OPERATION & MAINTENANCE MANUAL

ST ACHS STREET SEWAGE PUMP STATION UPGRADE

Record Amendment Sheet

Date	Reason for Amendment	Section No.	Page No.	Approved By
10/3/10	Revision 01 - For Review	All	All	Allan Cupitt
30/4/10	Revision 02 - Final	All	All	Allan Cupitt

CONTENTS

G. JP RICHARDSON - ITP PLAN& QUALITY ASSURANCE

- F1017/3 – Switchboard & Sheet metal Inspection Report
- F1018/2 – Switchboard/ Sheet metal Inspection Checklist
- F1019/8 – Switchboard Electrical Inspection & Test Report
- F1019/10 – Switchboard Continuity & Insulation Test Report
- F1019/8 – Switchboard Electrical Inspection & Test Report – Earth Leakage Test
- F1019/8 - Switchboard Electrical Inspection & Test Report – VFD & Soft Starter Setup
- EMC0381/BL – JSA – Live Voltage Work – Testing Switchboard

H. FLYTH SUBMERSIBLE PUMPS
I. ELECTROMAGNETIC FLOWMETER
J. SWITCHBOARD – SURGE DIVERTOR
K. SWITCHBOARD – RTU SURGE REDUCTION FILTER
L. SWITCHBOARD – PHASE FAILURE RELAY
M. SWITCHBOARD –RTU POWER SUPPLY
N. SWITCHBOARD –RADIO

1 BACKGROUND & PURPOSE

The Feasibility Report, completed in July 2004 for St Achs Street Pump Station Augmentation, identified that this pumping station (SP087) did not have the capacity to handle the wet weather flows, nor did it have sufficient down stream infrastructure.

St Achs Street Sewage Pumping Station is located at the corner of Railway Street and St Achs Street, Nudgee. The pumping station was constructed in 1971 and the existing 7.5kW submersible pumps were installed in 1984. The 2001 population of the pumping station's catchment was 1579 Equivalent People (EP) with design flows of 21.9L/s. Currently the pumps operate for approximately 6 hours per day at 22.8L/s. With the ultimate population projection at 3778EP, the forecasted design flow is 52.5L/s.

The existing sewerage pump station will be changed to a lift station and a combination of DN400mm and 450mm (HDPE & VC respectively) diameter gravity main will be installed below minimum grade for 1.25km to the Queensland Rail property. This will eliminate dry weather overflows. The existing rising main from St Achs St will be plugged.

In 2000 the condition ratings on both the pumping station structure and pumping equipment were listed as excellent while the condition of the existing rising main from the pump station was listed as fair.

2 DESIGN REPORT

Tenix Alliance was engaged by the Brisbane City Council to both design and construction of the pump station upgrade.

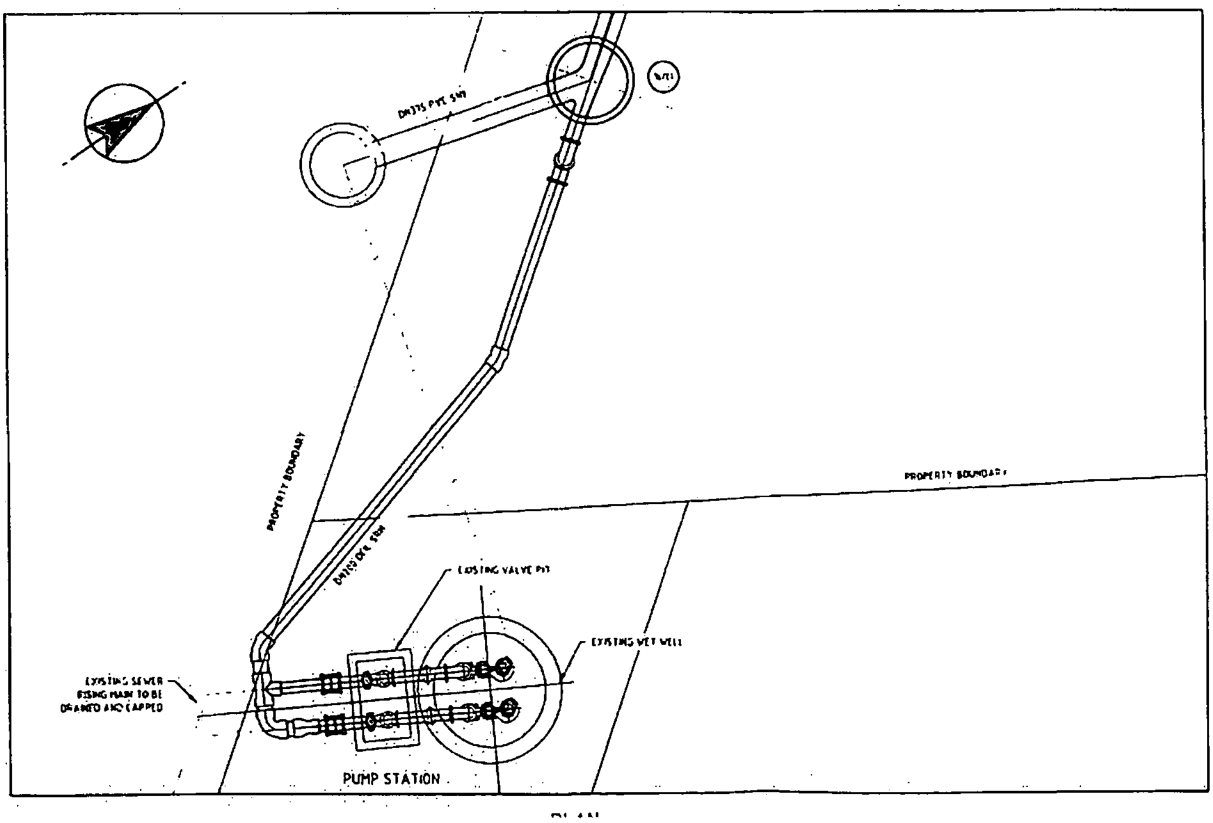
Tenix Alliance subsequently engaged MWH to undertake this design.

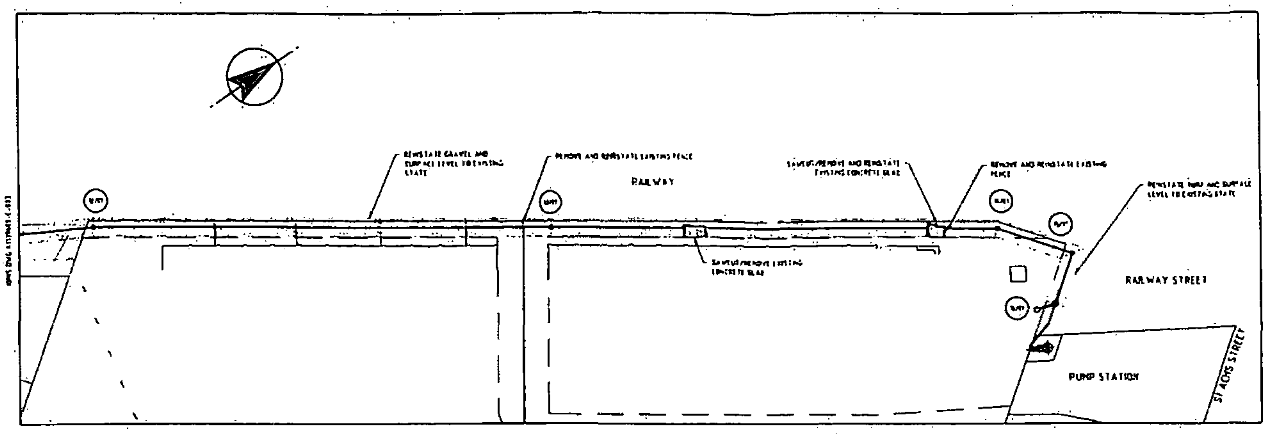
The design report, (Appendix A), was completed as part of the over all design and details all options and considerations considered during this phase.

3. PIPELINE ROUTE

The route of the new gravity main is as shown on the following maps but is best described as along the order as listed:-

- From the existing Pump Station, at the northern end of Saint Achs Street
- South –west along railway parade to as far as the Reserve grounds
- South across the Reserve grounds to the southern side of St Vincents Road.
- South –west along St Vincents Road to adjacent to the Railway carpark
- South-east beneath the carpark to an existing manhole within the Queensland Rail property

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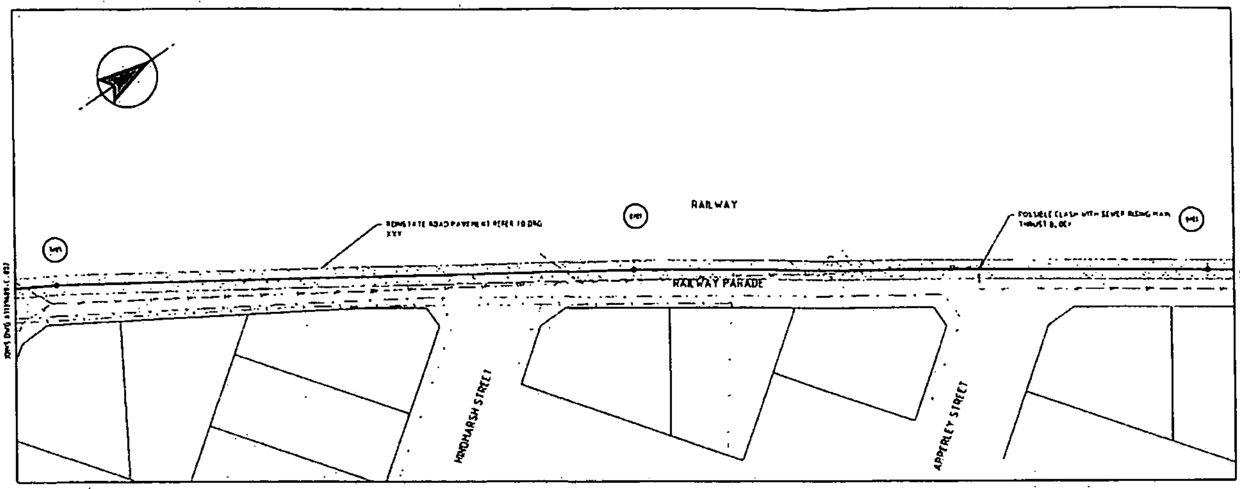
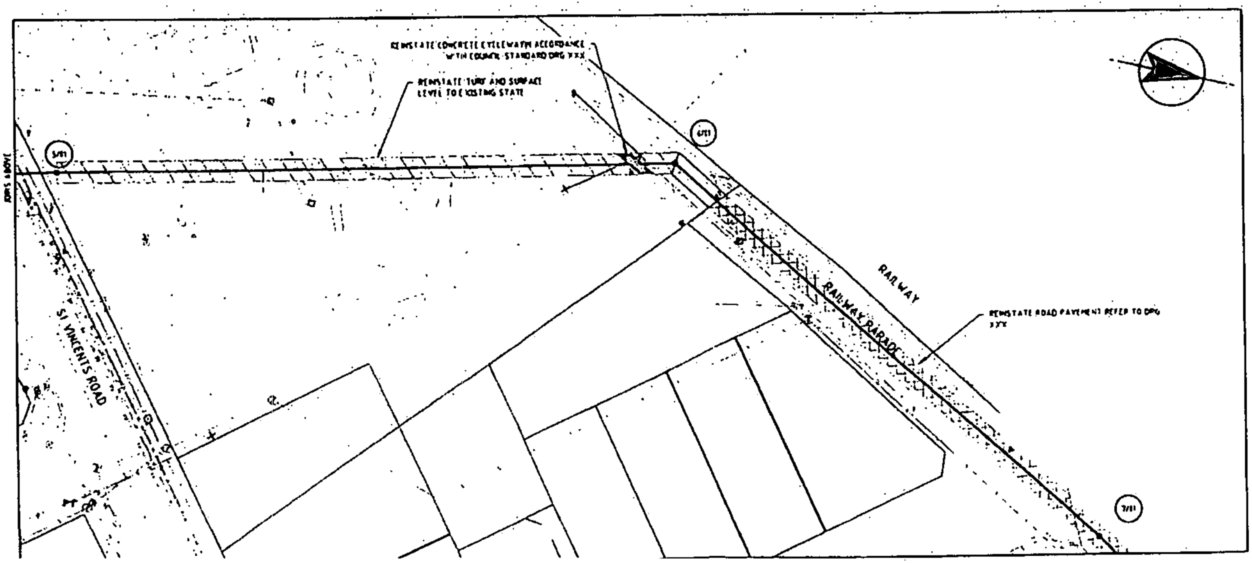
RAILWAY STREET
PUMP STATION
ST ACHS STREET


RAILWAY
RAILWAY PARADE
APPERLEY STREET

PLAN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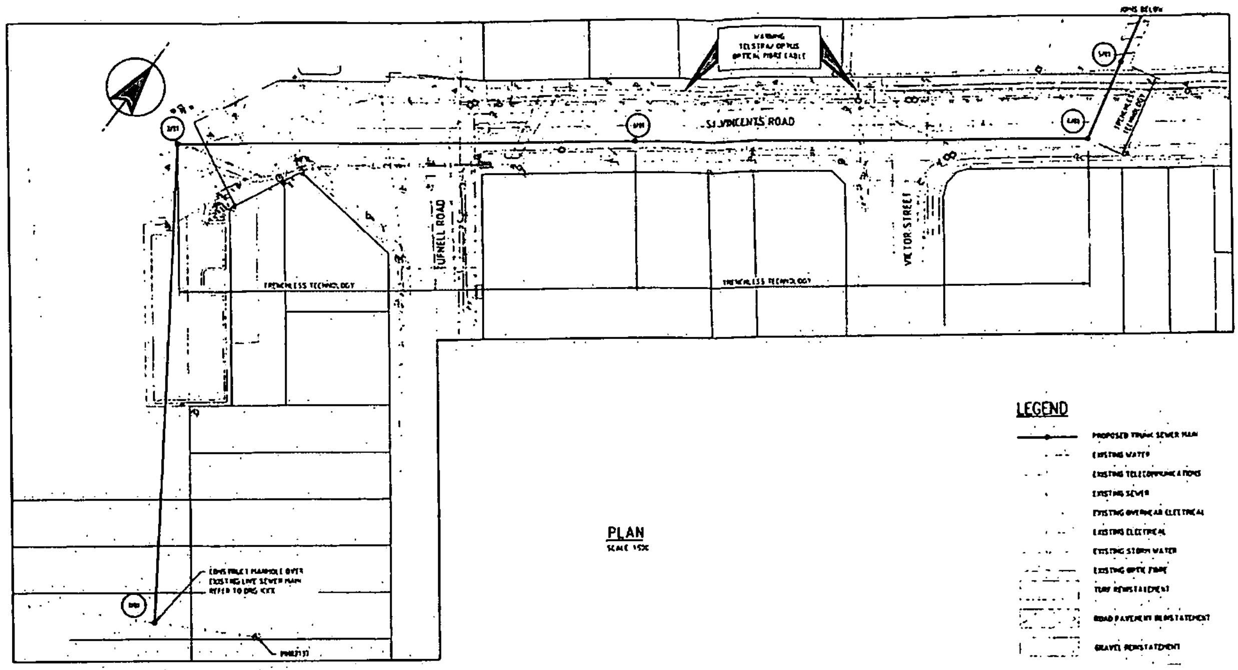
RAILWAY
RAILWAY PARADE


ST VINCENTS ROAD
TUFNELL ROAD
VICTOR STREET
TRENCHLESS TECHNOLOGY
PLAN
LEGEND

4. CONSTRUCTION

Physical works on this project commenced in April 2009, following the procurement of the pipe and fittings.

The pipe laying was effectively completed in August 2009 except for the pump station conversion works which were completed at the end of the year following acceptance of the interim operation and commissioning plans as well as the submission of CCTV footage of the newly installed gravity main.

The construction works was undertaken by 3 elected subcontractors:-

1. Rob Carr Pty Ltd

Rob Carr Pty Ltd installed DN400 VC Jacking pipe by micro-tunnelling methods between the Queensland Rail property and the Council Reserve on St Vincents Road, (316 meters).

2. Dormway Pty Ltd

Dormway Pty Ltd installed DN450 HDPE pipe by conventional open trenched means across the Council Reserve to the Council pump station located at the northern end of St Achs Street (941 meters).

Dormway were also responsible for undertaking the mechanical pump station conversion works.

3. JP Richardson Industries Pty Ltd

JP Richardson was responsible for supplying & installing the new switchboard, decommissioning the old switchboard and installing new mains cable supply.

5. ASBUILT DETAILS

Appendix B contains asbuilt drawings from each of the 3 previously mentioned subcontractors.

6. PROPRIETARY EQUIPMENT

The following items of proprietary equipment were provided as part of this pump station upgrade.

1. Two 3.1KW x 415volt x 3 phase x 50 hertz operating "Flygt" submersible pumps (model - NS3102.181 L.T).

   These small pumps were installed to provide the ability to lift the effluent from within the pump station wetwell to the level of the gravity main and replaced the much larger pumps whose function had been to pump the effluent along a long distance rising main.

2. One DN200 x Promag 50W2H electromagnetic flowmeter.

   This is housed within an in-ground chamber situated immediately down stream of the pump station valve chamber, (dry well). This unit communicates directly with the telemetry system within the electrical switchboard and can provide flow volume data.

3. One Electrical Switchboard

   A new modern switchboard was installed to replace the older existing switchboard.

   The switchboard in turn contained the following specialist equipment:-

   3.1 Surge Divertor
   3.2 RTU Surge Reduction Filter
   3.3 Phase Failure Relay
   3.4 RTU Power Supply
   3.5 Radio

   Supply and Technical details for the specialist proprietary equipment is enclosed within Appendix's G through to N of this manual.

7. PROPRIETARY EQUIPMENT SUPPLIER DETAILS

7.1 ITT FLYGT SUBMERSIBLE PUMPS

Daniel Gregory
daniel.gregory@itt.com
27 Devlan Street
Mansfield; Qld
Ph 07 3749 7477; Fax 07 3849 7633

7.2 PROMAG ELECTROMAGNETIC FLOW METER

Adrian Maxwell – Endress and Hauser
andrian.maxwell@au.endress.com
Unit 8, 277 Lane Cove Road
North Ryde; NSW 2113
Ph 07 3457 0200; Fax 07 3457 0299; Mob 0428 293 522

7.3 SURGE DIVERTER - Model TDS 108 4S 277 - Manufacturer -Critec

Energy Correction Options
www.ecoptions.com.au
PO Box 431
Kelvin Grove; Qld 4059
Ph 07 3356 0577; Fax 07 3356 1432

7.4 RTU SURGE REDUCTION FILTER- Model TDS 10A 240V- Manufacturer -Critec

Energy Correction Options
www.ecoptions.com.au
PO Box 431
Kelvin Grove; Qld 4059
Ph 07 3356 0577; Fax 07 3356 1432

7.5 PHASE FAILURE RELAY- Model 252 PS GW- Manufacturer -Crompton

Crompton Instrutments
PO Box 5108
Minto Business Centre
Minto; NSW 2566
Ph 02 9603 2066; Fax 02 9603 9335

7.6 RTU POWER SUPPLY- Model PB251- Manufacturer -PowerBox

Queensland Urban Utilities

7.7 RADIO- Model DR900 06A02 D0- Manufacturer -Trio

Queensland Urban Utilities

8. QUALITY ASSURANCE

ITP Plans & Quality Assurance Documentation of each of the three contractors is enclosed within Appendix's E, F & G of this manual.

APPENDIX A – DESIGN REPORT

MWH

BUILDING A BETTER WORLD

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ST ACHS PUMP STATION UPGRADE

DESIGN REPORT

A1139600

17/10/2008

MWH

REVISION SCHEDULE

REV. NO.	DATE	DESCRIPTION	PREPARED BY	REVIEWED BY	APPROVED BY
0		Preliminary	JVH		
1.0	16/10/08	For Review	JVH	JG	
2.0	17/11/08	Final	JVH	JG	

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STATUS: Draft | **PROJECT NUMBER:** A1139600 | October 2008
OUR REFERENCE: St Achs Pump Station Upgrade_Final

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MWH

CONTENTS

ST ACHS PUMP STATION UPGRADE

DESIGN REPORT

TABLES

APPENDICES

APPENDIX A: PUMP SELECTION AND CONTROL MEMO REV1

A1_ST ACHS PS PUMP SELECTION AND CONTROL MEMO 080912

A2_ST ACHS PUMP STATION SYSTEM PERFORMANCE CURVE- NORMAL OPERATION

A2B_ST ACHS PUMP SYSTEM-NORMAL-081021_REVISED DISCHARGE ARRANGEMENT

A3_ST ACHS PUMP STATION SYSTEM PERFORMANCE CURVE- OVERFLOW EVENT OPERATION

A4_ FLYGT NP 3102 PUMP CURVE (VSD)

A5_ST ACHS PUMP DATA SHEET_1

A6_PS AND RM

A7_VELOCITY REQUIRED TO MOVE POCKETS OF AIR

A8_DISCHARGE MANHOLE HYDRAULIC MODEL

APPENDIX B: GRAVITY MAIN

B1_FLOW CALCS1 Q=53LPERS

B2_FLOW CALCS2 Q=35LPERS

B3_FLOW CALCS3 Q=MAX

B4_PIPE MATERIAL SELECTION

APPENDIX C: ENVIRONMENTAL SCAN REPORT

C1_ST ACHS PUMP STATION UPGRADE_ENVIRONMENTAL SCAN REPORT

APPENDIX D: GEOTECHNICAL INVESTIGATION REPORTS

D1 ST ACH GEOTECHNICAL REPORT_MAY 2007

D2 ST ACH GEOTECHNICAL REPORT_AUGUST 2008

D3 ST ACH GEOTECHNICAL CORRESPONDENCE

1. BACKGROUND

This report summarises the findings and assumptions used in the detailed design of St Achs sewage pump station upgrade. The design is the culmination of several previous feasibility and option studies carried out for Brisbane Water.

The design presented in this report is identified as Option 7 in the "St Achs Street Pump Station Augmentation – Addendum to Feasibility Study Addendum 3" (May 2007) and was selected by BW as the preferred solution to be advanced to detail design.

Option 7 comprises the modification of the existing pump station into a lift station and the construction of a new gravity main. The existing main is to be drained a plugged.

1.1 EXISTING SITUATION

St Achs Street Sewage Pumping Station is located at the corner of Railway Street and St Achs Street Nudgee. The pumping station was constructed in 1971. The existing 7.5kW submersible pumps were installed in 1984.

The 2001 population of the pumping station's catchment was 1579 Equivalent People (EP) with design flows of 21.9L/s. Currently the pumps operate for approximately 6 hours per day at 22.8L/s. The ultimate population projection is 3778EP. The ultimate forecasted design flow is 52.5L/s.

In 2000 the condition ratings on both the pumping station structure and pumping equipment were listed as excellent. The condition of the existing rising main from the pump station was listed as fair.

1.2 PROJECT DRIVERS

The project's drivers are to:

- Meet the projected future flows. SP087 will be 30% under capacity by 2006 and 100% under capacity by 2026 if the present configuration of pumps and rising main remain.
- Limit any potential future overflows. The present wet well configuration will result in more dry weather overflows as the pumps' capacity is exceeded by increasing PDWF's over time.
- Reduce Maintenance costs.
- Satisfy Corporate Plan 2006-2010 Outcome 11.3 "Infrastructure Provision" through Service Development 11.3.1.2.DO3 "City Development" the objective of which is to ensure that water and sewerage system is enhanced to ensure that it operates effectively, and that the system is progressively expanded to meet the projected increases in demand throughout Brisbane".

