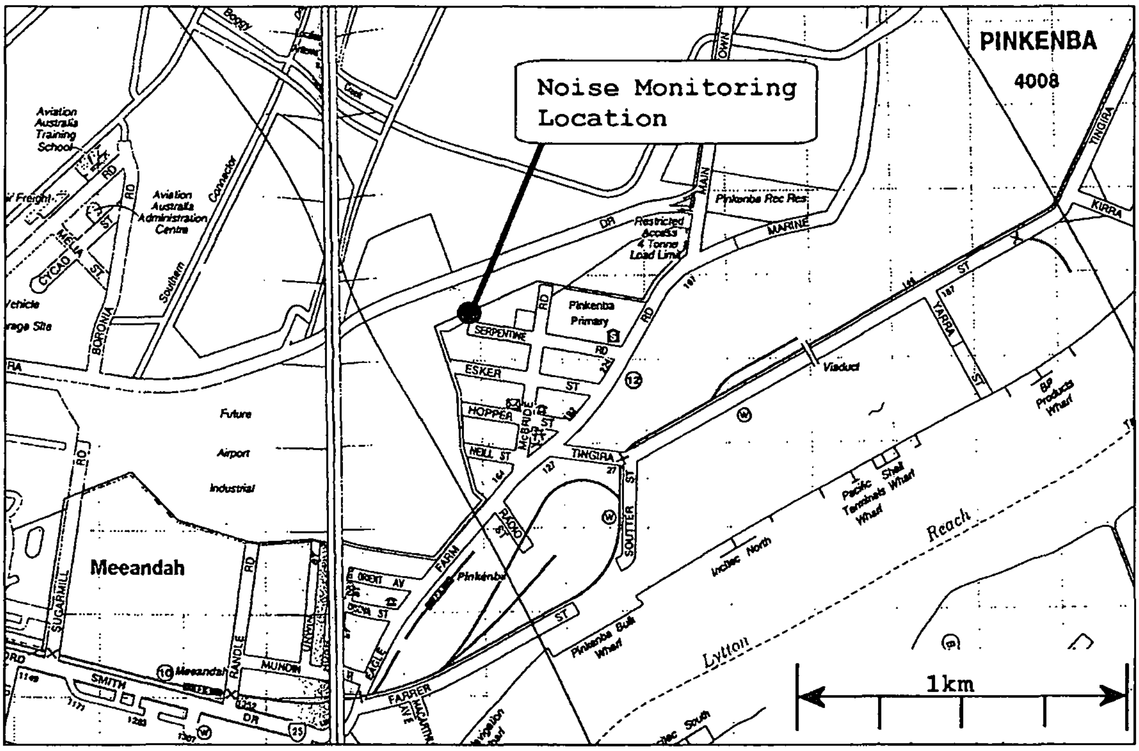


Figure 1 – Site Plan and Noise Monitoring Location

Introduction

This environmental noise impact assessment has been undertaken in accordance with the requirements of:

- the QLD *Environmental Protection (Noise) Policy 1997*;
- the Brisbane City Plan 2000 "Noise Impact Assessment Planning Scheme Policy"
- the QLD EPA "Noise Measurement Manual – for use in testing for compliance with the *Environmental Protection Act 1994*".

Methodology

Noise Monitoring

Existing ambient environmental noise levels were measured adjacent to the nearest noise sensitive receiver to the pumping station.

Noise Levels were measured for a sampling period of 15 minutes at various times throughout the day and night to establish representative ambient noise levels of the area.

Instrumentation

Existing noise levels were measured using a RION NA-27 Type 1 integrating/averaging Sound Level Meter / Octave Band Analyser (Serial Number 00380655). The instrument was set to measure A-weighted 1/1 Octave sound pressure levels, on 'Fast' response. A windscreen was used to protect the microphone for all measurements.

Noise Predictions

Noise predictions were undertaken with the proprietary environmental noise prediction software package SoundPLAN 6.0 using the software's "General Prediction Method."

Noise Sources

Noise sources that will be present on site will include:

- 2 x 216 kW pump/motor sets (redundant system, only one operating at any time) inside drywell.
- Odour Scrubber
- Electrical transformer
- Emergency diesel genset

For the purposes of this Assessment, the noise emission levels of the various noise sources were obtained from the following documents:

- The Sound Power Levels of the drywell motors and pumps were taken from Brisbane Water's Standard Specification for "Professional Services – Engineering - 'Submersible Sewage Pumps'" clause 4.1.7 for Drywell pump units. SPL = 82 dB(A) at 1 metre.

- The Sound Power Level of the emergency diesel generator was taken from Brisbane Water's Standard Specification for "Professional Services – Engineering - 'Diesel Generator Sets'" clause 4.7, which refers to Brisbane Water's Standard Specification "Brisbane Water – 'Noise Emission Levels'" SPL = 85dB(A) at 1 metre.

- The Sound Power Level of the Odour Scrubber was estimated from manufacturer's information relating to similar units of comparable size and duty. SPL = 50 dB(A) at 3 metres.

- The Sound Power Level of the Transformer was obtained from the manufacturer's data. SPL = ___________ dB(A) at ____ metres.

Noise Level Criteria

The noise immission level criteria applicable to this project is developed from the requirements of the Environmental Protection (Noise) Policy 1997 in conjunction with the Brisbane City Plan 2000 "Noise Impact Assessment Planning Scheme Policy" (NIAPSP).

The noise level criteria can be summarised as shown in Table 1:

Day (7am – 6pm)	Evening (6pm – 10pm)	Night (10pm – 7am)
Background noise level + 5 dB(A)	Background noise level + 5 dB(A)	Background noise level + 3 dB(A)

Table 1 – Noise Level Criteria

Results

Noise Monitoring

The results of the ambient background noise level monitoring are shown in Table 2:

Measurement #	Date / Time	Wind Speed (m/s) & Direction	Temp °C	$L_{A10(15min)}$	$L_{Aeq(15min)}$	**Background $L_{A90(15min)}$**	Ambient Noise Sources
1	14/05/2004 11:47 AM	2-3 m/s, NE	23	65	65	**42**	Distant traffic - dominant & constant Nearby traffic (Lomandra Drive) Aircraft flyovers & takeoffs distant industrial noise birdsong wind in trees/grass
2	14/05/2004 2:22 PM	< 1m/s, NE	25	55	52	**42**	Distant traffic - dominant & constant Nearby traffic (Lomandra Drive) Aircraft flyovers & takeoffs Electric passenger train distant industrial noise birdsong minor domestic noise (TV/Radio)
3	14/05/2004 6:23 PM	nil	20	57	55	**49**	Distant traffic - dominant & constant Insects Aircraft landing
4	14/05/2004 11:42 PM	nil	15	47	45	**43**	Distant industrial noise (dominant & constant & tonal) Distant Traffic No birdsong No insects

Table 2 – Ambient Background Noise Level Monitoring Results, Serpentine Rd

Criteria

The results of the background noise level monitoring indicate that the noise level criteria applicable to the subject site can be summarised as shown in Table 4:

Day (7am - 6pm)	Evening (6pm – 10pm)	Night (10pm - 7am)
47 dB(A)	54 dB(A)	46 dB(A)

Table 4 – Noise level criteria based on noise level monitoring results

Based on the lowest value from Table 3, the target design noise level for the subject site at the nearest noise-sensitive receiver is **46 dB(A)**.

Noise Predictions

The results of the noise level predictions at the nearest noise-sensitive receptor are shown in Table 5.

Noise Source	Predicted Noise Level
Pump/Motor Unit (with recommendations discussed below)	40dB(A)
Emergency Diesel Generator Set (in acoustic enclosure)	37dB(A)
Odour Scrubber	< 10dB(A) [inaudible]
Transformer (with recommendations discussed below)	40 dB(A)
Total	**44 dB(A)**

Table 5 – Predicted Noise Levels at nearest noise-sensitive receptor

Discussion

As shown in Tables 4 and 5, compliance with the applicable noise level criteria is expected to be achieved with the recommendations discussed below.

Recommendations

It is recommended that the Emergency Diesel Generator be enclosed in an acoustic enclosure which conforms to Brisbane Water's Standard Specifications.

It is recommended that the noise emissions of the pumps/motors in the drywell be acoustically treated by reducing the reverberant noise level within the drywell. This can be achieved with the installation of sound absorptive panels on at least two of the drywell's walls. Suitable pre-fabricated sound absorptive panels would be to sound-absorptive type of roadside noise barriers obtainable from FENCO ph. (07) 3277 8990; www.fenco.com.au. The product brochure, showing the sound absorptive characteristics are shown in Attachment 1. The dimensions of the standard FENCO sound-absorptive panels are 4m x 650mm x 125mm.

It is recommended that an earth mound be constructed at the perimeter of the site to shield the line-of sight from the nearest affected noise-sensitive receptors to the noise sources shown in Table 5.

ATTACHMENT 1

Product Brochure

FENCO Sound-absorptive panel

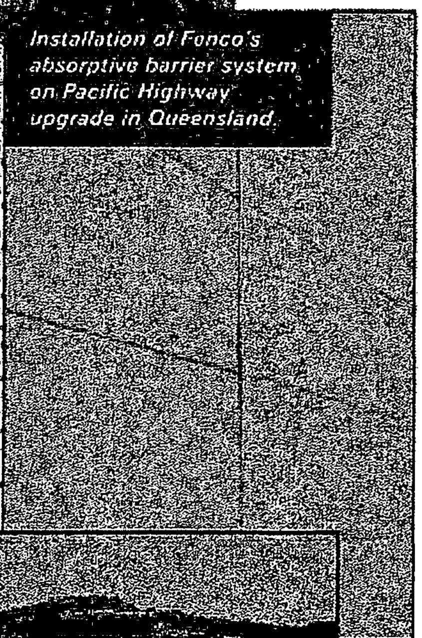
FENCO

NOISE BARRIERS
Design & Construction

TEL: (07) 3277 8990
FAX: (07) 3277 6123

60 MEADOW AVENUE
COOPERS PLAINS QLD 4108

ABSORPTIVE NOISE BARRIER SYSTEM



Installation of Fenco's absorptive barrier system on Pacific Highway upgrade in Queensland.

• Superior Acoustic Performance

Noise Reduction Coefficient = NRC 1.17
Sound Transmission Class = STC 36

Frequency Hz	125	250	500	1000	2000	4000
Sound Absorption Coeff.	0.6	1.32	1.24	1.14	0.97	0.76

• Cost Effective Solution

Accredited by Queensland Department of Main Roads as complying with noise barrier specification MRS 11.15.

• Rapid Installation

Over 300 square metres of panel can be installed per day

• Strong

Fully engineered modular steel system.

• Durable

All steel components are hot dipped galvanised to provide excellent corrosion resistance and longevity of the system.

• Quality Australian Design & Construction

Fenco is a quality Australian company holding ISO 9001 accreditation.

PARSONS BRINCKERHOFF

Appendix K

Cardno MBK Structural Design Information

K1. Design Report
K2. Pipe Protection Works
K3. Bouyancy Calculations

K1. Design Report

Cameron, Ian

From: Darren McDonald [dmcdonald@cardno.com.au]

Sent: Tuesday, 10 August 2004 1:05 PM

To: Cameron, Ian

Subject: SP300 DESIGN REPORT

Cardno

Cardno MBK (Qld) Pty Ltd | ABN 57 051 074 992
Level 1, 5 Gardner Close, Milton, QLD 4064
PO Box 388, Toowong QLD 4066
Tel 07 3369 9822 | Fax 07 3369 9722

Ian

Please find attached updated design report as requested.

Rgds

Darren McDonald
Senior Structural Engineer
Cardno MBK (Qld) Pty Ltd
Ph (07) 3100 2145 Direct
Mob 0412 778806
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Engineering the Future

SP300 SERPENTINE ROAD

PUMP STATION

DESIGN REPORT

10 AUGUST 2004

TABLE OF CONTENTS

1.0 INTRODUCTION 3

2.0 GEOTECHNICAL ASSESSMENT 3
- 2.1 Available Geotechnical Information 3
- 2.2 Assessment by Parsons Brinckerhoff 3
- 2.3 Assessment by Coffey Geosciences 3

3.0 DESIGN CONSTRUCTION REQUIREMENTS 4
- 3.1 Settlement 4
- 3.2 Construction Issues 4
- 3.3 Design Issues 4

4.0 DESIGN OUTCOMES 5
- 4.1 General Arrangement 5
- 4.2 Structural Details 5
- 4.3 Corrosion 5

CLIENT

DOCUMENT NAME SP300 SERPENTINE ROAD PUMP STATION

Preliminary	☐	**Author**	
Draft	☐	**Signature**	
Draft Final	☐	**Date**	
Final	X	**Reviewer**	
Superseded	☐	**Signature**	
Other (Specify)	☐	**Date**	

1.0 INTRODUCTION

Cardno MBK were responsible for the structural design of the Serpentine Road Pump Station , Number SP300.

The structures comprising the pump station include the wet well, valve pit, ferric chloride dosing area slab, odour scrubber pad, transformer base, switchboard base, generator pad, 3.2 tonne monorail crane and concrete hardstand area.

2.0 GEOTECHNICAL ASSESSMENT

The pump station is located in the weak recent sediments of the lower Brisbane River and the difficult foundation conditions were critical in 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 pump station, is illustrated by the following materials, supplied to Cardno MBK by Parsons Brinckerhoff:

BCC Investigation Report 93038 dated August 1994.

Coffee Geosciences facsimile transmission dated 28 July 2004; Preliminary potential settlement estimates.

Borehole 2 of BCC Investigation Report 93038 has the closest recorded borehole information to the Sepentine Road Pump Station. The subsurface information for this borehole and has been adopted by Coffey Geosciences in the calculation of the potential settlement estimates. No testing has been undertaken on the actual site.

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.

2.3 Assessment by Coffey Geosciences

A preliminary 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 and associated works.

The assumed subsurface profile consists of fill to a depth of 1.9m underlain by very loose sands clayey sands to 11.0m in depth followed by soft to firm clay to 27.5m in depth.

Elastic settlements of the upper level loose sands are likely to occur under applied loadings, however, these settlements are likely to occur rapidly during construction.

Combined primary and secondary consolidation settlements of the underlying clays are potentially in the order of 200mm per 10kPa of applied loading. The extent of settlement of structures founded on high-level footings will be determined by magnitude of the applied loading relative to the foundation area.

The current effective stress levels in the soil are unlikely to be exceeded by the construction of the pump station therefore consolidation settlements are unlikely to occur.

3.0 DESIGN CONSTRUCTION REQUIREMENTS

3.1 Settlement

It was realised that settlement of the hardstand areas and associated pump station structures was inevitable as the additional surcharge loadings applied to the site in the placement of fill materials, and in the construction of the pavements, building structures etc. would 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 pump station is unlikely to be affected by long-term consolidation issues, as the effective vertical stress on the underlying soils is unlikely to be exceeded in the construction of the pump station. Piling of the pump station structure is not considered a viable solution due to potential problems caused by the differential movements between the rigid pump station structure and connecting pipework.

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. The sheet piling is to be left in place permanently and anchored laterally during construction by horizontal screw anchors or an equivalent approved method to be proposed by the building contractor.

Due to a high water table there is a net buoyancy effect on the pump station structure. A false floor may be adopted in the dry well to help counteract the buoyancy effect. The wet well is considered as permanently wet with a minimum water level of RL-0.54.

Leighton Contractors are responsible for determining the sheet piling requirements and the method of additional anchorage against buoyancy forces for the structure based on design information supplied by Cardno MBK.

3.3 Design Issues

The main design issue for the in-ground pump station is considered to be:

- Provision of sufficient mass in the structure and additional anchorage to counteract buoyancy forces under high water table conditions. It is considered that the design should conservatively allow for the water table to be located at the ground surface.

4.0 DESIGN OUTCOMES

4.1 General Arrangement

The design process considered two possible 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. It was determined that the structure would not be constructed with a stepped wet well and that the valve pit and wet well would be combined in a single structure.

The other structures, including the ferric chloride dosing area slab, odour scrubber pad, transformer base, and generator slab 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.

A 3.2 tonne SWL monorail crane has been designed in accordance with the design brief supplied by Parsons Brinckerhoff. The monorail crane and hoist system is to provide a minimum hook clearance above the valve pit top slab of 4.7m. The monorail is to cantilever beyond the immediate supporting structure by a minimum of 2.0m to facilitate loading and unloading of the pumps and associated pipework.

The design of the structural steelwork is in accordance with the requirements of both AS4100 – *Steel Structures* and AS1418.1,.2 and .3 – *SAA Crane Code*. The monorail beam and supporting structure have been designed for factored vertical hoisted loads as well as lateral loads and longitudinal end buffer impact loads. The lateral and buffer loads have conservatively been adopted as 20% of the factored hoisted load.

4.2 Structural Details

All major structures were detailed in reinforced concrete. These 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 200mm concrete slab and 200mm 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 in ground concrete structures should be protected against potentially aggressive groundwater attack.

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 2.0m.

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

A hot dip galvanised coating in accordance with AS1650 is recommended to all external structural steelwork. A minimum coating thickness of 85 microns is recommended.

Cameron, Ian

From: Stacy Bale [sbale@cardno.com.au]
Sent: Tuesday, 27 July 2004 1:08 PM
To: Cameron, Ian
Cc: Roger Jackman (E-mail)
Subject: Serpentine Road Pump Station Design Calculations

Cardno

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Level 1, 5 Gardner Close, Milton, QLD 4064
PO Box 388, Toowong QLD 4066
Tel 07 3369 9822 | Fax 07 3369 9722

Ian

Please find attached a PDF file of the specific design calculations for the Serpentine Road Pump Station

Regards

Stacy Bale
Design Engineer

Phone +61 7 3369 9822
Fax: +61 7 3369 9722
email:sbale@cardno.com.au
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Engineering the Future

Cardno MBK
Cardno MBK QLD Pty Ltd
ACN 051 074 992

BRISBANE STRUCTURES CALCULATION COVER SHEET

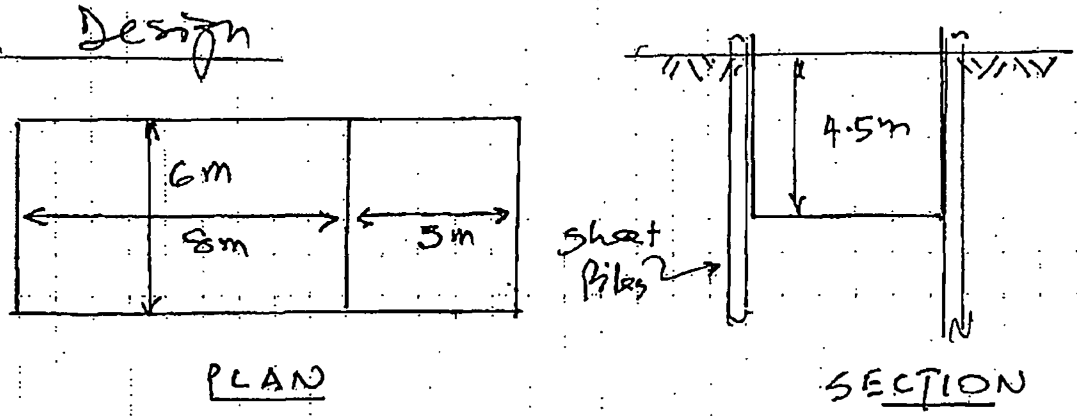
PROJECT:	AUSTRALIA TRADE COAST SEWER PROJECT
PROJECT NUMBER:	7519/02 - 03
DATE:	06-7-04.

ACTIVITY	SHT. No.	DESIGN	DATE	CHECKED	DATE
Wall Design	1				
Boyancy	3				
Top Slab	9				
Bottom Slab	12				

Cardno

PROJECT Serpentine Road Pump Station.	PROJECT NO. 7519/02/03 Designed Date Sheet 1 of

1. Wall Design



Design as a open top tank.

Note water pr ≈ $K_o = 0.5$ soil pressure.

$q = 4.5 \times 9.81 = 45$ kN/m²

use charts for $\frac{b}{a} = 2.0$, $\frac{c}{a} = 1.5$

free top hinged base:

horizontal $M_{corner} = -78 \times 45 \times \frac{4.5^2}{1000} = 71.0$

$M_{centre} = -51$ " $= 46.4$

Vertical M = 38 " " = 36

For fixed base M_{stem} = ~~-221~~ -86 × " = ~~209~~ 78

Use ~~50~~% FEM = ~~84~~ 40 kNm

use 300 thk walls for larger compartment

Not a liquid retaining structure, however limit crack width to 0.3.

∴ N16-150 horizontal Rf.