2. DESIGN CRITERIA

2.1 PUMP STATION CAPACITY

The capacity of the upgraded lift station will be 53L/s which represents the peak wet weather flow (PWWF) for the catchment. The capacity of both the duty and the standby pumpsets has been sized to convey 53L/s.

In the event of a power or pump failure catchment flows will backup and bypass the pump station to a new gravity main that will be constructed as part of this upgrade project.

The new overflow arrangement removes the possibility of overflows to the environment that are the result of a pump station failure and therefore it is not necessary to provide an emergency storage facility or to provide a for an onsite emergency standby generator.

2.2 DESIGN LEVELS

The table below summarises the key levels that govern the design of the pump station and gravity main. The levels and dimensions have been obtained from a site survey, as built drawings and from measurements taken from the existing pump station.

Table 2-1: Critical Design Levels

Description	Value	Basis / Source
Top of pump station wet well	5.32mRL	Survey data
IL wet well	1.57mRL	Site Measure (Tenix)
IL sewer discharge into wetwell	2.9mRL	Site Measure (Tenix)
IL rising main pipework from PS	4.27mRL	Site Measure (Tenix)
Duty pump on (TWL)	3.10mRL	
Pump off (BWL)	1.87mRL	
Standby pump on	3.40mRL	
Alarm Level	3.70mRL	
IL of discharge manhole outlet	3.75mRL	
IL of new overflow (from MH81356)	4.02mRL	Design Brief
IL at connection to existing reticulation	1.91 mRL	Survey data

The overflow level from MH81356 was predetermined at 4.02mRL and has been adopted for the design.

3. PUMP STATION

3.1 LAYOUT

3.1.1 WETWELL

The existing pump station wet well and valve chamber will be retained. The existing pump sets will be replaced with new pumps each with a design flow of 53 L/s. The pump sets will be chain suspended in accordance with BCC standard drawings and as shown in the project drawings.

The existing pipework and valves inside the wetwell will be retained as the latest asset condition assessment indicate they are still in good condition. During the pump station upgrade works the quality of the existing pipework and valves will re-assessed to determine whether this opportunity should be used to replace any fittings.

3.1.2 NEW RISING MAIN

A cut-in to the existing rising main will be made on the downstream side of the valve chamber and a new 10m long section of rising main will be constructed between the chamber and a new discharge manhole (MH17 in the project drawings).

3.1.3 FLOWMETER

BW have requested a flow meter is included in the rising main. The flow meter will be installed inside a pre-cast concrete valve chamber.

3.1.4 AIR RELIEF VALVE

An air relief valve will be located on the high point of the rising main. The air valve will be a manually operated ball valve located inside a maintenance hole, with a return line back to the pump station.

As the high point on the section of rising main is at a higher elevation than the discharge level, the air valve should only be cracked to expel any air when the pumps are running.

A calculation to determine whether air in the rising main can be expelled with by becoming entrained in the motive fluid has been undertaken and is included in Appendix A. This indicates that based on the design velocity and design grade of the rising main, air pockets should generally be transported down the incline of the downward sloping section of the rising main. However, as minimum the velocity required is close to the theoretically required to move air down the rising main it is considered prudent to include the air valve.

3.1.5 DISCHARGE MANHOLE

The rising main from SP087 will discharge to a new discharge manhole MH17. The discharge manhole will be of the underflow bellmouth type which is consistent with the BW standard drawings. From the new discharge manhole flow enters the new gravity main at MH16.

A hydraulic profile of the design flow through BW standard discharge manhole has been modelled and is provided in Appendix A.

3.1.6 EXISTING RISING MAIN

Once the cut-in and new rising main has been installed, the existing rising main will be drained, capped and decommissioned.

The inlet and outlet to the existing discharge maintenance hole will be plugged, and drain holes will be cored in the floor of the chamber before the chamber is backfilled and abandoned.

3.1.7 SWITCHBOARD

The existing switchboard will be removed and a new S/B will be installed, on a new plinth located adjacent to the wet well. This will be confirmed when details of the switchboard are finalised.

3.2 PUMP SELECTION

A Flygt pump was found to suit the low-head duty near BEP. The following pump selection is recommended and is based on the revised discharge configuration:

• Make & Model:	Flygt NP 3102-53-423-00-6501 (158mm impellor) chain suspended centrifugal pump
• Duty head:	2.8 m (average – operating head) Also required: 2.3 m (head at wet-well overflow level)
• Duty flow:	44 L/s (average – operating flow) Also required: 53 L/s (PWWF at wet-well overflow level)

- Duty speed: 1445 rpm, at 50 Hz (with VSD drive for flexibility)
- Motor: 3-phase, 4-pole, 3.1 kW

Further information relating to the selection of the pump is provided in Appendix A *Pump Selection and Pump Control Memo Rev. 1.*

3.3 PUMP OPERATION

3.3.1 PUMP STATION CONTROL

The existing pump station wet-well is relatively small and hence the available wet-well operating volume between pump-on and pump-off is limited.

- Wet-well TWL (pump on): 3.10 m
- Wet-well BWL (pump off): 1.87 m
- Wet-well floor slab: 1.57 m
- Wet-well diameter: 1.828 m
- Pump wet-well control volume: 3.23 kL
- Incoming flow: 22 L/s (worst case for high number of pump starts)
- Pumped flow out (single pump): 44 L/s (average flow between TWL and BWL – flow ranges between 38 L/s and 46 L/s)
- Number of pump starts: 11.6 starts per hour
- Pumped flow out (single pump): 53 L/s (maximum flow with wet-well at overflow level)

The pump station control system will be configured to allow only one pump to run at any time. Conventional practice is for the standby pump to switch on (duty + assist) when the wet-well level rises above TWL, however, running both the duty and standby pumps together would result in large flows that are in excess of the capacity of the proposed gravity sewer.

3.3.2 PUMP STARTS

The following table below provides an indication of the range of pump start frequencies that could be expected for the pump station. Based on an average pump flow of 42 L/s, the maximum number of pump starts per hour is approximately 11.6. This is within allowable start frequency given in the Department of Natural Resources and Water's design guideline of less than 12 starts per hour for pump motors less than 50 kW.

In order to reduce the pump starting frequency, it is recommended that two pump sets be installed, with auto duty-standby rotation. This will halve the pump start frequency.

Flygt NP 3102			
Inflow (L/s)	Average Pump flow (L/s)	Wetwell Operating volume (kL)	No pump starts per hour
5	42	3.23	4.9
10	42	3.23	8.5
15	42	3.23	10.7
25	42	3.23	11.2
35	42	3.23	6.3

Current ADWF = 6 L/s, Current PDWF = 13.8 L/s, Current PWWF 30 L/s
Ultimate ADWF = 10.6 L/s, Ultimate C1 Flow = 37 L/s, Ultimate PWWF = 53 L/s

3.4 POWER SUPPLY AND EMERGENCY GENERATOR

The existing power supply available at the pump station provides adequate capacity and will be utilised.

An existing emergency standby generator that currently services the existing pump station will be decommissioned and removed from the pump station site.

3.5 ODOUR CONTROL MEASURES

No site specific odour control measures are provided for in this design. However, sewage residence times will be reduced as the long rising main will be decommissioned. Also the existing discharge manhole located in close proximity residential properties will also be decommissioned.

4. GRAVITY MAIN

4.1 PROPOSED ALIGNMENT

The project drawings show the proposed route alignment for the subject gravity main. At the upstream end, the main will start at manhole MH16 located adjacent to MH81379 (the existing grit manhole for PS087). MH16 will receive pumped flows from SP087 and in the event of pump failure the manhole will receive overflow from MH81379.

The main will run west toward the railway line offset approximately 2.5m from the existing fence line. At the railway boundary the main turns south and run along the eastern side of the existing industrial property boundary on an alignment approx 2.0m from the existing fence. A 4m wide easement has been obtained for this section of main located within private property.

The main continues south along Railway Parade where the main will be located in the road carriageway offset approximately 1.5m from the western edge of the road bitumen. At the end of Railway Parade the main will cross a park. The park contains large trees, furniture and landscaping features. An alignment of least impact has been adopted with the highest priority given to mature vegetation.

The main will turn south in to St Vincent Road and follow an alignment approximately 1.5m from the edge of kerb on the eastern side of the road. The main will cross two side streets (Victor St and Tuffnel Road) before entering Queensland Rail property. The main then turns east connecting into the existing reticulation by way of a new manhole to be located downstream of MH82136.

4.2 EXISTING SERVICES

The presence of existing services has been identified and these are shown in the project drawings. Potholing to confirm the depth and location of the services has not been undertaken as part of the detail design phase. The Contractor will need to make this a first priority prior to commencing construction to ensure that there are no conflicts between the proposed main and any existing services.

4.3 MATERIALS

4.3.1 OPEN TRENCH CONSTRUCTION

The gravity main is a DN450 polyethylene pipeline with an SDR of 13.6 with electro-fusion joints. The pipe has an internal diameter of 382mm.

Material selection was based on BCC preference for using polyethylene pipe and on the insitu ground conditions derived from the project geotechnical investigation.

The material selection is based on a 'worst-case' soil condition and maximum depth of cover scenario. A copy of the calculation is provided in Appendix B.

4.3.2 TRENCHLESS CONSTRUCTION

The section of main to be constructed in St Vincents Road is proposed to be constructed by pipe jacking method. The preliminary pipe material selected is DN400 Keramo Vitrified Clay Jacking pipe. The pipe has an internal diameter of 400mm.

Detail design relating to the installation of the jacking pipe will be the responsibility of the specialist sub-contractor engaged to carry out the works. The sub-contractor will also be required to provide confirmation of the suitability of the pipe material nominated above.

Special emphasis should be made at the time of letting the trenchless construction contract that it is the responsibility of the pipejacking contractor to undertake the necessary detailed design for this portion of the work. The contractor will be responsible for ensuring the suitability of the selected pipe material, sizing of the equipment that will undertake the pipejacking etc.

4.4 PROPOSED GRADES

The main will be constructed on a grade of 1:725. This is governed by level of the existing main where we connecting into the existing sewer (1.956mRL) and the proposed overflow level at the pump station (4.02mRL). The design grades have been developed in consultation will BW.

This design grade is below the minimum grade recommended for a pipeline with this diameter. However, as the new main will only receive intermittent pumped flows, the velocities for the design flowrate should to minimise the potential for solids deposition in the main.

4.4.1 DESIGN FLOWS

The main has a maximum flow capacity approximately 72L/s.

Under normal operating conditions the pump station will discharge into the gravity main at 53L/s. Based on the design grade and a Colebrook-White friction factor of Ks=1.5 the design velocity and depth of flow in the main will be as follows:

Table 4-1: Summary of Flow Velocities and Flow Depths

				Flow at 53L/s		Flow at 35L/s	
Diameter	Internal Dia	Grade	Max pipe capacity	Depth of flow	Velocity	Depth of flow	Velocity
DN450 PE100 PN12.5 (SDR13.6)	382mm	1 in 725	72L/s	255mm	0.66m/s	195mm	0.60m/s

Analysis based on Colebrook-White factor of Ks=1.5mm

As the existing wetwell provides for only a relatively small operating volume (3.5kL) the new gravity sewer will only receive intermittent flows from the pump station. For example, assuming zero inflow to the station the pump would run for approximately 78 seconds to drawdown the operating volume of the well (i.e. based on an average pump rate of 45L/s between TWL and BWL). Hence, when the pump operates for this duration it would discharge a 'slug' of flow that would be around 120m in length. (Due to the small wet well size it will not be possible to fill the entire length of the gravity main).

Flow calculations for three flow scenarios (Q=53L/s, Q=35L/s & Qmax) is included in Appendix B.

4.5 MANHOLES

Due the limited fall available between the upstream and downstream end of the main, the drop through the manholes has been reduced below those in the design standards. The BW design manual advises that where possible a minimum 40mm fall through a manhole should be provided.

The table below sets out the minimum manhole drops that have been adopted for the design.

Table 4-2: Summary of Manholes Drops

Drop through 'straight through' MH	Drop through MHs 0 to 45 degree deflection	Drop through MHs 45 to 90 degree deflection
0mm	10mm	20mm

4.6 OVERFLOW

A new overflow will be constructed between the existing grit manhole MH31379 and proposed manhole MH16. The overflow level in the existing grit chamber is 4.02mRL as specified in the design brief.

The overflow configuration is shown in the design drawings and is designed to be consistent with the requirements identified in the BW standard drawings.

4.7 GEOTECHNICAL INFORMATION

Two geotechnical reports have been completed for this project and are included in Appendix D. One for the northern end of the project, completed in May 2007 and one for the southern end of the project, completed in August 2008. Both investigation were undertaken by City Design.

5. CONSULTATION AND APPROVALS

5.1.1 ENVIRONMENTAL ISSUES

MWH has carried out a high level environmental scan to identify the environmental issues and approvals relating to the project. A copy of the Environmental scan report is included in Appendix C.

5.1.2 PARKS DEPARTMENT

Tenix has undertaken consultation with BCC Parks division.

5.1.3 QUEENSLAND RAIL

Tenix has undertaken consultation with QR to address alignment issues and land contamination issues.

5.1.4 ROADS DEPARTMENT

Tenix has undertaken the relevant consultation with the ALSS to address any alignment issues.

6. CONSTRUCTION ISSUES

[ ]

7. COST ESTIMATES

[ ]

8. REFERENCES

1. "St Achs Street Pump Station Augmentation", Brisbane Water, 2003 (Completed July 2004).
2. "St Achs Street Pump Station Augmentation Addendum", Brisbane Water, July 2004.
3. "St Achs Street Pump Station Augmentation Addendum 2", Brisbane Water, June 2005.

APPENDIX B – ASBUILT DRAWINGS

B1 - Rob Carr Pty Ltd

B2 - Dormway Pty Ltd

B3 - JP Richardson Industries Pty Ltd

BRISBANE WATER

SP087 SAINT ACHS STREET SEWAGE PUMPING STATION

SITE COVER SHEET

ELECTRICAL DRAWINGS INDEX

DWG N°.	TITLE	SHEET	REVISIONS				
486/5/7-0101-000	SITE COVER SHEET	00	P1	0	A		
486/5/7-0101-001	POWER DISTRIBUTION SCHEMATIC DIAGRAM	01	P1	0	A		
486/5/7-0101-002	PUMP 01 SCHEMATIC DIAGRAM	02	P1	0	A		
486/5/7-0101-003	PUMP 02 SCHEMATIC DIAGRAM	03	P1	0	A		
486/5/7-0101-004	[illegible]	04					
486/5/7-0101-005	[illegible]	05					
486/5/7-0101-006	COMMON CONTROLS SCHEMATIC DIAGRAM	06	P1	0	A		
486/5/7-0101-007	COMMON RTU I/O SCHEMATIC DIAGRAM	07	P1	0	A		
486/5/7-0101-008	RTU POWER DISTRIBUTION SCHEMATIC DIAGRAM	08	P1	0	A		
486/5/7-0101-009	RTU DIGITAL INPUTS TERMINATION DIAGRAM	09	P1	0	A		
486/5/7-0101-010	RTU DIGITAL INPUTS TERMINATION DIAGRAM	10	P1	0	A		
486/5/7-0101-011	RTU DIGITAL OUTPUTS TERMINATION DIAGRAM	11	P1	0	A		
486/5/7-0101-012	RTU ANALOGS & MISCELLANEOUS TERMINATION DIAGRAM	12	P1	0	A		
486/5/7-0101-013	[illegible]	13					
486/5/7-0101-014	EQUIPMENT LIST	14	P1	0	A		
486/5/7-0101-015	CABLE SCHEDULE	15	P1	0	A		
486/5/7-0101-016	SWITCHBOARD LABEL SCHEDULE	16	P1	0	A		
486/5/7-0101-017	SWITCHBOARD CONSTRUCTION DETAILS	17	P1	0	A		
486/5/7-0101-018	SWITCHBOARD CONSTRUCTION DETAILS	18	P1	0	A		
486/5/7-0101-019	LEVEL PROBES INSTALLATION DETAILS	19	P1	0	A		
486/5/7-0101-020	[illegible]	20					
486/5/7-0101-021	[illegible]	21					
486/5/7-0101-022	SWITCHBOARD GENERAL ARRANGEMENT ELEVATIONS - DOUBLE SIDED	22	P1	0	A		
486/5/7-0101-023	SWITCHBOARD GENERAL ARRANGEMENT SECTIONS - DOUBLE SIDED	23	P1	0	A		
486/5/7-0101-024	SLAB & CONDUIT DETAILS - SHEET 1 OF 2	24	P1	0	A		
486/5/7-0101-025	SLAB & CONDUIT DETAILS - SHEET 2 OF 2	25	P1	0	A		

STANDARD VARIABLES

DESCRIPTION	VALUES
[illegible]	[illegible]
NORMAL SUPPLY MAIN SWITCH	125A S250PE/125
GENERATOR SUPPLY MAIN SWITCH	125A S250PE/125
PUMP1 CIRCUIT BREAKER	20A S125GJ/20
PUMP2 CIRCUIT BREAKER	20A S125GJ/20
[illegible]	[illegible]
PUMP SOFT STARTER SIZE	MSF-017 +
PUMP RATING	3.1kW 6.7A
PUMP LINE CONTACTOR	CA7-9
PUMP BYPASS CONTACTOR	CA7-9
[illegible]	[illegible]
[illegible]	[illegible]
PUMP SOCKET OUTLET + INCLINE SLEEVE	DS1 3114013972 + 51BA058
PUMP INLET PLUG + HANDLE	DS1 3118013972 + 311A013
WET WELL LEVEL TRANSMITTER	FMI67-A2BMC1A3 4m
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
FLOWMETER RANGE	100l/s
RADIO	DR900-07A02-D0
EMERGENCY PUMPING TIME	TBAsec
No of SINGLE POINT PROBES	3
INCOMING MAINS SUPPLY CABLE	$16mm^2$
MAIN EARTHING CABLE	$6mm^2$
[illegible]	[illegible]
PUMP MOTOR SUPPLY CABLE	$TBAmm^2$

STANDARD DESIGN OPTIONS

OPTION	DESCRIPTION	FITTED
A	[illegible]	**YES** NO
B	[illegible]	**YES** NO
C	[illegible]	**YES** NO
D	[illegible]	**YES** NO
E	[illegible]	**YES** NO
F	[illegible]	**YES** NO
G	[illegible]	**YES** NO
H	STATION DELIVERY FLOWMETER - 24vDC ENDRESS & HAUSER	YES **NO**
I	BACKUP COMMUNICATION - GSM	YES **NO**
J	PUMP CONNECTION (Via De-contactors)	YES **NO**
K	[illegible]	**YES** NO
L	MOTOR THERMISTORS (Via De-contactors)	YES **NO**
M	[illegible]	**YES** NO
N	[illegible]	**YES** NO
O	PUMPS ELECTRICAL INTERLOCK (Mains & Generator)	YES **NO**
P	[illegible]	**YES** NO
Q	FLOWMETER PIT SUMP PUMP AND LEVEL PROBE	YES **NO**
R	TELEMETRY RADIO	YES **NO**
S	[illegible]	**YES** NO
T	DOUBLE SIDED SWITCHBOARD	YES **NO**
U	[illegible]	**YES** NO
V	[illegible]	**YES** NO

TENIX
TEST
"ISSUED FOR CONSTRUCTION" S97
SIGN [signature] M34100 7/5/09

"AS CONSTRUCTED"

Sheet 00

FOR CONSTRUCTION

No	DATE	AMENDMENT	DRN.	APD.
A	04.09	FOR CONSTRUCTION	P.H.	A.W.
0	01.09	FOR TENDER	P.H.	A.W.
P1	12.08	ISSUED FOR REVIEW	P.H.	A.W.

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Reference Drawings

DRAFTED: P.HAGUE
DRAFTING CHECK: A.WITTHOFT
CAD FILE: 87-0101set_A
B.C.C. FILE No.

Original Signed by A.WITTHOFT 8895 14.1.09 — DESIGN — R.P.E.Q No. DATE
Original signed by R.JANFADA 5192 14.1.09 — DESIGN CHECK — R.P.E.Q No. DATE
Original Signed by K.VAHEESAN 15.1.09 — PRINCIPAL DESIGN MANAGER — DATE
Original Signed by P.SHERRIFF 15.1.09 — CLIENT DELEGATE — DATE