Cardno

PROJECT	PROJECT NO. 7519/02/03 Designed Date ... Sheet 2 of

Smaller compartment,
Water retaining structure:

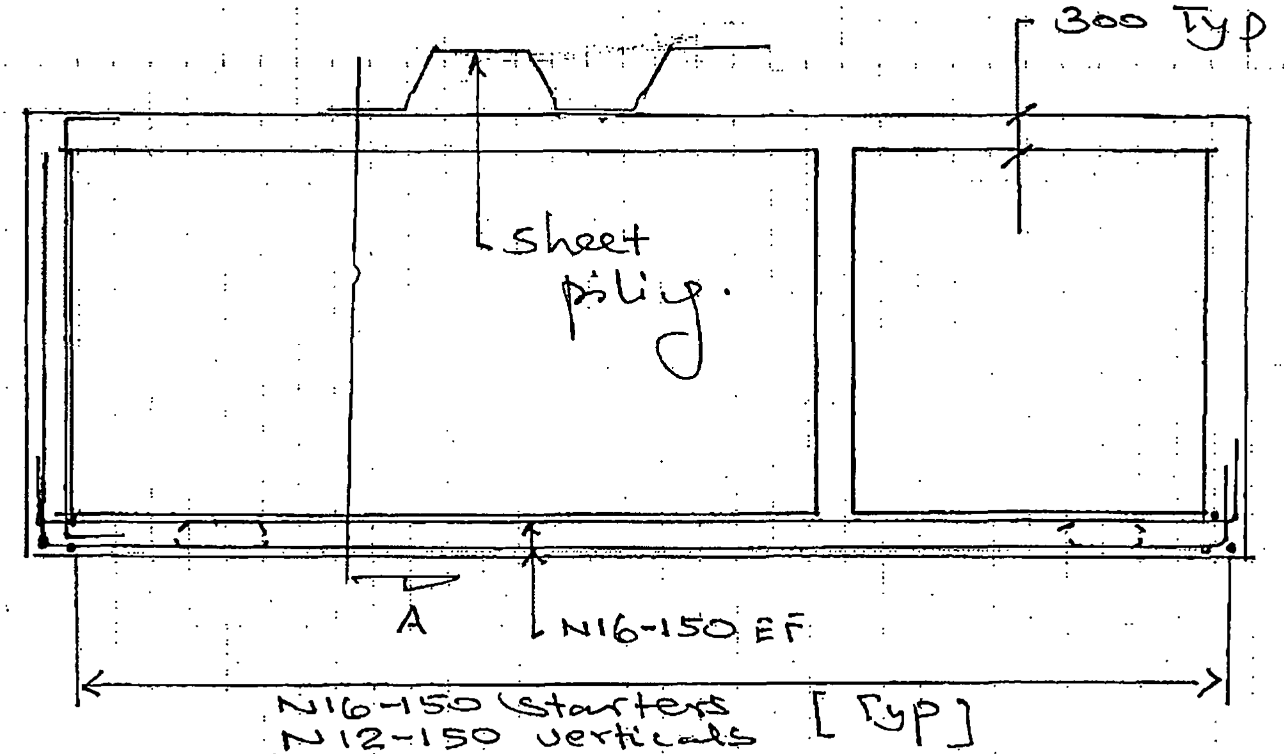
$b/a = 1.5 \quad c/a = 1.0$

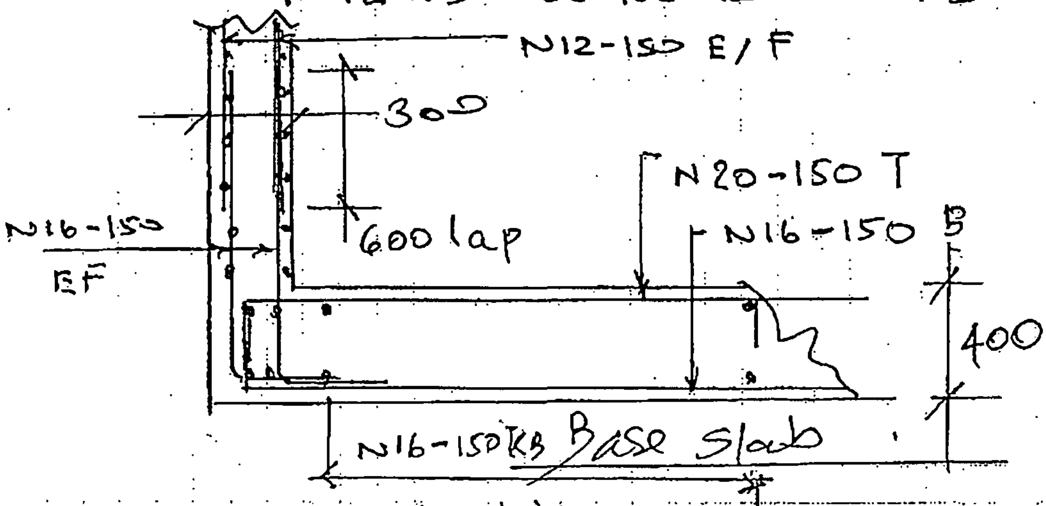
Corner $M = -50 \times 4.5^2 \times \frac{45}{1000} = 46$

Provide N16-150

Starter bars N16-150

Verticals N12-150



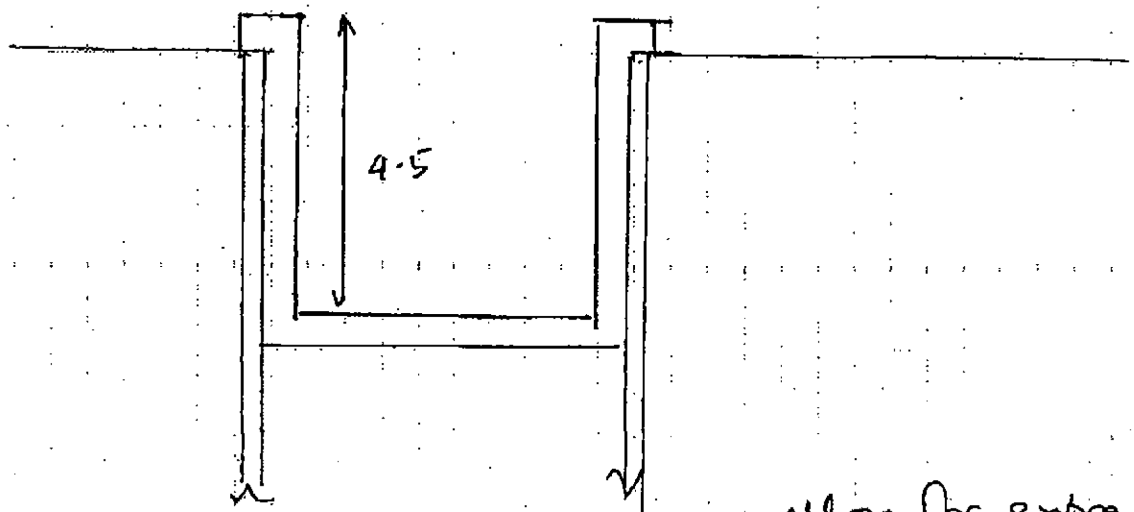


Section A

PROJECT	PROJECT NO. 7519/02/03
	Designed
	Date Sheet 3 of

(3) Boyancy.

Sheet piling is designed to carry any uplift to prevent flotation.



↓ allow for extra conc

Wall weight = 42 × 0.32 × 24 × 4.5 = 1451

Slab " = 0.45 × 24 × 14 × 6 = 907

Top slab = 13.5 × 5.5 × 0.2 × 24 = 356

Water pressure = 14 × 6 × 45 = 3780   2715

Additional force required

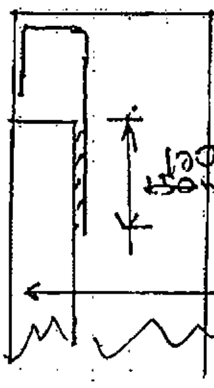
= 3780 × 1.33 − 2715 = 2312 kN

Number of N12 bars required

$$= \frac{2312 \times 10^3}{110 \times 200} = 105$$

$$= \frac{38}{105} = 0.36$$

∴ Weld N12 − 300 verticals



Sheet pile.

Cardno

PROJECT

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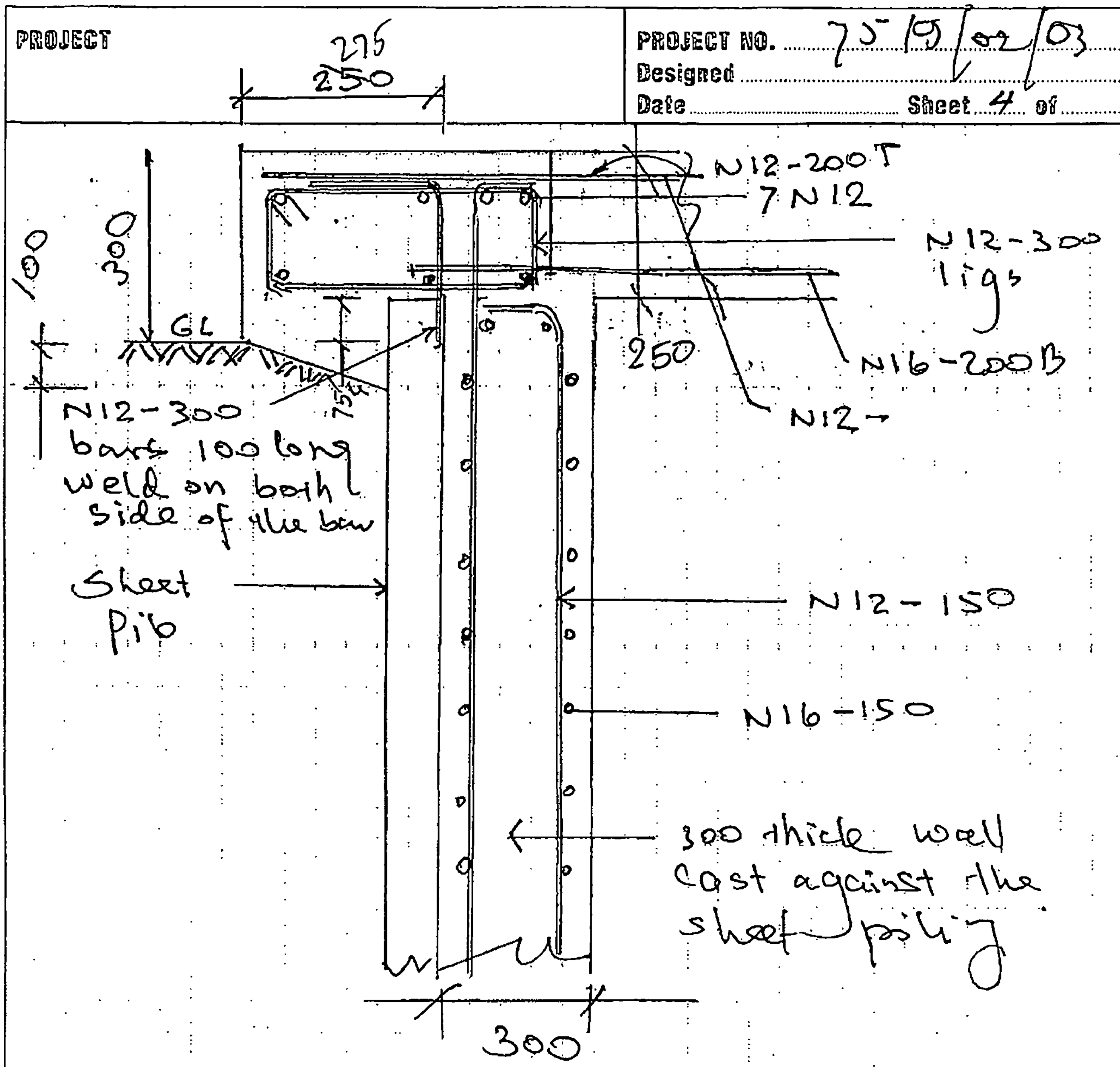
Designed
Date Sheet 4 of



Typical Edge Section at top

Sheet 5

Calculation of service stress in steel bars and Crack width estimation

Cover to links, c_{min} =	40 mm		*Distance between bars, s* =	150 mm
Overall depth, h =	250 mm	= a'	*Stirrup (or lower rf.) size* =	0 mm
Main bar size =	16 mm		*Reinforcement available* =	As 1340, As' 0
Tensionn rf. ratio ρ =	0.00664		*Compression rf. ratio* ρ' =	0
fcu = 32	*fy* = 500		*Ec(instant)* =	26.4 *kN/mm2*
Service Moment, Ms =	45.0		*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
45.0	*1000*	202	48	15.15	0.36	0.88	189	0.0013	0.0010

At the soffit of the member, a_{cr} = 81

Design surface crack width = ***0.247*** *mm* $= \varepsilon_m \;/\; 1 + (2(acr - Cmin)/(h-x))$

7519/02-03

sheet 6

Calculation of service stress in steel bars and Crack width estimation

Cover to links, c_{min} = 40 mm		Distance between bars, s =	150 mm
Overall depth, h = 250 mm = a'		Stirrup (or lower rf.) size =	16 mm
Main bar size = 16 mm		Reinforcement available =	As 1340, As' 0
Tensionn rf. ratio ρ = 0.00721		Compression rf. ratio ρ' =	0
fcu = 32	fy = 500	Ec(instant) =	26.4 kN/mm2
Service Moment, Ms = 37.0		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
37.0	1000	186	64	15.15	0.37	0.88	169	0.0013	0.0010

At the soffit of the member, a_{cr} = 91

Design surface crack width = 0.284 mm = ε_m / 1+ (2 (acr - Cmin) / (h-x))

7519/02-03

Sheet 7

Calculation of service stress in steel bars and Crack width estimation

Cover to links, c_{min} = 40 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 = 0.00532

Compression rf. ratio ρ' = 0

fcu = 32 fy = 500

Ec(instant) = 26.4 kN/mm2

Service Moment, Ms = 71.0

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
71.0	1000	252	48	15.15	0.33	0.89	236	0.0015	0.0012

At the soffit of the member , a_{cr} = 81

Design surface crack width = ***0.309*** *mm* = ε_m / 1+ (2 (acr - Cmin)/(h-x))

7519/02-03

sheet 8

Calculation of service stress in steel bars and Crack width estimation

Cover to links, c_{min} = 40 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 = 0.00532

Compression rf. ratio ρ' = 0

fcu = 32 fy = 500

Ec(instant) = 26.4 kN/mm2

Service Moment, Ms = 47.0

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
47.0	1000	252	48	15.15	0.33	0.89	156	0.0010	0.0007

At the soffit of the member, a_{cr} = 81

Design surface crack width = ***0.174*** *mm* = ε_m / 1+ (2 (acr - Cmin)/(h-x))

7519/02-1

Cardno

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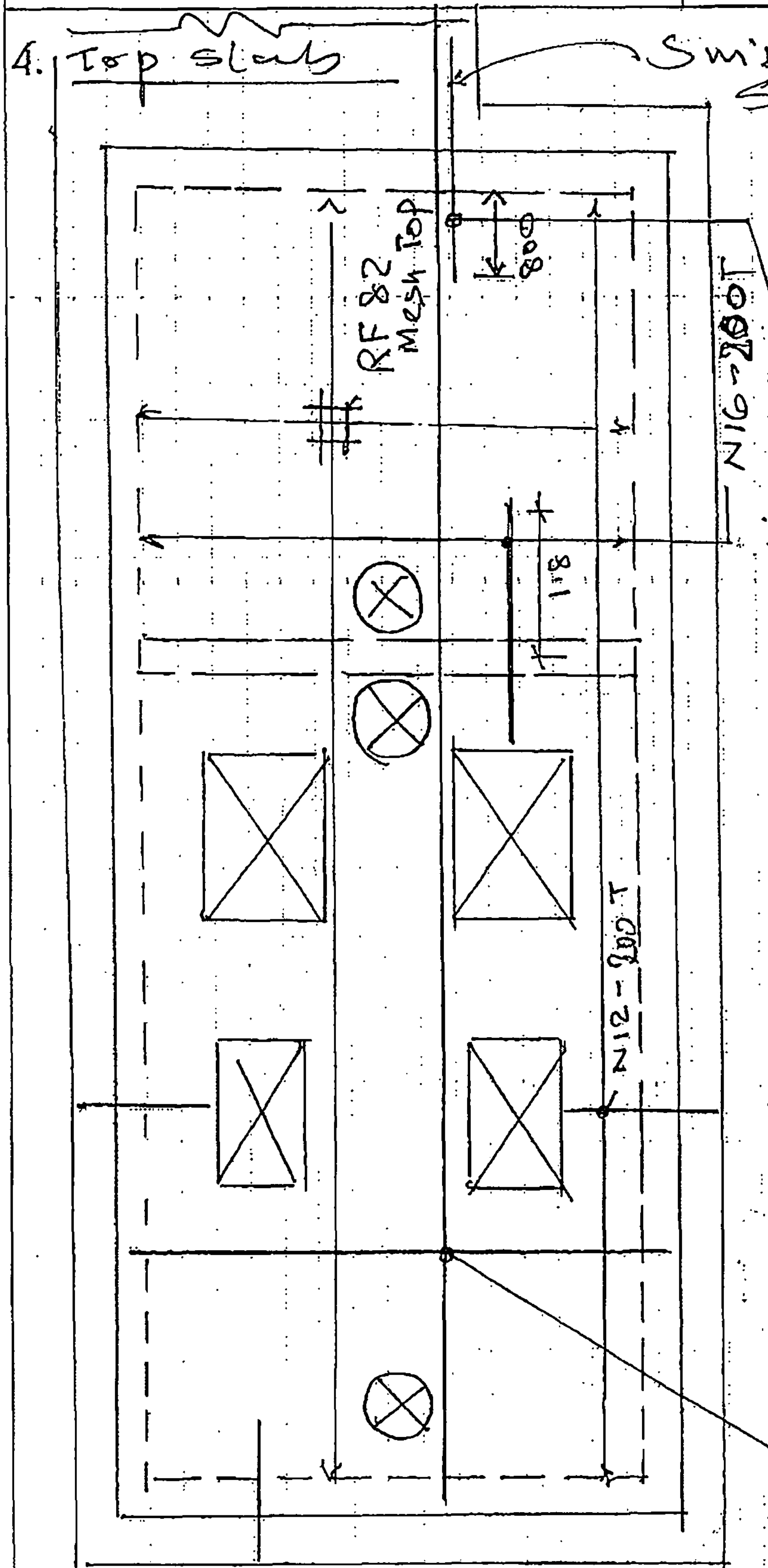
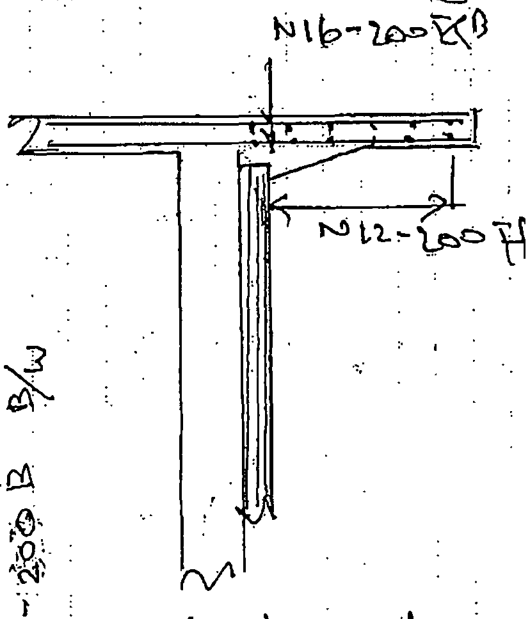
4. Top slab



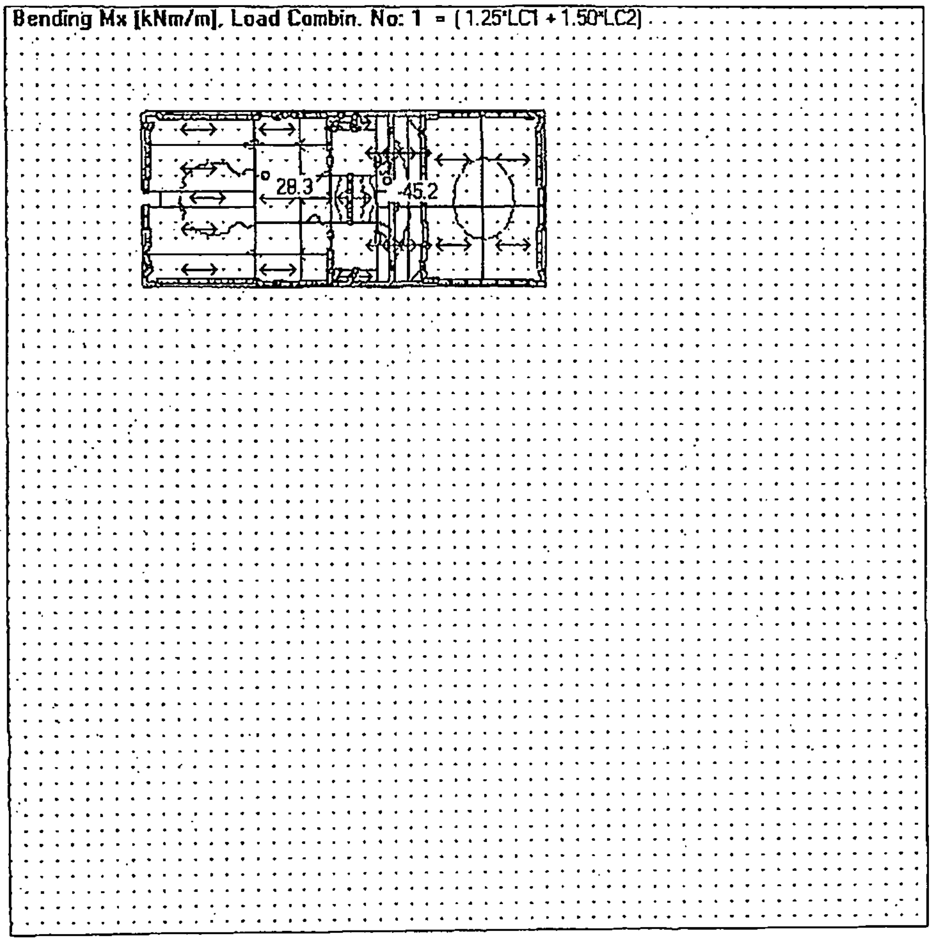
ult { M_{top} = 45 kNm/m ; M_{bot} = 37 kNm/m }

M_{max} service = 30



Section at S/room Slab

SLABS 3.00, Analysis and Design of Reinforced Concrete Slabs
Company: Cardno MBK
File: c:\slabs\data\pump.dat, 20/05/2004, 17:36
Job:
Project:
Location:
Client:



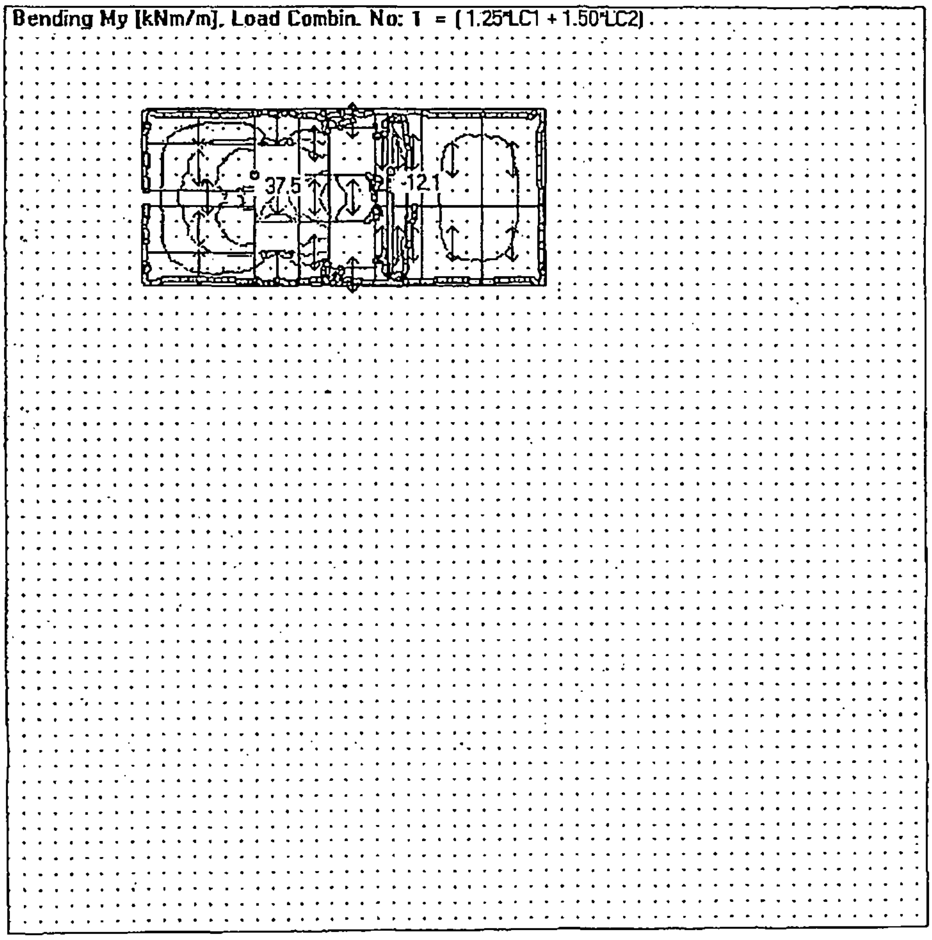
Bending Mx

Bending Mx [kNm/m]
min:
-45.23
-30.52
-15.81
-1.10
13.62
max:
28.33

7519/02-03

sheet 10

SLABS 3.00, Analysis and Design of Reinforced Concrete Slabs
Company: Cardno MBK
File: c:\slabs\data\pump.dat, 20/05/2004, 17:38
Job:
Project:
Location:
Client:



Bending My

Bending My [kNm/m]
min: -12.11
-2.18
7.75
17.68
27.62 max: 37.55

7519/02-03

sheet 11

Cardno

PROJECT

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Designed
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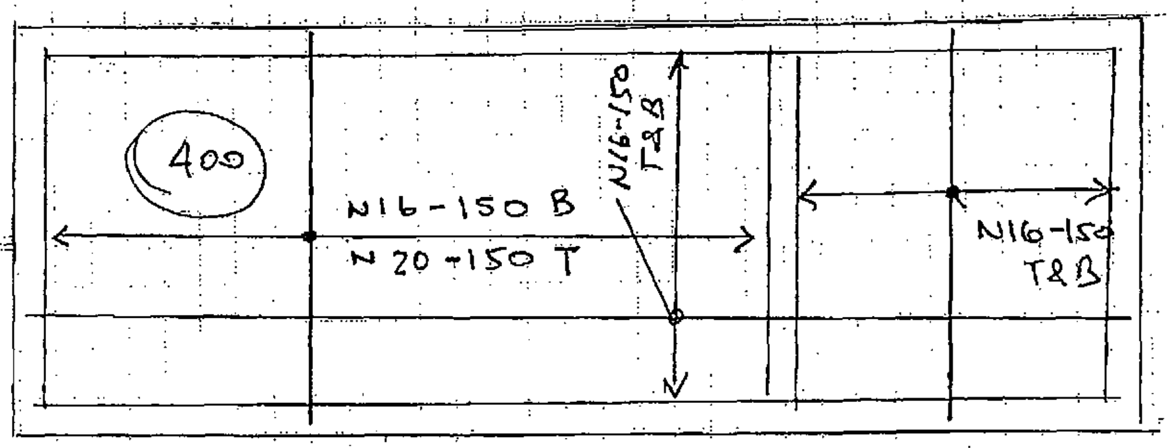
5) Bottom slab

$\frac{b}{a}$ = 1.25 – 1.5 actual: 1.33

My = 45 x 45 x $\frac{6^2}{1000}$ = 73 kN.m
Mx = 45 x 6.3 x 6.3 / 1000 = 102 kNm
for 400 thk slab
N16-150 ~~short~~ long dirn
N20-150 short dirn



sheet 13

Calculation of service stress in steel bars and Crack width estimation

Cover to links, c_{min} = 40 *mm*

Distance between bars , s = 150 *mm*

Overall depth, h = 400 *mm = a'*

Stirrup (or lower rf.) size = 0 *mm*

Main bar size = 20 *mm*

Reinforcement available = As 2094, As' 0

Tensionn rf. ratio ρ = 0.00598

Compression rf. ratio ρ' = 0

fcu = 32 *fy =* 500

Ec(instant) = 26.4 *kN/mm2*

Service Moment , Ms = 102.0

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
102.0	1000	350	50	15.15	0.34	0.89	157	0.0010	0.0007

At the soffit of the member , a_{cr} = 80

Design surface crack width = ***0.192*** *mm* = ε_m / 1+ (2 (acr - Cmin)/(h-x))

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sheet 14

Calculation of service stress in steel bars and Crack width estimation

Cover to links, c_{min} = 40 mm

Distance between bars , s = 150 mm

Overall depth, h = 400 mm = a'

Stirrup (or lower rf.) size = 20 mm

Main bar size = 16 mm

Reinforcement available = As 1340 As' 0

Tensionn rf. ratio ρ = 0.00404

Compression rf. ratio ρ' = 0

fcu = 32 fy = 500

Ec(instant) = 26.4 kN/mm2

Service Moment, Ms = 73.0

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
73.0	1000	332	68	15.15	0.29	0.90	182	0.0012	0.0007

At the soffit of the member , a_{cr} = 93

Design surface crack width = **0.237** mm $= \varepsilon_m$ / 1+ (2 (acr - Cmin)/(h-x))

7519/02-03

K2. Pipe Protection Works

19/10 2004 TUE 9:06 FAX 61 7 3369 9722 cardno alexander browne 001/007

Cardno Alexander Browne

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Facsimile Transmission

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Web: www.cardno .com.au

SP300 — REVISED PIPE LOADING CALC'S ATTACHED

Rgds

Darren

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Project SP300		
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File No. 7579/02-03	Date 18 OCT 04	Page No. 1

REVISED PIPE LOADING CALC'S

ROAD ALIGNMENT HAS BEEN ALTERED TO AVOID CONCRETE PIPES.

1370 MSCL

ADOPT 175 THK RELIEVING SLAB AS PREVIOUSLY DETAILED

PIPES (2), (3)

DN1295, DN910 MSCL.

COVER = 0.85m (APPROX).

CHECK SUITABILITY OF SLAB WITH RELIEVING SLAB

LOADINGS TO AS2566.1-1998.

FIGURE 4.1 ⇒ ADOPT W_q = 35 KPa.

ADOPT E_n = 2.0 MPa   PIPE ENCASED IN GOOD QUALITY FILL MATERIAL

y/D = 3.2% ≯ 3.0

∴ ~~REQUIRE RELIEVING SLAB OVER PIPES.~~

∴ OKAY.

19/10 2004 TUE 9:06 FAX 61 7 3369 9722 cardno alexander browne 003/007

2

SP300
DN1295 MSCL
Buried Pipe Design

Definition	Symbol	Value	Value		
PIPE DETAILS					
Pipe Diameter	DN	1,370		mm	
Pipe Outside Diameter	De	1,440		mm	
Pressure Class	PN	12.5			
Pipe Type	MSCL				
Minimum wall thickness	t	10		mm	
Lining Thickness	tc	25		mm	
Yeild Stress	y	250		MPa	
Stress Utilisation factor		50%			
Allowable Stress		125	-	MPa	
Allowable Pressure	P_{all}	1.736	#DIV/0!	MPa	
Diameter at neutral axis of wall	D	1,430	-	mm	
Initial 3-minute ring-bending modulus	E_b	207,000	207,000	MPa	Table 2.1
Long-term ring-bending modulus	E_{bL}	207,000	207,000	MPa	Table 2.1
2 year ring-bending modulus	E_{b2y}	207,000	207,000	MPa	
12 hour ring-bending modulus	E_{b12hr}	207,000	207,000	MPa	
Second moment of area	I	163	-	mm^4/mm	2.2.1.2 (C2.2.1)
Poisson's ratio		0.30	0.30		
Initial 3-minute ring-bending stiffness	S_{DI}	11,522	#DIV/0!	N/m/m	2.2.1.1(1)
Long-term ring-bending stiffness	S_{DL}	11,522	#DIV/0!	N/m/m	2.2.1.1(2)
2 year ring-bending stiffness	S_{D2y}	11,522	#DIV/0!	N/m/m	
12 hour ring-bending stiffness	S_{D12hr}	11,522	#DIV/0!	N/m/m	
LIMITING PARAMETERS FOR PIPE					
Long Term Factors of Safety					
Pressure		1.39	1.39		
Bending		1.39	1.39		
Combined		1.39	1.39		
Allowable long term vertical deflection		3.0%	3.0%		
Allowable long term bending strain		1.0%	1.0%		
Required Factor of Safety against buckling		2.50	2.50		
SITE CONDITIONS					
Side Clearance	lc	300	300		
Trench width	B	2.04		m	
Cover height	H	0.85		m	> 0.5 for vehicular loads
Water table height	H_W			m	
Native soil type	E_n	2.0		MPa	
Embedment material	E_e	5		MPa	
Soil specific weight		20	20	kN/m^3	
Soil particle specific density		2.65	2.65		
Operating pressure	P_W	1.0		MPa	
Negative internal pressure	q_v	10		kPa	
Operating temperature		30	30	deg. C	
Temperature re-rating factor	r_t	1.0	1.0		
EXTERNAL LOADING					
Live loading	w_q	35		kPa	Refer Fig. 4.1
Friction angle		30		deg.	
Soil pressure ratio		0.50			
Reduction factor for deep installations		1.0			
Soil loading	w_g	17.0	-	kPa	
Surface applied load	w_{qs}	-	-	kPa	
Total load causing deflection		52.0	-	kPa	
EFFECTIVE SOIL MODULUS					
B/D	B/D	1.427	#DIV/0!		
E_e/E_n	E_e/E_n	2.500	#DIV/0!		
Bedding constant	K	0.100	0.100		Refer Clause 5.2

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3

Design factor		0.311	#DIV/0!		3.4.3(3)
Leonhardt correction factor		0.460	#DIV/0!		3.4.3(2)
Effective soil modulus	E'	2.298	#DIV/0! MPa		3.4.3(1)
Soil pressure ratio	K_0	0.150	0.150		
DEFLECTION PREDICTION					
Predicted long-term vertical deflection	y/D	2.2%	#DIV/0!	OK	**less than 3.0% is acceptable**
STRAIN PREDICTION					
Shape factor	D_f	3.16	#DIV/0!		
Predicted long-term ring-bending strain		0.05%	#DIV/0!	OK	**less than 1.0% is acceptable**
COMBINED LOADING EFFECT					
Factor of safety for pressure only	F	9.00	#DIV/0!		
Re-rounding factor	r_c	0.67	1.00		
Combined factors of safety		2.28	#DIV/0!	OK	**greater than 1.39 is acceptable**
BUCKLING STABILITY					
Submerged density		12.45	12.45 kN/m^3		
Buckling pressure for $H>H_w$	q_b	68	- kPa		
Critical buckling pressure	q_{crit1}	304	#DIV/0! kPa		
	q_{crit2}	393	#DIV/0! kPa		
	q_{crit}	393	#DIV/0! kPa		
Factor of safety against buckling	F_s	5.78	#DIV/0!	OK	**greater than 2.5 is acceptable**

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PIPES (6), (5)

DN710 MSCL

~~PIPE COVER = 2.70m (APPROX)~~

$W_q = 10.0$ kPa $E_n = 2.0$ (GOOD QUALITY FILL MAT'L).

$E_s = 5.0$

~~FROM SPREADSHEET PIPE IS OKAY.~~

HOWEVER ADOPT 200 THK RELIEVING SLAB OVER ENTIRE AREA.

200 THK N32 1 LAYER SL82 EACH FACE

AS DISCUSSED 29-10-2004

EXTEND DRIVEWAY/APRON SLAB TO EXTEND OVER PIPEWORK.

DMD.

19/10 2004 TUE 9:07 FAX 61 7 3369 9722 cardno alexander browne 006/007

SP300
DN910 MSCL
Buried Pipe Design

Definition	Symbol	Value	Value		
PIPE DETAILS					
Pipe Diameter	DN	910		mm	
Pipe Outside Diameter	De	960		mm	
Pressure Class	PN	12.5			
Pipe Type	MSCL				
Minimum wall thickness	t	6		mm	
Lining Thickness	tc	16		mm	
Yeild Stress	y	250		MPa	
Stress Utilisation factor		50%			
Allowable Stress		125	-	MPa	
Allowable Pressure	P_{all}	1.563	#DIV/0!	MPa	
Diameter at neutral axis of wall	D	954	-	mm	
Initial 3-minute ring-bending modulus	E_b	207,000	207,000	MPa	Table 2.1
Long-term ring-bending modulus	E_{bL}	207,000	207,000	MPa	Table 2.1
2 year ring-bending modulus	E_{b2y}	207,000	207,000	MPa	
12 hour ring-bending modulus	E_{b12hr}	207,000	207,000	MPa	
Second moment of area	I	37	-	mm^4/mm	2.2.1.2 (C2.2.1)
Poisson's ratio		0.30	0.30		
Initial 3-minute ring-bending stiffness	S_{DI}	8,721	#DIV/0!	N/m/m	2.2.1.1(1)
Long-term ring-bending stiffness	S_{DL}	8,721	#DIV/0!	N/m/m	2.2.1.1(2)
2 year ring-bending stiffness	S_{D2y}	8,721	#DIV/0!	N/m/m	
12 hour ring-bending stiffness	S_{D12hr}	8,721	#DIV/0!	N/m/m	
LIMITING PARAMETERS FOR PIPE					
Long Term Factors of Safety					
Pressure		1.39	1.39		
Bending		1.39	1.39		
Combined		1.39	1.39		
Allowable long term vertical deflection		3.0%	3.0%		
Allowable long term bending strain		1.0%	1.0%		
Required Factor of Safety against buckling		2.50	2.50		
SITE CONDITIONS					
Side Clearance	lc	300	300		
Trench width	B	1.56		m	
Cover height	H	2.70		m	> 0.5 for vehicular loads
Water table height	H_W			m	
Native soil type	E_n	2.0		MPa	
Embedment material	E_e	5		MPa	
Soil specific weight		20	20	kN/m^3	
Soil particle specific density		2.65	2.65		
Operating pressure	P_W	1.0		MPa	
Negative internal pressure	q_v	10		kPa	
Operating temperature		30	30	deg. C	
Temperature re-rating factor	r_t	1.0	1.0		
EXTERNAL LOADING					
Live loading	w_q	10		kPa	Refer Fig. 4.1
Friction angle		30		deg.	
Soil pressure ratio		0.50			
Reduction factor for deep installations		1.0			
Soil loading	w_g	54.0	-	kPa	
Surface applied load	w_{gs}	-	-	kPa	
Total load causing deflection		64.0	-	kPa	
EFFECTIVE SOIL MODULUS					
B/D	B/D	1.635	#DIV/0!		
E_e/E_n	E_e/E_n	2.500	#DIV/0!		
Bedding constant	K	0.100	0.100		Refer Clause 5.2

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6

Design factor		0.437	#DIV/0!		3.4.3(3)
Leonhardt correction factor		0.489	#DIV/0!		3.4.3(2)
Effective soil modulus	E'	2.445	#DIV/0! MPa		3.4.3(1)
Soil pressure ratio	K_0	0.150	0.150		
DEFLECTION PREDICTION					
Predicted long-term vertical deflection	**y/D**	**2.9%**	**#DIV/0!**	OK	**less than 3.0% is acceptable**
STRAIN PREDICTION					
Shape factor	D_f	3.22	#DIV/0!		
Predicted long-term ring-bending strain		**0.06%**	**#DIV/0!**	OK	**less than 1.0% is acceptable**
COMBINED LOADING EFFECT					
Factor of safety for pressure only	**F**	**10.00**	**#DIV/0!**		
Re-rounding factor	r_c	0.67	1.00		
Combined factors of safety		**2.05**	**#DIV/0!**	OK	**greater than 1.39 is acceptable**
BUCKLING STABILITY					
Submerged density		12.45	12.45 kN/m³		
Buckling pressure for $H>H_w$	q_b	75	- kPa		
Critical buckling pressure	q_{crit1}	230	#DIV/0! kPa		
	q_{crit2}	374	#DIV/0! kPa		
	q_{crit}	374	#DIV/0! kPa		
Factor of safety against buckling	F_s	**5.00**	**#DIV/0!**	OK	**greater than 2.5 is acceptable**

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Facsimile Transmission

Cardno Alexander Browne

Engineering the Future

Attention: IAN CAMERON

Organisation: PB.

Sent by: DARREN MCDONALD

Date: 24-09-04

File No: 7519/02-03 No. of Pages: 13

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SP300 PIPE CALC'S

IAN CALC'S ATTACHED, CONCRETE PIPES NOT INCLUDED.

Rgds

D

24/09 2004 FRI 13:39 FAX 61 7 3369 9722 cardno alexander browne 002/013

Cardno

PROJECT	PROJECT NO. 7519/02-03
SP300	Designed DAM Date 22 SEPT 04 Sheet 1 of

CHECK EXISTING PIPES FOR VEHICULAR LOADINGS

REF DWGS 486/5/7 - TR201/021, 020, 046, 022

φ1370 MSCL RISING MAIN

COVER ≃ 500

φ1370 PIPE $t_s = 10mm$

$t_c = 25mm$

CAPACITY OF PIPE W/O RELIEVING SLAB.

REF AS2566.1-1998 BURIED FLEXIBLE PIPELINES STRUCTURAL DESIGN

DESIGNING FOR LOCALISED EFFECTS

⇒ W7 WHEEL LOADING

70 kN ON 500X200mm AREA.

FIGURE 4.1 $W_q = 80$ kPa

FROM BURIED PIPE DESIGN SPREADSHEET

⇒ VERTICAL DEFLECTION IS UNACCEPTABLE (REFER ATTACHED CALC)

∴ PROVIDE RELIEVING SLAB.

α = LIVE LOAD IMPACT FACTOR = 1.4 - 0.15H

= 1.34

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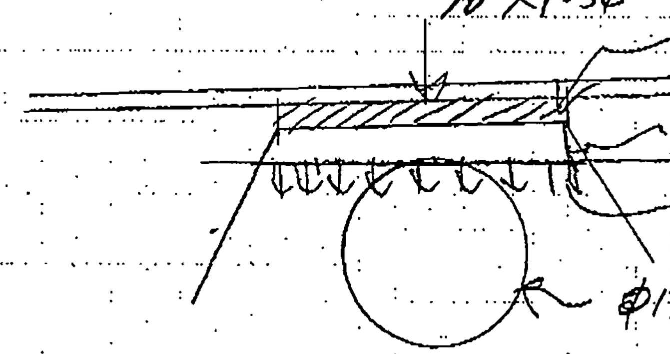
Cardno

PROJECT	PROJECT NO. 7519/02-03
SP300	Designed DMM Date 22 SEP 04 Sheet 2 of

TRY 2000 WIDE RELIEVING SLAB

W7 WHEEL LOAD



ASSUME LOAD IS SPREAD OVER 2×2m

$W_q \doteq 70 \times 1.34 / 2.4 \times 2.4 = 16.3$ Say 20 KPa.

FROM SPREADSHEET

$y/D = 1.9\% < 2.0\%$ ∴ OKAY

∴ 2.0m WIDE RELIEVING SLAB IS ACCEPTABLE

$M^*_{SLAB} \simeq 20 \times 1^2/2 = 10$ kN·m/m

∴ 150 THK SLAB
F81 MESH CENTRAL

$\phi M_b \doteq 0.8 \times 454 \times 75 \times 500 \times 0.90$
$\Rightarrow 12.2$ kN·m > 10.0

∴ OKAY

WOULD BE BETTER TO PLACE MESH BOTTOM 50 COVER.

Cardno

PROJECT	PROJECT NO. 7579/02-03
SP300	Designed DMM Date 22 SEPT 04 Sheet 3 of

SHOULD INCREASE THICKNESS OF SLAB TO ASSIST IN LOAD SPREAD

ADOPT 175 THK
F81 MESH CENTRAL
RELIEVING SLAB.

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SERPENTINE ROAD SP300 ϕ1370 w/o RELIEVING SLAB

Buried Pipe Design Definition	Symbol	Value	Value		
PIPE DETAILS					
Pipe Diameter	DN	1,370	-	mm	
Pipe Outside Diameter	De	1,440	-	mm	
Pressure Class	PN	12.5	-		
Pipe Type	MSCL				
Minimum wall thickness	t	10	-	mm	
Lining Thickness	tc	25	-	mm	
Yeild Stress	y	250	250	MPa	
Stress Utilisation factor		50%	50%		
Allowable Stress		125	125	MPa	
Allowable Pressure	P_{al}	1.736	#DIV/0!	MPa	
Diameter at neutral axis of wall	D	1,430	-	mm	
Initial 3-minute ring-bending modulus	E_b	207,000	207,000	MPa	Table 2.1
Long-term ring-bending modulus	E_{bL}	207,000	207,000	MPa	Table 2.1
2 year ring-bending modulus	E_{b2y}	207,000	207,000	MPa	
12 hour ring-bending modulus	E_{b12hr}	207,000	207,000	MPa	
Second moment of area	I	163	-	mm^4/mm	2.2.1.2 (C2.2.1)
Poisson's ratio		0.30	0.30		
Initial 3-minute ring-bending stiffness	S_{DI}	11,522	#DIV/0!	N/m/m	2.2.1.1(1)
Long-term ring-bending stiffness	S_{DL}	11,522	#DIV/0!	N/m/m	2.2.1.1(2)
2 year ring-bending stiffness	S_{D2y}	11,522	#DIV/0!	N/m/m	
12 hour ring-bending stiffness	S_{D12hr}	11,522	#DIV/0!	N/m/m	
LIMITING PARAMETERS FOR PIPE					
Long Term Factors of Safety					
Pressure		1.39	1.39		
Bending		1.39	1.39		
Combined		1.39	1.39		
Allowable long term vertical deflection		3.0%	3.0%		
Allowable long term bending strain		1.0%	1.0%		
Required Factor of Safety against buckling		2.50	2.50		
SITE CONDITIONS					
Side Clearance	lc	300	300		
Trench width	B	2.04	0.60	m	
Cover height	H	0.50	2.30	m	> 0.5 for vehicular loads
Water table height	H_W	-	2.3	m	
Native soil type	E_n	1.0	1.8	MPa	
Embedment material	E_e	5	5	MPa	
Soil specific weight		20	20	kN/m^3	
Soil particle specific density		2.65	2.65		
Operating pressure	P_W	1.0	1.0	MPa	
Negative internal pressure	q_v	100	10	kPa	
Operating temperature		30	30	deg. C	
Temperature re-rating factor	r_t	1.0	1.0		
EXTERNAL LOADING					
Live loading	w_q	80	16	kPa	Refer Fig. 4.1
Friction angle		30	30	deg.	
Soil pressure ratio		0.50	0.50		
Reduction factor for deep installations		1.0	1.0		
Soil loading	w_g	10.0	46.0	kPa ←	
Surface applied load	w_{gs}	-	-	kPa	
Total load causing deflection		90.0	62.0	kPa	

EFFECTIVE SOIL MODULUS

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B/D	B/D	1.427	#DIV/0!		
E_e/E_n	E_e/E_n	5.000	2.778		
Bedding constant	K	0.100	0.100		Refer Clause 5.2
Design factor		0.311	#DIV/0!		3.4.3(3)
Leonhardt correction factor		0.242	#DIV/0!		3.4.3(2)
Effective soil modulus	E'	1.209	#DIV/0!	MPa	3.4.3(1)
Soil pressure ratio	K_0	0.150	0.150		
DEFLECTION PREDICTION		FAILS			
Predicted long-term vertical deflection	y/D	5.4%	#DIV/0!	[redacted]	**less than 3.0% is acceptable**
STRAIN PREDICTION					
Shape factor	D_f	3.08	#DIV/0!		
Predicted long-term ring-bending strain		**0.12%**	**#DIV/0!**	OK	**less than 1.0% is acceptable**
COMBINED LOADING EFFECT					
Factor of safety for pressure only	F	9.00	-		
Re-rounding factor	r_c	0.67	0.67		
Combined factors of safety		**2.13**	**#DIV/0!**	OK	**greater than 1.39 is acceptable**
BUCKLING STABILITY					
Submerged density		12.45	12.45	kN/m^3	
Buckling pressure for $H>H_w$	q_b	106	68	kPa	
Critical buckling pressure	q_{crit1}	304	#DIV/0!	kPa	
	q_{crit2}	256	#DIV/0!	kPa	
	q_{crit}	304	#DIV/0!	kPa	
Factor of safety against buckling	F_s	**2.87**	**#DIV/0!**	OK	**greater than 2.5 is acceptable**

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SERPENTINE ROAD SP300
diam 1370 with relieving slab
Buried Pipe Design

Definition	Symbol	Value	Value		
PIPE DETAILS					
Pipe Diameter	DN	1,370	-	mm	
Pipe Outside Diameter	De	1,440	-	mm	
Pressure Class	PN	12.5	-		
Pipe Type	MSCL				
Minimum wall thickness	t	10	-	mm	
Lining Thickness	tc	25	-	mm	
Yelld Stress	y	250	250	MPa	
Stress Utilisation factor		50%	50%		
Allowable Stress		125	125	MPa	
Allowable Pressure	P_{all}	1.736	#DIV/0!	MPa	
Diameter at neutral axis of wall	D	1,430	-	mm	
Initial 3-minute ring-bending modulus	E_b	207,000	207,000	MPa	Table 2.1
Long-term ring-bending modulus	E_{bL}	207,000	207,000	MPa	Table 2.1
2 year ring-bending modulus	E_{b2y}	207,000	207,000	MPa	
12 hour ring-bending modulus	E_{b12hr}	207,000	207,000	MPa	
Second moment of area	I	163	-	mm^4/mm	2.2.1.2 (C2.2.1)
Poisson's ratio		0.30	0.30		
Initial 3-minute ring-bending stiffness	S_{DI}	11,522	#DIV/0!	N/m/m	2.2.1.1(1)
Long-term ring-bending stiffness	S_{DL}	11,522	#DIV/0!	N/m/m	2.2.1.1(2)
2 year ring-bending stiffness	S_{D2y}	11,522	#DIV/0!	N/m/m	
12 hour ring-bending stiffness	S_{D12hr}	11,522	#DIV/0!	N/m/m	
LIMITING PARAMETERS FOR PIPE					
Long Term Factors of Safety					
Pressure		1.39	1.39		
Bending		1.39	1.39		
Combined		1.39	1.39		
Allowable long term vertical deflection		3.0%	3.0%		
Allowable long term bending strain		1.0%	1.0%		
Required Factor of Safety against buckling		2.50	2.50		
SITE CONDITIONS					
Side Clearance	lc	300	300		
Trench width	B	2.04	0.60	m	
Cover height	H	0.50	2.30	m	> 0.5 for vehicular loads
Water table height	H_W	-	2.3	m	
Native soil type	E_n	1.0	1.8	MPa	
Embedment material	E_e	5	5	MPa	
Soil specific weight		22	20	kN/m^3	
Soil particle specific density		2.65	2.65		
Operating pressure	P_W	1.0	1.0	MPa	
Negative internal pressure	q_v	100	10	kPa	
Operating temperature		30	30	deg. C	
Temperature re-rating factor	r_t	1.0	1.0		
EXTERNAL LOADING					
Live loading		20	16	kPa	Refer Fig. 4.1
Friction angle		30	30	deg.	
Soil pressure ratio		0.50	0.50		
Reduction factor for deep installations		1.0	1.0		
Soil loading	w_g	11.0	46.0	kPa	
Surface applied load	w_{gs}	-	-	kPa	
Total load causing deflection		31.0	62.0	kPa	

EFFECTIVE SOIL MODULUS

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B/D	B/D	1.427	#DIV/0!	
E_e/E_n	E_e/E_n	5.000	2.778	
Bedding constant	K	0.100	0.100	Refer Clause 5.2
Design factor		0.311	#DIV/0!	3.4.3(3)
Leonhardt correction factor		0.242	#DIV/0!	3.4.3(2)
Effective soil modulus	E'	1.209	#DIV/0! MPa	3.4.3(1)
Soil pressure ratio	K_0	0.150	0.150	
DEFLECTION PREDICTION				
Predicted long-term vertical deflection	y/D	**1.9%**	**#DIV/0! OK**	**less than 3.0% is acceptable**
STRAIN PREDICTION				
Shape factor	D_f	3.08	#DIV/0!	
Predicted long-term ring-bending strain		**0.04%**	**#DIV/0! OK**	**less than 1.0% is acceptable**
COMBINED LOADING EFFECT				
Factor of safety for pressure only	**F**	**9.00**	**-**	
Re-rounding factor	r_c	0.67	0.67	
Combined factors of safety		**2.31**	**#DIV/0! OK**	**greater than 1.39 is acceptable**
BUCKLING STABILITY				
Submerged density		13.70	12.45 kN/m^3	
Buckling pressure for $H>H_w$	q_b	48	68 kPa	
Critical buckling pressure	q_{crit1}	304	#DIV/0! kPa	
	q_{crit2}	256	#DIV/0! kPa	
	q_{crit}	304	#DIV/0! kPa	
Factor of safety against buckling	F_s	**6.34**	**#DIV/0! OK**	**greater than 2.5 is acceptable**

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Cardno

PROJECT	PROJECT NO. 7519/02-03
SP300	Designed DMcD
	Date 22 SEPT 04 Sheet 4 of

DN 910

COVER = 2.40m.

$\phi 910$ $t_s = 6$

$t_c = 16$

FROM AS2566-1-1998 FIGURE 4.10

$W_q = 10$ KPa

NEED TO CONFIRM SOIL MODULUS OF NATIVE SOIL TYPE

APPROX DEPTH BELOW N.S = 2.0m.

∴ FROM TEST PIT (REFER COFFEE REPORT B17928/2/E IT "2.2 TEST PIT")

CLAYEY SAND

LOOSE MATERIAL

∴ $E_n = 1.0$ MPa.

PIPE FAILS UNDER SOIL LOADS (REFER ATTACHED)

SERPENTINE ROAD SP300
diam 910, 2400 cover, W7 wheel loading
Buried Pipe Design

Definition	Symbol	Value	Value		
PIPE DETAILS					
Pipe Diameter	DN	910	-	mm	
Pipe Outside Diameter	De	960	-	mm	
Pressure Class	PN	12.5	-		
Pipe Type	MSCL				
Minimum wall thickness	t	6	-	mm	
Lining Thickness	tc	16	-	mm	
Yeild Stress	y	250	250	MPa	
Stress Utilisation factor		50%	50%		
Allowable Stress		125	125	MPa	
Allowable Pressure	P_{al}	1.563	#DIV/0!	MPa	
Diameter at neutral axis of wall	D	954	-	mm	
Initial 3-minute ring-bending modulus	E_b	207,000	207,000	MPa	Table 2.1
Long-term ring-bending modulus	E_{bL}	207,000	207,000	MPa	Table 2.1
2 year ring-bending modulus	E_{b2y}	207,000	207,000	MPa	
12 hour ring-bending modulus	E_{b12hr}	207,000	207,000	MPa	
Second moment of area	I	37	-	mm^4/mm	2.2.1.2 (C2.2.1)
Poisson's ratio		0.30	0.30		
Initial 3-minute ring-bending stiffness	S_{DI}	8,721	#DIV/0!	N/m/m	2.2.1.1(1)
Long-term ring-bending stiffness	S_{DL}	8,721	#DIV/0!	N/m/m	2.2.1.1(2)
2 year ring-bending stiffness	S_{D2y}	8,721	#DIV/0!	N/m/m	
12 hour ring-bending stiffness	S_{D12hr}	8,721	#DIV/0!	N/m/m	
LIMITING PARAMETERS FOR PIPE					
Long Term Factors of Safety					
Pressure		1.39	1.39		
Bending		1.39	1.39		
Combined		1.39	1.39		
Allowable long term vertical deflection		3.0%	3.0%		
Allowable long term bending strain		1.0%	1.0%		
Required Factor of Safety against buckling		2.50	2.50		
SITE CONDITIONS					
Side Clearance	lc	300	300		
Trench width	B	1.56	0.60	m	
Cover height	H	2.40	2.30	m	> 0.5 for vehicular loads
Water table height	H_W	-	2.3	m	
Native soil type	E_n	1.0	1.8	MPa	
Embedment material	E_e	5	5	MPa	
Soil specific weight		20	20	kN/m^3	
Soil particle specific density		2.65	2.65		
Operating pressure	P_W	1.0	1.0	MPa	
Negative internal pressure	q_v	100	10	kPa	
Operating temperature		30	30	deg. C	
Temperature re-rating factor	r_t	1.0	1.0		
EXTERNAL LOADING					
Live loading		10	16	kPa	Refer Fig. 4.1
Friction angle		30	30	deg.	
Soil pressure ratio		0.50	0.50		
Reduction factor for deep installations		1.0	1.0		
Soil loading	w_g	48.0	46.0	kPa	
Surface applied load	w_{gs}	-	-	kPa	
Total load causing deflection		58.0	62.0	kPa	

EFFECTIVE SOIL MODULUS

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B/D	B/D	1.635	#DIV/0!	
E_e/E_n	E_e/E_n	5.000	2.778	
Bedding constant	K	0.100	0.100	Refer Clause 5.2
Design factor		0.437	#DIV/0!	3.4.3(3)
Leonhardt correction factor		0.264	#DIV/0!	3.4.3(2)
Effective soil modulus	E'	1.320	#DIV/0! MPa	3.4.3(1)
Soil pressure ratio	K_0	0.150	0.150	
DEFLECTION PREDICTION				
Predicted long-term vertical deflection	**y/D**	**3.9%**	**#DIV/0!** [redacted]	**less than 3.0% is acceptable**
STRAIN PREDICTION				
Shape factor	D_f	3.12	#DIV/0!	
Predicted long-term ring-bending strain		**0.08%**	**#DIV/0!** OK	**less than 1.0% is acceptable**
COMBINED LOADING EFFECT				
Factor of safety for pressure only	F	**10.00**	-	
Re-rounding factor	r_c	0.67	0.67	
Combined factors of safety		**2.01**	**#DIV/0!** OK	**greater than 1.39 is acceptable**
BUCKLING STABILITY				
Submerged density		12.45	12.45 kN/m^3	
Buckling pressure for H>H_w	q_b	69	68 kPa	
Critical buckling pressure	q_{crit1}	230	#DIV/0! kPa	
	q_{crit2}	248	#DIV/0! kPa	
	q_{crit}	248	#DIV/0! kPa	
Factor of safety against buckling	F_s	**3.61**	**#DIV/0!** OK	**greater than 2.5 is acceptable**

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24/09 2004 FRI 13:40 FAX 61 7 3369 9722 cardno alexander browne 012/013

SERPENTINE ROAD SP300
diam 910, 2400 cover NO WHEEL LOADING.
Buried Pipe Design

Definition	Symbol	Value	Value		
PIPE DETAILS					
Pipe Diameter	DN	910	-	mm	
Pipe Outside Diameter	De	960	-	mm	
Pressure Class	PN	12.5	-		
Pipe Type	MSCL				
Minimum wall thickness	t	6	-	mm	
Lining Thickness	tc	16	-	mm	
Yeild Stress	y	250	250	MPa	
Stress Utilisation factor		50%	50%		
Allowable Stress		125	125	MPa	
Allowable Pressure	P_{al}	1.563	#DIV/0!	MPa	
Diameter at neutral axis of wall	D	954	-	mm	
Initial 3-minute ring-bending modulus	E_b	207,000	207,000	MPa	Table 2.1
Long-term ring-bending modulus	E_{bL}	207,000	207,000	MPa	Table 2.1
2 year ring-bending modulus	E_{b2y}	207,000	207,000	MPa	
12 hour ring-bending modulus	E_{b12hr}	207,000	207,000	MPa	
Second moment of area	I	37	-	mm^4/mm	2.2.1.2 (C2.2.1)
Poisson's ratio		0.30	0.30		
Initial 3-minute ring-bending stiffness	S_{DI}	8,721	#DIV/0!	N/m/m	2.2.1.1(1)
Long-term ring-bending stiffness	S_{DL}	8,721	#DIV/0!	N/m/m	2.2.1.1(2)
2 year ring-bending stiffness	S_{D2y}	8,721	#DIV/0!	N/m/m	
12 hour ring-bending stiffness	S_{D12hr}	8,721	#DIV/0!	N/m/m	
LIMITING PARAMETERS FOR PIPE					
Long Term Factors of Safety					
Pressure		1.39	1.39		
Bending		1.39	1.39		
Combined		1.39	1.39		
Allowable long term vertical deflection		3.0%	3.0%		
Allowable long term bending strain		1.0%	1.0%		
Required Factor of Safety against buckling		2.50	2.50		
SITE CONDITIONS					
Side Clearance	Ic	300	300		
Trench width	B	1.56	0.60	m	
Cover height	H	2.40	2.30	m	> 0.5 for vehicular loads
Water table height	H_W	-	2.3	m	
Native soil type	E_n	1.0	1.8	MPa	
Embedment material	E_e	5	5	MPa	
Soil specific weight		20	20	kN/m^3	
Soil particle specific density		2.65	2.65		
Operating pressure	P_W	1.0	1.0	MPa	
Negative internal pressure	q_v	100	10	kPa	
Operating temperature		30	30	deg. C	
Temperature re-rating factor	r_t	1.0	1.0		
EXTERNAL LOADING					
Live loading		-	16	kPa	Refer Fig. 4.1
Friction angle		30	30	deg.	
Soil pressure ratio		0.50	0.50		
Reduction factor for deep installations		1.0	1.0		
Soil loading	W_g	48.0	46.0	kPa	
Surface applied load	W_{gs}	-	-	kPa	
Total load causing deflection		48.0	62.0	kPa	

EFFECTIVE SOIL MODULUS

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24/09 2004 FRI 13:40 FAX 61 7 3369 9722 cardno alexander browne 013/013

B/D	B/D	1.635	#DIV/0!	
E_c/E_n	E_e/E_n	5.000	2.778	
Bedding constant	K	0.100	0.100	Refer Clause 5.2
Design factor		0.437	#DIV/0!	3.4.3(3)
Leonhardt correction factor		0.264	#DIV/0!	3.4.3(2)
Effective soil modulus	E'	1.320	#DIV/0! MPa	3.4.3(1)
Soil pressure ratio	K_0	0.150	0.150	
DEFLECTION PREDICTION				
Predicted long-term vertical deflection	y/D	**3.2%**	**#DIV/0!** [redacted]	**less than 3.0% is acceptable**
STRAIN PREDICTION				
Shape factor	D_f	3.12	#DIV/0!	
Predicted long-term ring-bending strain		**0.06%**	**#DIV/0!** [illegible]	**less than 1.0% is acceptable**
COMBINED LOADING EFFECT				
Factor of safety for pressure only	F	10.00	-	
Re-rounding factor	r_c	0.67	0.67	
Combined factors of safety		**2.04**	**#DIV/0!** [illegible]	**greater than 1.39 is acceptable**
BUCKLING STABILITY				
Submerged density		12.45	12.45 kN/m^3	
Buckling pressure for $H>H_w$	q_b	59	68 kPa	
Critical buckling pressure	q_{crit1}	230	#DIV/0! kPa	
	q_{crit2}	248	#DIV/0! kPa	
	q_{crit}	248	#DIV/0! kPa	
Factor of safety against buckling	F_s	**4.22**	**#DIV/0!** [illegible]	**greater than 2.5 is acceptable**

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K3. Buoyancy Calculations

Cardno Alexander Browne

Engineering the Future

Facsimile Transmission

Attention: IAN CAMERON

Organisation: PB

Sent by: DARREN MCDONALD

Date: 2 NOVEMBER 2004

File No: 7519/02-03 No. of Pages: 3

Fax No: 3831 4223 ☐ Urgent ☒ Routine

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SP300

FURTHER CALCS TO JUSTIFY BOUYANCY CONDITION. I HAD TO RESORT TO SKIN FRICTION ON THE SHEET PILING. FINGERS CROSSED, THIS SHOULD LAY THIS MATTER TO REST.

Rgds

Darren

02/11 2004 TUE 9:44 FAX 61 7 3369 9722 cardno alexander browne 002/003

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CONSULTING ENGINEERS
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Project SP300		
Client PB	Ckd.	App.
File No. 7519/02-03	Date 1 NOV	Page No.

TO AS1170.0 AND AS1170.1

STABILITY OF SP300 PUMP STN

COMBINATION FACTORS AS1170.0-2002 Cl 4.2.

STABILISING EFFECTS
0.90 G.

DESTABILISING
Su

Su = 1.2 Fgw Fgw DEFINED IN AS1170.1-2002

AS1170.1 -2002 SECTION 4
Clause 4.3 Hydrostatic Pressure.
ADOPT Su = 1.2 Fgw WITH ANNUAL PROB OF EXCEEDANCE 1 IN 50

∴ REQUIRE Q50 FLOOD HEIGHT.

100 YR STORM SURGE 2.14 AHD + 0.30m
50 YR STORM SURGE 1.75 AHD + 0.30m (GREENHOUSE / GLOBAL WARMING)

ADOPT 50 YR 2.20m AHD. (INCL GREENHOUSE).

TOTAL MASS BASED ON CURRENT DRAWINGS
= 5041 KN

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Project SP300		
Client PB	Ckd.	App.
File No. 7579/02-03	Date 1 Nov	Page No.

BOUYANCY (REVISED FOR Q50 2.20m AHD)

F_{gw} = 14 × 6 × (2.20 + 2.70) × 9.8 = 4033 kN.

1.2 F_{gw} = 1.2 × 4033 = 4839 kN

0.9 G = 4536 kN.

4839 > 4536 ∴ NG. AS1170 NOT SATISFIED

HOWEVER, SKIN FRICTION ON THE SHEET PILING HAS NOT BEEN CONSIDERED AT THIS STAGE

IT WOULD BE PRUDENT TO ALLOW 5 KPa WITH ϕ_g = 0.50

∴ SKIN FRICTION = (14×2 + 6×2) × 4.5 × 5 × 0.5
= 450 kN.

(5041 + 450) × 0.9 = 4940 > 4839 ∴ OK!

STRUCTURE SATISFIES AS1170 FOR BOUYANCY EFFECTS FOR Q50 FLOOD LEVELS
NO FURTHER STRUCTURE MASS REQUIRED

05/10 '04 08:20 FAX 0733689722 CARDNO MBK PTY LTD 001

Facsimile Transmission

Cardno Alexander Browne

Engineering the Future

Attention: IAN CAMERON

Organisation: PB

Sent by: DARREN McDONALD

Date: 5 OCT 04.

File No: 7519/02-03 No. of Pages: 4

Fax No: 3831 4223 ☐ Urgent ☑ Routine

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SP300 — BOUYANCY CALC'S ATTACHED

Regds
Darren

Please check all sheets have been transmitted and are legible. If not, ring or send a facsimile immediately. If this facsimile has been sent to you by mistake, please phone us and return the facsimile to us by mail. This facsimile may contain confidential information and if you have received it by mistake you must not use this facsimile or the information it contains in any way.

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Cardno

PROJECT	PROJECT NO. 7519/02-03
SP300 SERPENTINE ROAD	Designed BMSP Date AUG 04 Sheet 1 of

SP300

BOUYANCY EFFECTS

ADOPTED WT RL IS TO BE 1.50m
AS DISCUSSED AT SITE MEETING 13/08/04.