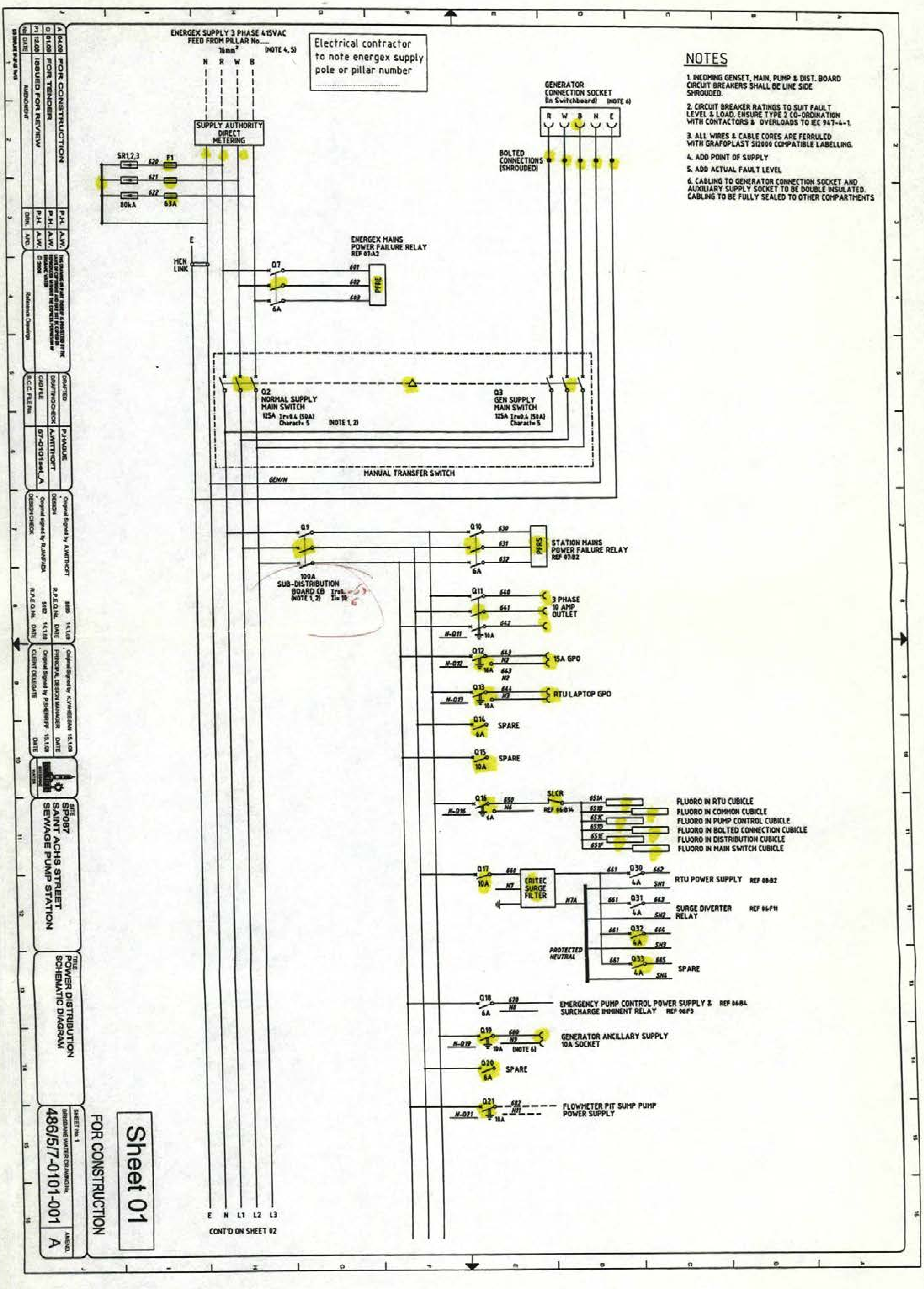
BRISBANE WATER

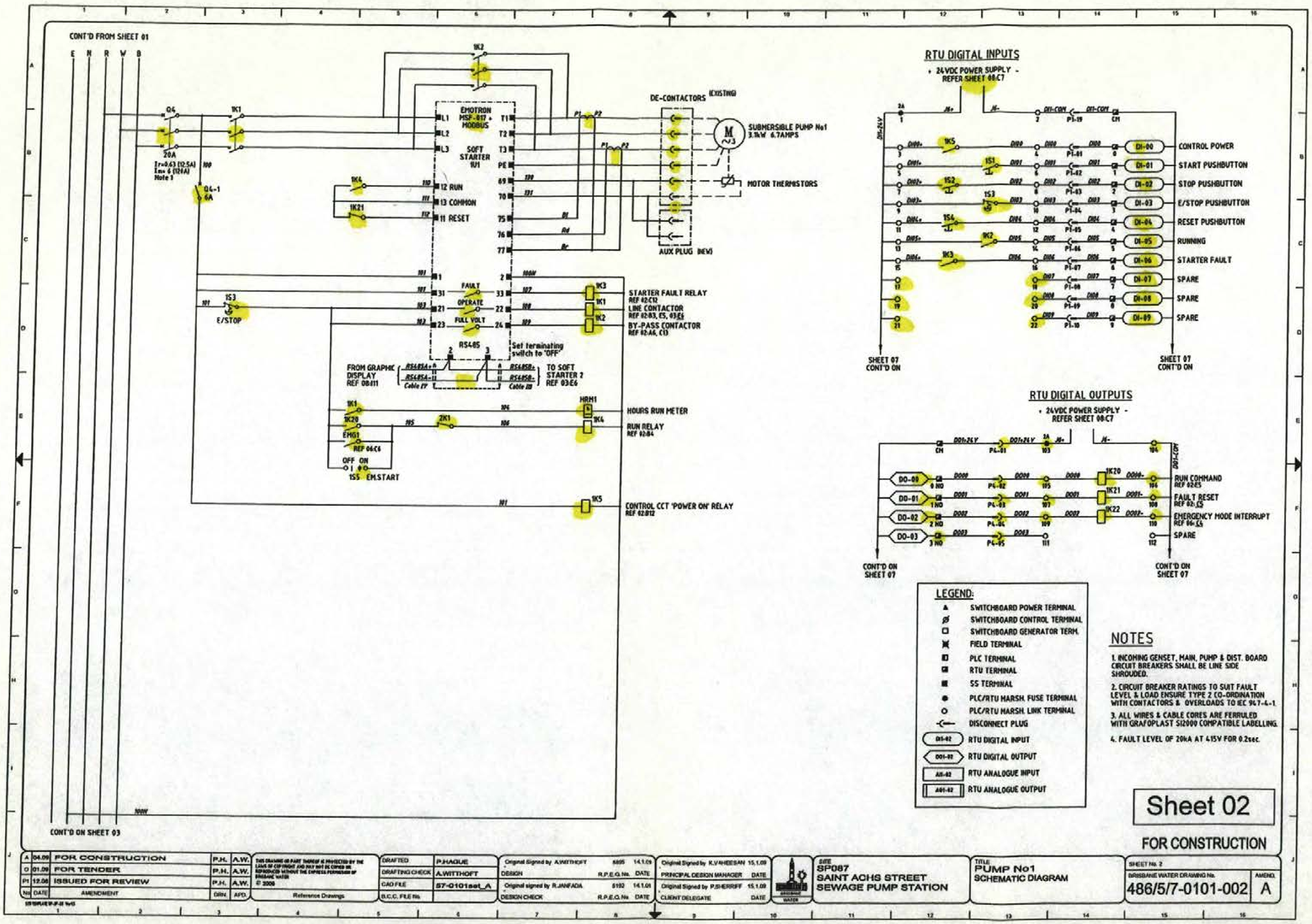
SITE: SP087 SAINT ACHS STREET SEWAGE PUMP STATION

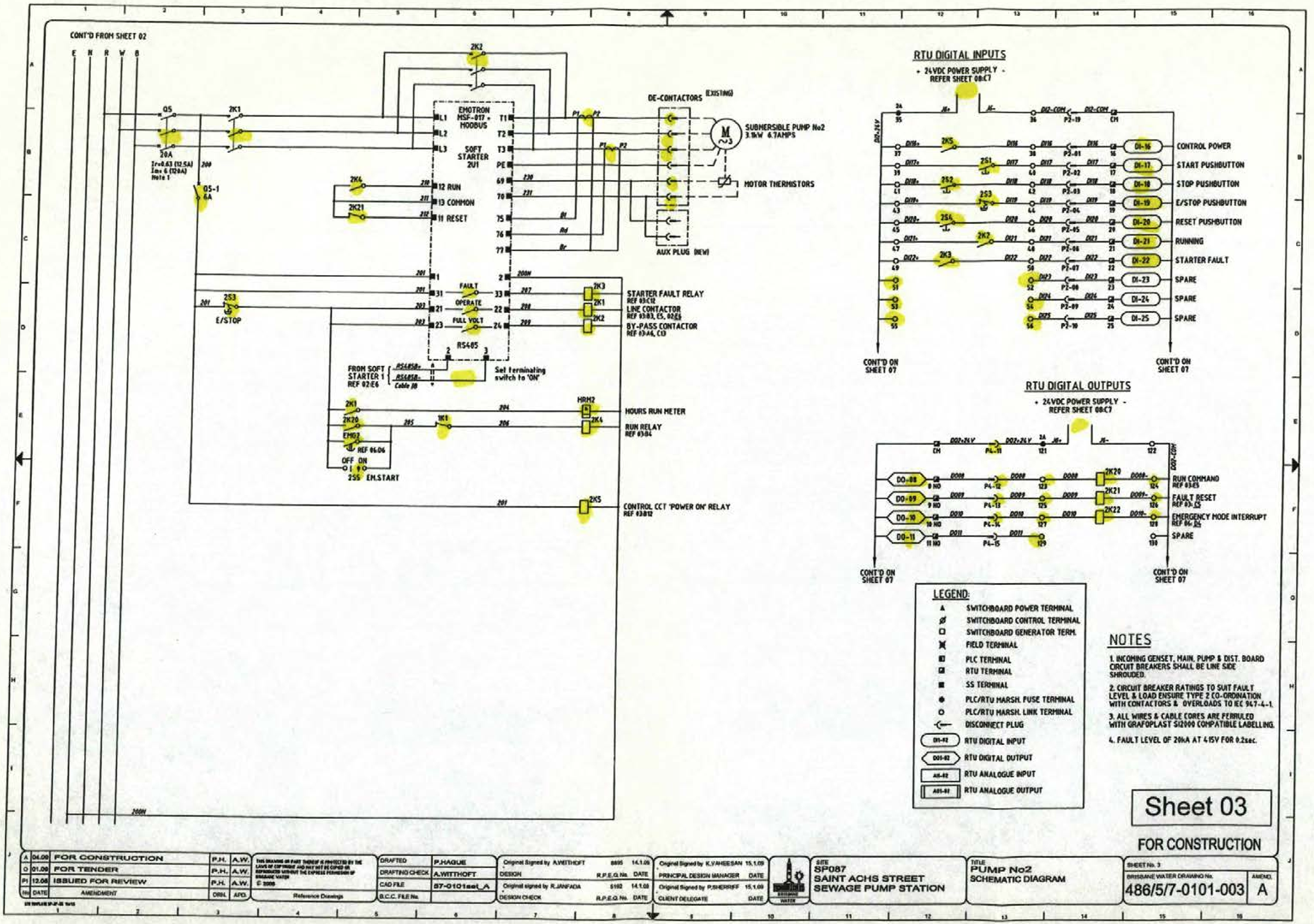
TITLE: SITE COVER SHEET

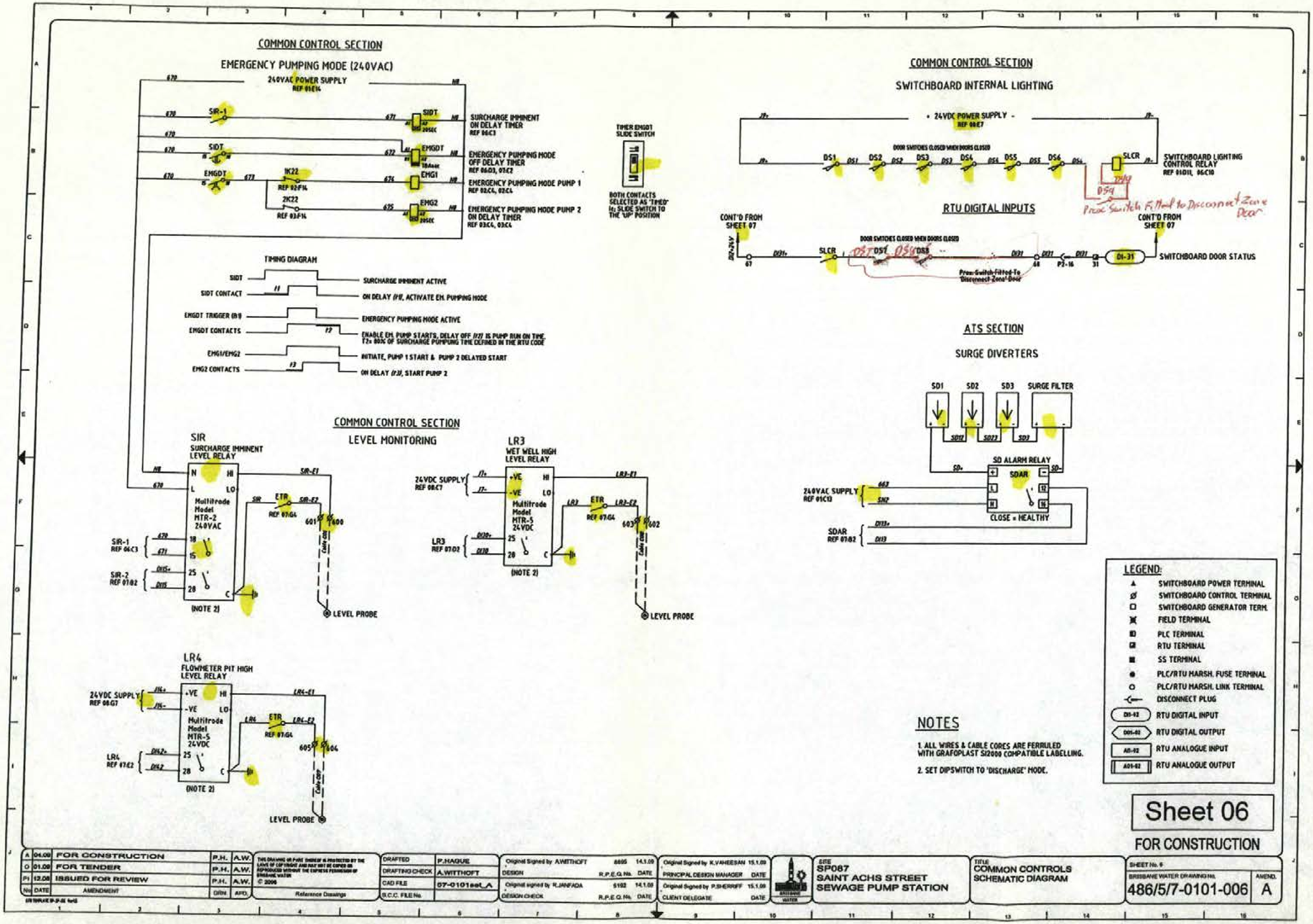
SHEET No. 0
BRISBANE WATER DRAWING No. 486/5/7-0101-000
AMEND. A

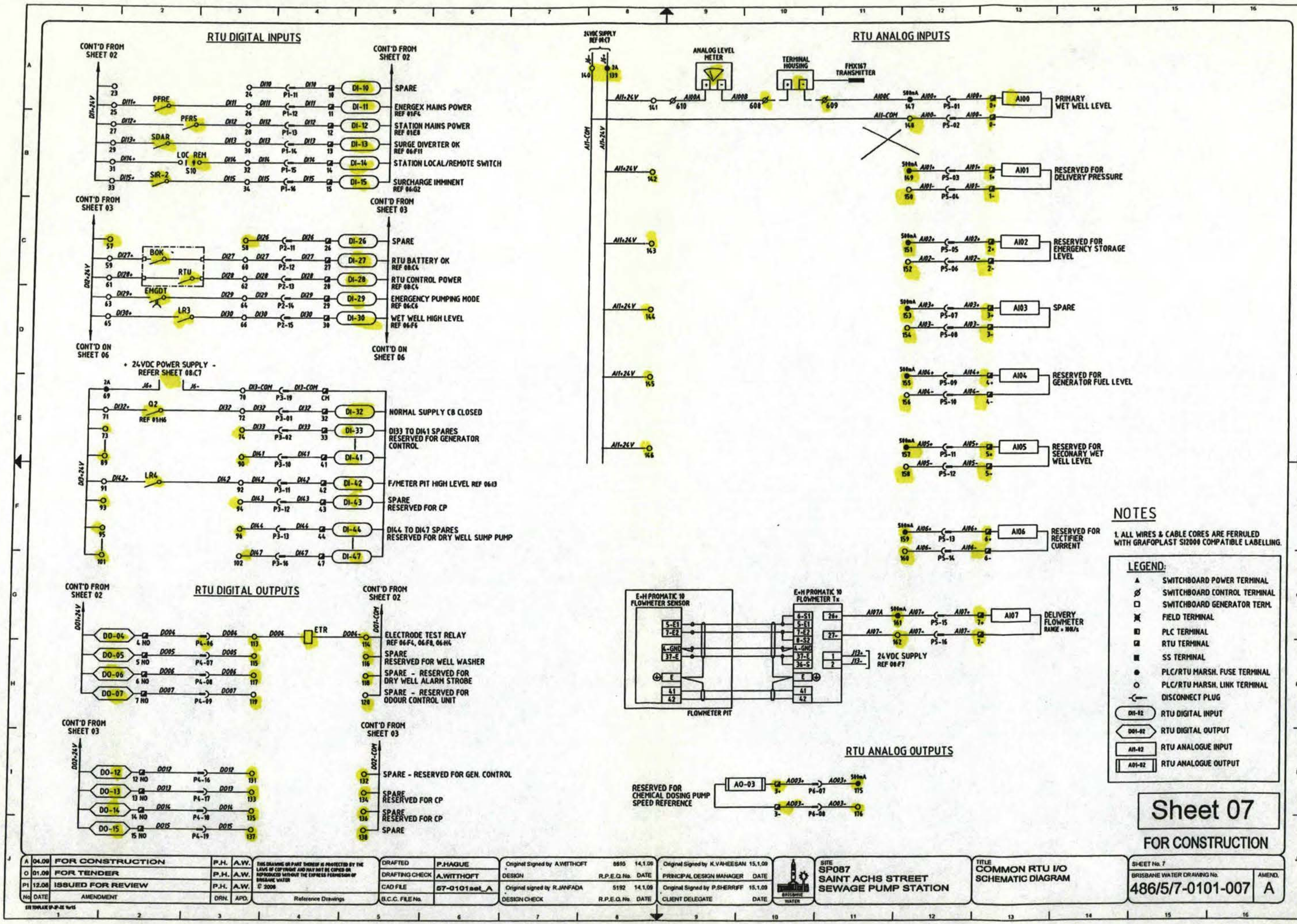
M34100

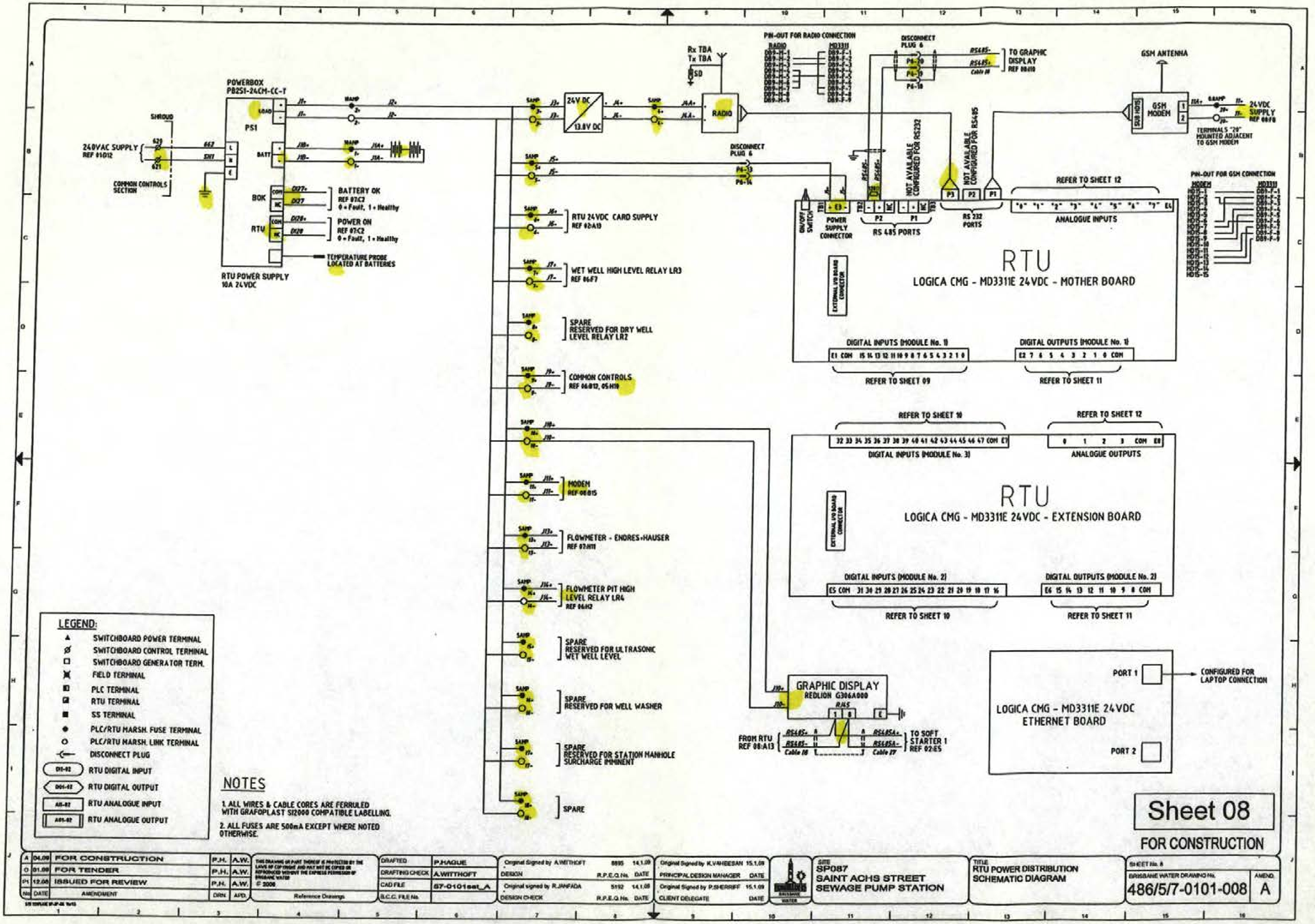

ENERGEX SUPPLY 3 PHASE 415VAC
FEED FROM PILLAR No.....
16mm² (NOTE 4, 5)
Electrical contractor to note energex supply pole or pillar number
SUPPLY AUTHORITY DIRECT METERING
GENERATOR CONNECTION SOCKET (In Switchboard) (NOTE 6)
BOLTED CONNECTIONS (SHROUDED)
NOTES
1. INCOMING GENSET, MAIN, PUMP & DIST. BOARD CIRCUIT BREAKERS SHALL BE LINE SIDE SHROUDED.
2. CIRCUIT BREAKER RATINGS TO SUIT FAULT LEVEL & LOAD. ENSURE TYPE 2 CO-ORDINATION WITH CONTACTORS & OVERLOADS TO IEC 947-4-1.
3. ALL WIRES & CABLE CORES ARE FERRULED WITH GRAFOPLAST SI2000 COMPATIBLE LABELLING.
4. ADD POINT OF SUPPLY
5. ADD ACTUAL FAULT LEVEL
6. CABLING TO GENERATOR CONNECTION SOCKET AND AUXILIARY SUPPLY SOCKET TO BE DOUBLE INSULATED. CABLING TO BE FULLY SEALED TO OTHER COMPARTMENTS
SR1,2,3
F1
80kA
63A
MEN LINK
ENERGEX MAINS POWER FAILURE RELAY REF 07/A2
PFRE
Q2 NORMAL SUPPLY MAIN SWITCH 125A (NOTE 1, 2)
Q3 GEN SUPPLY MAIN SWITCH 125A
MANUAL TRANSFER SWITCH
STATION MAINS POWER FAILURE RELAY REF 07/B2
100A SUB-DISTRIBUTION BOARD CB (NOTE 1, 2)
3 PHASE 10 AMP OUTLET
15A GPO
RTU LAPTOP GPO
SPARE
SPARE
FLUORO IN RTU CUBICLE
FLUORO IN COMMON CUBICLE
FLUORO IN PUMP CONTROL CUBICLE
FLUORO IN BOLTED CONNECTION CUBICLE
FLUORO IN DISTRIBUTION CUBICLE
FLUORO IN MAIN SWITCH CUBICLE
CRITEC SURGE FILTER
RTU POWER SUPPLY REF 08/B2
SURGE DIVERTER RELAY REF 06/F11
SPARE
PROTECTED NEUTRAL
EMERGENCY PUMP CONTROL POWER SUPPLY & SURCHARGE IMMINENT RELAY REF 06/B4 REF 06/F3
GENERATOR ANCILLARY SUPPLY 10A SOCKET (NOTE 6)
SPARE
FLOWMETER PIT SUMP PUMP POWER SUPPLY
E N L1 L2 L3
CONT'D ON SHEET 02
A 04.09 FOR CONSTRUCTION
0 01.09 FOR TENDER
P1 12.08 ISSUED FOR REVIEW
DRAFTED P.J.HAGUE
DRAFTING CHECK A.WITTHOFT
SP087 SAINT ACHS STREET SEWAGE PUMP STATION
POWER DISTRIBUTION SCHEMATIC DIAGRAM
486/5/7-0101-001 A
FOR CONSTRUCTION
Sheet 01