DISPLACED VOLUME OF WATER = 14 X 6 X (1.50 + 2.40)
= 328 m³
⇒ 3215 KN

MASS STRUCTURE

ASSUMES WATER LEVEL IN WET WELL RL -0.54

AVG CONCRETE THICKNESS INTO SHEET PILING 100mm

16500 KG PUMPS AND EQUIPMENT

1500 KG CRANE STRUCTURE

ΣDL = 3751

∴ 3751 X (0.90) = 3375 > 3215 KN.

WITH WATER TABLE ASSUMED TO ACT AT RL 1.50 NO ADDITIONAL WEIGHT IS REQUIRED TO COUNTERACT BOUYANCY EFFECTS

HOWEVER A FALSE FLOOR IS TO BE PLACED IN THE DRY WELL -
⇒ ADDITIONAL SAFETY FACTOR.

Cardno

PROJECT	PROJECT NO. 7519/02-03
SP300 PUMP STATION.	Designed DMD
	Date OCT 04. Sheet 2 of

MASS OF STRUCTURE

BASE RL = -2.00 REF DWG 7519/02/03-21

TOP RL = +3.30

TOP SLAB

$= (14.2 \times 6.2 - 4 \times 1.5 - 0.7^2 \times 1.2 \times 1.5) \times 0.25 \times 24$

$= 478$ KN

WALLS (300 THK) NOT INCLUDING CONCRETE IN RIBS OF SHEET PILING

$= 2 \times 5.6 \times 5.0 \times 0.3 \times 24 + 2 \times 13 \times 5.0 \times 0.3 \times 24$

$+ 7 \times 5.0 \times 5.0 \times 0.3 \times 24$

$= 1519$ KN

WALLS ADDITIONAL CONCRETE IN RIBS OF SHEET PILING

$= 5.4 \times 40 \times 0.1 \times 24 = 518$ KN.

BASE - $13.6 \times 5.6 \times 0.4 \times 24$. $= 731$ KN

PUMPS/EQUIPMENT = 162 KN

CRANE STRUCTURE = 15 KN.

LIQUID IN WET WELL $= (2 - 0.54) \times 4.6 \times 5.0 \times 9.8$

$= 329$ KN

Cardno

PROJECT	PROJECT NO. 7579/02-03
SP300 PUMP STN	Designed DMYD
	Date OCT 04 Sheet 3 of

$\Sigma_{DL} = 3751$ KN.

$0.9 \times 3751 > 3215$ BOUYANCY IS OKAY

IF WE ASSUME HYPOTHETICALLY
~~A~~ W.T. RL = 2.0m

$\Rightarrow$ BOUYANCY $= 3215 \times \frac{4.4}{3.9} = 3627$ KN.

$(0.9) \times (3751 + W_{FF}) > 3627$

W_{FF} = WEIGHT FALSE FLOOR ≥ 279 KN.
$\geq 11.6\ m^3$ CONCRETE

AREA OF FALSE FLOOR $= 40m^2$

$\therefore$ REQUIRE 300 THK FALSE FLOOR
TO COUNTER BOUYANCY EFFECTS
IF WT RL ~~IS~~ OF 2.00 AHD
IS TO BE ADOPTED

$\Rightarrow$ ACTUAL FALSE FLOOR $3.9 \times 5.0 \times 850$ THK

$W_{FF} = 3.9 \times 5.0 \times 0.85 \times 24 = 398$ KN

$\therefore$ OKAY FOR WT @ 2.00m AHD

PARSONS BRINCKERHOFF

Australia Trade Coast Sewer Project
Contract No. BW30137-02.03
Revised Developed Design Report
Separable Portion No. 2
Serpentine Road Pump Station SP300

Appendix L

PB Structural Calculations
L1. Temporary Pipe Protection
L2. DN1295 Conc. Pipe Protection

L1. Temporary Pipe Protection

MEMORANDUM

Parsons Brinckerhoff
12th floor, IBM Centre
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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: 30 September 2004

To:

cc:

From: Simon Cloherty

Job No: 2138110B

Re: Trade Coast Sewerage Project - SP300

SP300 – Serpentine Road Pumping Station – Site Inspection Report

A site inspection was carried out by Simon Cloherty of this office on Thursday 30/09/04 at 9:15am. Leighton Contractors was represented by James Whybrow. The purpose of the inspection was to determine the approximate depths and sizes of the existing rising mains and understand Leighton Contractors requirements for access to the site of the new Serpentine Road Pumping Station.

Leighton Contractors need to drive a 30tonne excavator over the existing pipes to get access to the pump station footprint to carry out piling works. The route will cross 4 pipes all being 1370mm diameter MSCL pipes. A mark up of drawing 486/5/7-TR201/043 is attached showing the approximate depths of the pipes to be crossed and the measures to be taken to ensure the pipes are not overstressed by the passage of the excavator. The first pipe to be crossed is approximately 2000mm below ground level and does not require any additional precautions. The second pipe is approximately 400mm below the ground level and will require bridging with 2/6000x2400 20mm thick steel plates as indicated on the attached sketch. The last two pipes to be crossed are approximately 1000mm below ground level. As a precaution these pipes will require fill to be placed for the vehicle track to a depth of 500mm to give a total cover of 1500mm to the pipes. The fill should extend 2500mm each side of the pipes and the track should be 4800mm wide.

Calculations of the estimated pipe deflection under the excavator load are attached. The calculations are only for the pipe that is 400mm below the surface. The existing and additional fill will provide sufficient cover to the other pipes to limit the stresses to acceptable levels.

Over a Century of Engineering Excellence

Cameron, Ian

From: Cloherty, Simon
Sent: Monday, 11 October 2004 8:54 AM
To: Cameron, Ian
Subject: FW: SP300 piling rig site inpsection report

-----Original Message-----
From: Cloherty, Simon
Sent: Thursday, 30 September 2004 2:36 PM
To: Cameron, Ian
Subject: SP300 piling rig site inpsection report

Ian,

Attached is a memo, calcs and sketches for the piling rig stuff.

It is all saved in I:\2138110B\work.

I'm not sure who it should be addressed to Leightons or Brisbane water.

If you have any comments let me know.

Simon.

SP300 site nspection report 3.. | piling rig bridging calculatio... | piling rig bridging sketch 1.p... | piling rig bridging sketch 2.p...

Simon Cloherty
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www.pb.com.au and www.pbworld.com

Everyone profits by delivering client outcomes on time

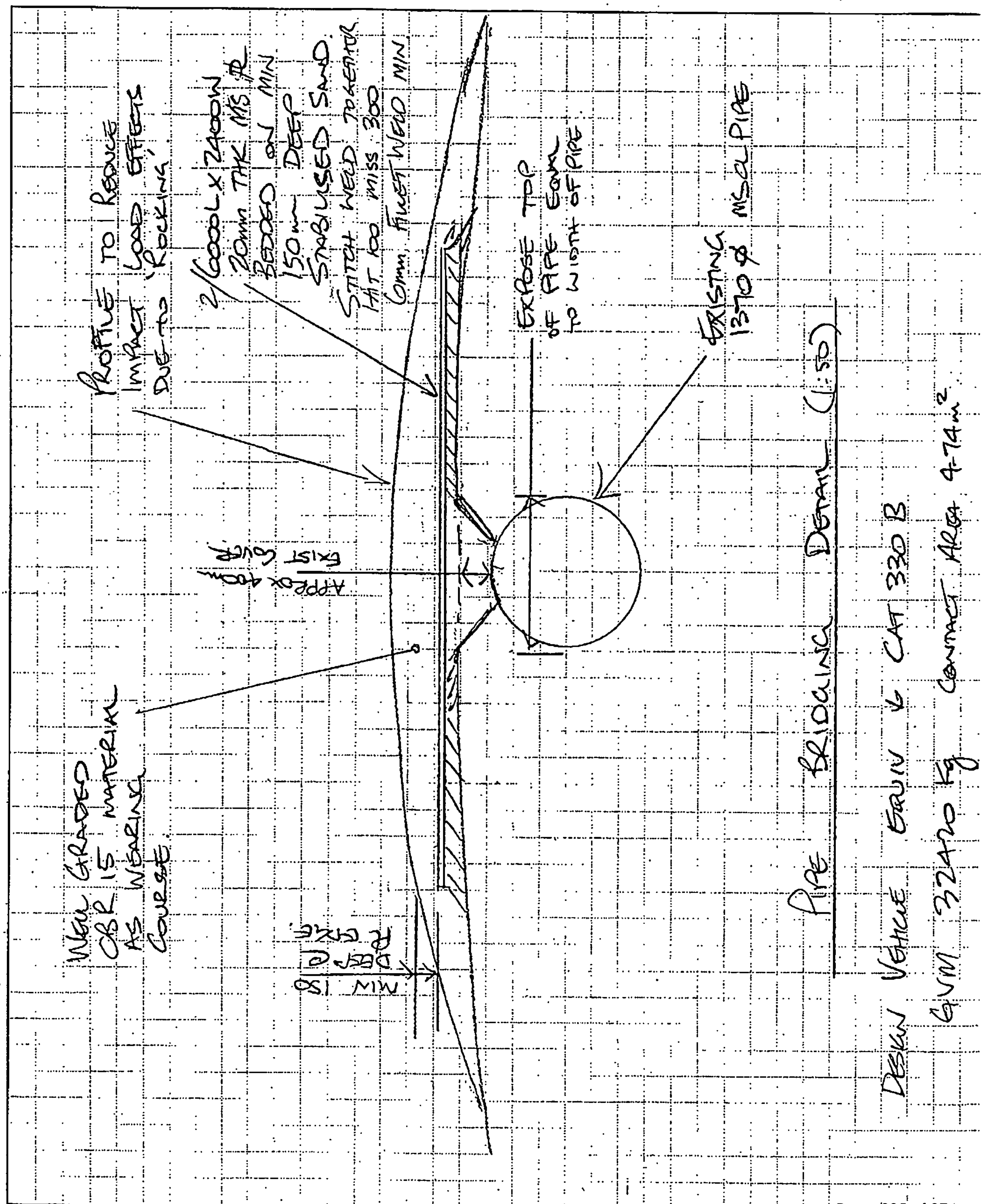
PB 100 YEARS

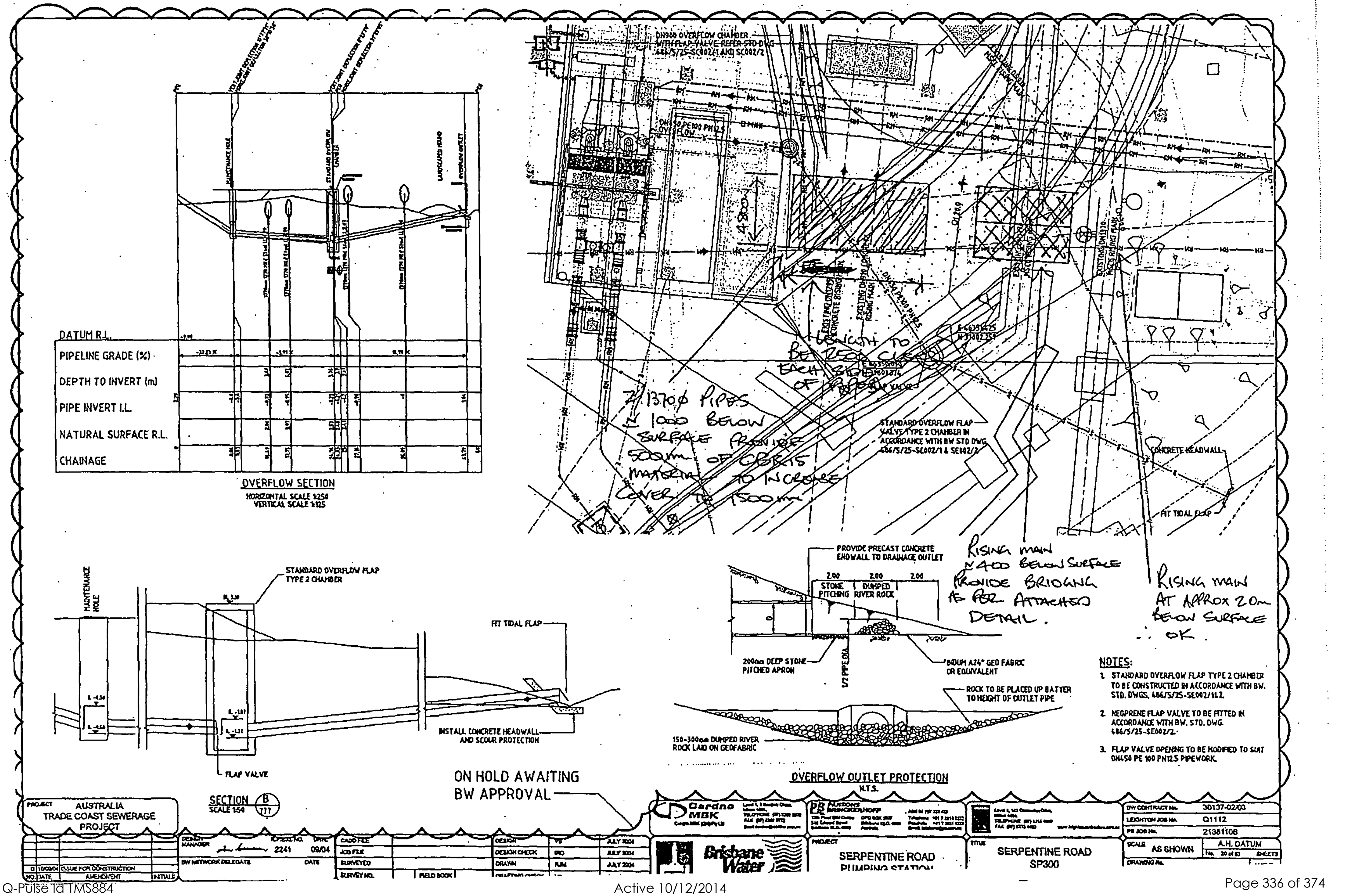
Calculation Shee

Job SP300
RISING MAIN BRIDGING
DETAIL

Design SC
Date 30.9.04
Checked
Date

Office BNE
Job No. 2138710 B
Page No.




DN900 OVERFLOW CHAMBER WITH FLAP VALVE REFER STD DWG 486/5/25-SE002/1 AND SE002/2
DN450 PE100 PN12.5 OVERFLOW
DATUM R.L.
PIPELINE GRADE (%)
DEPTH TO INVERT (m)
PIPE INVERT I.L.
NATURAL SURFACE R.L.
CHAINAGE
OVERFLOW SECTION
HORIZONTAL SCALE 1:250
VERTICAL SCALE 1:125
LENGTH TO BE 750 CLR EACH SIDE OF PIPE
2/1370ϕ PIPES ~1000 BELOW SURFACE PROVIDE 500mm OF CBR15 MATERIAL TO INCREASE COVER TO 1500mm
STANDARD OVERFLOW FLAP VALVE TYPE 2 CHAMBER IN ACCORDANCE WITH BW STD DWG 486/5/25-SE002/1 & SE002/2
CONCRETE HEADWALL
FIT TIDAL FLAP
STANDARD OVERFLOW FLAP TYPE 2 CHAMBER
MAINTENANCE HOLE
FLAP VALVE
INSTALL CONCRETE HEADWALL AND SCOUR PROTECTION
SECTION B
SCALE 1:50
ON HOLD AWAITING BW APPROVAL
PROVIDE PRECAST CONCRETE ENDWALL TO DRAINAGE OUTLET
2.00
2.00
2.00
STONE PITCHING
DUMPED RIVER ROCK
200mm DEEP STONE PITCHED APRON
1/2 PIPE DIA
"BIDIM A24" GEO FABRIC OR EQUIVALENT
ROCK TO BE PLACED UP BATTER TO HEIGHT OF OUTLET PIPE
150-300mm DUMPED RIVER ROCK LAID ON GEOFABRIC
OVERFLOW OUTLET PROTECTION
N.T.S.
RISING MAIN ~400 BELOW SURFACE PROVIDE BRIDGING AS PER ATTACHED DETAIL.
RISING MAIN AT APPROX 2.0m BELOW SURFACE ∴ OK.
NOTES:
1. STANDARD OVERFLOW FLAP TYPE 2 CHAMBER TO BE CONSTRUCTED IN ACCORDANCE WITH BW. STD. DWGS. 486/5/25-SE002/1&2.
2. NEOPRENE FLAP VALVE TO BE FITTED IN ACCORDANCE WITH BW. STD. DWG. 486/5/25-SE002/2.
3. FLAP VALVE OPENING TO BE MODIFIED TO SUIT DN450 PE 100 PN12.5 PIPEWORK.
PROJECT AUSTRALIA TRADE COAST SEWERAGE PROJECT
0 10/09/04 ISSUE FOR CONSTRUCTION
NO. DATE AMENDMENT INITIALS
2241 09/04
BW NETWORK DELEGATE
CADD FILE
JOB FILE
SURVEYED
SURVEY NO.
FIELD BOOK
DESIGN
DESIGN CHECK
DRAWN
JULY 2004
Cardno MBK
PB PARSONS BRINCKERHOFF
Brisbane Water
PROJECT SERPENTINE ROAD PUMPING STATION
TITLE SERPENTINE ROAD SP300
BW CONTRACT No. 30137-02/03
LEIGHTON JOB No. Q1112
PB JOB No. 2136110B
SCALE AS SHOWN
A.H. DATUM

PB 100 YEARS

Calculation Shee

Job SP300 Design SC Office BNE

TRADE COAST SEWERAGE Date 30/9/04 Job No. 21381108

Checked Page No. 1

Date

CHECK EXISTING PIPES FOR PILING RIG LOAD.

(REF DRAWING 486/5/7 – TR201/020–022, 043, 044)

1370 ϕ MILD STEEL RISING MAIN. $t_s = 10$ mm. $t_c = 25$ mm.

COVER ≃ 400 mm

PILING RIG INFO FROM LEIGHTONS EMAIL 30/9/04

GVW = 32 420 kg

GROUND CONTACT AREA = 4.74 m²

TRACKS 3950 x 600

EQUIV. TO CAT 330 B

CONTACT LOAD = 324 / 4.74 = 68.3 kPa

TRACK LOAD = 0.6 x 68.3 = 41 k/m

CHECK LOAD WITHOUT SPREADER PLATES TO AS 2566.

$\alpha = 1.4 - 0.15H = 1.34$

$$\frac{\Delta y}{D} = \frac{K \times 10^{-3} (w_g + w_{gs} + w_q)}{8 \times 10^{-6} S_{DL} + 0.061 E'}$$

PB 100 YEARS

Calculation Shee

Job SP300	Design SC	Office BNE
	Date 30-9-04	Job No. 2138100
	Checked	Page No. 2
	Date	

$W_g = 18 \times 0.4 = 7.2$ KPa

$W_q = 1.34 \times 68 = 91.1$ KPa

$W_{gs} = 0$

$K = 0.1$

$S_D = S_{DI}$ → USE SHORT TERM SINCE ONLY CONSTRUCTION LOAD EVENTS.

$= \dfrac{E_b I}{D^3} \times 10^6$

$D = 1370$ mm

$E_b = 207$ GPa

$I = \dfrac{t^3}{12} = \dfrac{10^3}{12} = 83.33$ mm⁴/mm

$S_{DI} = \dfrac{207 \times 10^3 \times 83.33}{1370^3} \times 10^6 = 6708$ N/m/m

$D_E = 1370$ mm $+ (10+25) \times 2 = 1440$ mm

$B_E = 1440 + 700 = 2140$ mm

$E_m = 1.0 \Rightarrow 1.8$ MPa

$E_0 \quad 5 \Rightarrow 5.0$ MPa

Calculation Shee

Job SP300

Design SC

Office BVG

Date 30.9.04

Job No. 2138110B

Checked

Page No.

Date

$B/D = 2140/1440 = 1.486$

$E_e'/E_n' = 5/1.8 = 2.77$

$\zeta = 0.3$

$E' = 0.3 \times 5 = 1.5$ MPa

$$\frac{\Delta y}{D} = \frac{0.1 \times 10^{-3} (98)}{8 \times 10^{-6}\ 6708 + 0.061 \times 1.5} = 6.75\%$$

$\frac{\Delta y_{all}}{D} = 3.0\%$ max NG

∴ Relieving / Spreader Plates 6000 x 2400.

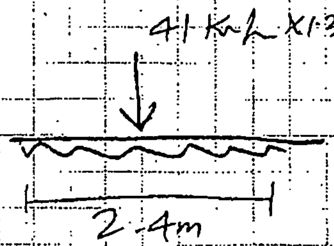
∴ Spread load over 2400

$W_{TRACK} = 41$ kN/m

$q = 41/2.4 \times 1.34 = 22.7$

$\therefore \frac{y}{D} = (22.7 + 7.2)/98 \times 6.15 = 2.06\% < 3\%$ ok

Plate Reqd



$M^*_{PL} = \frac{41 \times 1.34}{2.4} \times \frac{2.4^2}{8}$

$= 16.4$ kN.m

PB 100 YEARS

Calculation Shee

Job SP300 | Design SC | Office BNE
Date 30.9.04 | Job No. 2138110B
Checked | Page No.
Date

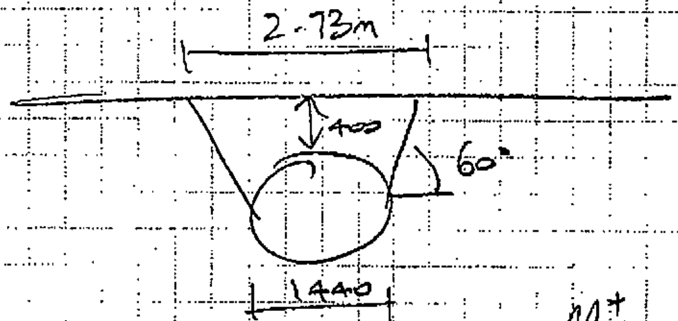
$Z_{REQ'D} = 16.4 \times 10^6 / 0.7 \times 250 = 72.88 \times 10^3 \text{ mm}^3$

$S = \frac{bd^2}{4} \quad d_{REQ'D} = \sqrt{\frac{72\,880 \times 4}{1000}} = 17.07 \text{ mm}$

∴ 20 PL OK

ALTERNATIVELY

DESIGN PL TO BRIDGE PIPE.



$M^+_{PL} = \frac{41 \times 1.34 \times 2.73^2}{8} = 51.2 \text{ kN.m}$

$b = 2400$

$Z_{REQ'D} = 227\,480 \text{ mm}^3$

$t_{REQ'D} = 19.5 \text{ mm}. \quad 20\,PL \quad I = \frac{20^3 \times 2400}{12} = 1.6 \times 10^6 \text{ mm}^4$

EXPECTED $\Delta = 10^3 \times \frac{5 \times 41 \times 10^3 \times 2.73^4}{384 \times 200 \times 10^6 \times 1.6 \times 10^6} = 92 \text{ mm}$

L2. DN1295 Conc. Pipe Protection

PB 100 YEARS

Calculation She

Job SPS 300 – SERPENTINE ROAD – PIPE PROTECTION SLAB. DESIGN.	Design SC	Office BNE
	Date 8 · 11 · 04	Job No. 2138110B.
	Checked	Page No. 1
	Date	

PIPE BRIDGING SLAB.

PIPES – 2 x 1295 ID CONCRETE

∴ ≃ 1400 OD

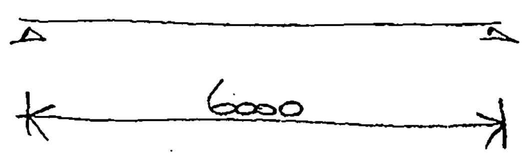
PIPES ≃ 2100 CTN to CTN.

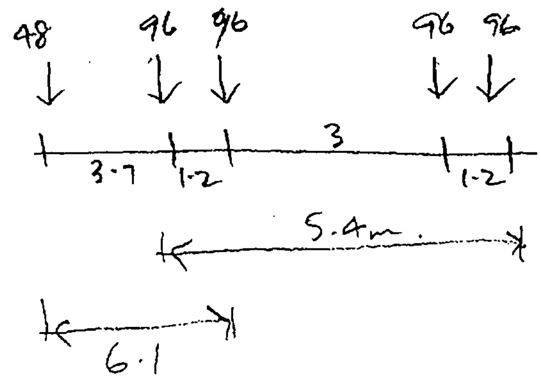
ALLOWING 500 CLEAR EACH SIDE GIVES MIN

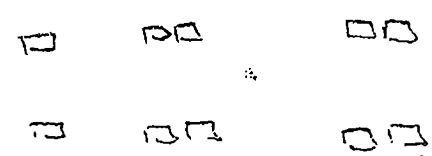
SPAN = 2100 + 1000 + 1400 = 4500 mm.

ADOPT 6000 SPAN. TO GIVE MORE CLEARANCE

DESIGN FOR T44 LOADING







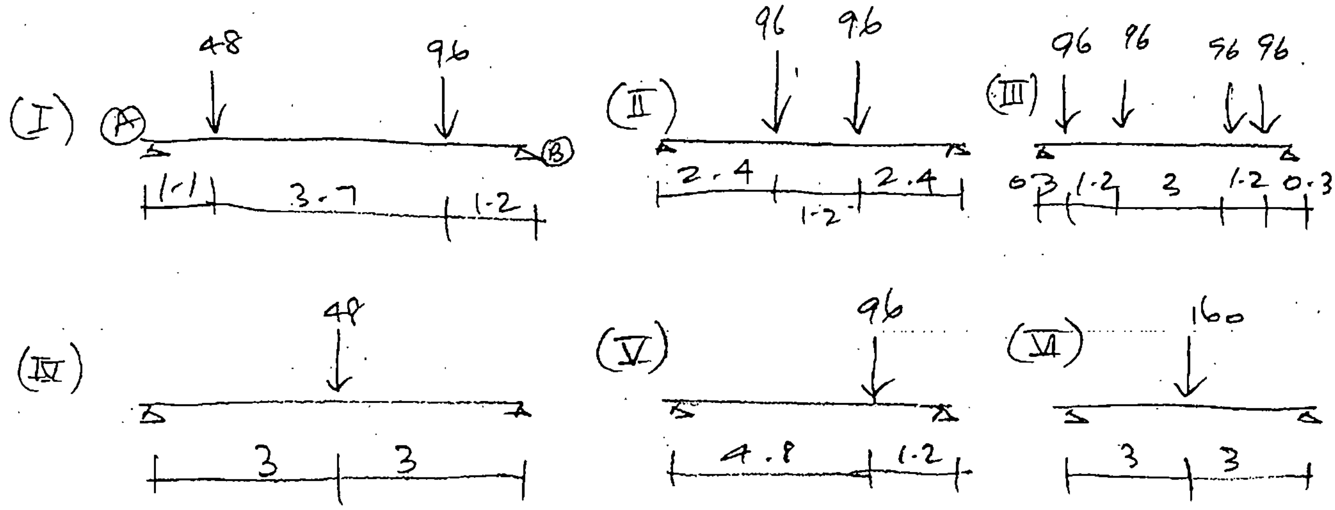
Calculation Sh

Job ______ Design ______ Office ______

Date ______ Job No. ______

Checked ______ Page No. 2

Date ______



CASE I
R_A = 58 KN
R_B = 86 KN
M = 70 KNm

CASE II
R_A = 96 KN
R_B = 96 KN
M = 230 KN.m
→ CRITICAL SHEAR

CASE III
R_A = 192
R_B = 192.
M = 173 KN.m.

CASE IV
R_A = 24
R_B = 24
M = 72 KN.m.

CASE V
R_A = 20
R_B = 76
M = 92 KN.m.

CASE VI
R_A = 80
R_B = 80
M = [illegible]
→ CRITICAL MOMENT.

PB 100 YEARS

Calculation Sh

Job ______ Design ______ Office ______

Date ______ Job No. ______

Checked ______ Page No. 3

Date ______

LOAD FACTOR = 1.8

DYNAMIC LOAD ALLOWANCE = 1.4

$\gamma_u = 2.52 = 1.8 \times 1.4$

TRY 350 THK SLAB.

$V^* = 96 \times 2.52 + \frac{6}{2} \times 0.35 \times 24 \times 1.2 \times 5 = 756$ KN

$M^* = 240 \times 2.52 + \frac{6^2}{8} \times 0.35 \times 24 \times 1.2 \times 5 = 830$ KN.m

WIDTH OF BRIDGING SLAB = 5.0m MIN.

$V^*/m = 756/5 = 151$ KN/m

$M^*/m = 830/5 = 166$ KN.m/m

$d = 350 - 40 - 10 = 300$

$M^*/bd^2 = 1.84$ MPa. A_{ST} REQ'D = 1516 mm²/m N20-200

$\beta_1 = (1.6 - 0.3) \times 1.1 = 1.43$.

$A_{ST} \simeq 1550/2 = 775$ mm²/m (50% OF FLEXURAL STEEL).

N40 CONC. $f'_c = 40$ MPa

$V_{UC} = 1.43 \times 300 \times 10^3 \times \left(\frac{775 \times 40}{300\,000}\right)^{1/3} = 201$ KN/m.

$\phi V_{UC} = 141$ KN/m < V*

Calculation Sh

Job ______ Design ______ Office ______

Date ______ Job No. ______

Checked ______ Page No. 4

Date ______

IF 100 % STEEL DEVELOPED.

$V_{UC} = 253$ kN/m. $\phi V_{UC} = 178$ kN/m $> V^*$ ∴ OK

ESTIMATE DEFLECTION.

$A_{ST}/bd = 0.0052$

$I_{ef} \simeq (0.02 + 2.5 \times 0.0052) \times 300^3 \times 1000$

$= 889 \times 10^6 \text{ mm}^4/\text{m}$

FULL WIDTH $I_{ef} = 4444 \times 10^6 \text{ mm}^4$

$E_{CONC} = 0.043 \sqrt{40} \times (2400)^{1.5} = 31 \text{ GPa}$.

CREEP FACTOR 2

Δ_{LT} IGNORE WHEEL LOADS.

$$\Delta_{LT} = \frac{(1+2) \times 5 \times 0.35 \times 24 \times 6^4}{384 \times 31 \times 10^9 \times 889 \times 10^{-6}} \times 10^6 = 3.1\text{mm} = L/200$$

$$\Delta_{WHEEL} = \frac{160 \times 10^3 \times 6^3}{48 \times 31 \times 10^9 \times 4444 \times 10^{-6}} \times 10^3 = 5.22\text{mm} = L/1200$$

@ 40% Δ_{WHEEL} to Δ_{LT}

$\Delta_{LT} = 3.1 + 2 \times 5.2 \times 0.4 = 7.26\text{mm} = L/826$

∴ 350 THK SLAB OK

N40 N20-200 BTM. + N16-200 EW T&B

[illegible]

PB 100 YEARS

Calculation Sh

Job ______ Design ______ Office ______

Date ______ Job No. ______

Checked ______ Page No. 5

Date ______

WORKING REACTION @ FOOTINGS

DL = 0.35 x 24 x 6 x 5/2 = 84 KN

LL = 96 KN.

AREA = 5000 x B.

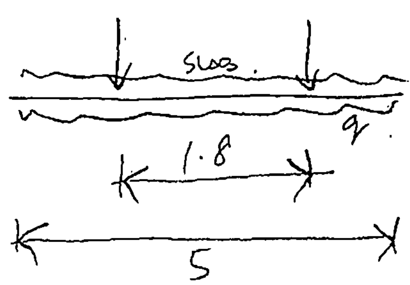
LIMIT BEARING PRESSURE TO 100 KPa.

AREA REQ'D = (96+84)/100 = 1.8 m²

∴ B REQ'D = 1.8/5 = 0.36 m

ADOPT 500W FOOTING BEAM.

→ q = (96+84)/5x0.5 = 72 KPa ∴ OK.



WHEEL + SLAB

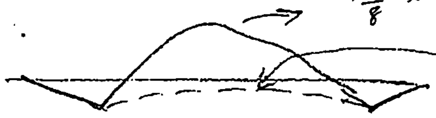
WHEEL = 120 KN.

SLAB = 30 K/m → STRAIGHT GROUND.

q = 120x2/5 = 48

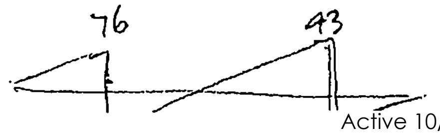
BMD.

$\frac{1.8^2}{8} \times 48 - 61 = -42$



↳ $1.6^2 \times \frac{48}{2} = 61$ KN.m → M* 3N20 T&B

SFD

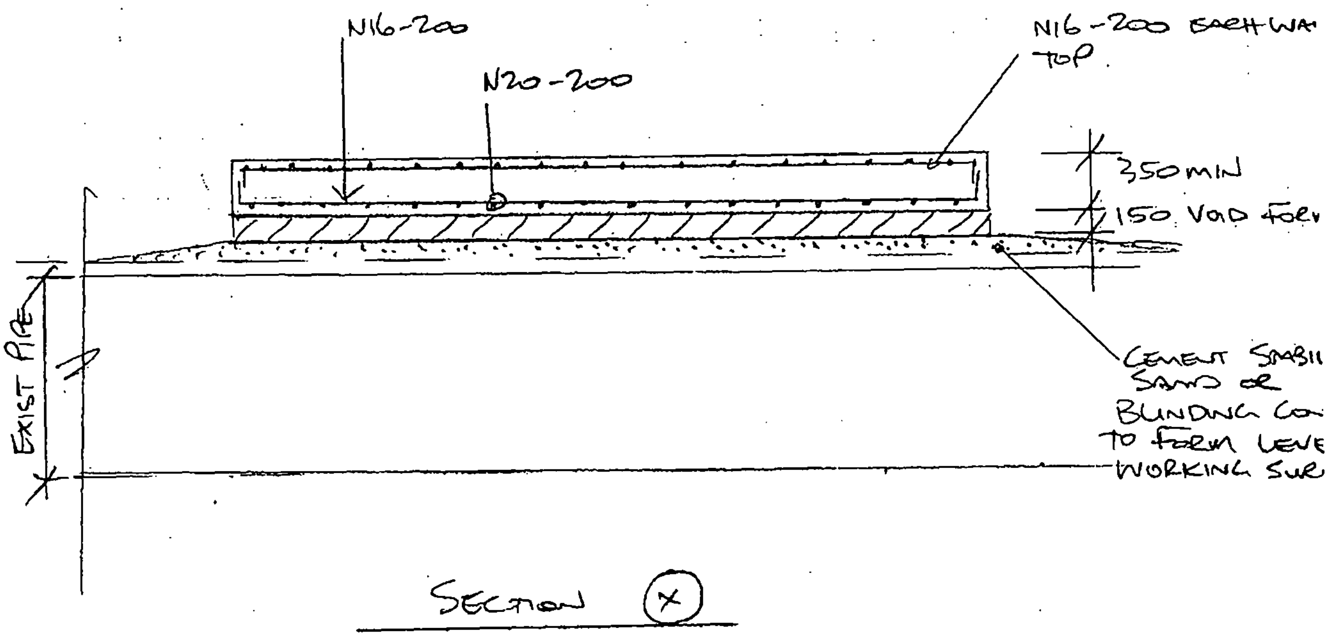


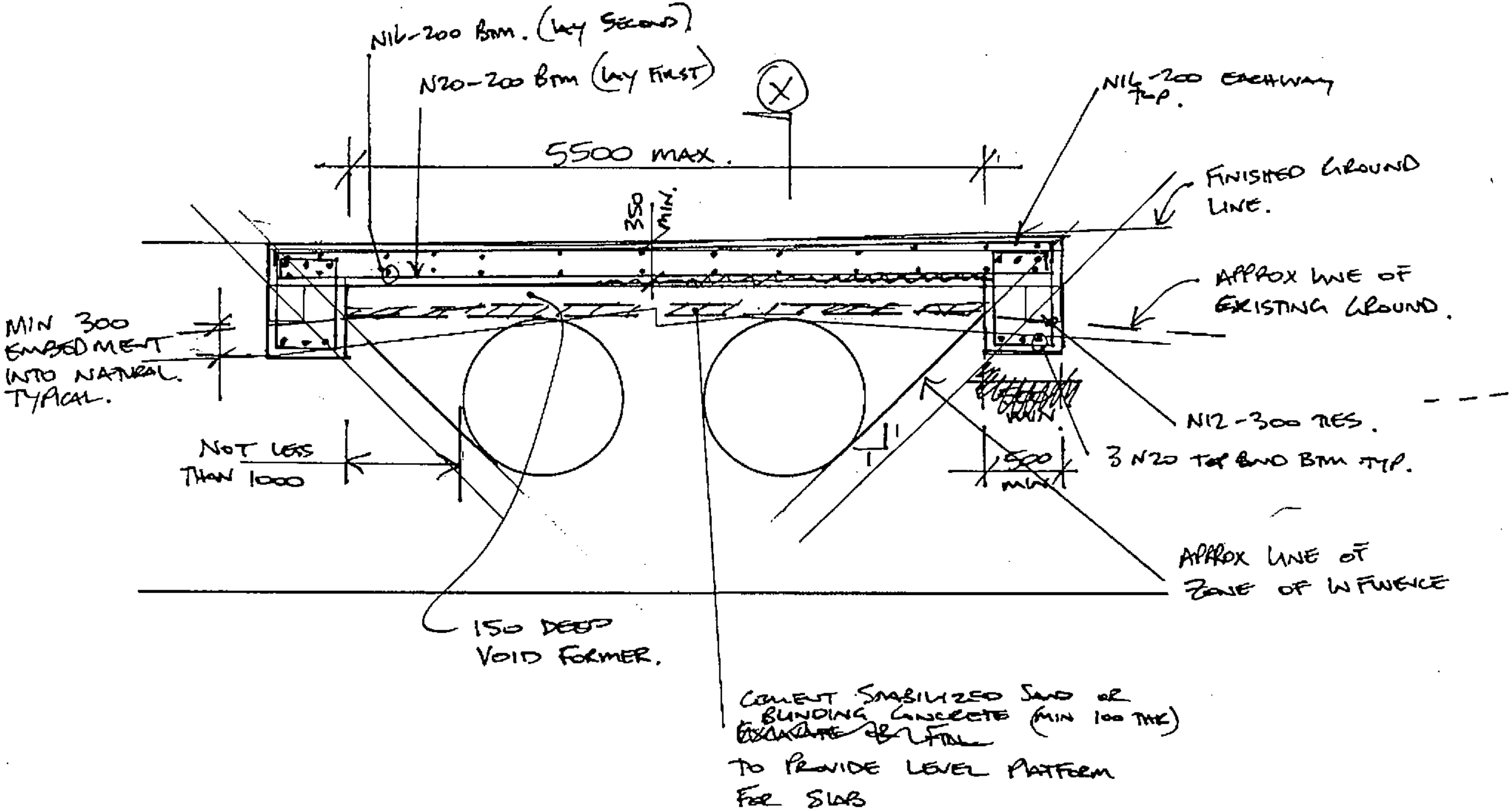
V* = 76 KN. → N12 -300 TIES ...

PB 100 YEARS

Calculation Sh

Job	Design	Office
	Date	Job No.
	Checked	Page No. 6
	Date	





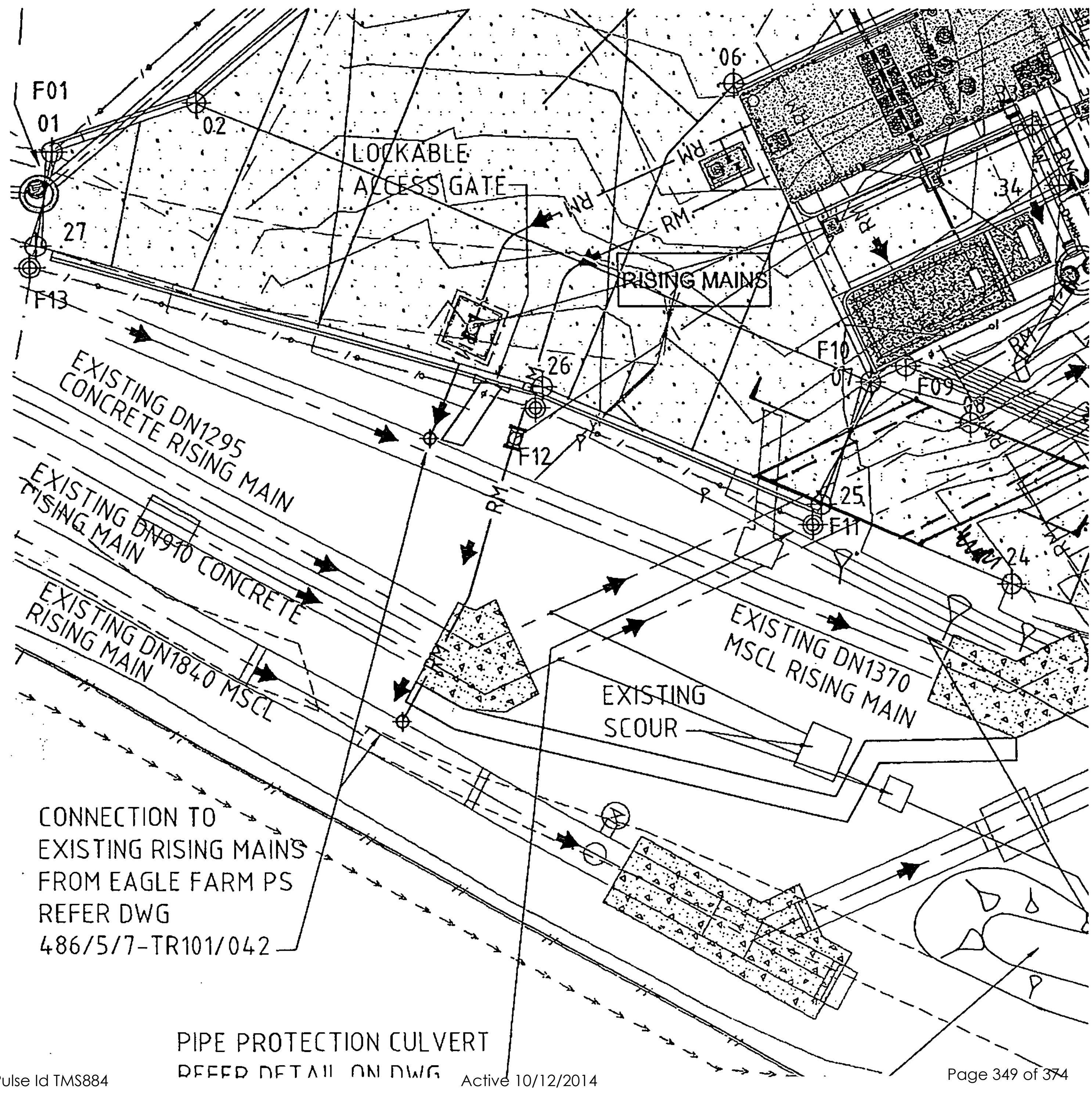
VOID FORMER SHALL BE OF BIODEGRADABLE MATERIAL OR REMOVED ONCE THE SLAB ACHIEVES THE DESIGN STRENGTH. POLYSTYRENE MAY BE USED PROVIDED IT IS REMOVED FROM BENEATH

CONCRETE $f'_c = 40$ MPa @ 28 DAYS

COVER 40mm UNO.

ALLOWABLE BEARING CAPACITY UNDER FOOTING BEAMS 100 KPa.

SCALE 1:50


F01
01
02
06
LOCKABLE
ACCESS GATE
RM
RM
RISING MAINS
27
F13
26
F12
F10
07
F09
34
25
F11
24
EXISTING DN1295
CONCRETE RISING MAIN
EXISTING DN910 CONCRETE
RISING MAIN
EXISTING DN1840 MSCL
RISING MAIN
EXISTING DN1370
MSCL RISING MAIN
EXISTING
SCOUR
CONNECTION TO
EXISTING RISING MAINS
FROM EAGLE FARM PS
REFER DWG
486/5/7-TR101/042
PIPE PROTECTION CULVERT
REFER DETAIL ON DWG

PARSONS BRINCKERHOFF

Appendix M

Purafil Odour Scrubber – Relevant Information and Correspondence

Final Recommendation

The final recommendation is given below after discussions in the project weekly meeting dated 3rd November 2004.

The final recommendation is for Serpentine Road SP300 only and is based on the original recommendation process with a couple of modifications:

- Modification to the blower operation incorporating a VSD controlled from the proposed existing level transmitter
- A maximum flow of 250 L/s (replacing the original 360 L/s).