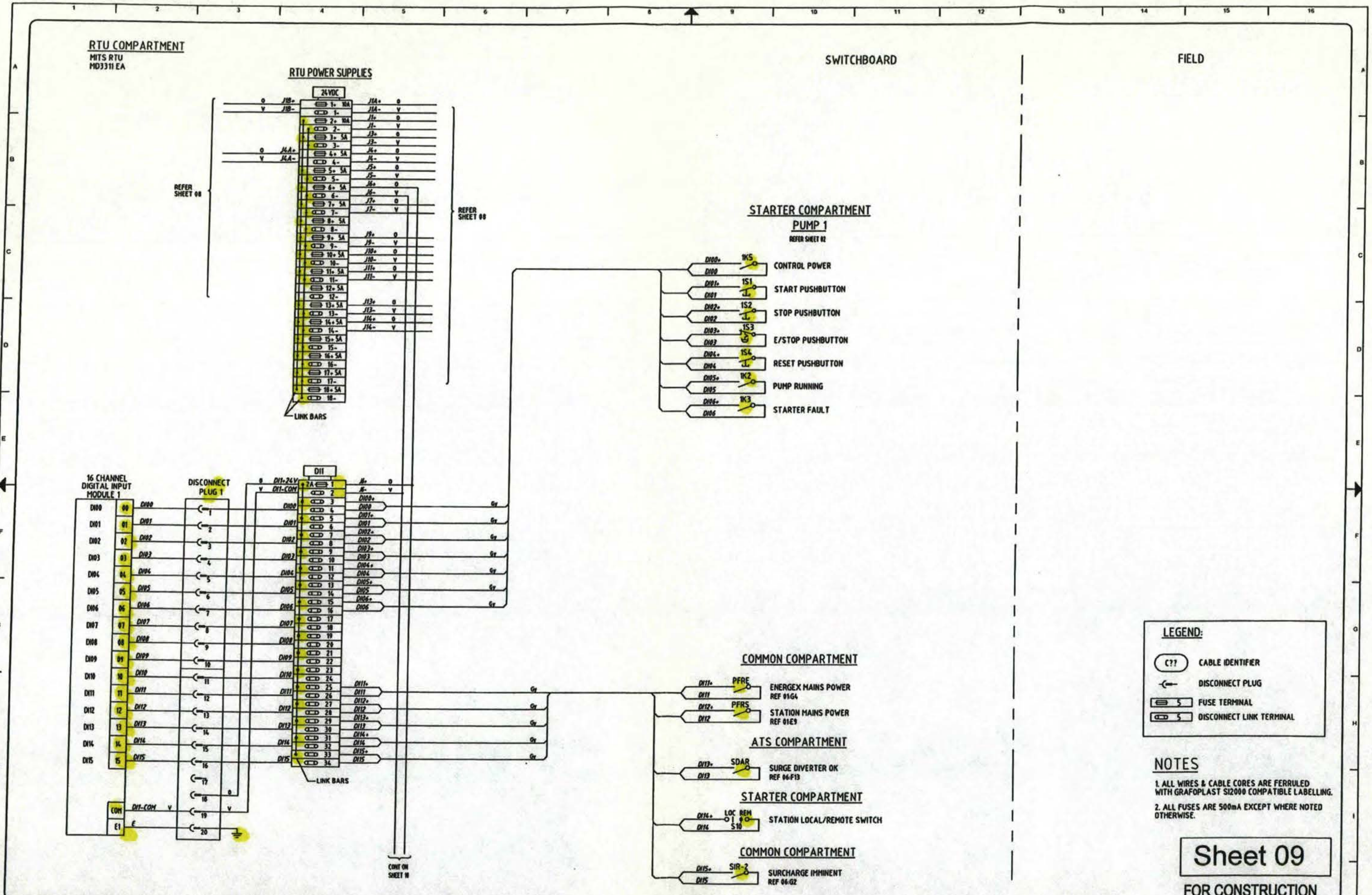

CONT'D FROM SHEET 01
E N R W B
1K2
Q4
1K1
20A
EMOTRON
MSF-017 +
MODBUS
SOFT
STARTER
1U1
DE-CONTACTORS (EXISTING)
SUBMERSIBLE PUMP No1
3.1kW 6.7AMPS
MOTOR THERMISTORS
AUX PLUG (NEW)
Q4-1
6A
1K4
1K21
12 RUN
13 COMMON
11 RESET
1S3
E/STOP
FAULT
OPERATE
FULL VOLT
RS485
Set terminating switch to 'OFF'
STARTER FAULT RELAY
LINE CONTACTOR
BY-PASS CONTACTOR
FROM GRAPHIC DISPLAY
TO SOFT STARTER 2
HRM1
HOURS RUN METER
RUN RELAY
EMG1
1S5 EM.START
CONTROL CCT 'POWER ON' RELAY
CONT'D ON SHEET 03
RTU DIGITAL INPUTS
24VDC POWER SUPPLY - REFER SHEET 08:C7
CONTROL POWER
START PUSHBUTTON
STOP PUSHBUTTON
E/STOP PUSHBUTTON
RESET PUSHBUTTON
RUNNING
STARTER FAULT
SPARE
SPARE
SPARE
SHEET 07 CONT'D ON
SHEET 07 CONT'D ON
RTU DIGITAL OUTPUTS
24VDC POWER SUPPLY - REFER SHEET 08:C7
RUN COMMAND
FAULT RESET
EMERGENCY MODE INTERRUPT
SPARE
CONT'D ON SHEET 07
CONT'D ON SHEET 07
LEGEND:
SWITCHBOARD POWER TERMINAL
SWITCHBOARD CONTROL TERMINAL
SWITCHBOARD GENERATOR TERM.
FIELD TERMINAL
PLC TERMINAL
RTU TERMINAL
SS TERMINAL
PLC/RTU MARSH. FUSE TERMINAL
PLC/RTU MARSH. LINK TERMINAL
DISCONNECT PLUG
RTU DIGITAL INPUT
RTU DIGITAL OUTPUT
RTU ANALOGUE INPUT
RTU ANALOGUE OUTPUT
NOTES
1. INCOMING GENSET, MAIN, PUMP & DIST. BOARD CIRCUIT BREAKERS SHALL BE LINE SIDE SHROUDED.
2. CIRCUIT BREAKER RATINGS TO SUIT FAULT LEVEL & LOAD ENSURE TYPE 2 CO-ORDINATION WITH CONTACTORS & OVERLOADS TO IEC 947-4-1.
3. ALL WIRES & CABLE CORES ARE FERRULED WITH GRAFOPLAST SI2000 COMPATIBLE LABELLING.
4. FAULT LEVEL OF 20kA AT 415V FOR 0.2sec.
Sheet 02
FOR CONSTRUCTION
A 04.09 FOR CONSTRUCTION P.H. A.W.
0 01.09 FOR TENDER P.H. A.W.
P1 12.08 ISSUED FOR REVIEW P.H. A.W.
DRAFTED P.HAGUE
DRAFTING CHECK A.WITTHOFT
CAD FILE 57-0101set_A
SP087
SAINT ACHS STREET
SEWAGE PUMP STATION
PUMP No1
SCHEMATIC DIAGRAM
BRISBANE WATER DRAWING No.
486/5/7-0101-002 A


CONT'D FROM SHEET 02
EMOTRON MSF-017 + MODBUS
SOFT STARTER 2U1
DE-CONTACTORS (EXISTING)
SUBMERSIBLE PUMP No2 3.1kW 6.7AMPS
MOTOR THERMISTORS
AUX PLUG (NEW)
STARTER FAULT RELAY
LINE CONTACTOR
BY-PASS CONTACTOR
FROM SOFT STARTER 1 REF 02:E6
Set terminating switch to 'ON'
HOURS RUN METER
RUN RELAY
CONTROL CCT 'POWER ON' RELAY
E/STOP
EM.START
RTU DIGITAL INPUTS
+ 24VDC POWER SUPPLY - REFER SHEET 08:C7
CONTROL POWER
START PUSHBUTTON
STOP PUSHBUTTON
E/STOP PUSHBUTTON
RESET PUSHBUTTON
RUNNING
STARTER FAULT
SPARE
CONT'D ON SHEET 07
RTU DIGITAL OUTPUTS
+ 24VDC POWER SUPPLY - REFER SHEET 08:C7
RUN COMMAND
FAULT RESET
EMERGENCY MODE INTERRUPT
SPARE
LEGEND:
SWITCHBOARD POWER TERMINAL
SWITCHBOARD CONTROL TERMINAL
SWITCHBOARD GENERATOR TERM.
FIELD TERMINAL
PLC TERMINAL
RTU TERMINAL
SS TERMINAL
PLC/RTU MARSH. FUSE TERMINAL
PLC/RTU MARSH. LINK TERMINAL
DISCONNECT PLUG
RTU DIGITAL INPUT
RTU DIGITAL OUTPUT
RTU ANALOGUE INPUT
RTU ANALOGUE OUTPUT
NOTES
1. INCOMING GENSET, MAIN, PUMP & DIST. BOARD CIRCUIT BREAKERS SHALL BE LINE SIDE SHROUDED.
2. CIRCUIT BREAKER RATINGS TO SUIT FAULT LEVEL & LOAD ENSURE TYPE 2 CO-ORDINATION WITH CONTACTORS & OVERLOADS TO IEC 947-4-1.
3. ALL WIRES & CABLE CORES ARE FERRULED WITH GRAFOPLAST SI2000 COMPATIBLE LABELLING.
4. FAULT LEVEL OF 20kA AT 415V FOR 0.2sec.
Sheet 03
FOR CONSTRUCTION
A 04.09 FOR CONSTRUCTION P.H. A.W.
0 01.09 FOR TENDER P.H. A.W.
P1 12.08 ISSUED FOR REVIEW P.H. A.W.
DRAFTED P.HAGUE
DRAFTING CHECK A.WITTHOFT
CAD FILE 57-0101set_A
Original Signed by A.WITTHOFT
DESIGN
Original signed by R.JANFADA
DESIGN CHECK
Original Signed by K.VAHEESAN 15.1.09
PRINCIPAL DESIGN MANAGER
Original Signed by P.SHERRIFF 15.1.09
CLIENT DELEGATE
SITE SP087
SAINT ACHS STREET SEWAGE PUMP STATION
TITLE PUMP No2 SCHEMATIC DIAGRAM
SHEET No. 3
BRISBANE WATER DRAWING No.
486/5/7-0101-003
AMEND. A


COMMON CONTROL SECTION
EMERGENCY PUMPING MODE (240VAC)
COMMON CONTROL SECTION
SWITCHBOARD INTERNAL LIGHTING
RTU DIGITAL INPUTS
TIMING DIAGRAM
ATS SECTION
SURGE DIVERTERS
COMMON CONTROL SECTION
LEVEL MONITORING
NOTES
1. ALL WIRES & CABLE CORES ARE FERRULED WITH GRAFOPLAST SI2000 COMPATIBLE LABELLING.
2. SET DIPSWITCH TO 'DISCHARGE' MODE.
LEGEND:
Sheet 06
FOR CONSTRUCTION
SP087
SAINT ACHS STREET
SEWAGE PUMP STATION
COMMON CONTROLS
SCHEMATIC DIAGRAM
486/5/7-0101-006
A


RTU DIGITAL INPUTS
CONT'D FROM SHEET 02
SPARE
ENERGEX MAINS POWER REF 01F4
STATION MAINS POWER REF 01E8
SURGE DIVERTER OK REF 06/F11
STATION LOCAL/REMOTE SWITCH
SURCHARGE IMMINENT REF 06/G2
CONT'D FROM SHEET 03
SPARE
RTU BATTERY OK REF 08:C4
RTU CONTROL POWER REF 08:C4
EMERGENCY PUMPING MODE REF 06:C6
WET WELL HIGH LEVEL REF 06:F6
CONT'D ON SHEET 06
+ 24VDC POWER SUPPLY - REFER SHEET 08:C7
NORMAL SUPPLY CB CLOSED
DI33 TO DI41 SPARES RESERVED FOR GENERATOR CONTROL
F/METER PIT HIGH LEVEL REF 06:I3
SPARE RESERVED FOR CP
DI44 TO DI47 SPARES RESERVED FOR DRY WELL SUMP PUMP
RTU DIGITAL OUTPUTS
CONT'D FROM SHEET 02
ETR
ELECTRODE TEST RELAY REF 06:F4, 06:F8, 06:H6
SPARE RESERVED FOR WELL WASHER
SPARE - RESERVED FOR DRY WELL ALARM STROBE
SPARE - RESERVED FOR ODOUR CONTROL UNIT
CONT'D FROM SHEET 03
SPARE - RESERVED FOR GEN. CONTROL
SPARE RESERVED FOR CP
SPARE RESERVED FOR CP
SPARE
RTU ANALOG INPUTS
24VDC SUPPLY REF 08:C7
ANALOG LEVEL METER
TERMINAL HOUSING
FMX167 TRANSMITTER
PRIMARY WET WELL LEVEL
RESERVED FOR DELIVERY PRESSURE
RESERVED FOR EMERGENCY STORAGE LEVEL
SPARE
RESERVED FOR GENERATOR FUEL LEVEL
RESERVED FOR SECONARY WET WELL LEVEL
RESERVED FOR RECTIFIER CURRENT
E+H PROMATIC 10 FLOWMETER SENSOR
E+H PROMATIC 10 FLOWMETER Tx
FLOWMETER PIT
24VDC SUPPLY REF 08:F7
DELIVERY FLOWMETER RANGE = 100L/s
RTU ANALOG OUTPUTS
RESERVED FOR CHEMICAL DOSING PUMP SPEED REFERENCE
NOTES
1. ALL WIRES & CABLE CORES ARE FERRULED WITH GRAFOPLAST SI2000 COMPATIBLE LABELLING.
LEGEND:
SWITCHBOARD POWER TERMINAL
SWITCHBOARD CONTROL TERMINAL
SWITCHBOARD GENERATOR TERM.
FIELD TERMINAL
PLC TERMINAL
RTU TERMINAL
SS TERMINAL
PLC/RTU MARSH. FUSE TERMINAL
PLC/RTU MARSH. LINK TERMINAL
DISCONNECT PLUG
RTU DIGITAL INPUT
RTU DIGITAL OUTPUT
RTU ANALOGUE INPUT
RTU ANALOGUE OUTPUT
Sheet 07
FOR CONSTRUCTION
A 04.09 FOR CONSTRUCTION P.H. A.W.
O 01.09 FOR TENDER P.H. A.W.
P1 12.08 ISSUED FOR REVIEW P.H. A.W.
No DATE AMENDMENT DRN. APD.
Reference Drawings
DRAFTED P.HAGUE
DRAFTING CHECK A.WITTHOFT
CAD FILE 87-0101set_A
B.C.C. FILE No.
Original Signed by A.WITTHOFT
DESIGN
Original signed by R.JANFADA
DESIGN CHECK
Original Signed by K.VAHEESAN
PRINCIPAL DESIGN MANAGER
Original Signed by P.SHERRIFF
CLIENT DELEGATE
SITE SP087 SAINT ACHS STREET SEWAGE PUMP STATION
TITLE COMMON RTU I/O SCHEMATIC DIAGRAM
SHEET No. 7
BRISBANE WATER DRAWING No.
486/5/7-0101-007
AMEND. A


POWERBOX
PB2S1-24CM-CC-T
PS1
SHROUD
240VAC SUPPLY
REF 01D12
COMMON CONTROLS SECTION
BOK
RTU
BATTERY OK
REF 07:C2
0 = Fault, 1 = Healthy
POWER ON
REF 07:C2
0 = Fault, 1 = Healthy
TEMPERATURE PROBE LOCATED AT BATTERIES
RTU POWER SUPPLY
10A 24VDC
24V DC
13.8V DC
RADIO
Rx TBA
Tx TBA
PIN-OUT FOR RADIO CONNECTION
DISCONNECT PLUG 6
TO GRAPHIC DISPLAY
GSM ANTENNA
GSM MODEM
24VDC SUPPLY
TERMINALS "20" MOUNTED ADJACENT TO GSM MODEM
PIN-OUT FOR GSM CONNECTION
RTU 24VDC CARD SUPPLY
WET WELL HIGH LEVEL RELAY LR3
SPARE
RESERVED FOR DRY WELL LEVEL RELAY LR2
COMMON CONTROLS
MODEM
FLOWMETER - ENDRES+HAUSER
FLOWMETER PIT HIGH LEVEL RELAY LR4
SPARE
RESERVED FOR ULTRASONIC WET WELL LEVEL
SPARE
RESERVED FOR WELL WASHER
SPARE
RESERVED FOR STATION MANHOLE SURCHARGE IMMINENT
SPARE
NOT AVAILABLE CONFIGURED FOR RS232
NOT AVAILABLE CONFIGURED FOR RS485
REFER TO SHEET 12
ON/OFF SWITCH
POWER SUPPLY CONNECTOR
RS 485 PORTS
RS 232 PORTS
ANALOGUE INPUTS
RTU
LOGICA CMG - MD3311E 24VDC - MOTHER BOARD
EXTERNAL I/O BOARD CONNECTOR
DIGITAL INPUTS (MODULE No. 1)
DIGITAL OUTPUTS (MODULE No. 1)
REFER TO SHEET 09
REFER TO SHEET 11
REFER TO SHEET 10
REFER TO SHEET 12
DIGITAL INPUTS (MODULE No. 3)
ANALOGUE OUTPUTS
RTU
LOGICA CMG - MD3311E 24VDC - EXTENSION BOARD
DIGITAL INPUTS (MODULE No. 2)
DIGITAL OUTPUTS (MODULE No. 2)
REFER TO SHEET 10
REFER TO SHEET 11
GRAPHIC DISPLAY
REDLION G306A000
FROM RTU
TO SOFT STARTER 1
REF 02:E5
LOGICA CMG - MD3311E 24VDC
ETHERNET BOARD
PORT 1
PORT 2
CONFIGURED FOR LAPTOP CONNECTION
LEGEND:
SWITCHBOARD POWER TERMINAL
SWITCHBOARD CONTROL TERMINAL
SWITCHBOARD GENERATOR TERM.
FIELD TERMINAL
PLC TERMINAL
RTU TERMINAL
SS TERMINAL
PLC/RTU MARSH. FUSE TERMINAL
PLC/RTU MARSH. LINK TERMINAL
DISCONNECT PLUG
RTU DIGITAL INPUT
RTU DIGITAL OUTPUT
RTU ANALOGUE INPUT
RTU ANALOGUE OUTPUT
NOTES
1. ALL WIRES & CABLE CORES ARE FERRULED WITH GRAFOPLAST SI2000 COMPATIBLE LABELLING.
2. ALL FUSES ARE 500mA EXCEPT WHERE NOTED OTHERWISE.
Sheet 08
FOR CONSTRUCTION
A 04.09 FOR CONSTRUCTION P.H. A.W.
0 01.09 FOR TENDER P.H. A.W.
P1 12.08 ISSUED FOR REVIEW P.H. A.W.
DRAFTED P.HAQUE
DRAFTING CHECK A.WITTHOFT
CAD FILE 87-0101sat_A
SITE
SP087
SAINT ACHS STREET
SEWAGE PUMP STATION
TITLE
RTU POWER DISTRIBUTION
SCHEMATIC DIAGRAM
486/5/7-0101-008
A



No	DATE	AMENDMENT	DRN.	APD.
A	04.09	FOR CONSTRUCTION	P.H.	A.W.
O	01.09	FOR TENDER	P.H.	A.W.
P1	12.08	ISSUED FOR REVIEW	P.H.	A.W.

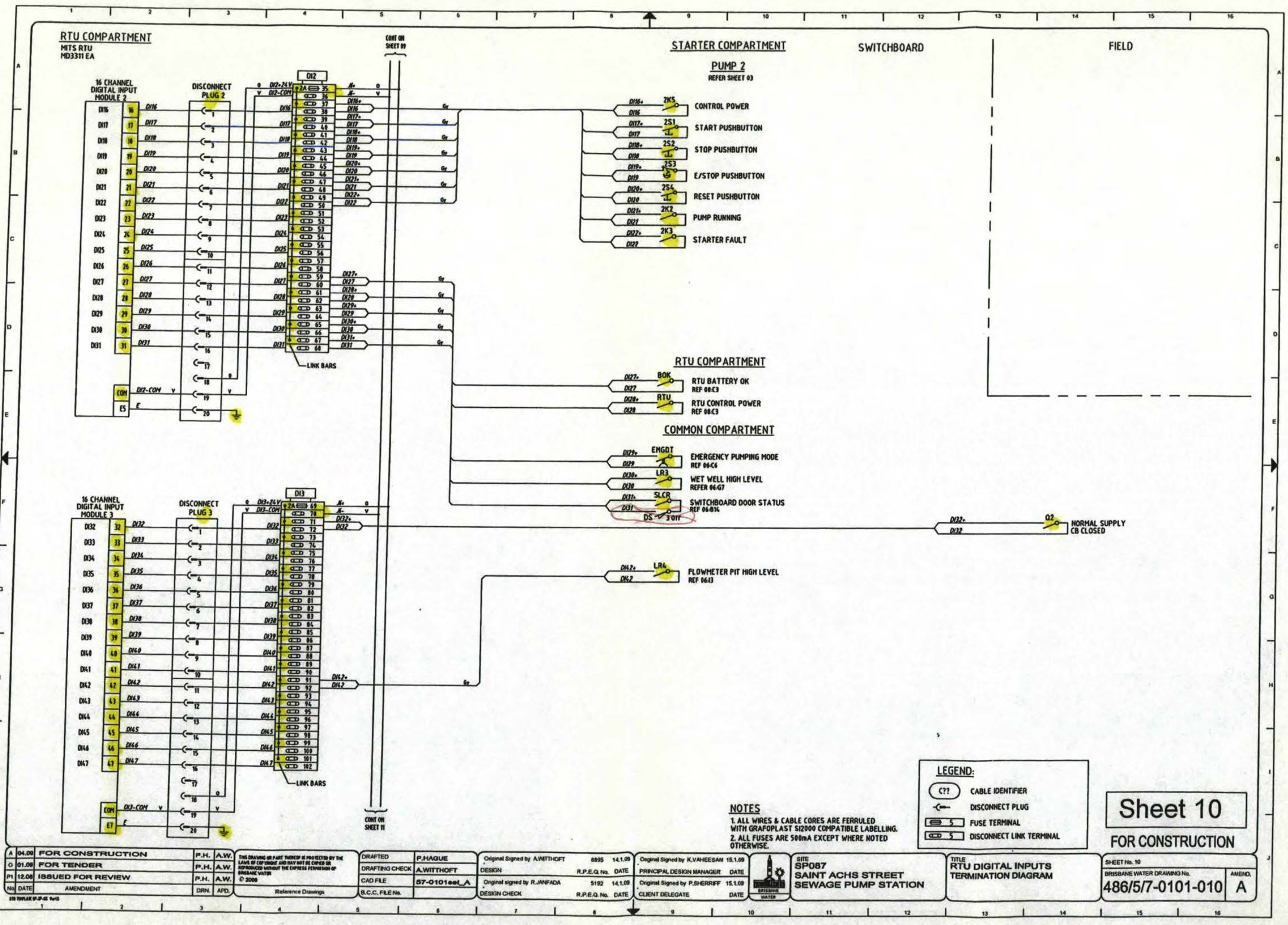
DRAFTED: P.HAGUE
DRAFTING CHECK: A.WITTHOFT
CAD FILE: 57-0101set_A

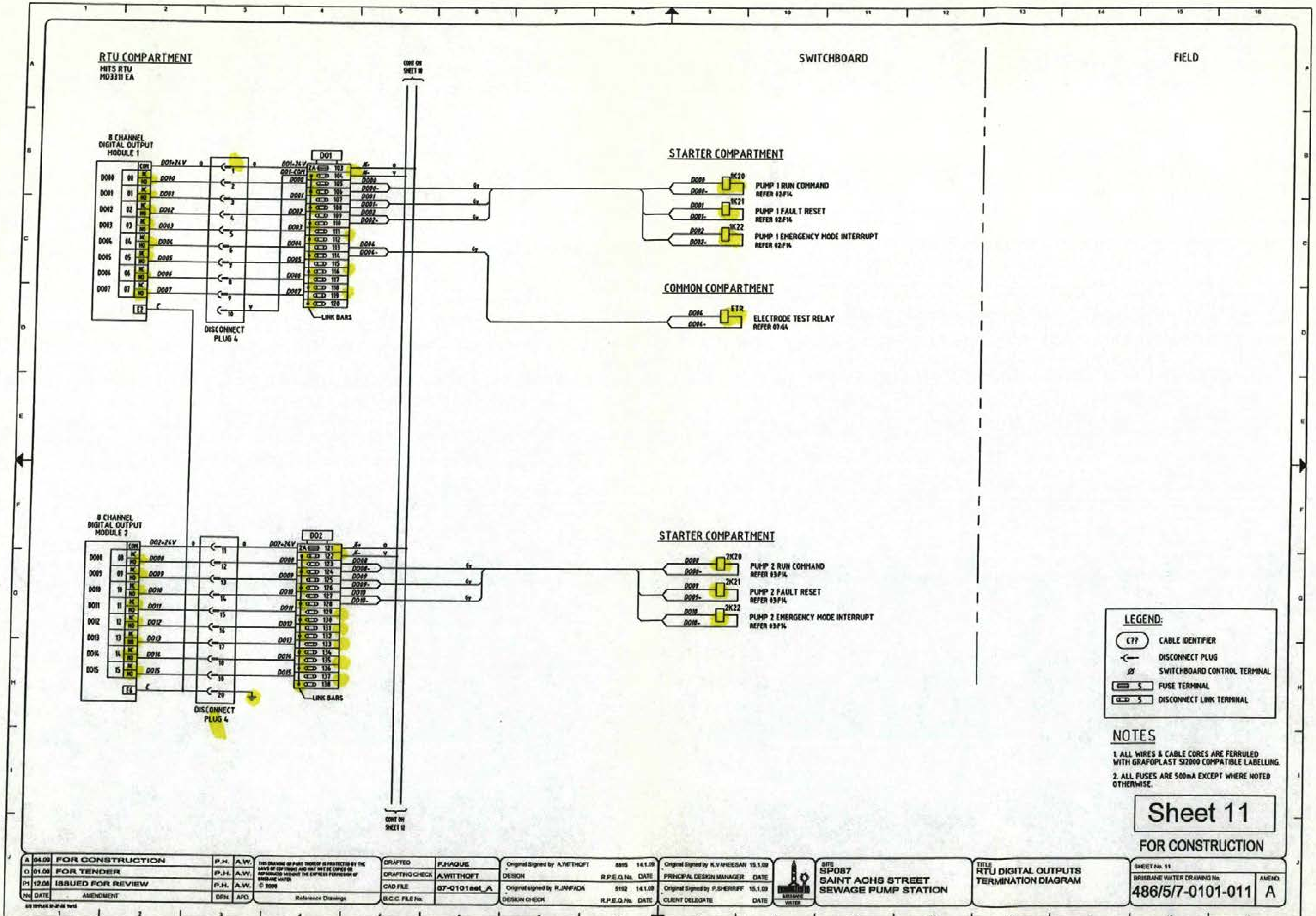
Original Signed by A.WITTHOFT 8895 14.1.09 — DESIGN R.P.E.Q. No. DATE
Original signed by R.JANFADA 5192 14.1.09 — DESIGN CHECK R.P.E.Q. No. DATE
Original Signed by K.VAHEESAN 15.1.09 — PRINCIPAL DESIGN MANAGER DATE
Original Signed by P.SHERRIFF 15.1.09 — CLIENT DELEGATE DATE

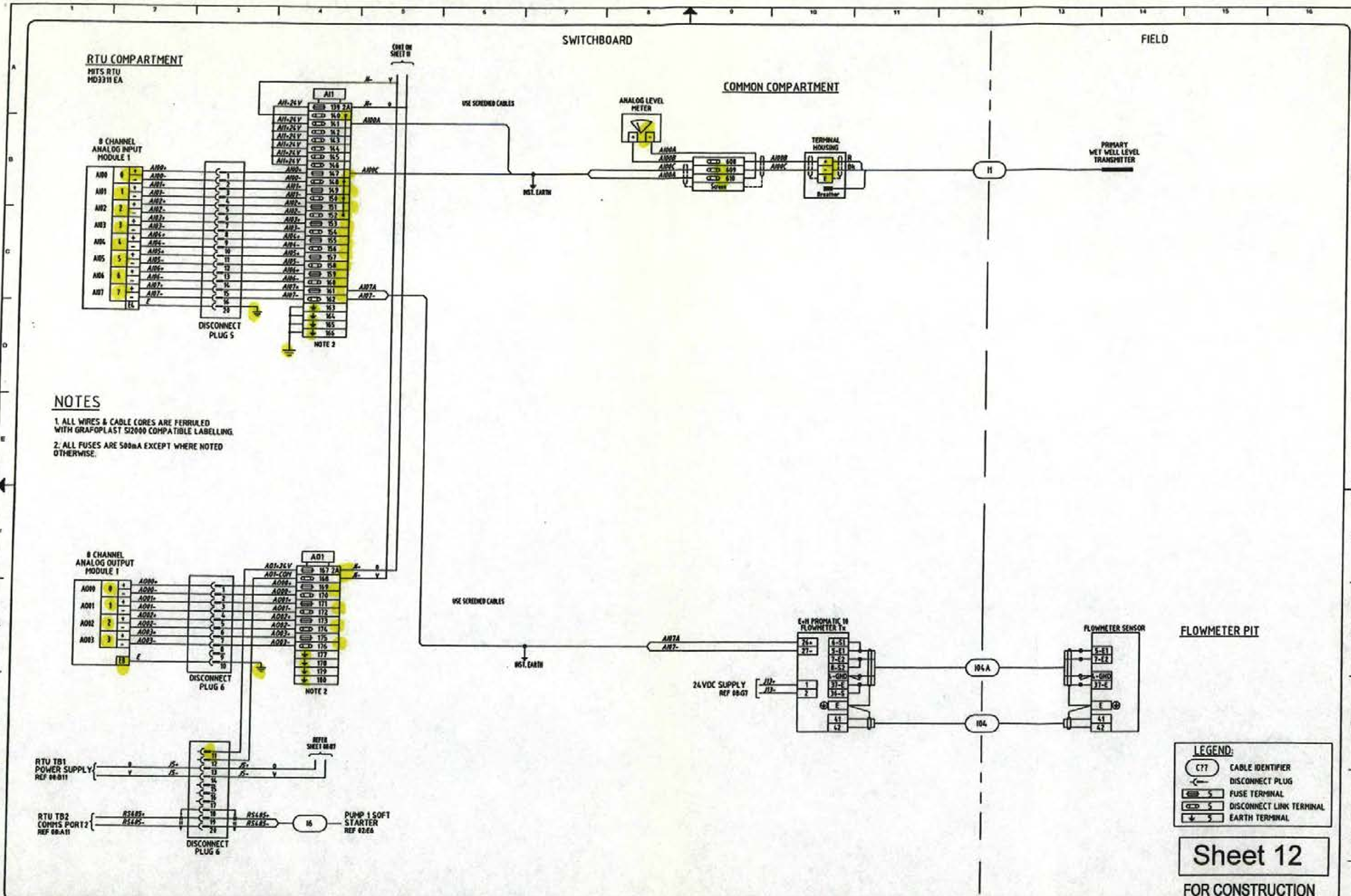
SITE: SP087 SAINT ACHS STREET SEWAGE PUMP STATION

TITLE: RTU DIGITAL INPUTS TERMINATION DIAGRAM

SHEET No. 9 — BRISBANE WATER DRAWING No. 486/5/7-0101-009 — AMEND. A


RTU COMPARTMENT
MITS RTU
MD3311 EA
16 CHANNEL DIGITAL INPUT MODULE 2
DISCONNECT PLUG 2
CONT ON SHEET 09
LINK BARS
16 CHANNEL DIGITAL INPUT MODULE 3
DISCONNECT PLUG 3
CONT ON SHEET 11
STARTER COMPARTMENT
SWITCHBOARD
FIELD
PUMP 2
REFER SHEET 03
CONTROL POWER
START PUSHBUTTON
STOP PUSHBUTTON
E/STOP PUSHBUTTON
RESET PUSHBUTTON
PUMP RUNNING
STARTER FAULT
RTU COMPARTMENT
RTU BATTERY OK
REF 08:C3
RTU CONTROL POWER
REF 08:C3
COMMON COMPARTMENT
EMERGENCY PUMPING MODE
REF 06:C6
WET WELL HIGH LEVEL
REFER 06:G7
SWITCHBOARD DOOR STATUS
REF 06:B14
NORMAL SUPPLY CB CLOSED
FLOWMETER PIT HIGH LEVEL
REF 06:I3
LEGEND:
CABLE IDENTIFIER
DISCONNECT PLUG
FUSE TERMINAL
DISCONNECT LINK TERMINAL
NOTES
1. ALL WIRES & CABLE CORES ARE FERRULED WITH GRAFOPLAST SI2000 COMPATIBLE LABELLING.
2. ALL FUSES ARE 500mA EXCEPT WHERE NOTED OTHERWISE.
Sheet 10
FOR CONSTRUCTION
A 04.09 FOR CONSTRUCTION P.H. A.W.
O 01.09 FOR TENDER P.H. A.W.
P1 12.08 ISSUED FOR REVIEW P.H. A.W.
No DATE AMENDMENT DRN. APD.
© 2009
Reference Drawings
DRAFTED P.HAQUE
DRAFTING CHECK A.WITTHOFT
CAD FILE 57-0101set_A
B.C.C. FILE No.
SITE
SP087
SAINT ACHS STREET
SEWAGE PUMP STATION
TITLE
RTU DIGITAL INPUTS
TERMINATION DIAGRAM
SHEET No. 10
BRISBANE WATER DRAWING No.
486/5/7-0101-010
AMEND. A


RTU COMPARTMENT
MITS RTU
MD3311 EA
SWITCHBOARD
FIELD
8 CHANNEL DIGITAL OUTPUT MODULE 1
DISCONNECT PLUG 4
LINK BARS
STARTER COMPARTMENT
PUMP 1 RUN COMMAND
REFER 02/F14
PUMP 1 FAULT RESET
REFER 02/F14
PUMP 1 EMERGENCY MODE INTERRUPT
REFER 02/F14
COMMON COMPARTMENT
ELECTRODE TEST RELAY
REFER 07/G4
8 CHANNEL DIGITAL OUTPUT MODULE 2
STARTER COMPARTMENT
PUMP 2 RUN COMMAND
REFER 03/F14
PUMP 2 FAULT RESET
REFER 03/F14
PUMP 2 EMERGENCY MODE INTERRUPT
REFER 03/F14
DISCONNECT PLUG 4
LINK BARS
CONT ON SHEET 12
LEGEND:
CABLE IDENTIFIER
DISCONNECT PLUG
SWITCHBOARD CONTROL TERMINAL
FUSE TERMINAL
DISCONNECT LINK TERMINAL
NOTES
1. ALL WIRES & CABLE CORES ARE FERRULED WITH GRAFOPLAST SI2000 COMPATIBLE LABELLING.
2. ALL FUSES ARE 500mA EXCEPT WHERE NOTED OTHERWISE.
Sheet 11
FOR CONSTRUCTION
A 04.09 FOR CONSTRUCTION P.H. A.W.
O 01.09 FOR TENDER P.H. A.W.
P1 12.08 ISSUED FOR REVIEW P.H. A.W.
No DATE AMENDMENT DRN. APD.
Reference Drawings
DRAFTED P.HAQUE
DRAFTING CHECK A.WITTHOFT
CAD FILE 07-0101set_A
B.C.C. FILE No.
Original Signed by A.WITTHOFT 14.1.09
DESIGN R.P.E.Q. No. DATE
Original signed by R.JANFADA 14.1.09
DESIGN CHECK R.P.E.Q. No. DATE
Original Signed by K.VAHEESAN 15.1.09
PRINCIPAL DESIGN MANAGER DATE
Original Signed by P.SHERRIFF 15.1.09
CLIENT DELEGATE DATE
SITE
SP087
SAINT ACHS STREET
SEWAGE PUMP STATION
TITLE
RTU DIGITAL OUTPUTS
TERMINATION DIAGRAM
SHEET No. 11
BRISBANE WATER DRAWING No.
486/5/7-0101-011
AMEND.
A



NOTES

1. ALL WIRES & CABLE CORES ARE FERRULED WITH GRAFOPLAST SI2000 COMPATIBLE LABELLING.
2. ALL FUSES ARE 500mA EXCEPT WHERE NOTED OTHERWISE.

No	DATE	AMENDMENT	DRN	APD
A	04.09	FOR CONSTRUCTION	P.H.	A.W.
O	01.09	FOR TENDER	P.H.	A.W.
P1	12.08	ISSUED FOR REVIEW	P.H.	A.W.

DRAFTED: P.HAQUE
DRAFTING CHECK: A.WITTHOFT
CAD FILE: 57-0101set_A

SITE: SP087 SAINT ACHS STREET SEWAGE PUMP STATION

TITLE: RTU ANALOGS & MISCELLANEOUS TERMINATION DIAGRAM

SHEET No. 12

BRISBANE WATER DRAWING No. 486/5/7-0101-012 AMEND. A

MTSS2PE25033

ITEM	QTY	DESCRIPTION	MANUFACTURER	CATALOGUE No	OPT	REMARKS
1	1		TERASAKI	MTSS2PE25033		
2	1	Q2 NORMAL SUPPLY MAIN SWITCH	TERASAKI		-	Set Ir=0.6 (58A) Ii=5
3	1	Q3 GENERATOR SUPPLY MAIN SWITCH	TERASAKI		-	Set Ir=0.6 (58A) Ii=5
4	1	Q4 PUMP1 CIRCUIT BREAKER	TERASAKI	S125GJ/20	-	Set Ir=0.63 (12.5A) Ii=6 (120A)
5	1	Q5 PUMP2 CIRCUIT BREAKER	TERASAKI	S125GJ/20	-	Set Ir=0.63 (12.5A) Ii=6 (120A)
6	3	SHROUDS		T2CF123SLNG	E	
7	1	Q7 EMERGEX PHASE FAILURE CIRCUIT BREAKER	TERASAKI	DTCB15N6C	-	
8	2	SHROUDS		T2CF2535LNG	F	
9	1	Q9 SUB-DISTRIBUTION BOARD CIRCUIT BREAKER	TERASAKI	E125NJ/80	-	Set Ir=1 Ii=10
10	1	Q10 STATION MAINS PHASE FAILURE CIRCUIT BREAKER	TERASAKI	DTCB6306C	-	
11	1	Q11 3 PHASE OUTLET CIRCUIT BREAKER	TERASAKI	DTCB6316C	-	PLUS DSRCBH-32-30-3PN
12	1	Q12 ISA GPO CIRCUIT BREAKER	TERASAKI	DSRCBH-16-30A	-	
13	1	Q13 RTU LAPTOP GPO CIRCUIT BREAKER	TERASAKI	DSRCBH-10-30A	-	
14	1	Q14 SPARE	TERASAKI	DTCB6116C	E	
15	1	Q15 SPARE	TERASAKI	DTCB6116C	E	
16	1	Q16 SW/BD INTERNAL LIGHTING CIRCUIT BREAKER	TERASAKI	DSRCBH-6-30A	-	
17	1	Q17 SURGE FILTER CIRCUIT BREAKER	TERASAKI	DTCB6116C	-	
18	1	Q18 EM PUMP CNTRL & SURCHARGE IMMINENT CB	TERASAKI	DTCB6106C	-	
19	1	Q19 GENERATOR AUXILLARY SUPPLY CIRCUIT BREAKER	TERASAKI	DSRCBH-10-30A	-	
20	1	Q20 SPARE	TERASAKI	DTCB6106C	K	
21	1	Q21 VALVE PIT SUMP PUMP POWER SUPPLY	TERASAKI	DSRCBH-10-30A	G	
22	2	250A HANDLES		T2HS25R66M		
23	3	125A HANDLES		T2HS12R6GM		
24	1	250A AUX CONTACT		T2AXCOM3STA		
25						
26	1	Q30 RTU POWER SUPPLY CIRCUIT BREAKER	TERASAKI	DTCB6106C	-	
27	1	Q31 SURGE DIVERTERS RELAY CIRCUIT BREAKER	TERASAKI	DTCB6106C	-	
28	1		TERASAKI	DTCB6106C	H	
29	1	Q33 SPARE	TERASAKI	DTCB6106C	-	
30						
31	1	Q4-1 PUMP1 CONTROL CIRCUIT BREAKER	TERASAKI	DTCB6106C	-	
32	1	Q5-1 PUMP2 CONTROL CIRCUIT BREAKER	TERASAKI	DTCB6106C	-	
33					E	
34						
35					F	
36	1	DISTRIBUTION BOARD CHASSIS	TERASAKI	CD-3-21/10-3U	-	
37	3	F1 - SURGE DIVERTER CIRCUIT FUSES	NHP	63AMP GNS	-	FUSES & HOLDERS
38	3	SURGE DIVERTER	CRITEC	TDS1100-2SR-277	-	
39	1	SURGE DIVERTER ALARM RELAY - SDAR	CRITEC	DAR-275V	-	
40	1	RTU SURGE REDUCTION FILTER	CRITEC	TSF-10A-24V 20	-	
41	1	EMERGEX MAINS PHASE FAILURE RELAY - PFRE	CROMPTON INSTRUMENTS	252-PSGW	-	
42						
43	1	STATION MAINS PHASE FAILURE RELAY - PFRS	CROMPTON INSTRUMENTS	252-PSGW	-	
44						
45	1	MAIN NEUTRAL LINK	DAL ELEC.	BLANS	-	INSULATED
46	1	MAIN EARTH LINK	DAL ELEC.	BLANES	-	
47	1	DIST. BD NEUTRAL LINK	DAL ELEC.	20LA1N	-	INSULATED
48	1	DIST. BD EARTH LINK	DAL ELEC.	20LAE1N	-	
49	1	SURGE DIVERTER NEUTRAL LINK	CLIPSAL	L5A	-	INSULATED
50	1	INSTRUMENT EARTH LINK	DAL ELEC.	BL0612	-	INSULATED
51	1	RTU FILTERED SUPPLY NEUTRAL LINK	CLIPSAL	L7	-	INSULATED
52	1	3 PHASE SWITCHED OUTLET	CLIPSAL	56C410	-	USE ENCLOSURE AS SHROUD
53	1	1 PHASE OUTLET ISA	CLIPSAL	15/15-900 (SHROUD)	-	
54	1	RTU LAPTOP GPO	CLIPSAL	15-445M-WEAP	-	
55	1	1 PHASE INLET - GENERATOR ANCILLARY POWER	CLIPSAL	56SAI10	F	IP56
56	1	3 PHASE INLET APPLIANCE INLET - GENERATOR POWER	HENDRES	HDC061	F	c/w PROTECTIVE CAP & CHAIN
57						
58		MODBUS CARD		01-1733-00		
59	1	PUMP SOFT STARTER	EMOTRON MSF2.0	MSF-017 + MODBUS COMMS		
60	1	EXTERNAL KEYPAD KIT	EMOTRON MSF2.0	01-3060-00	-	
61						
62	1	PUMP LINE CONTACTOR - K1	SPRECHER & SCHUH	CA7-9-10-240V		
63	1	PUMP BY-PASS CONTACTOR - K2	SPRECHER & SCHUH	CA7-9-10-240V		
64					C	

ITEM	QTY	DESCRIPTION	MANUFACTURER	CATALOGUE No	OPT	REMARKS
65	2	PUMP FAULT RELAY - K3	IDEC	RH2B-UL-24VAC	-	
66	2 12	PUMP1 RUN RELAY - K4	IDEC	RH2B-UL-24VAC	-	
67	1	~~PUMP DELAY RUN RELAY - K?~~	~~SPRECHER & SCHUH~~	~~RZ7-FSA3E-U23~~		~~ON DELAY~~
68	2	PUMP CONTROL CCT POWER OK RELAY - K5	IDEC	RH2B-UL-24VAC	-	
69	6		IDEC	SH2B-05C	E	BASE
70					A	
71					B	
72	6		IDEC	SH2B-05C	B	Base
73	2	PUMP RUN COMMAND RELAY - K20	IDEC	RH2B-UL-24VDC	-	
74	2	PUMP FAULT RESET RELAY - K21	IDEC	RH2B-UL-24VDC	-	
75	2	PUMP EMERGENCY MODE INTERRUPT RELAY - K22	IDEC	RH2B-UL-24VDC	-	
76	2	PUMP START PUSHBUTTON - S1	SPRECHER & SCHUH	D7P-F3-PX10	-	
77	2	PUMP STOP PUSHBUTTON - S2	SPRECHER & SCHUH	D7P-F4-PX01	-	
78	2	PUMP ON/STOP PUSHBUTTON - S3	SPRECHER & SCHUH	D7P-MT26-PX01S	-	c/w Mom E/Stop Ring - Label
79	2	PUMP RESET PUSHBUTTON - S4	SPRECHER & SCHUH	D7P-F6-PX10	-	D7-15YE112
80	2	PUMP HOUR RUN METER	NATIONAL	TH639	-	
81	2	PUMP POWER SOCKET OUTLET + INLINE SLEEVE	MARECHAL	DS1 31HA0972 + SIBA456	J	
82	2	PUMP POWER INLET PLUG + HANDLE	MARECHAL	DS1 31HA0972 + 31HA18	J	
83	2	PUMP CONTROL SOCKET OUTLET + INLINE SLEEVE	MARECHAL	PKC 0F0460 + 0SBA53	J	
84	2	PUMP CONTROL INLET PLUG + HANDLE	MARECHAL	PKC 0F0460 + 0SBA20	J	
85					E	
86					E	
87					E	
88					E	
89					E	
90					E	
91					E	
92	1	LH3 - WET WELL HIGH LEVEL RELAY	MULTITRODE	MTR-5	-	24VDC
93	1	LH4 - FLOWMETER PIT HIGH LEVEL RELAY	MULTITRODE	MTR-5	B	24VDC
94					B	
95	1	SR - SURCHARGE IMMINENT LEVEL RELAY	MULTITRODE	MTR-2	-	240VAC
96	3	SINGLE POINT PROBES	MULTITRODE	3 off - 0.2/2-Y (2 ...)	-	
97	1	EMERGENCY PUMPING MODE RELAY PUMP1 - EMR1	IDEC	RH2B-UL-240VAC	-	
98	1	SURCHARGE IMMINENT RELAY TIMER - SRT	SPRECHER & SCHUH	RZ7-FSA3E-U23	-	ON DELAY
99	1	EMERGENCY PUMPING MODE TIMER - EMDT	SPRECHER & SCHUH	RZ7-FSA-U23	-	OFF DELAY 0.05-60min
100	1	EMERGENCY PUMPING MODE TIMER PUMP2 - EMR2	SPRECHER & SCHUH	RZ7-FSA3E-U23	-	ON DELAY
101	2	EMERGENCY PUMPING MODE SWITCH - S5	SPRECHER & SCHUH	D7P-LS45-PX10	-	ENGRAVE "OFF ON"
102					F	
103					F	
104					F	
105					F	
106					F	
107					F	
108					F	
109					F	
110					F	
111					F	
112					F	
113					F	
114					F	
115	1	GRAPHIC DISPLAY	REDLION	G306A000	-	G306A000
116						
117	1	SW/BD LIGHTING CONTROL RELAY - SLCR	IDEC	RH2B-UL-24VDC	-	
118	1	STATION LOCAL/REMOTE SWITCH - S11	KRAUS & NAIMER	CA10 A291-600-FT2		ENGRAVE "LOCAL REMOTE"
119	1	ELECTRODES TEST RELAY - ETR	IDEC	RH2B-UL-24VDC	-	
120		CA10-A291-600-FT2-F* ENGRAVED LOCAL - REMOTE				
121	1	WET WELL LEVEL INDICATOR	CROMPTON INSTRUMENTS	244-01... 4-20mA	-	0-100% ADJ RED POINTER
122						
123	6	SW/BD DOOR MICRO SWITCHES	CANSCO	SH212	-	4 OFF N/O
124	1	~~SW/BD DISCONNECT COMPART DOOR PROXIMITY SWITCH~~	~~PEPPERL & FUCHS~~	~~NCB5-18GM40-Z0~~		
125	6	SW/BD RV INTERNAL FLUORO LIGHTS	THORN	[illegible]	-	
126						
127					S	
128					S	