The basis of the design is that the pumps in the wet well have variable speed drives and hence the wet wells level will be kept fairly constant during operation and should only draw down and then fill during times of low flow. When the fill occurs it will be detected by the change in the level transmitter and the blower VSD drive will respond to increase the air flow to keep the wet well under negative pressure.

It was noted that activated carbon systems are best utilised where the conditions are as follows:

Low flow – High H_2S
High flow – Low H_2S

Therefore in this instance with the majority of the operation being with a small change in level within the wet well then the air changes can be low giving low flow. The H_2S levels as measured indicate that they will be high although this may not be the case in reality; this is yet to be determined. With this modified system the times of fill are anticipated to be low and so operation outside of the recommended range are not frequent and as such the life of the media should not be reduced significantly.

The Purafil system allows for 1 air change in normal operation and is a standard design that is used by the company world wide and they have extensive experience in running in these conditions. This has now been modified to allow a bigger unit incorporating a VSD motor which will detect rise in level in the wet well and ramp up the blower speed in order to maintain a flow that will continue to give a negative pressure.

The overflow flap valve has been calculated to require 80pa to open, but in this instance it does not really play a part as the wet well will be maintained under negative conditions.

This option is by far the most economical option.

The unit to be supplied is the DS-1000.

Opex and capex details

The anticipated capital cost for this unit will be $33,000 excluding GST.

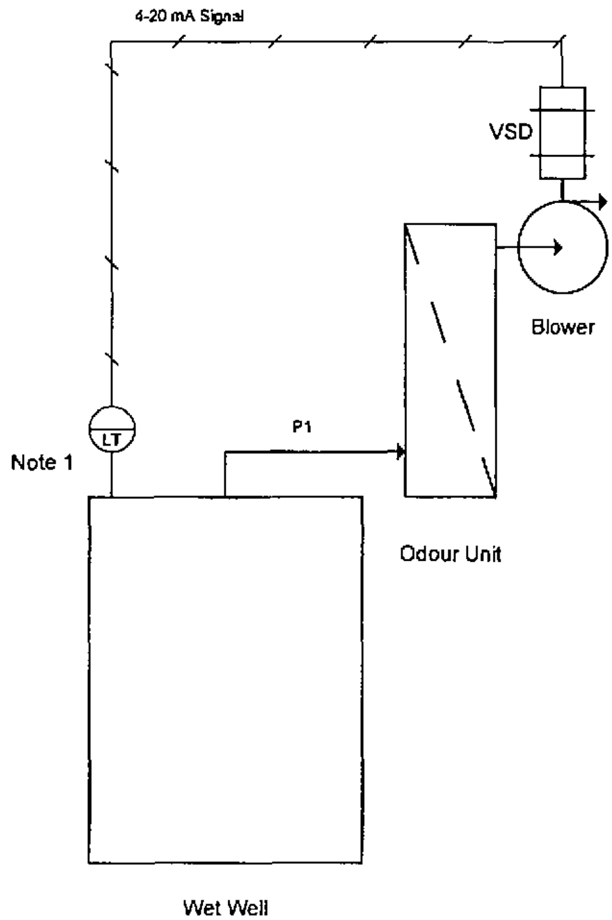
The anticipated operating costs would be in the region of $10,000.

Operating philosophy

The Purafil units are based on dry chemical air filtration media technology. The drums are filled with multiple layers of media for a broad spectrum removal of sewage odours.

The unit comprises of:

- Polythene canister
- Media
- 3 media sampling ports
- VSD Blower
- Adjustable damper



Note 1: Existing Level Transmitter

The units are sized to treat the volume of air calculated to give 1 air change per hour in normal operation. On fill mode the level transmitter will directly control the blower speed to increase the air flow being drawn out of the wet well.

The blower sucks polluted air directly from the top of the wet well.

The air is pulled through a packed media bed out to atmosphere.

The unit will give an efficiency of greater the 99.5% efficiency.

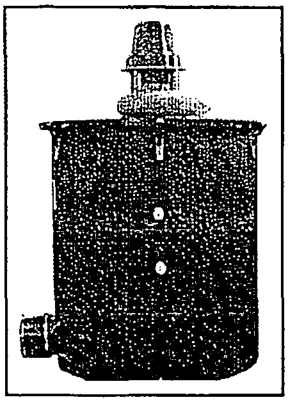
Life of the units

Purafil have developed a program called MediaPik which calculates the service life of the media against contaminant load, airflow and running times. This then uses the best appropriate media for the task, which in this case for H2S removal Odorcarb II of which has a capacity by weight of 35% for H2S.

Variable speed drives

The variable speed drive (VSD) in the Purafil unit is utilised to increase the air changes if required. It is believed the VSD will be housed in a local panel to the unit.

Purafil ESD Drum Scrubber - 1000



Manufactured by Purafil Environmental Systems Division (ESD), the Drum Scrubber–1000 (DS-1000) is ideal for removal of odorous gases found at pump stations, lift stations, wet wells, force mains, and even at the wastewater treatment plant. Recommended for moderate-load applications, the DS-1000 is sized for airflows up to 1000 cfm.

Construction: The DS-1000's polyethylene canister measures 52 inches (132.1 cm) in diameter, 79.5 inches (201.9 cm) in height (including blower), and 1/4-inch (6.4 mm) in thickness. The unit is mounted on a 60-inch square aluminum skid.

Media: At the core of ESD's high-efficiency odor control systems are dry-chemical air filtration medias. The DS-1000 is bulk filled with multiple layers of Odoroxidant™, Odorcarb™ II, and Odormix™ media for broad-spectrum removal of sewage odors at 99.5+% efficiencies.

Applications

- Pump Stations
- Lift Stations
- Wet Wells
- Force Mains
- Head Works
- Aerobic Digesters
- Clarifiers
- Sludge Dewatering

Targeted Odors/Gases

- Hydrogen sulfide
- Ammonia
- Aldehydes
- Sulfur dioxide
- Mercaptans
- Organic compound

System Advantages

Corrosion-Resistant Housing: The DS-1000 is constructed of corrosion-resistant materials and requires essentially no maintenance, making it ideal for remote, outdoor applications or areas where high levels of acid gases are present.

Low Maintenance: The DS-1000 has only one moving part—a blower. Other than routine service checks, no maintenance is required to ensure maximum scrubber performance. The expected service life of the DS-1000 is nine months to one year, depending on the contaminant level.

Complete Gas Removal: Purafil ESD's Odoroxidant, Odorcarb II, and Odormix media offer broad-spectrum removal of sewage odors. By using these media in combination, users are assured of complete odor control.

Media Sampling Ports: Three media sampling ports, located on the side of the DS-1000, allow for easy access to the media beds. Upon receiving the samples, Purafil ESD's laboratory performs a complimentary Media Life Analysis to project remaining service life. Timely replacement of spent media is critical in preventing odor breakthrough.

Local Service: Purafil ESD's network of local representatives offers convenient and timely service. These factory-trained representatives work in conjunction with ESD's in-house laboratory to provide comprehensive technical service.

Standard Features:

- Linear, low-density, polyethylene canister (¼-inch in thickness)
- Odoroxidant, Odorcarb II, and Odormix media (39 ft³)
- Integrated motor housing
- Totally Enclosed Fan Cooled (TEFC) motor
- High-density, rotomolded, polypropylene motor/blower assembly
- Adjustable damper (PVC)
- Stainless steel and rubber latches
- Stainless steel fasteners
- Thermoplastic packing and FRP lid
- Polypropylene impellers and motor shaft bushings
- Integrated rainhood
- Fernco flexible coupling at inlet
- Polyethylene inlet (10-inch pipe diameter)
- Airflows up to 1000 cfm

Optional Features

- Other Purafil ESD media

Other System Advantages

- System media are UL Classified Class 1 and 2.
- Spent media is landfill disposable.
- Maintains superior performance in climates with fluctuating temperature and relative humidity.

PURAFIL
Environmental Systems Division

2654 Weaver Way • Doraville, Georgia 30340 • Phone: (770) 662-8545 • Fax: (770) 263-6922 • www.purafil.com

SUGGESTED SPECIFICATIONS - DS-1000

DRUM SCRUBBER – 1,000 CFM

For use with drawing AW-121703 Rev. B

PURAFIL Environmental Systems Division

1. GENERAL

1.01 Intent

A. It is the intent of these Suggested Specifications to give the Contractor/Engineer the descriptions of the equipment, instructions for delivers, and installation of the Purafil Drum Scrubber-1,000cfm (DS-1000) as manufactured by Purafil, Inc. Doraville, Georgia or equal.

B. The Contractor/Engineer is advised that all drawings shall be for general reference.

C. The Contractor/Engineer shall provide all equipment and work indicated below unless otherwise noted and any additional work to produce a completely finished job as required by the Engineer.

2. PRODUCTS

2.01 General

A. This specification defines the requirements for a Drum Scrubber-1,000cfm (DS-1000) as manufactured by Purafil, Inc. Doraville, Georgia or equal.

B. The DS-1000 consists of dry scrubbing media contained in a 550-gallon, linear, low density, polyethylene drum with a blower mounted on top of a FRP lid.

C. The DS-1000 shall contain 39 ft^3 (0.96 m^3) of Odoroxidant™, Odorcarb™ II, and Odormix™ media. The DS-1000 shall contain 400 pounds (183 kg) of impregnated activated alumina, Odoroxidant media, 945 pounds (431 kg) of impregnated activated carbon, Odorcarb II Media, followed by 400 pounds (183 kg) of a 50/50 volume blend of activated carbon and active-oxidant impregnated alumina, Odormix Media, as manufactured by Purafil, Inc.

D. The DS-1000 shall be designed to operate at 99.5+% gas removal efficiencies.

E. The airflow capacity shall range from 800 cfm (1,360 m^3/hr) to 1,100 cfm (1,870 m^3/hr)

F. The configuration shall be arranged so that the contaminated air shall flow into the bottom inlet plenum and be drawn upwards through the media bed. Treated air shall discharge out the top of the vessel through a centrifugal air ventilator.

G. All components of the DS-1000 shall include:

1. 550-gallon, linear, low density, polyethylene drum and FRP lid
2. 1,745 pounds (796 kg) of dry scrubbing media
3. Polypropylene blower section with damper

2.02 Drum

A. The drum material shall be linear, low density, polyethylene, 1/4" (6.4mm) in thickness.

B. The drum shall have a capacity of 550 gallons and measure 52" (132.1 cm) in diameter and 60" (152.4 cm) in height.

C. Latches shall be stainless steel and rubber.

D. Fasteners shall be stainless steel.

E. The drum shall contain 39 ft^3 (1.10 m^3) of Odoroxidant, Odorcarb II and Odormix medias as manufactured by Purafil, Inc.

F. The drum shall be provided with two media sampling ports, each measuring one inch in diameter.

G. The media shall be supported by an FRP air diffuser and surrounded by thermoplastic packing and will contain a mist eliminator to remove moisture.

H. Polymedia filters shall be used to separate the thermoplastic packing from the Odorcarb II media, the blower from the Odormix media, and to separate the layers of media.

I. The inlet shall have a 8" (203.2 mm) FERNCO flexible coupling.

J. The drum shall have a 0.75" (19 mm) dia. drain pipe.

2.03 Blower Section

A. The blower shall be sized to deliver 1,000 cfm (1,700 m^3/hr)

B. The blower/motor shall be covered with an FRP rainhood.

C. The blower shall consist of a direct drive motor-fan assembly.

D. The motor shall be a 3.0 hp, 3450 RPM, 115/230 volt / 1 phase/ 60 Hz TEFC motor.

E. The unit comes ready to be field wired.

2.04 Chemical Media

A. The DS-1000 shall contain 8 ft^3 (0.22 m^3) of Odoroxidant media, 21 ft^3 (0.58 m^3) of Odorcarb II Media, and 10 ft^3 (0.28 m^3) Odormix Media as manufactured by Purafil, Inc.

2654 Weaver Way • Doraville,GA 30340 • (Toll-Free) 1-800-222-6367 • (Phone) 770-662-8545 • (Fax) 770-263-6922
Email:purafil@purafil.com • www.purafil.com

B. The Odoroxidant™ Media shall consist of manufactured, generally spherical, porous pellets. Pellets shall be formed from a combination of activated alumina and other binders, suitably impregnated with potassium permanganate to provide optimum adsorption, absorption, and oxidation of a wide variety of gaseous contaminants. The potassium permanganate shall be applied during pellet formation, such that the impregnant is uniformly distributed throughout the pellet volume and is totally available for reaction.

C. Odoroxidant Media shall have the following physical properties:
   1. Moisture content: 35% maximum
   2. Average crush strength: 35% minimum - 70% maximum
   3. Average abrasion: 4.5% maximum
   4. Bulk density: 50 lbs/ft^3 (800 kg/m^3)
   5. Nominal pellet diameter: 1/8" (3.2 mm)
   6. Potassium permanganate content: 8% minimum

D. Odoroxidant Media shall be UL Classified Class 1.

E. Odoroxidant Media shall be capable of absorbing and removing odorous gases throughout the entire pellet.

F. The Odorcarb™ II Media shall consist of manufactured, generally spherical porous pellets. The pellets shall be formed from a combination of powered activated carbon, alumina, and other binders suitably impregnated with chemicals to enhance the capacity for removal of odorous gases. The pellets shall also chemically react to produce solid reaction products within the media. Impregnants shall be applied during pellet formation such that the impregnant is uniformly distributed throughout the pellet volume.

G. Odorcarb II Media shall have the following physical properties:
   1. Moisture content: 35% maximum
   2. Average crush strength: 35% minimum - 70% maximum
   3. Average abrasion: 4.5 maximum
   4. Bulk density: 45 lbs/ft^3 (721 kg/m^3)
   5. Nominal pellet diameter: 1/16" – 1/8" (1.587mm)

H. Odorcarb II Media shall be UL Classified Class 2.

I. Odorcarb II Media shall be capable of absorbing and removing odorous gases throughout the entire pellet.

J. The Odormix™ Media shall consist of an equal mix (by volume) of Odoroxidant Media and Odorkol Media. Odoroxidant Media shall be manufactured of generally spherical, porous pellets formed from a combination of powdered activated alumina and other binders, suitably impregnated with potassium permanganate to provide optimum adsorption, absorption, and oxidation of a wide variety of gaseous contaminants. The potassium permanganate shall be applied during pellet formation, such as the impregnant is uniformly distributed throughout the pellet volume and is totally available for reaction. Odorkol Media shall be a premium grade, activated carbon with a high surface area available for adsorption.

K. Odormix Media shall have the following physical properties:
   1. <u>Odoroxidant Media</u>
      - Moisture content: 35% maximum
      - Average crush strength: 35% minimum - 70% maximum
      - Average abrasion: 4.5% maximum
      - Bulk density: 50 lbs/ft^3 (800 kg/m^3)
      - Nominal pellet diameter: 1/16" (1.587mm)
      - Potassium permanganate content: 8% minimum

   2. <u>Odorkol Media</u>
      - Moisture content: 5.0% maximum
      - CTC: 55 minimum
      - Base material: activated carbon
      - Bulk density: 30-32 lbs/ft^3 (480-512 kg/m^3)
      - Odormix Media shall be UL Classified Class 1.

L. ANALYTICAL SERVICES

   a. Media Sampling and Analysis
      i. The manufacturer shall, after start up, shall analyze media samples to predict the remaining service life of system media. Such service will be provided as needed at the manufacturer's expense.

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Email:purafil@purafil.com • www.purafil.com

M. MANUFACTURER

a. Purafil, Inc.

   i. The manufacturer shall have a minimum of ten (10) years experience in the design, fabrication, and testing of systems that are 99.5+% efficient at removing gaseous contaminants.
   ii. The manufacturer shall be a single source provider of equipment, media, and testing services and be certified to ISO-9001 standards.
   iii. The manufacturer shall have local, factory-trained representatives.
   iv. The manufacturer shall be Purafil, Inc. of Doraville, Georgia.

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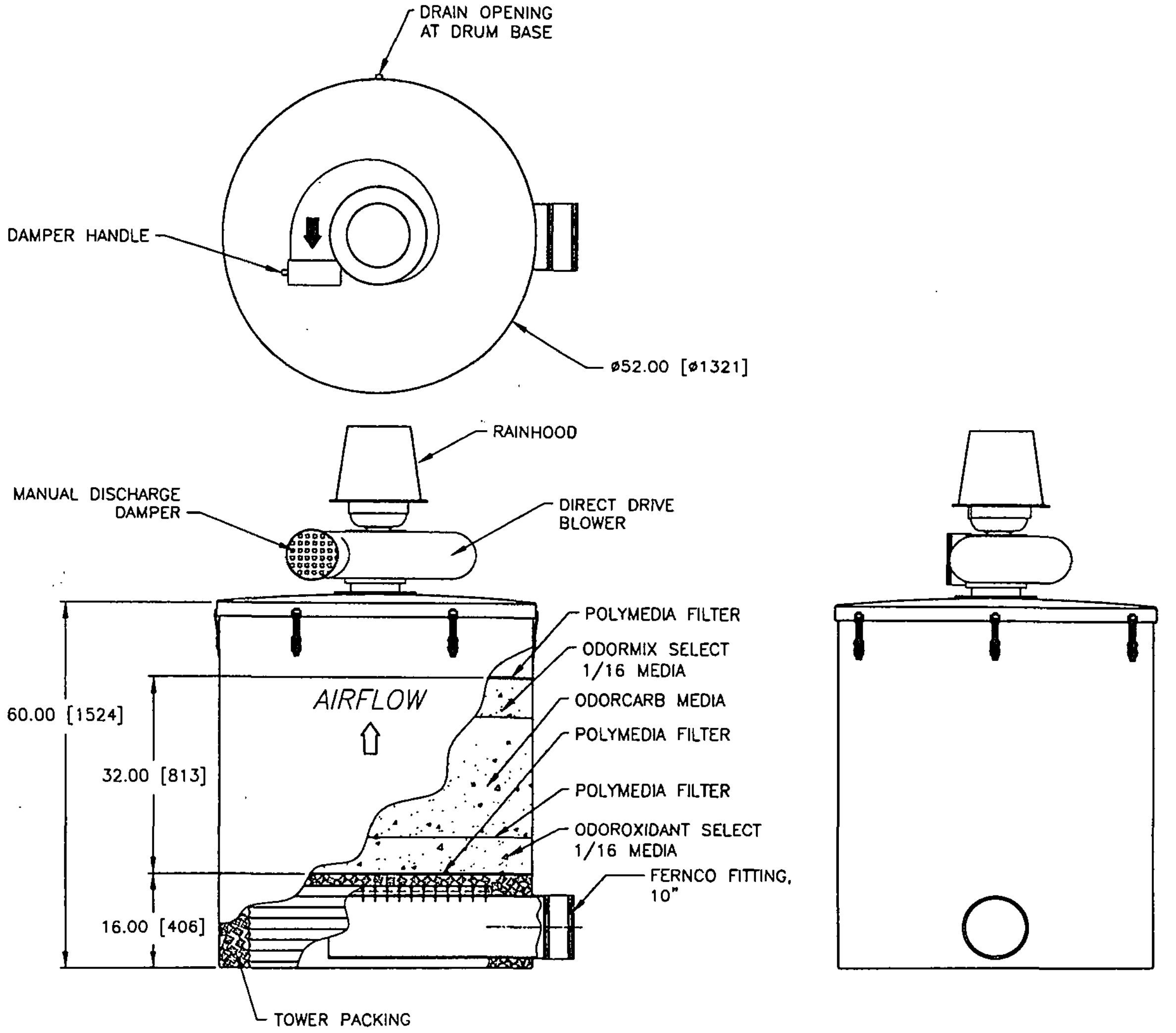
Email:purafil@purafil.com • www.purafil.com

Environmental Systems
A Division of Purafil, Inc.
2654 WEAVER WAY
DORAVILLE, GA 30340
(770)662-8545

1000 CFM DRUM SCRUBBER

WITH BLOWER & RAINHOOD



JOB/UNIT IDENTIFICATION:

MODEL #: DS-100D

MATERIAL: DRUM – LOW DENSITY POLYETHYLENE

FINISH: DRUM – BLACK

ELECTRICAL:

	VOLTS	PH	HZ	HP	TYPE
☐	(STD) 115/230	1	60	3.0	TEFC
☐					

MAX RECOMMENDED AIRFLOW: 1500 CFM W/2.25 IWG ESP AVAILABLE

MIST ELIMINATOR:

	TYPE	QTY	SIZE
☐	NONE		
☐			

PURAFIL® AIR PURIFICATION MEDIA(S) IN DIRECTION OF AIRFLOW:

MEDIA TYPE	TOTAL MEDIA
ODOROXIDANT SELECT 1/16	400 LB [181 KG]
ODORCARB	945 LB [429 KG]
ODORMIX SELECT 1/16	400 LB [181 KG]

INLET CONNECTION:

☐ 10.0" [254mm] INLET

☐ FOR APPROVAL ☐ FOR INFORMATION
☐ FOR CONSTRUCTION ☐ AS BUILT

DATE: 07/01/04

REV DATE:

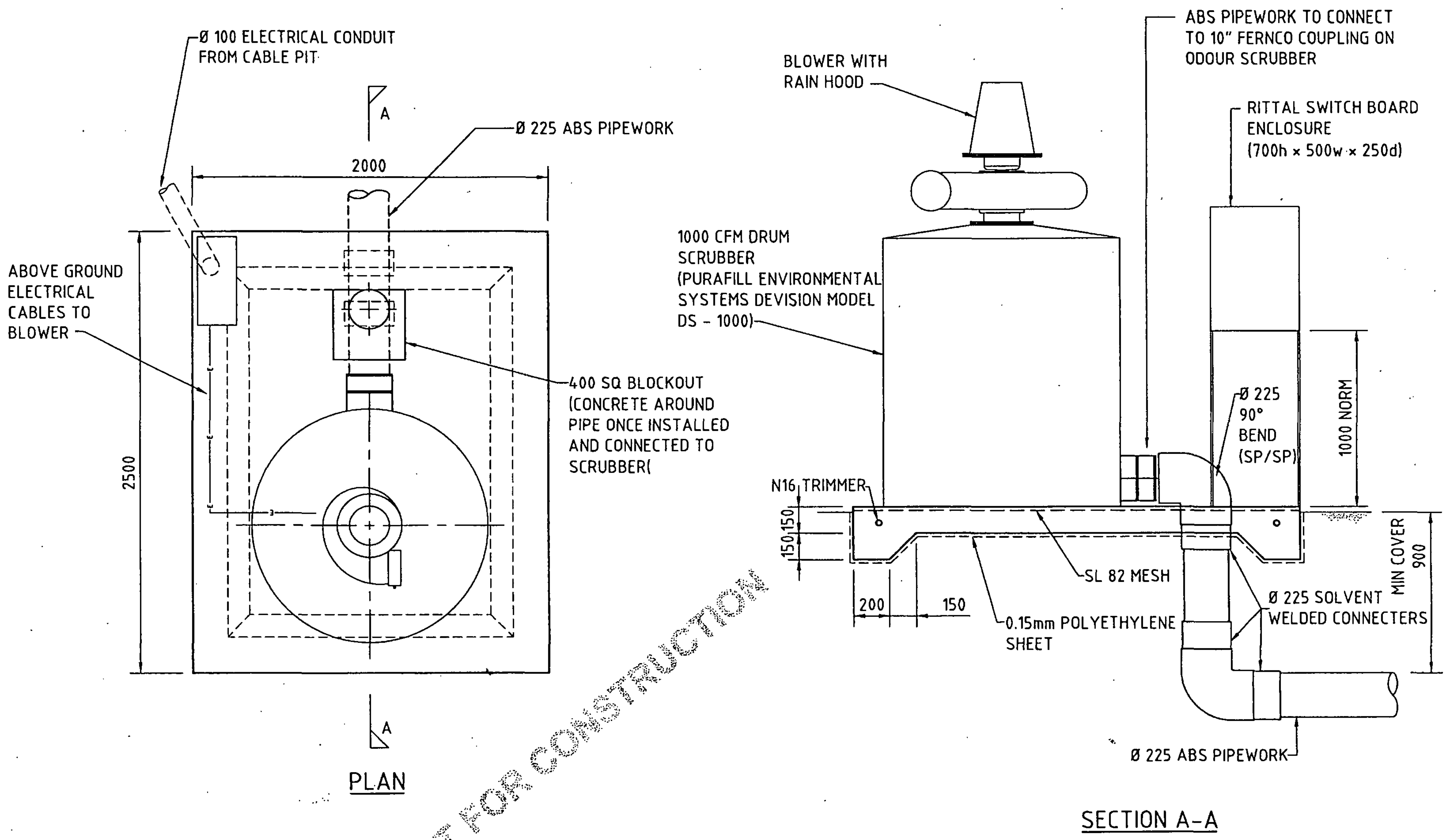
APPROXIMATE OPERATING WEIGHT: 1938 LB [879 KG]

APPROVED BY: AAY/BLG

DRAWING NUMBER: CC-070104

REVISION: –

DIMENSIONS ARE IN INCHES. METRIC EQUIVALENTS IN BRACKETS [ ] ARE IN MILLIMETERS.
PURAFIL, INC. RESERVES THE RIGHT TO MODIFY DESIGN FOR IMPROVED PRODUCT PERFORMANCE.