ITEM	QTY	DESCRIPTION	MANUFACTURER	CATALOGUE No	OPT	REMARKS
129						
130						
131						
132	1	FLOWMETER - FREE ISSUE	ENDRES+HAUSER	PROMAG 10	H	RANGE = 50l/s
133	1	WET WELL LEVEL TRANSMITTER	ENDRESS + HAUSER	[illegible]	-	RANGE = 3m
134	1	WET WELL LEVEL TRANSMITTER TERMINAL HOUSING	ENDRESS + HAUSER	Part of Item 133	-	
135						
136						
137						
138			PB251-24CM-cc-T			
139	1	RTU POWER SUPPLY 24VDC	POWERBOX	PB251-24CM-CC-T	-	
140	1	RADIO 24V/13.8VDC CONVERTER	POWERBOX	PBIH-2412G-CC	R	VTA124CR24
141			PBIH-2412G-CC		I	
142	2	BATTERIES	YUASA	NP...	-	
143	1	RADIO	TAIT	[illegible]	R	
144	1	RADIO ANTENNA	TAIT	YAGI ANTENNA	R	6 ELEMENT ... ALUM
145	1	[illegible]	POLYPHASER CORPORATION	IS-50NX-C2	R	
146	1	[illegible]	[illegible]	[illegible]	-	
147	1	[illegible]	WAVECOM	FASTRACK Supreme	I	c/w SH Cable
148	1	[illegible] CELLULAR [illegible] ANTENNA	RF INDUSTRIES	[illegible]	I	
149	6	DISCONNECT PLUGS	PHOENIX CONTACT	MSTB 2,5/20-ST-5,08	-	
150	6	DISCONNECT TERMINAL BLOCKS	PHOENIX CONTACT	UMSTBVK2,5/20-G-5,08	-	
151	6	CABLE HOUSING	PHOENIX CONTACT	KGG-MSTB2,5/20	-	
152	1	CODING PINS	PHOENIX CONTACT	CP-MSTB + CR-MSTB	-	
153						
154						
157	1	COAX CABLE (INTERNAL)	R.F. INDUSTRIES	RG58	R	
158	1	COAX CABLE (EXTERNAL)	R.F. INDUSTRIES	RG213	R	
159	1	COAX PLUG	R.F. INDUSTRIES	SMA	R	
160	1	COAX PLUG	R.F. INDUSTRIES	N08 (MALE)	R	
161	1	COAX PLUG	R.F. INDUSTRIES	N07 (MALE)	R	
162	1	U CLAMPS	R.F. INDUSTRIES	UHF	R	
163						
		SWITCHBOARD TERMINALS				
164.1	35	FUSED TERMINALS with LED 24V INDICATION	PHOENIX CONTACT	UT4-HESI LED24 (5x20)	-	
164.2		FUSE CARTRIDGES	PHOENIX CONTACT	FUSES	-	RATINGS AS REQUIRED
164.3	150	DISCONNECT TERMINALS	PHOENIX CONTACT	UT4-MT P/P	-	
164.4	10	EARTH TERMINALS	PHOENIX CONTACT	UT4-MTD-PE/S	-	
164.5		GROUP MARKER CARRIER	PHOENIX CONTACT	UBE	-	
164.6	1	TEST PLUG ADAPTOR	PHOENIX CONTACT	PS-6	-	
164.7	1	SCREW DRIVER	PHOENIX CONTACT	SZS 0.6 x 3.5	-	
164.8		PLUG-IN BRIDGING STRIP	PHOENIX CONTACT	FBS	-	AS REQUIRED
165						
166						
		MISCELLANEOUS				
167	2	CORROSION INHIBITOR	CORTEC	VPCI-110 ...	-	FROM AP CONTROLS
168	1	EMERGEX PADLOCK - 45mm brass pls holder	R.A. REED LOCKSMITHS	KEY No 325	-	
169	9	500 MA FUSES	20X5mm			
170	1	0.8 MA FUSES				
171	6	2 A FUSES			-	
172	15	5A FUSES			-	
173	2	10A FUSES			-	
174					E	
175					6	
176					E	
177					E	
178					E	
179					E	
180					E	

M34100

Sheet 14

FOR TENDER

No	DATE	AMENDMENT	DRN.	APD.
0	01.09	FOR TENDER	P.H.	A.W.
P1	12.08	ISSUED FOR REVIEW	P.H.	A.W.

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Reference Drawings

DRAFTED: P.HAGUE
DRAFTING CHECK: A.WITTHOFT
CAD FILE: 87-0101set_O
B.C.C. FILE No.

Original Signed by A.WITTHOFT 6595 14.1.09 — DESIGN, R.P.E.Q. No. DATE
Original signed by R.JANFADA 5102 14.1.09 — DESIGN CHECK, R.P.E.Q. No. DATE
Original Signed by K.VAHEESAN 15.1.09 — PRINCIPAL DESIGN MANAGER, DATE
Original Signed by P.SHERRIFF 15.1.09 — CLIENT DELEGATE, DATE

SITE: SP087 SAINT ACHS STREET SEWAGE PUMP STATION

TITLE: EQUIPMENT LIST

SHEET No. 14
BRISBANE WATER DRAWING No: 486/5/7-0101-014
AMEND. O

CABLE No.	STATUS	SIZE	CORES	TYPE	LENGTH (m) Note 1	FROM	TO	CABLE FUNCTION	NOTES
P01	NEW	16mm²	4C	PVC/CU/PVC		ENERGEX Supply Pillar/Pole	Switchboard	Incoming Mains Supply	
P02	NEW	6mm²	1C	Building Wire		Switchboard	Earth stake	Main Earth	
P03									
P04									
P05		-							Reserved Pump 1
P06		-							Reserved Pump 1
P07	NEW	TBAmm²	3C+E+2pilots	Flexible (Subversible)		Switchboard	Pump No1	Pump 1 Motor Feed + Thermistors	
P08		-							Reserved Pump 2
P09		-							Reserved Pump 2
P10	NEW	TBAmm²	3C+E+2pilots	Flexible (Subversible)		Switchboard	Pump No2	Pump 2 Motor Feed + Thermistors	
P11		-							Reserved Dry Well Sump Pump
P11A		-							Reserved Dry Well Sump Pump
P12		-							Reserved Pump Well Lighting
P13									
P14									Reserved Pump Well Vent Fan
P14A									Reserved Pump Well Vent Fan
P15	NEW	2.5mm²	2C+E	PVC/CU/PVC		Switchboard	Valve Pit Sump Pump Junction Box	Valve Pit Sump Pump Motor	
P15A	NEW	2.5mm²	2C+E	Vendor		Valve Pit Sump Pump Junction Box	Valve Pit Sump Pump	Valve Pit Sump Pump Motor	
P16		-							Reserved Odour Control Unit
P17		-							Reserved Chemical Dosing Unit
P18									
P19									
P20									
C100									
C101		-							Reserved Pump 1 MO probe
C102		-							Reserved Pump 1 MS probe
C103		-							Reserved Pump 1 B.Temp RTD
C104		-							Reserved Pump 1 relux l/s
C105		-							Reserved Pump 1 Lockout
C200									
C201		-							Reserved Pump 2 MO probe
C202		-							Reserved Pump 2 MS probe
C203		-							Reserved Pump 2 B.Temp RTD
C204		-							Reserved Pump 2 relux l/s
C205		-							Reserved Pump 2 Lockout
C01	NEW		2C	Vendor - 0.20130FSP	10mtrs	Switchboard	Surcharge Imminent Probe	Surcharge Imminent Signal (SIR)	
		-							Reserved Remote SIR Terminals
C02	NEW		2C	Vendor - 0.20130FSP	10mtrs	Switchboard	Wet Well High Level Probe	Wet Well High Level Signal (LR3)	
		-							Reserved Remote LR3 Terminals
C03		-							Reserved Dry Well Trip Level
C04		-							Reserved Dry Well Alarm Level
C05		-							Reserved Sump Pump level
C06		-							Reserved Sump Pump level
C07	NEW	1.5mm²	2C	Vendor - 0.20130FSP	15mtrs	Switchboard	Flowmeter Pit High Level Probe	Flowmeter Pit High Level Signal (LR4)	
C08		-							Reserved Manhole Surcharge
C09		-							Reserved Wet Well Washer
C10		-							Reserved Generator controls
C11									Reserved Dry Well Alarm Strobe
C12		-							Reserved Odour Control Unit
CP01		-							Reserved CP Anode)
I01	NEW			Vendor	10mtrs	Switchboard	Wet Well Hydroscopic Level Sensor	Primary Wet Well Level	
		-							Reserved Remote Mount TX
I02									
I03		-							Reserved Em.storage level
I04	NEW			Vendor	15mtrs	Switchboard	Delivery Flowmeter	Flowmeter Sensor Power Supply	
I04A	NEW			Vendor	15mtrs	Switchboard	Delivery Flowmeter	Flowmeter Signals	
									Reserved Ultrasonic Level
									Reserved Ultrasonic Level
I06	NEW	0.75mm²	1Pr	Dekoron		Switchboard - RTU	Switchboard - Graphic Display	RS485 Comms	Overall Screened Twisted Pair
I07	NEW	0.75mm²	1Pr	Dekoron		Switchboard - Graphic Display	Switchboard - Pump 1 Soft Starter	RS485 Comms	Overall Screened Twisted Pair
I08	NEW	0.75mm²	1Pr	Dekoron		Switchboard - Pump 1 Soft Starter	Switchboard - Pump 2 Soft Starter	RS485 Comms	Overall Screened Twisted Pair
I09		-							Reserved Chemical Dosing Unit
I10									
X01	NEW			Vendor		Switchboard - Radio	Aerial Coax Surge Protector	Radio Communications	
X02	NEW			Vendor		Aerial Coax Surge Protector	Aerial	Radio Communications	

NOTE:
1. THE CONTRACTOR IS RESPONSIBLE OR DETERMINING THE ACTUAL CABLE LENGTHS REQUIRED ON SITE.

No	DATE	AMENDMENT	DRN.	APD.
A	04.09	FOR CONSTRUCTION	P.H.	A.W.
0	01.09	FOR TENDER	P.H.	A.W.
P1	12.08	ISSUED FOR REVIEW	P.H.	A.W.

DRAFTED P.HAGUE
DRAFTING CHECK A.WITTHOFT
CAD FILE 87-0101-015 A

SITE SP087 SAINT ACHS STREET SEWAGE PUMP STATION

TITLE CABLE SCHEDULE

Sheet 15

FOR CONSTRUCTION

BRISBANE WATER DRAWING No. 486/5/7-0101-015 AMEND. A

ITEM #	OPT.	DESCRIPTION	LABEL 1	LABEL 2 (IF NECESSARY)	TEXT HEIGHT	MATERIAL / COLOUR
02		ENERGEX SUPPLY	NORMAL SUPPLY MAIN SWITCH 125A		10mm 6mm	ABS PLASTIC B/W
03		GENERATOR SUPPLY	GENERATOR SUPPLY MAIN SWITCH 125A		10mm 6mm	ABS PLASTIC B/W
04/05		PUMP CIRCUIT BREAKER	PUMP No1 20A	PUMP No2 20A	6mm 6mm	ABS PLASTIC W/B
07		PHASE FAILURE CIRCUIT BREAKER	ENERGEX PHASE FAILURE RELAY 07	FED FROM LINE SIDE OF MAIN SWITCH	6mm 6mm	ABS PLASTIC W/B - R/W
08						
09		SUB-DISTRIBUTION BOARD CB	SUB-DISTRIBUTION BOARD 1004		6mm 6mm	ABS PLASTIC W/B
10		PHASE FAILURE CIRCUIT BREAKER	STATION PHASE FAILURE RELAY 010		6mm 6mm	ABS PLASTIC W/B
11		3 PHASE OUTLET CIRCUIT BREAKER	3Ø OUTLET 011		6mm 6mm	ABS PLASTIC W/B
12		1 PHASE OUTLET CIRCUIT BREAKER	1Ø GPO 012		6mm 6mm	ABS PLASTIC W/B
13		RTU LAPTOP CIRCUIT BREAKER	RTU LAPTOP GPO 013		6mm 6mm	ABS PLASTIC W/B
14		Spare CB	Spare Q14		6 6	W/B
15		Spare CB	Spare Q15		6 6	W/B
16		SWITCHBOARD LIGHTING CIRCUIT BREAKER	SWITCHBOARD LIGHTING 016		6mm 6mm	ABS PLASTIC W/B
17		RTU SURGE FILTER CIRCUIT BREAKER	RTU SURGE FILTER 017		6mm 6mm	ABS PLASTIC W/B
18		EM PUMP CONTROL & SIR CIRCUIT BREAKER	EM PUMPING CCT & SIR 018		6mm 6mm	ABS PLASTIC W/B
19		GENERATOR ANCILLARY SUPPLY CB	GENERATOR ANCILLARY SUPPLY 019		6mm 6mm	ABS PLASTIC W/B
20		Spare CB	Spare Q20		6 6	W/B
21	Q	VALVE PIT SUMP PUMP POWER SUPPLY CB	VALVE PIT SUMP PUMP Q21		6mm 6mm	ABS PLASTIC W/B
26		RTU POWER SUPPLY CIRCUIT BREAKER	RTU POWER SUPPLY Q30		6mm 6mm	ABS PLASTIC W/B
27		SURGE DIVERTER RELAY CIRCUIT BREAKER	SURGE DIVERTER RELAY Q31		6mm 6mm	ABS PLASTIC W/B
24		Spare CB	Spare Q32		6 6	W/B
29		SPARE CIRCUIT BREAKER	SPARE Q33		6mm 6mm	ABS PLASTIC W/B
31/32		PUMP CONTROL CIRCUIT BREAKER	PUMP No1 Q4-1	PUMP No2 Q5-1	6mm 6mm	ABS PLASTIC W/B
37		SURGE DIVERTER FUSES	SURGE DIVERTER FUSES 63A	FED FROM LINE SIDE OF MAIN SWITCH	6mm 6mm	ABS PLASTIC W/B - R/W
38		SURGE DIVERTERS	SURGE DIVERTERS	FED FROM LINE SIDE OF MAIN SWITCH	6mm 6mm	ABS PLASTIC W/B - R/W
39		SURGE DIVERTER ALARM RELAT	SDAR		6mm 6mm	ABS PLASTIC W/B
40		RTU SURGE REDUCTION FILTER	RTU SURGE REDUCTION FILTER		6mm 6mm	ABS PLASTIC W/B
41		PHASE FAILURE RELAY	ENERGEX MAINS POWER FAIL - PFRE	FED FROM LINE SIDE OF MAIN SWITCH	6mm 6mm	ABS PLASTIC W/B - R/W
43		PHASE FAILURE RELAY	STATION MAINS POWER FAIL - PFRS		6mm 6mm	ABS PLASTIC W/B
45		MAIN NEUTRAL LINK	MAIN NEUTRAL		6mm	ABS PLASTIC W/B
46		MAIN EARTH LINK	MAIN EARTH		6mm	ABS PLASTIC W/B
47		SUB-BOARD NEUTRAL LINK	NEUTRAL		6mm	ABS PLASTIC W/B
48		SUB-BOARD EARTH LINK	EARTH		6mm	ABS PLASTIC W/B
49		SURGE DIVERTER NEUTRAL LINK	NEUTRAL		6mm	ABS PLASTIC W/B
50		INSTRUMENT EARTH LINK	INSTRUMENT EARTH		6mm	ABS PLASTIC W/B
52) 53) 51		RTU FILTERED SUPPLY NEUTRAL LINK	FILTERED SUPPLY NEUTRAL		6mm 6mm	ABS PLASTIC W/B
54		LAPTOP GPO	LAPTOP GPO		6mm	ABS PLASTIC W/B
55	M	GENERATOR 240VAC CONNECTION SOCKET	GENERATOR ANCILLARY SUPPLY		6mm 6mm	ABS PLASTIC W/B
56	M	GENERATOR POWER CONNECTION SOCKET	GENERATOR CONNECTION		6mm 6mm	ABS PLASTIC W/B
59		PUMP SOFT STARTER	PUMP No1 1U1	PUMP No2 2U1	6mm 6mm	ABS PLASTIC W/B
60		PUMP SOFT STARTER KEYPAD	PUMP No1	PUMP No2	6mm	ABS PLASTIC W/B
62		LINE CONTACTOR	PUMP 1 1K1	PUMP 2 2K1	6mm 6mm	ABS PLASTIC W/B
63		BYPASS CONTACTOR	PUMP 1 1K2	PUMP 2 2K2	6mm 6mm	ABS PLASTIC W/B
65		PUMP S/STARTER FAULT RELAY	1K3	2K3	6mm	ABS PLASTIC W/B
66		PUMP1 RUN RELAY	1K4	2K4	6mm	ABS PLASTIC W/B
67		~~PUMP2 DELAY RUN TIMER~~	~~2T1~~		6mm	ABS PLASTIC W/B
68		PUMP POWER ON RELAY	1K5	2K5	6mm	ABS PLASTIC W/B

ITEM #	OPT.	DESCRIPTION	LABEL 1	LABEL 2 (IF NECESSARY)	TEXT HEIGHT	MATERIAL / COLOUR
73		PUMP RUN COMMAND RELAY	1K20	2K20	6mm	ABS PLASTIC W/B
74		PUMP FAULT RESET RELAY	1K21	2K21	6mm	ABS PLASTIC W/B
75		PUMP EMERGENCY MODE INTERRUPT RELAY	1K22	2K22	6mm	ABS PLASTIC W/B
76		PUMP START PUSHBUTTON	START	START	6mm	ABS PLASTIC W/B
77		PUMP STOP PUSHBUTTON	STOP	STOP	6mm	ABS PLASTIC W/B
78		PUMP EM.STOP PUSHBUTTON	EMERGENCY STOP	EMERGENCY STOP	6mm	ABS PLASTIC Y/B
79		PUMP RESET PUSHBUTTON	FAULT RESET	FAULT RESET	6mm	ABS PLASTIC W/B
80		PUMP HOURS RUN METER	HOURS RUN	HOURS RUN	6mm	ABS PLASTIC W/B
81/82	J	PUMP DE-CONTACTOR	PUMP No1	PUMP No2	6mm	ABS PLASTIC W/B
83/84	J	PUMP AUX CONTROL PLUG & SOCKET	PUMP No1	PUMP No2	6mm	ABS PLASTIC W/B
92		WET WELL HIGH LEVEL RELAY	WET WELL HIGH LEVEL - LR3		6mm 6mm	ABS PLASTIC W/B
93	Q	FLOWMETER PIT LEVEL RELAY	FLOWMETER PIT HIGH LEVEL - LR6		6mm 6mm	ABS PLASTIC W/B
95		SURCHARGE IMMINENT LEVEL RELAY	WET WELL SURCHARGE IMMINENT - SIR		6mm 6mm	ABS PLASTIC W/B
97		EMERGENCY PUMPING MODE PUMP 1 RELAY	EMG1		6mm	ABS PLASTIC W/B
98		SURCHARGE IMMINENT ON DELAY TIMER	SIOT		6mm	ABS PLASTIC W/B
99		EMERGENCY PUMPING MODE OFF DELAY TIMER	EMGOT		6mm	ABS PLASTIC W/B
100		EMERGENCY PUMPING MODE PUMP 2 TIMER	EMG2		6mm	ABS PLASTIC W/B
101		EMERGENCY PUMPING MODE START SWITCH	EMERGENCY PUMPING MODE	EMERGENCY PUMPING MODE	6mm 6mm	ABS PLASTIC W/B
117		SWITCHBOARD LIGHTING CONTROL RELAY	SLCR		6mm	ABS PLASTIC W/B
118		STATION LOCAL/REMOTE SELECTOR SWITCH	STATION CONTROL MODE		6mm	ABS PLASTIC W/B
119		ELECTRODES TEST RELAY	ETR		6mm	ABS PLASTIC W/B
121		WET WELL LEVEL INDICATOR	WET WELL LEVEL		6mm	ABS PLASTIC W/B
132	H	DELIVERY FLOWMETER TRANSMITTER	DELIVERY FLOWMETER		6mm	ABS PLASTIC W/B
134		WET WELL LEVEL ADJ. UNIT	PRIMARY WET WELL LEVEL		6mm	ABS PLASTIC W/B
137						
139		RTU 240VAC/24VDC POWER SUPPLY	RTU 24VDC POWER SUPPLY		6mm 6mm	ABS PLASTIC W/B
140	R	RADIO 24V/13.8VDC CONVERTER	24/12 VDC CONVERTER - RADIO		6mm 6mm	ABS PLASTIC W/B
143	R	RADIO	RADIO		6mm	ABS PLASTIC W/B
145	R	RADIO COAX SURGE PROTECTION	RADIO SURGE PROTECTION		6mm	ABS PLASTIC W/B
144		TELEMETRY UNIT	RTU		6mm	ABS PLASTIC W/B
147	I	MODEM	MODEM		6mm	ABS PLASTIC W/B

ITEM #	OPT.	DESCRIPTION	LABEL 1	LABEL 2 (IF NECESSARY)	TEXT HEIGHT	MATERIAL / COLOUR
149		RTU DISCONNECT PLUG	PLUG No??		6mm	ABS PLASTIC W/B
150		RTU DISCONNECT TERMINAL BLOCKS	PLUG No??		6mm	ABS PLASTIC W/B
		TERMINAL HEADER	RTU POWER SUPPLIES		6mm 6mm	ABS PLASTIC W/B
		TERMINAL HEADER	DIGITAL INPUTS DI1	DIGITAL INPUTS DI2	6mm 6mm	ABS PLASTIC W/B
		TERMINAL HEADER	DIGITAL INPUTS DI3		6mm 6mm	ABS PLASTIC W/B
		TERMINAL HEADER	DIGITAL OUTPUTS DO1	DIGITAL OUTPUTS DO2	6mm 6mm	ABS PLASTIC W/B
		TERMINAL HEADER	ANALOG INPUTS AI1	Analog Outputs AO1	6mm 6mm	ABS PLASTIC W/B
		HEADER LABEL (Above Circuit Breakers)	NON FILTERED SUPPLY		6mm 6mm	ABS PLASTIC W/B
		HEADER LABEL (Above Circuit Breakers)	FILTERED SUPPLY		6mm 6mm	ABS PLASTIC W/B
		HEADER LABEL (Incomer Section)	MEN BEHIND		6mm	ABS PLASTIC W/B
		HEADER LABEL (Over Terminals 600-613)	LEVEL TX AND LEVEL PROBES		6mm 6mm	ABS PLASTIC W/B
	M	GENERATOR INTERFACE TERMINALS	GENERATOR INTERFACE		6mm 6mm	ABS PLASTIC W/B
	F2	GENERATOR BOLTED CONNECTIONS	BUSBAR LIVE WHEN SWITCHBOARD ENERGISED FROM GENERATOR		6mm 6mm	ABS PLASTIC R/W
		INSPECTION PLATE LABELS - 2 OFF	INSPECTION PLATE DO NOT INSTALL GLANDS	FIX BY GLUEING ONLY	6mm 6mm	ABS PLASTIC W/B
		PUMP INFORMATION LABEL Label size to be approximately 150x50	SP087 SAINT ACHS STREET PUMPS ZONE ?? IMPELLER ??? kW ??		6mm	ABS PLASTIC W/B

EXTERNAL LABEL LIST

LABEL	TEXT	TEXT HEIGHT	PAINT FILL LETTERING	SIZE	QTY	OPT
A	SP087	20mm	Black	100x35	1	
B	RTU	10mm	Black	50x20	1	
C	PUMP CONTROL	10mm	Black	120x20	1	
D	WARNING THIS SITE IS MONITORED BY NETWORK CONTROL. PLEASE INFORM THE OPERATOR BEFORE ISOLATING PUMPS OR STATION	8mm	Black	250x80	2	
E	PLEASE CHECK THAT THE STATION IS IN REMOTE MODE BEFORE LEAVING SITE	8mm	Black	210x40	1	
F	COMMON CONTROL	10mm	Black	120x20	1	
I	MAIN SWITCHES	10mm	Black	120x20	1	
J	DISTRIBUTION BOARD	10mm	Black	150x20	1	
L	GENERATOR CONNECTIONS	10mm	Black	180x20	1	F
M	PUMP DE-CONTACTORS	10mm	Black	150x20	1	J
N	GENERATOR INLET	10mm	Black	120x20	1	F
O	BATTERIES	10mm	Black	80x20	1	
P	SUPPLY AUTHORITY METERING	10mm	Black	200x20	1	
Q	DANGER 415V	10mm	Black	100x20	1	
R	DANGER - 2 SOURSES OF SUPPLY	10mm	Red	220x20	1	
S	CABLE ZONE	10mm	Black	100x20	1	
Z	WARNING AND CONTACT No LABEL FREE ISSUE BY BRISBANE WATER-	8mm	Black	250x40	1	

EXTERNAL LABELS 1mm THICK. 316 GRADE STAINLESS STEEL.
FIXED WITH M3 316 STAINLESS STEEL METAL THREADS.

FIELD LABEL LIST

LABEL	TEXT	TEXT HEIGHT	PAINT FILL LETTERING	SIZE	QTY

DETAIL Q

Sheet 16

FOR CONSTRUCTION

No	DATE	AMENDMENT	DRN.	APD.
A	04.09	FOR CONSTRUCTION	P.H.	A.W.
O	01.09	FOR TENDER	P.H.	A.W.
P1	12.08	ISSUED FOR REVIEW	P.H.	A.W.

Reference Drawings

DRAFTED: P.HAGUE
DRAFTING CHECK: A.WITTHOFT
CAD FILE: 57-0101set_A
B.C.C. FILE No.

Original Signed by A.WITTHOFT 8895 14.1.09 — DESIGN R.P.E.Q. No. DATE
Original signed by R.JANFADA 5192 14.1.09 — DESIGN CHECK R.P.E.Q. No. DATE
Original Signed by K.VAHEESAN 15.1.09 — PRINCIPAL DESIGN MANAGER DATE
Original Signed by P.SHERRIFF 15.1.09 — CLIENT DELEGATE DATE

BRISBANE WATER

SITE: SP087 SAINT ACHS STREET SEWAGE PUMP STATION

TITLE: SWITCHBOARD LABEL SCHEDULE

SHEET No. 16
BRISBANE WATER DRAWING No. 486/5/7-0101-016 AMEND. A

STR TEMPLATE SP-2P-A3 Ver13

CONSTRUCTION - EXTERNAL SWITCHBOARD

Cubicle construction 3mm Marine grade Aluminium (5251).
Plinth construction 160x60 channel 6061 T6 Grade Aluninium.
Folded, "Pulse MIG" & "TIG welded with all visible seams and joints fully welded, free from splatter and ground smooth where needed.
External doors and covers fitted with Emka 1011-207 self grip seal.
Stainless Steel "D" Handles fitted where indicated on the drawings.
M6 Earth studs fixed to the interior of all doors and hinged escutcheons and on adjacent cubicle interior surfaces.
Door stiffeners, door stays, cable straps, and document holders etc fitted where shown on the drawings.
Door stiffeners to be ~~S/Steel and~~ of suffkent strength to prevent being deformed when subjected to reasonable loads. Minimum 3mm S/Steel.
Lift-off covers and mounting panels fixed with M8 studs & stainless steel dome nuts.
Gland plates manufactured from 3mm aluminium, unless otherwise shown.
Inspection/Access plates manufactured from 3mm aluminium.
Gland/Inspection/Access plate openings reinforced with 25x10mm flat aluminium bar. (Detail F)
Cable glands to be fitted with compression side installed within cubicle. (Detail G)
Gland/Inspection/Access plates to be fitted with seals attached to cubicle.
Gland/Inspection/Access plate fixings at 100mm.
Gland/Inspection/Access plates to maintain a 50mm clearance from section dividers.
Gland/Inspection/Access plates are NOT to be split.
Inspection/Access plates are NOT to be earthed.
Provide Shrouding to all live parts to IP20 where required.
Hinges (external) Selectrix HIB650ss-316. Stainless steel.
Star washers fitted under all hinge screws.
Hinged escutcheons fixed with Emka 1/4 turn 1000-U142
All equipment to be removable via front access.
Install switchboard with non-hydroscopic material between plinth and concrete slab. (Detail E1)
All escutcheons to open a minimum of 90°

Locks Doors 1-6, 8

CLOSETRADE - Swing Handle HW-HAND-FLUSH-SS-MS874.
CLOSETRADE - 3 point lock rod set HW-CAM-3PL-SET-3B4500-RG006-1
Lockwood 71 Barel Lock
Key Codes RC496A, RC496AB, RC496ABC refer to each door for clarification.

Locks Door 7

CLOSETRADE - Swing Handle HW-HAND-FLUSH-SS-PAD-35.
CLOSETRADE - 3 point lock rod set HW-CAM-3PL-SET-3B4500-RG006-1
ENERGEX padlock 45mm brass pin tumbler.
Energex Key No325. c/w 2 keys.

Locks Door 9

CLOSETRADE - Swing Handle HW-HAND-FLUSH-SS-MS874.
CLOSETRADE - 3 point lock rod set HW-CAM-3PL-SET-3B4500-RG006-1-316SS (all S/Steel)
Lockwood 71 Barel Lock, Key Code RC496AB

OPERATING PARAMETERS

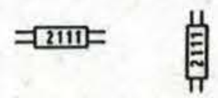
Standard	AS 3439.1
Current & Frequency	AC 50Hz
Rated Operational Voltage Ue	415 VAC
Rated Insulation Voltage Ui	660 V
Rated Auxiliary Voltage	240 VAC / 24 VDC
Rated Current (Main Bus)	300 AMPS
Short Circuit Current Isc	20 kA
Duration of Isc	.2 sec
Degree of Protection	IP 56 to AS 1939
Measure of Protection by barriers and enclosures.	
Service Conditions	Outdoors
Mass	Not exceeding 2000kg
Forms of Segregation	Form 1
Earthing System	TN-S

PAINTING

Aluminium Surface Preparation.
Finish smooth all exposed welds, clean, descale, and degrease all surfaces.
Surfaces pretreatment in accordance with AS 1580 & AS 3715 using Novox LF acid etch cleaner, Novacoat 12 conversion coating, & clean water rinses.
Apply DULUX ALPHATECH 3000 powder coat to manufacturer's recommendations.
CUBICLE & EXTERNAL COMPONENTS :- DULUX Mist Green (36648) matt finish.
INTERIOR ITEMS (mounting panels, escutcheons, etc) :- DULUX Bright White (32166)
Minimum Dry Film Thickness all surfaces 50 microns.

WIRING

All wiring to be PVC V90 HT 0.6/1Kv Grade with tinned conductor.
Control and instrumentation wiring has flexible copper conductors, and is colour coded as detailed below, numbered each end, and terminated by the use of appropriate pre-insulated crimp lugs or pins.
Separate lugs or pins shall be used for each conductor.
Use proprietary bridging links when required to common up terminals.
Not more than two wires shall be connected to any terminal.
Not more than one wire shall be connected on one side of any tunnel type terminal.
Where multiple connections are required on tunnel terminals, proprietary terminal link bars shall be used.
Power wiring to be minimum 2.5sqmm stranded copper conductors, phase colour coded as detailed below.
Control wiring to be minimun 1.0sqmm flexible copper conductors, colour coded as detailed below.
Low level control signals to be minimum 0.5sqmm flexible copper conductors. colour coded as detailed below.
4-20mA analog signals (internal & external) wired in shielded pair minimum size 0.5sqmm, and earthed at one end only. (Switchboard end for external signals)
All 240VAC wiring in the RTU or PLC sections shall be double insulated and all terminals shall be shouded and labelled- 'Danger 240VAC'
Earth cables minimum 2.5sqmm flexible.
Doors and hinged escutcheons bonded with flexible tinned copper braiding.
Switchboard to have dedicated earthing cable bonding directly to main earth bar.
Ensure mininum clearance of 100mm is maintained between cable ducting & gland plates.
Wire numbering will be equal to Grafoplast SI2000 system.
Terminal strips to be mounted 30mm off equipment panel to aid termination.
Wire numbers are readable left to right,bottom to top as shown.



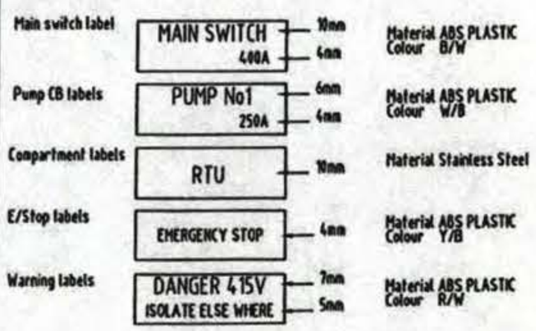
Refer to sheet 17 for coding details for RTU disconnection plugs.
Coding pins must be fitted to both the disconnect plug and terminal block.
Switchboard frame to be bonded to Main Earth bar

COLOUR CODE

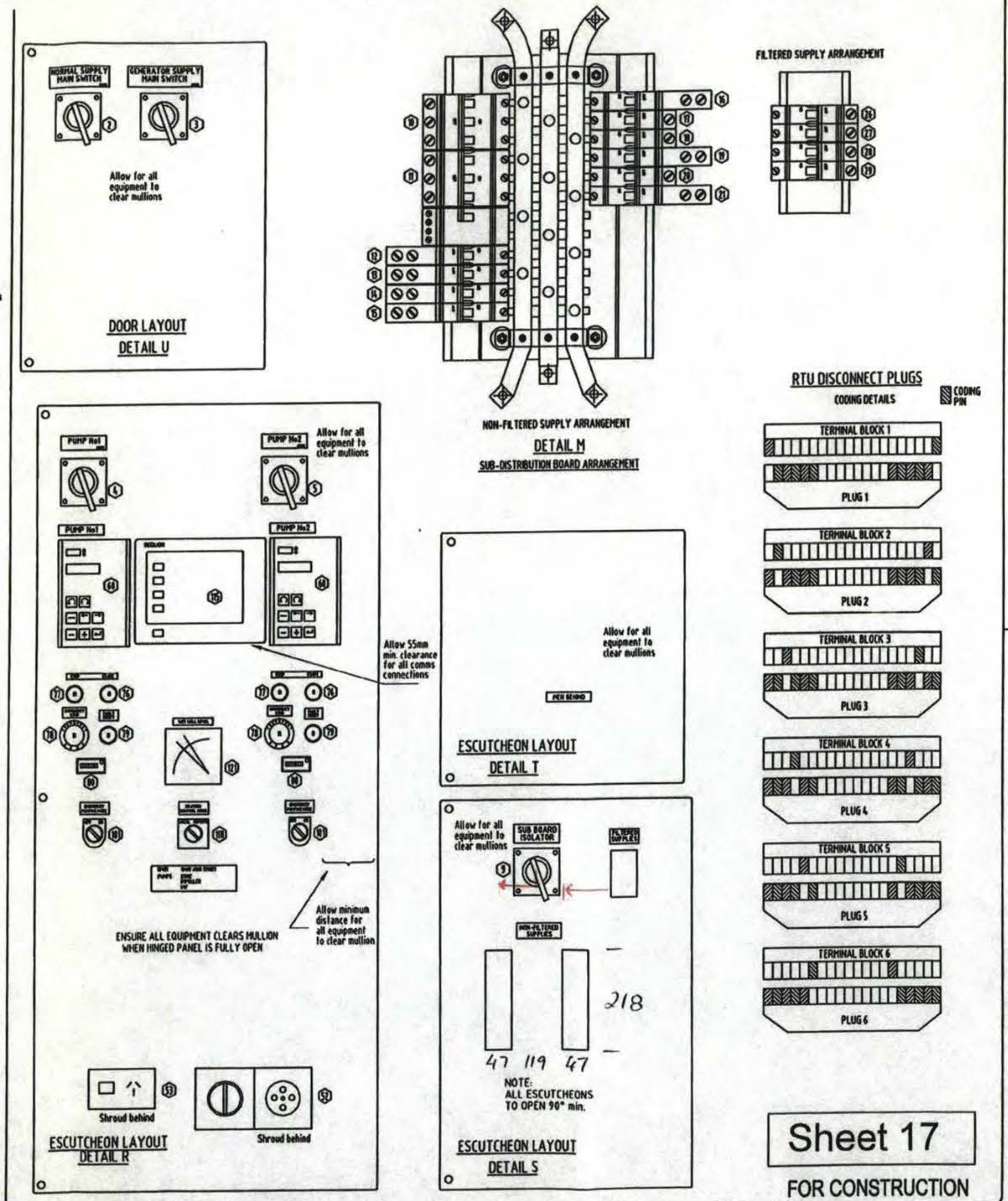
Phase wiring (A,B &C)	Red, White, Blue	2.5sqmm (min)
Potential Metering (240/415 VAC)	Red, White, Blue, Black	1.5sqmm
Current Metering (Secondary)	Red, White, Blue, Grey	2.5sqmm
240 VAC Control Active	Red	1.0sqmm
240 VAC Neutral	Black	1.0sqmm
24 VDC Positive supplies	Orange	1.0sqmm
24 VDC Negative supplies	Violet	1.0sqmm
General 24 VDC Wiring	Grey	1.0sqmm
RTU & PLC Wiring	Grey	0.5sqmm
Electrode Wiring	Salmon	1.0sqmm
Intrinsically safe wiring	Light Blue	1.5sqmm
Earth	Green/Yellow	2.5sqmm (min)
Door & Escutcheon Earth Bonds	Green/Yellow	4 sqmm

LABELS

Internal labels W/B engraved ABS PLASTIC to label schedule.
Warning labels R/W engraved ABS PLASTIC to label schedule.
E/Stop labels Y/B engraved ABS PLASTIC to label schedule.
First letter = Background colour, Second letter = Lettering colour.



Internal labels secured by M3 chrome plated metal threads.
CB's to be identified with individual labels as per label schedule.
Labels obstructed by switchboard wiring are relocated to adjacent duct lid and secured by M3 nylon threads. Lid to be secured by a single cable tie at one corner.
External labels 1mm thick 316 grade s/steel secured by M3 316 s/steel metal threads.
All internal and external labels are to have bevelled edges.



Sheet 17

FOR CONSTRUCTION

No	DATE	AMENDMENT	DRN.	APD.
A	04.09	FOR CONSTRUCTION	P.H.	A.W.
O	01.09	FOR TENDER	P.H.	A.W.
P1	12.08	ISSUED FOR REVIEW	P.H.	A.W.

Reference Drawings

DRAFTED	P.HAGUE
DRAFTING CHECK	A.WITTHOFT
CAD FILE	57-0101set_A
B.C.C. FILE No.	

Original Signed by A.WITTHOFT	6895	14.1.09
DESIGN	R.P.E.Q. No.	DATE
Original signed by R.JANFADA	5192	14.1.09
DESIGN CHECK	R.P.E.Q. No.	DATE

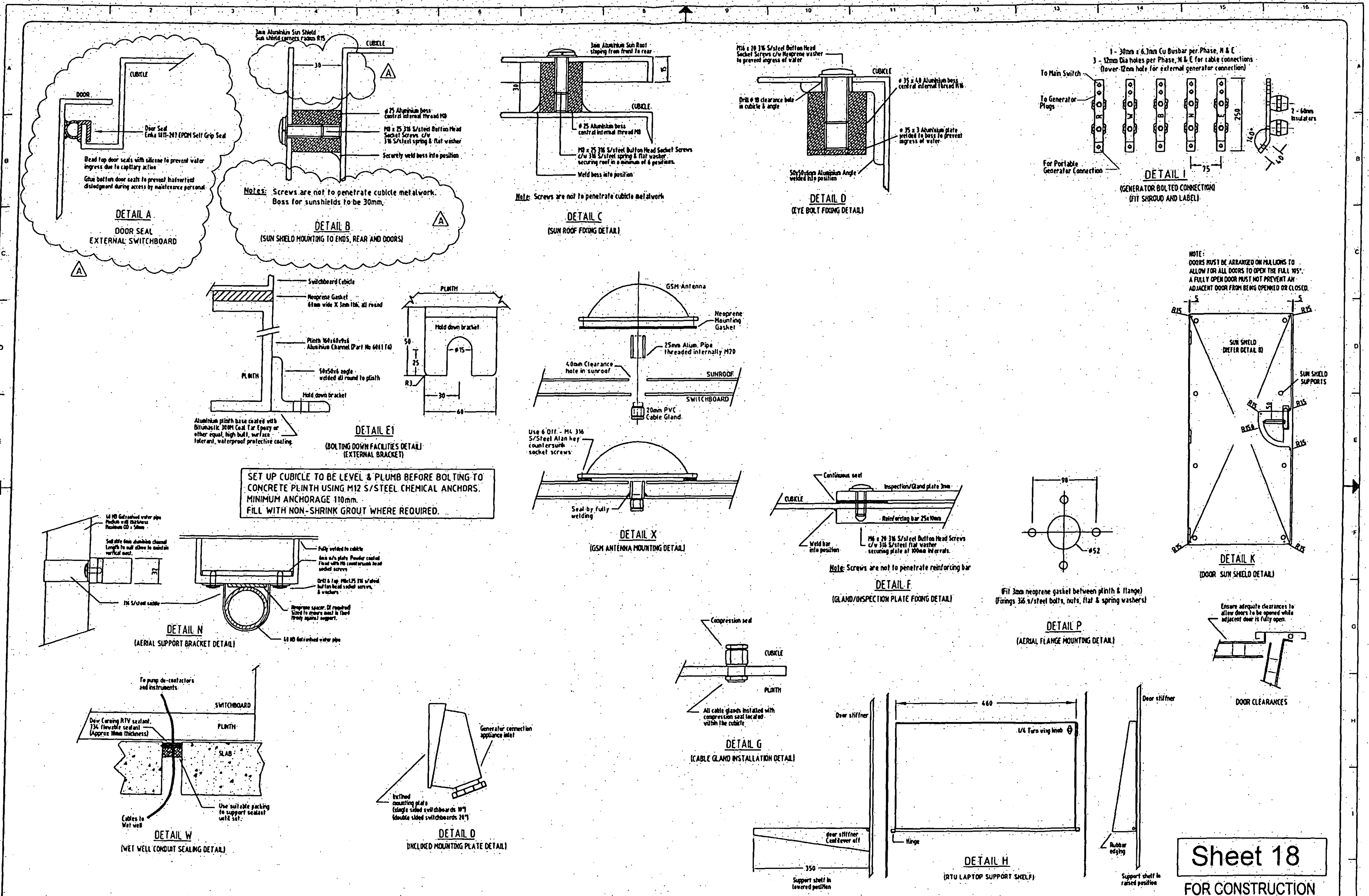
Original Signed by K.VAHEESAN	15.1.09
PRINCIPAL DESIGN MANAGER	DATE
Original Signed by P.SHERRIFF	15.1.09
CLIENT DELEGATE	DATE

BRISBANE WATER

SITE
SP087
SAINT ACHS STREET
SEWAGE PUMP STATION

TITLE
SWITCHBOARD
CONSTRUCTION DETAILS

SHEET No. 17
BRISBANE WATER DRAWING No. 486/5/7-0101-017
AMEND. A



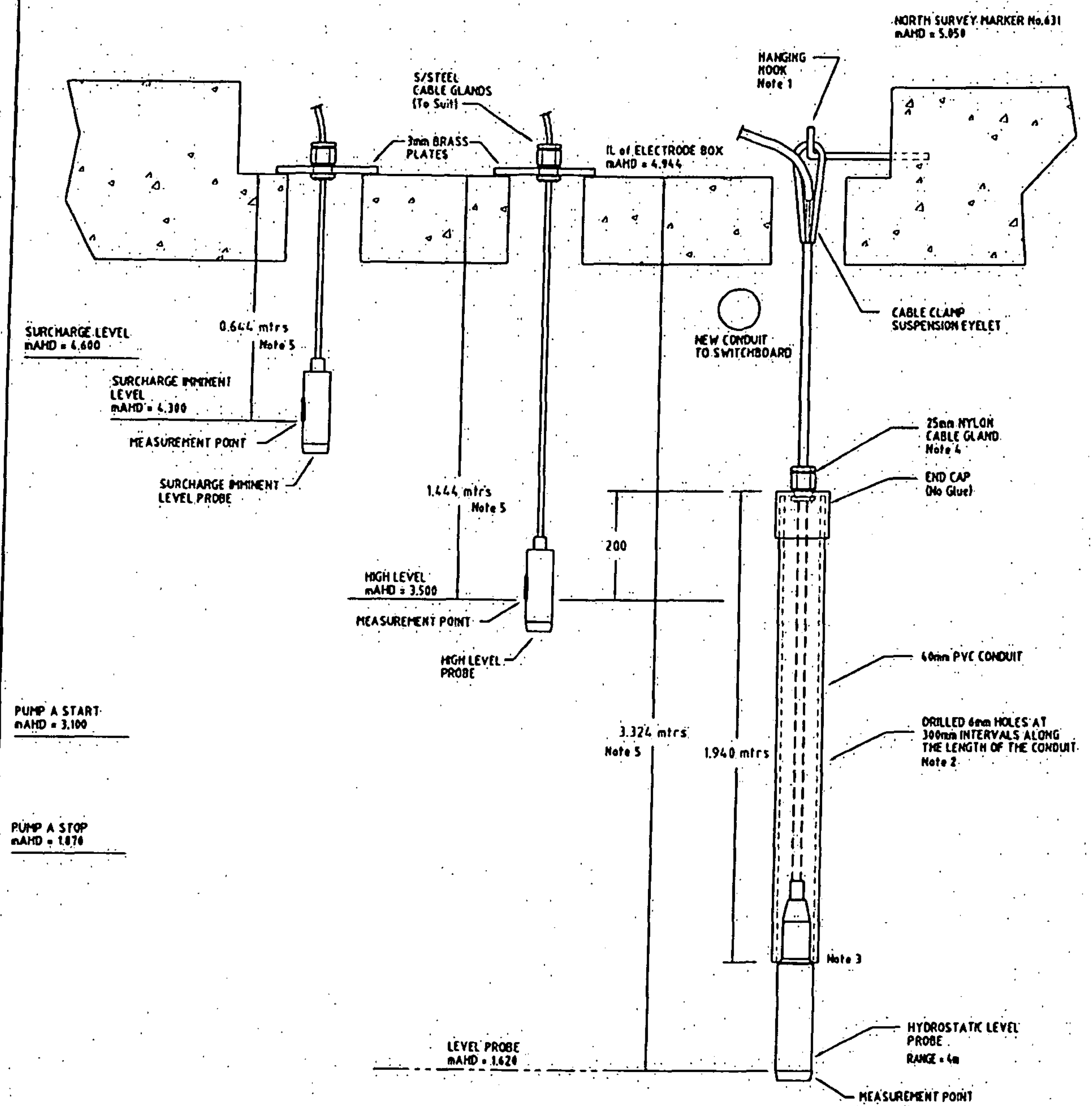
A	04.09	FOR CONSTRUCTION	P.H.	A.W.	DRAFTED	P.HAQUE
O	01.09	FOR TENDER	P.H.	A.W.	DRAFTING CHECK	A.WITTHOFT
P1	12.08	ISSUED FOR REVIEW	P.H.	A.W.	CAD FILE	57-0101001_A
No	DATE	AMENDMENT	DRN.	APD.	B.C.C. FILE No.	