AUSTRALIA TRADE COAST SEWERAGE PROJECT
SERPENTINE ROAD SPS 300
ODOUR SCRUBBER GENERAL ARRANGEMENT SKETCH

JOB No. 2138110B

14/1/05

Mountney, Paul

From: James McIntosh [j.mcintosh@airepure.com.au]
Sent: Thursday, 23 December 2004 11:03 AM
To: Mountney, Paul
Subject: Functional spec - Odour control unit

Paul,

Pls see attached.

Regards,

James McIntosh
Airepure Australia
Ph. (03) 9562 0011
Fax. (03) 9562 1177
Email. j.mcintosh@airepure.com.au

1. The Danfoss VLT-6000 series VF drive model 6004 will be installed in a separate enclosure.

2. The rating of the VLT-6000 series drive model 6004, 415v has a max continuous output current of 6 A. If required an additional circuit breaker on the distribution board needs to be supplied.

3. As the system is to operate with a negative pressure in the wet well, all gatic and manhole covers need to be well sealed and the sewer inlet to the station needs to be flooded at all times.

4. The following are the set control system requirements:

   - The VF Drive will operate continuously.
   - The Drive will receive a 4-20 mA signal from the RTU to control the speed of the blower.
   - The VF Drive will provide a digital output to the RTU to indicate drive fault.
   - The Drive will run at a set minimum speed under normal operating conditions. This set speed to be adjustable in software and set during commissioning to achieve the required negative pressure in the wet well. Normal operating conditions are when the wet well level is either constant, falling or rising at a rate less that that specified below.
   - The drive will run at an increased speed during periods when the wet well level is rising. The increased speed set point to be adjustable in software and set during commissioning to maintain the required negative pressure in the wet well.
   - Sewage Maintenance is to specify the required rate of rise in the wet well to trigger the increased speed operation. In specifying the rate of rise, need to consider the time period between sampling of the wet well level and the required change for each sample. This needs to be averaged to filter out transient changes. NOTE: Such filtering will increase the response time before speed changed will be effected????.
   - There will be no instrumentation required to monitor the negative pressure within the system.

5. The blower will be connected to the discharge port of the odour unit and will vent directly to atmosphere.

6. ABS plastic ducting 250 mm will lead from the wet well directly to the inlet of the odour control unit located above ground level. An isolation damper is to be fitted within this duct run for purposes of servicing and a method of shut-off to the wet well if required.

Mountney, Paul

From: Cameron, Ian
Sent: Monday, 22 November 2004 5:42 PM
To: Mountney, Paul
Cc: Bowyer, Victor; Maguire, Dean
Subject: FW: Serpentine Rd Odour Control comments

Odour Treatment Control System...

Paul

Pls see me to discuss

Thanks

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
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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: Henri Lai [mailto:Henri.Lai@brisbane.qld.gov.au]
Sent: Monday, 22 November 2004 10:25 AM
To: Cameron, Ian
Cc: Alan Mooney; Andrew Bannink; Greg Wright
Subject: Fwd: Serpentine Rd Odour Control comments

Ian,
Please find attached comments from Networks for the odour control unit for inclusion in the functional specification.
These comments are very relevant to the opeartion of the VSD fan of the odour control unit.

Rgds, Henri Lai

>>> Michael Barton 22/11/2004 9:57:58 >>>
Guys

Please see attached for comments form Peter Sherriff. I agree with him that a full functional spec needs to be written for each station in the ATC scheme.

Could you pelase ensure that this happens so that coding of the stations can be completed without ambiguity.

Thanks

Michael Barton
Maintenance Planner Sewerage
Networks Branch
Brisbane Water
Phone (07) 340 78417
Fax (07) 340 78470
0419 688 087
michael.barton@brisbane.qld.gov.au

>>> Peter Sherriff 22/11/04 9:54:07 >>>
Michael,
Comments on the Serpentinne Rd Odour Control Proposal.

Regards,
Peter.

Comments to Michael Barton re Odour Control Proposal

Michael,
I take it that the information provided is the initial draft format for the design of the odour control system. Is there going to be a fully documented functional specification for this project. The information provided in insufficient to allow code to be written to monitor and control the odour control unit. The comments and details below are the minimum requirements to enable additional code to be written. I believe that this should be formally documented in a functional specification to prevent any ambiguity.

1. As this equipment is additional to the original design for the station, we need to confirm that the additional equipment (V.F. Drive) will be installed in a separate enclosure.

2. Need to confirm the rating of the drive to provide additional circuit breaker on distribution board to supply drive.

3. If the system is to operate with a negative pressure in the wet well, all gatic and manhole covers and need to be well sealed and the sewer inlet to the station needs to be flooded at all times.

4. Confirm the following control system requirements:
    - The VF Drive will operate continuously.
    - The Drive will receive a 4-20 mA signal from the RTU to control the speed of the blower.
    - The VF Drive will provide a digital output to the RTU to indicate drive fault.
    - The Drive will run at a set minimum speed under normal operating conditions. This set speed to be adjustable in software and set during commissioning to achieve the required negative pressure in the wet well. Normal operating conditions are when the wet well level is either constant, falling or rising at a rate less that that specified below.
    - The drive will run at an increased speed during periods when the wet well level is rising. The increased speed set point to be adjustable in software and set during commissioning to maintain the required negative pressure in the wet well.
    - Sewage Maintenance is to specify the required rate of rise in the wet well to trigger the increased speed operation. In specifying the rate of rise, need to consider the time period between sampling of the wet well level and the required change for each sample. Does this need to be averaged to filter out transient changes. NOTE: Such filtering will increase the response time before speed changed will be effected.
    - There will be no instrumentation required to monitor the negative pressure within the system.

5. The comment "The blower sucks polluted air directly from the top of the wet well" to be reworded to indicate that the blower will be connected to the discharge port of the odour unit and will vent directly to atmosphere.

6. Some indication of the structure required to divert the extracted gases above ground level.

Cameron, Ian

From: Bowyer, Victor
Sent: Tuesday, 19 April 2005 4:15 PM
To: Cameron, Ian
Subject: FW: Odour Questions Answered

-----Original Message-----
From: Cameron, Ian
Sent: Wednesday, 17 November 2004 3:21 PM
To: Henri Lai (semdpsbw@brisbane.qld.gov.au); James Whybrow (James.Whybrow@leicon.com.au); Jason Paterson (Jason.Paterson@leicon.com.au); Frank Mitchell (frank.mitchell@leicon.com.au); Greg Wright (PM8BW@brisbane.qld.gov.au); Andrew Bannink (pm13bw@brisbane.qld.gov.au)
Cc: Bowyer, Victor; Maguire, Dean
Subject: FW: Odour Questions Answered

Henri

Response on VSD for odour control fan below

Regards,

Ian Cameron
Executive - Water
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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: Mountney, Paul
Sent: Wednesday, 17 November 2004 2:43 PM
To: Cameron, Ian
Subject: Odour Questions Answered

Ian

The VSD on the fan will ramp up to max speed on a linear basis (analogue signal). Given that the pumps on site have VSD's there probably is already a PLC linked to a level transducer, hopefully this can be picked up.

The fan speed vs. steady state conditions needs to be set during commissioning using an anemometer, this would be relative to the negative pressure achieved within the wet well in this steady state.

If required a manometer to monitor negative pressure can be provided at an additional cost.

Regards

Paul

Paul Mountney
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Everyone profits from delivering client outcomes on time

Mountney, Paul

From: James McIntosh [j.mcintosh@airepure.com.au]

Sent: Friday, 5 November 2004 10:23 PM

To: Mountney, Paul

Subject: Odour Control

Paul,

Sorry I didn't get back to you on Friday, the contact at Danfoss was supposed to send me an email detailing the VSD to use with instructions on use and installation. As yet I still haven't rec'd anything, doesn't look like I'm going too until Monday.
He did however advise me the type and cost. A VLT 6000 series with a cost of around $1,400.00 for the drive, we need to add an amount for a enclosure if this was to be installed into one. He didn't give a size, but we would be looking at a unit that could handle a motor of around 1.5 to 2 kW. Most of the info can be found at www.danfoss.com.au

The $3,000.00 mentioned in an earlier email for the VSD set-up would be pretty close to set-up the drive with enclosure. The DS-1000 as discussed would be around $28,500.00.

All prices are exclusive of GST.

Let us know if you need anything else, I can be contacted over the weekend or any time on my mobile 0419 138 676.

Regards,

James McIntosh
Airepure Australia
Ph. (03) 9562 0011
Fax. (03) 9562 1177
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Mountney, Paul

From: James McIntosh [j.mcintosh@airepure.com.au]
Sent: Friday, 22 October 2004 10:51 AM
To: Mountney, Paul
Subject: Odour units

Paul,

Please find attached photo of a couple of DS-100's installed at pump stations, the only requirement is power and connection to the inlet. Sorry about the size of the attachment, when I reduced it I lost clarity.

Replacement media costs:

Purafil DS-500: contains a total of 17 boxes (0.45 m3) of Purafil media comprising,

3 Boxes (68kg) Purafil Odoroxidant media @ $250.00 per box
10 Boxes (205 kg) Purafil Odorcarb II media @ $250.00 per box
4 Boxes (73 kg) Purafil Odormix media @ $195.00 per box
Total price per estimated 12 monthly usage: $4,030.00 + GST

Purafil DS-1000: contains a total of 39 boxes (1.05 m3) of Purafil media comprising,

8 Boxes (183 kg) Purafil Odoroxidant media @ $250.00 per box
21 Boxes (431 kg) Purafil Odorcarb II media @ $250.00 per box
10 Boxes (183 kg) Purafil Odormix media @ $195.00 per box
Total price per estimated 12 monthly usage: $9,200.00 + GST

Above prices are F.I.S into store, Brisbane.

Please note the above combinations of media are per Purafil's recommended design for removal of odourous substances found in wastewater applications. The client can if he chooses to modify or change the make-up of the media to better suit what may be present at individual pump stations or he may wish to simply target only H2S. If the later is required it is only a matter of multiplying the total number of boxes per unit with the specified H2S removal media which in this case is Odorcarb II.

Information on units @ constant negative pressure

Lytton Rd. SP 298

Wet well volume: 53 m3
One air change per hour: 0.88 m3/min
Inflow rate: 160 l/sec = 9.6 m3/min

Therefore, total flow rate required = 9.6 m3/min + 0.88 m3/min = 10.48 m3/min = 170 l/sec

We would then recommend a DS-1000, but media life at 90 ppm would be only approx. 5 months.

Purafil DS-1000: contains a total of 39 boxes (1.05 m3) of Purafil media comprising,

8 Boxes (183 kg) Purafil Odoroxidant media @ $250.00 per box
21 Boxes (431 kg) Purafil Odorcarb II media @ $250.00 per box
10 Boxes (183 kg) Purafil Odormix media @ $195.00 per box
Total price per estimate for 12 monthly usage 2.4 x above : $22,200.00 + GST

Viola Place. SP 299

Wet well volume: 58 m3

One air change per hour: 0.97 m3/min
Inflow rate: 104 l/sec = 6.2 m3/min

Therefore, total flow rate required = 6.2 m3/min + 0.97 m3/min = 7.17 m3/min = 110 l/sec

We would then recommend a DS-1000, but media life at 90 ppm would be only approx. 7 months.

Purafil DS-1000: contains a total of 39 boxes (1.05 m3) of Purafil media comprising,

8 Boxes (183 kg) Purafil Odoroxidant media @ $250.00 per box
21 Boxes (431 kg) Purafil Odorcarb II media @ $250.00 per box
10 Boxes (183 kg) Purafil Odormix media @ $195.00 per box
Total price per estimate for 12 monthly usage 1.7 x above : $15,640.00 + GST

Serpentine Rd SP300

Wet well volume: 108 m3
One air change per hour: 1.8 m3/min
Inflow rate: 160 l/sec = 20.7 m3/min

Therefore, total flow rate required = 20.7 m3/min + 1.8 m3/min = 22.5 m3/min = 370 l/sec

We would then recommend a DS-1000, but media life at 90 ppm would be only approx. 2 months.

Purafil DS-1000: contains a total of 39 boxes (1.05 m3) of Purafil media comprising,

8 Boxes (183 kg) Purafil Odoroxidant media @ $250.00 per box
21 Boxes (431 kg) Purafil Odorcarb II media @ $250.00 per box
10 Boxes (183 kg) Purafil Odormix media @ $195.00 per box
Total price per estimate for 12 monthly usage 6 x above : $55,200.00 + GST

Please see attached mediapik reports which support the media usage rates. Also attached is mediapik reports for each wet well @ 40 ppm H2S contaminant loads. I have also included a more descriptive article on Purafil media, this was written by a engineer in France who had great success using Purafil media and systems. Also info on other typesw of systems, it may have some use to you?

Best regards,

James McIntosh
Airepure Australia
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Email. j.mcintosh@airepure.com.au

Parsons Brinckerhoff

Australia Trade Coast Sewer Project
Design Meeting No. 40

Minutes of Meeting
Wednesday 29 September 2004, 10:40 am
Project Management Meeting Room
BW Offices, Fortitude Valley

Attendance:	Ian Cameron	IC	PB
	Andrew Bannink	AB	Brisbane Water
	Henri Lai	HL	Brisbane Water
	James Whybrow	JW	Leighton Contractor
	Jason Paterson	JP	Leighton Contractors
	John Bower	JB	Brisbane Water
	Ben Crosby	BC	Brisbane Water
	Greg Wright	GW	Brisbane Water
	Mark Sexton	MS	Brisbane Water
	Michael Barton	MB	Brisbane Water
Apology:	Frank Mitchell	FM	Leighton Contractors
Distribution:	All attendees		
	David Rankin	DR	PB
	David Heape	DH	Brisbane Water
	David Manson	DM	Leighton Contractors
	Garth Powell	GP	Coffeys
	Ian Shipway	IS	Coffeys
	Darren Mc Donald	DMcD	Cardno MBK
	Paul Mountney	PM	PB

Item No.	Description	Action
1.0	**Odour and Septicity Works** IC provided copies of The Odour Unit Study	
1.1	MS noted that oxygen trials at SP1 had resulted in the oxygen being shut down in winter, with no adverse H2S results at Luggage Point.	
1.2	JB noted his concerns about odours at SP298 & SP300. Usual BW approach to commissioning pump stations was to see results and then retrofit.	
1.3	MB agreed with JB concerns and wanted the flexibility to redirect Kingsford Smith Drive, Hugh Street, and Mc Bride Street if odour problems occur at SP300. MB also noted some concerns with ferric chloride dosing upon P removal at Luggage Point WWTP.	IC/VB
1.4	HL noted need to treat air at SP298 & SP300. HL responded to IC AC units are installed at Oxley Creek WWTP (AARCON) and on S1 sewer tunnel.	
1.5	MB raised the issue of a vent pole for SP300 to aid dispersion. JW noted a possible location was up the easement towards Lomandra Drive. MB also noted need for flap valve on vent pole for emergency release.	

Item No.	Description	Action
1.6	MB expressed concerns with short circuiting for SP300 wet well. Need to provide inlet duct with down turned pipework, to limit short circuiting. Negative pressure in the wet well was preferred, with alarms on fan system.	IC/PM
1.7	**Action:-** 1. SP298, provide bunded slab, and air scrubber. 2. SP299, provide no civils for chemical dosing, just price air scrubber, and determine lead time for delivery. 3. SP300, provide no civils for chemical dosing, and provide air scrubber with vent system to aid dispersion.	IC/PM
1.8	For all air scrubbers provide, make, model, lead time, cost and life of unit.	IC/PM
2.0	**SP300 Access**	
2.1	MB stated current BW practice not to drive over concrete mains.	
2.2	JW indicated piling by McDonald's was to commence Monday 4/10, and access was required across the existing pipes.	
2.3	MB suggested using Randle Road access. JW replied that for concrete trucks this route would be impractical.	
2.4	MB stated his objection to any construction traffic over concrete mains.	
2.5	JB requested that an engineering solution be found for traffic loads for construction and for longer term access, as requested previously.	
2.6	IC stated that Darren McDonald from Cardno MBK, had completed some calculations for the DN1370 steel main but was still working on the concrete mains calculations for traffic loads. IC to chase, and submit information to JB.	IC 30/9
2.7	JB suggested using a box culvert over the mains.	
2.8	MB requested access to pipes under relieving slab and concrete pavements. JW offered to leave dowels out of conc. slab.	
3.0	**Benching for Wet Wells**	
3.1	JW stated that the benching details need to be agreed for the project. PE needs to be provided 150 mm below BWL to protect concrete work. Discussions ensued on the benching details, and the use of epoxy and PE.	
3.2	The following details were agreed: 1. SP298 ▪ Adjust BWL 200 mm higher to centre of incoming sewer, so benching is submerged. ▪ Drop benching level by approx. 100 mm, i.e. to bottom of incoming pipe. ▪ Use 45 degree slope on benching. ▪ Cut into benching to get bond with wet well wall. ▪ Provide weep drainage in benching. 2. SP300 ▪ Use new internal vertical walls to roof slab rather than thick benching with 45 degree top slope.	IC/VB

Item No.	Description	Action
	▪ Mechanically anchor PE lining. ▪ Show BWL on Dwg No. 045. ▪ Have vactor opening over sumps, and use angled pipework for access to sumps.	
4.0	**SP300 Settlement**	
4.1	JB was still waiting on a response from Chris Thorley on the Coffeys report.	
4.2	JW said that the site would be dewatered, and this would cause pre-settlement.	
4.3	JW noted settlement was not as large as expected.	
4.4	JW to review Chris Thorleys' comments and advise any future requirements.	JB
5.0	**SP300 Drawings**	
5.1	JB noted the following issues: 1. Loading on pipes, Cardno MBK report required 2. Removing valve under walkway, JW stated block and tackle. 3. Overhead bridge crane. JW advised cannot install because of conflict with power cables to pumps. 4. IC to clarify conduits and cabling for pumps. 5. Design report to be updated for flotation calcs for structural design, and state F.S. and max. water level for groundwater. JB stated RL 2.70. 6. Zero flow in DN1840 to be modelled for surge, and advise results. 7. Stipulate CH for scour valves on RM. 8. FC drawings comments to be provided by BW by Friday 8/10.	IC IC JB
6.0	**SP146**	
6.1	JP requested use of DICL for manifold instead of steel. This was agreed, as well as building to allow for future valve pit.	JP
7.0	**SP299 Rising Mains**	
7.1	JB indicated that SP299 rising main DN110 could run over DN1840, Leightons to confirm levels.	
7.2	JW indicated pipe laying for SP299 RMs in next few weeks.	
8.0	**SP299 Drawing Review**	
8.1	Review by BW after SP300 review completed.	JB
	Meeting Close 1.55pm	
	Next Meeting on a date to be advised at 9:30 am, at PB Offices, IBM Building, Brisbane City.	

Part 3 Appropriate Records:

7 Inspection and Test Plans

7.1 QA Records

7.2 Switchboard

7.3 Generators

7.4 Pumps

8 Pre-Commissioning Report

9 As Constructed Drawings

9.1 Civil

9.2 Switchboard

9.3 Generators

9.4 Pumps

10 List of Contract Variations and Plant Modifications