Original Signed by A.WITTHOFT 6695 14.1.09 — DESIGN R.P.E.Q. No. DATE
Original signed by R.JANFADA 5192 14.1.09 — DESIGN CHECK R.P.E.Q. No. DATE
Original Signed by K.VAHEESAN 15.1.09 — PRINCIPAL DESIGN MANAGER DATE
Original Signed by P.SHERRIFF 15.1.09 — CLIENT DELEGATE DATE

SITE: SP087 SAINT ACHS STREET SEWAGE PUMP STATION

TITLE: SWITCHBOARD CONSTRUCTION DETAILS

SHEET No. 18 — BRISBANE WATER DRAWING No. 486/5/7-0101-018 — AMEND. A



LEVEL PROBE INSTALLATION NOTES

1. Install stainless steel hanging hook for the suspension of the hydrostatic probe.
2. Drill 4 x 6mm holes; 150mm from each end and every 300mm of the cut length, prior to installation.
3. Install so that the conduit rests on the shoulder of the probe. Do not glue the conduit to the end cap.
4. Install a 25mm nylon cable gland. Apply no compression to cable.
5. Measurements are to be taken from bottom of the electrode box to 'measurement points' on probes

	QTY	MATERIALS LIST
1	1	LENGTH OF HEAVY DUTY ORANGE PVC CONDUIT 40mm
2	1	CONDUIT END CAP
3	2	25mm NYLON CABLE GLAND
4	3	CABLE CLAMP SUSPENSION EYELET

Sheet 19

FOR CONSTRUCTION

No	DATE	AMENDMENT	DRN.	APD.
A	04.09	FOR CONSTRUCTION	P.H.	A.W.
0	01.09	FOR TENDER	P.H.	A.W.
P1	12.08	ISSUED FOR REVIEW	P.H.	A.W.

Reference Drawings

DRAFTED	P.HAQUE
DRAFTING CHECK	A.WITTHOFT
CAD FILE	67-0101set_A
B.C.C. FILE No.	

Original Signed by A.WITTHOFT	6895	14.1.09
DESIGN	R.P.E.Q. No.	DATE
Original signed by R.JANFADA	5192	14.1.09
DESIGN CHECK	R.P.E.Q. No.	DATE

Original Signed by K.VAHEESAN	15.1.09
PRINCIPAL DESIGN MANAGER	DATE
Original Signed by P.SHERRIFF	15.1.09
CLIENT DELEGATE	DATE

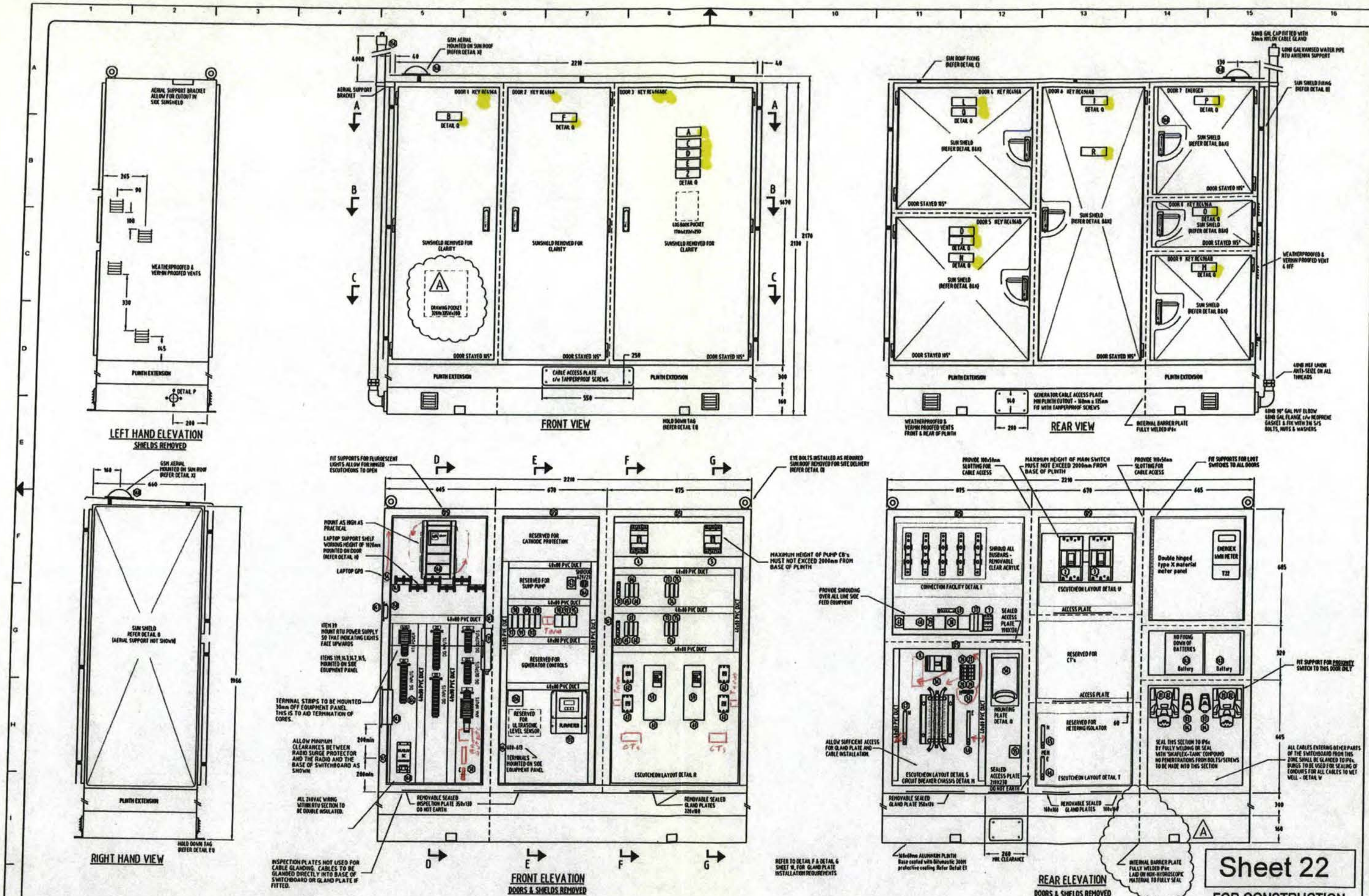
BRISBANE WATER

SITE
SP087
SAINT ACHS STREET
SEWAGE PUMP STATION

TITLE
LEVEL PROBES
INSTALLATION DETAILS

SHEET No. 19

BRISBANE WATER DRAWING No.	AMEND.
486/5/7-0101-019	A



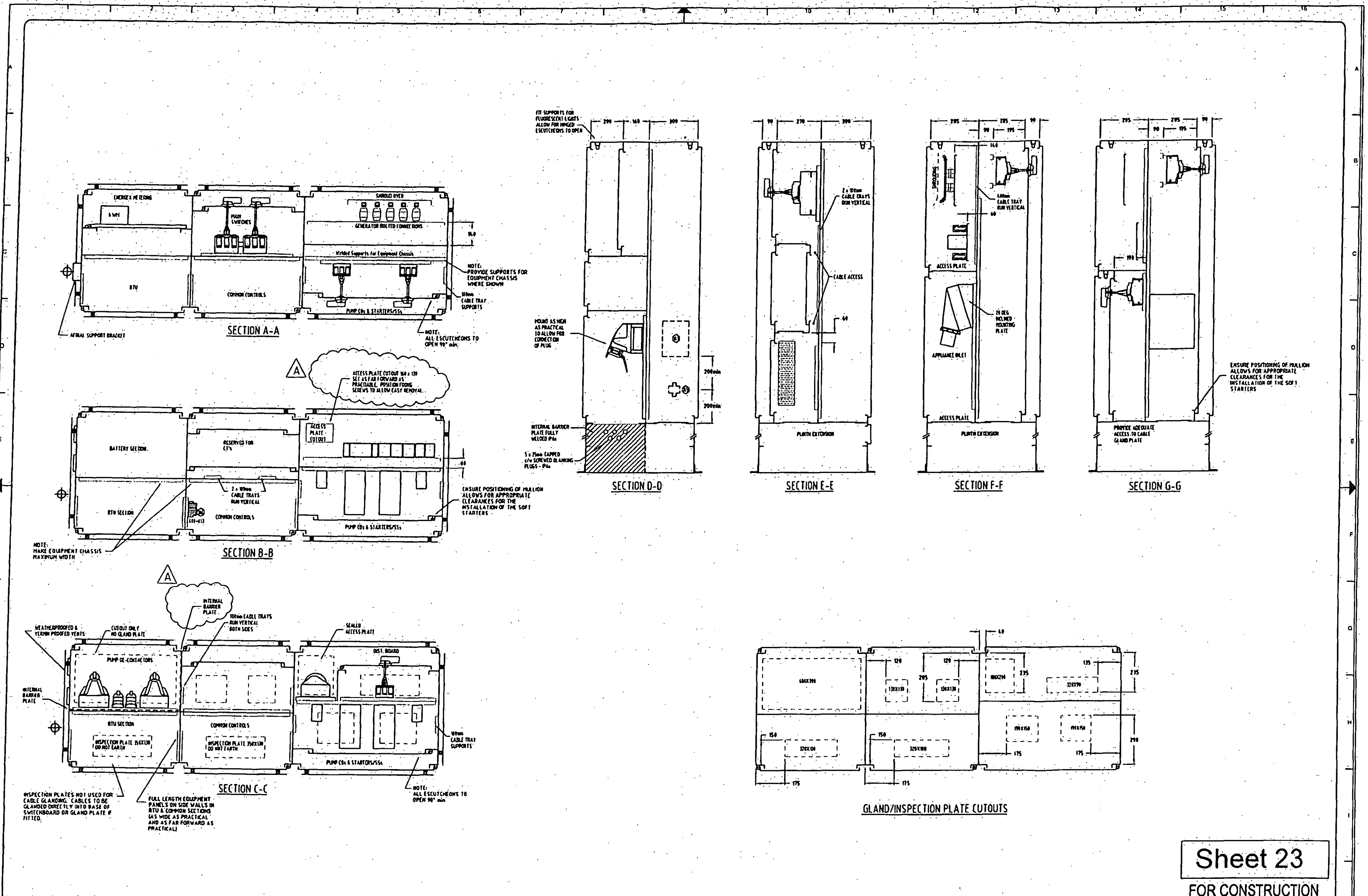
A	04.09	FOR CONSTRUCTION	P.H.	A.W.
O	01.09	FOR TENDER	P.H.	A.W.
P1	12.08	ISSUED FOR REVIEW	P.H.	A.W.
No	DATE	AMENDMENT	DRN.	APD.

DRAFTED: P.HAGUE
DRAFTING CHECK: A.WITTHOFT
CAD FILE: 57-0101mat_A
B.C.C. FILE No.

SITE: SP087 SAINT ACHS STREET SEWAGE PUMP STATION

TITLE: SWITCHBOARD GENERAL ARRANGEMENT ELEVATIONS

SHEET No. 22
BRISBANE WATER DRAWING No. 486/5/7-0101-022
AMEND. A



Sheet 23

FOR CONSTRUCTION

A	04.09	FOR CONSTRUCTION	P.H.	A.W.
O	01.09	FOR TENDER	P.H.	A.W.
P1	12.08	ISSUED FOR REVIEW	P.H.	A.W.
No	DATE	AMENDMENT	DRN.	APD.

DRAFTED	P.HAQUE
DRAFTING CHECK	A.WITTHOFT
CAD FILE	87-0101set_A
B.C.C. FILE No.	

Original Signed by A.WITTHOFT 8895 14.1.09 — DESIGN R.P.E.Q. No. DATE

Original signed by R.JANFADA 5192 14.1.09 — DESIGN CHECK R.P.E.Q. No. DATE

Original Signed by K.VAHEESAN 15.1.09 — PRINCIPAL DESIGN MANAGER DATE

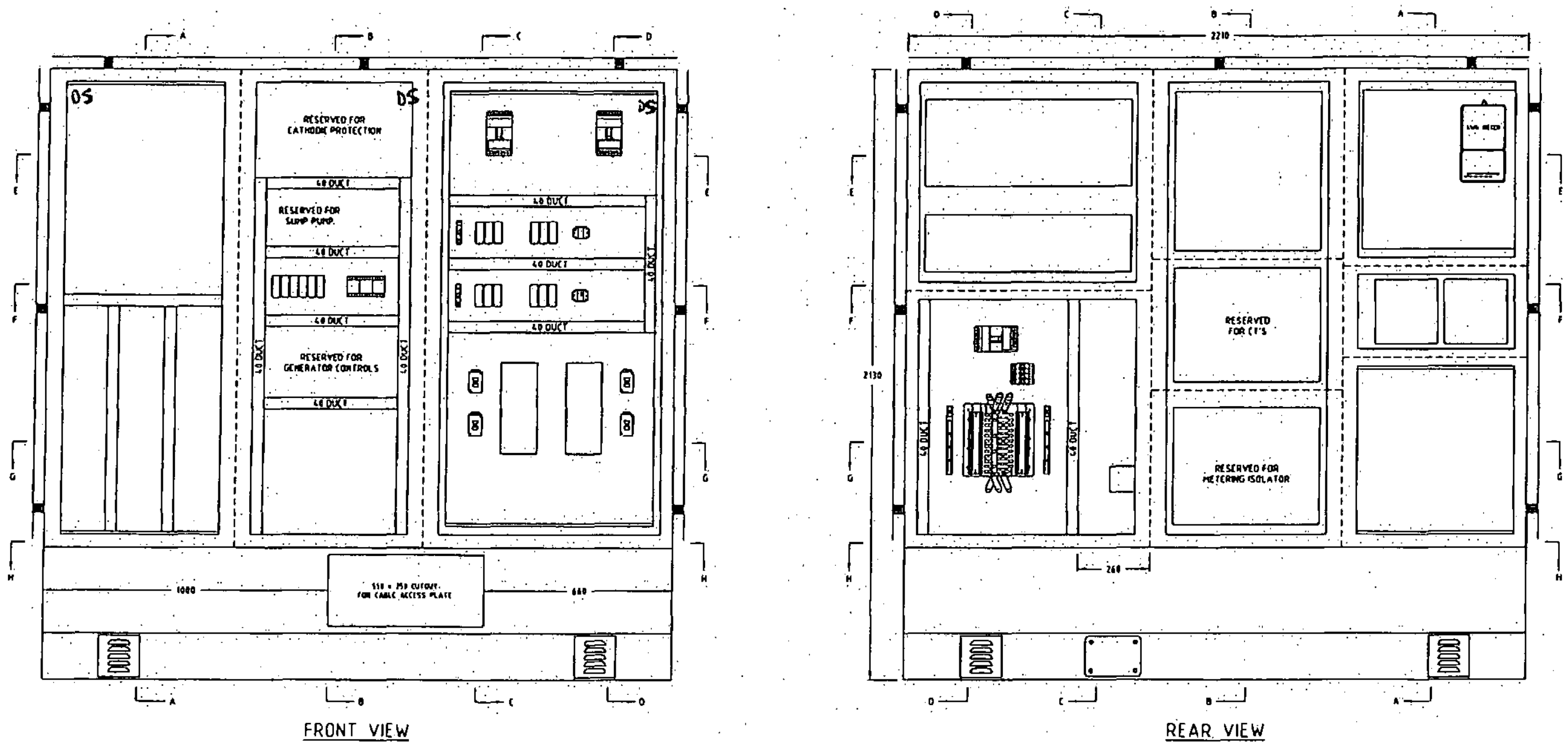
Original Signed by P.SHERRIFF 15.1.09 — CLIENT DELEGATE DATE

SITE: SP087 SAINT ACHS STREET SEWAGE PUMP STATION

TITLE: SWITCHBOARD GENERAL ARRANGEMENT SECTIONS

SHEET No. 23

BRISBANE WATER DRAWING No. 486/5/7-0101-023 AMEND. A



FILE NAME:

HAVE YOU ASSESSED THE RISK ASSOCIATED WITH THIS WORK?
REPORT PROMPTLY ANY CONDITION LIABLE TO CAUSE AN ACCIDENT REMEMBER
YOU ARE RESPONSIBLE FOR YOUR SAFETY

LAST AMENDMENT DATE:

LETTER	DESCRIPTION	DATE	AM'D BY	CHK'D

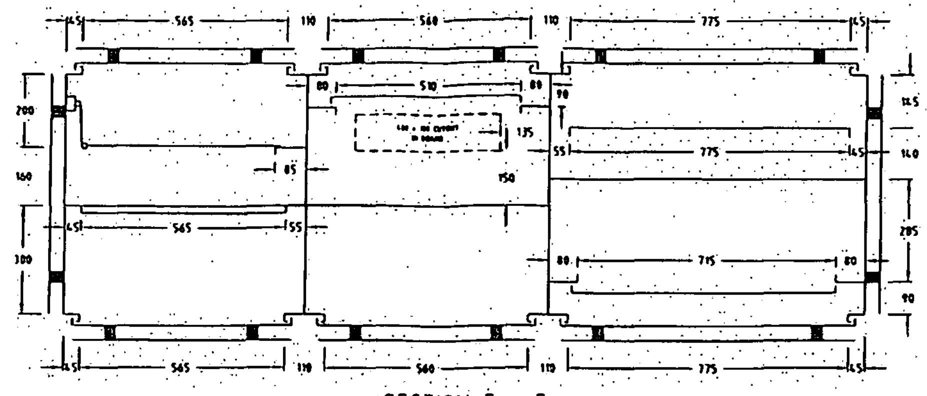
SCALE	N.T.S.
DESIGNED	B.J.
TRACED	M.W.
CHECKED	
DATE	07-05-09
APPROVED	
CLIENT NAME	TENIX
JOB No.	C34100

J. & P. RICHARDSON
INDUSTRIES PTY LTD – 114 CAMPBELL AVE WACOL 4076 ELECTRICAL CONTRACTORS & ENGINEERS ABN 23 001 952 325 PH(07)3271 2911 Fax(07)3271 3623 Email JPR@JPR.COM.AU

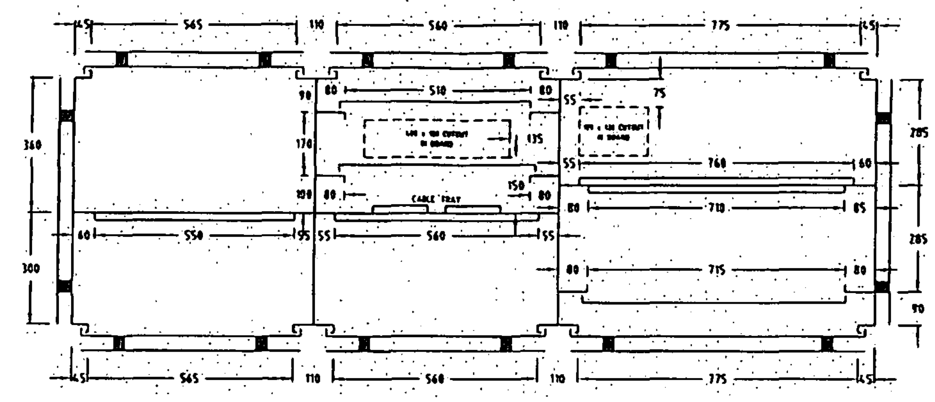
TITLE
SP087 SAINT ACHS STREET
SEWAGE PUMP STATION
SWITCHBOARD
GENERAL ARRANGEMENT

DRAWING No
E09-C34100/A0

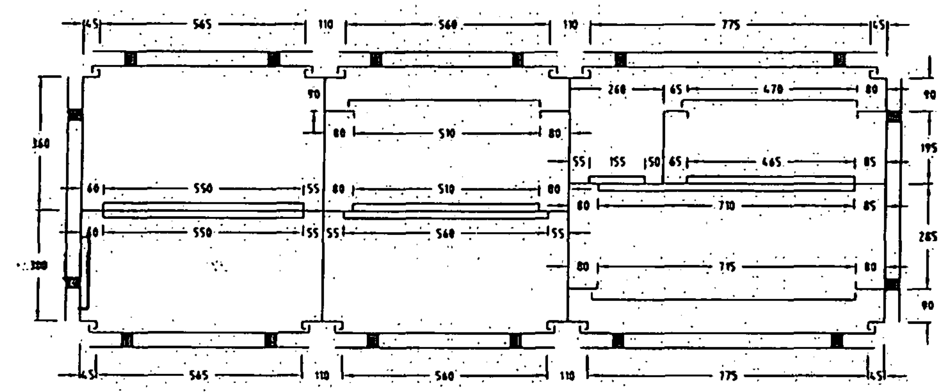
AMENDMENT



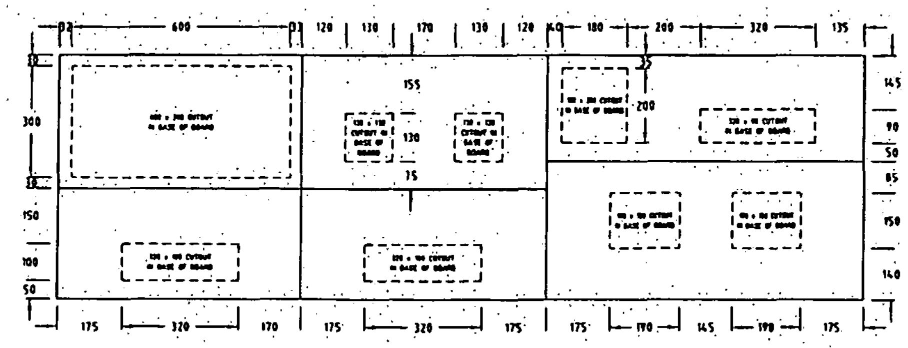
SECTION E - E



SECTION F - F



SECTION G - G



SECTION H - H

FILE NAME:

HAVE YOU ASSESSED THE RISK ASSOCIATED WITH THIS WORK?
REPORT PROMPTLY ANY CONDITION LIABLE TO CAUSE AN ACCIDENT REMEMBER
YOU ARE RESPONSIBLE FOR YOUR SAFETY

LAST AMENDMENT DATE:

LETTER	DESCRIPTION	DATE	AM'D BY	CHK'D

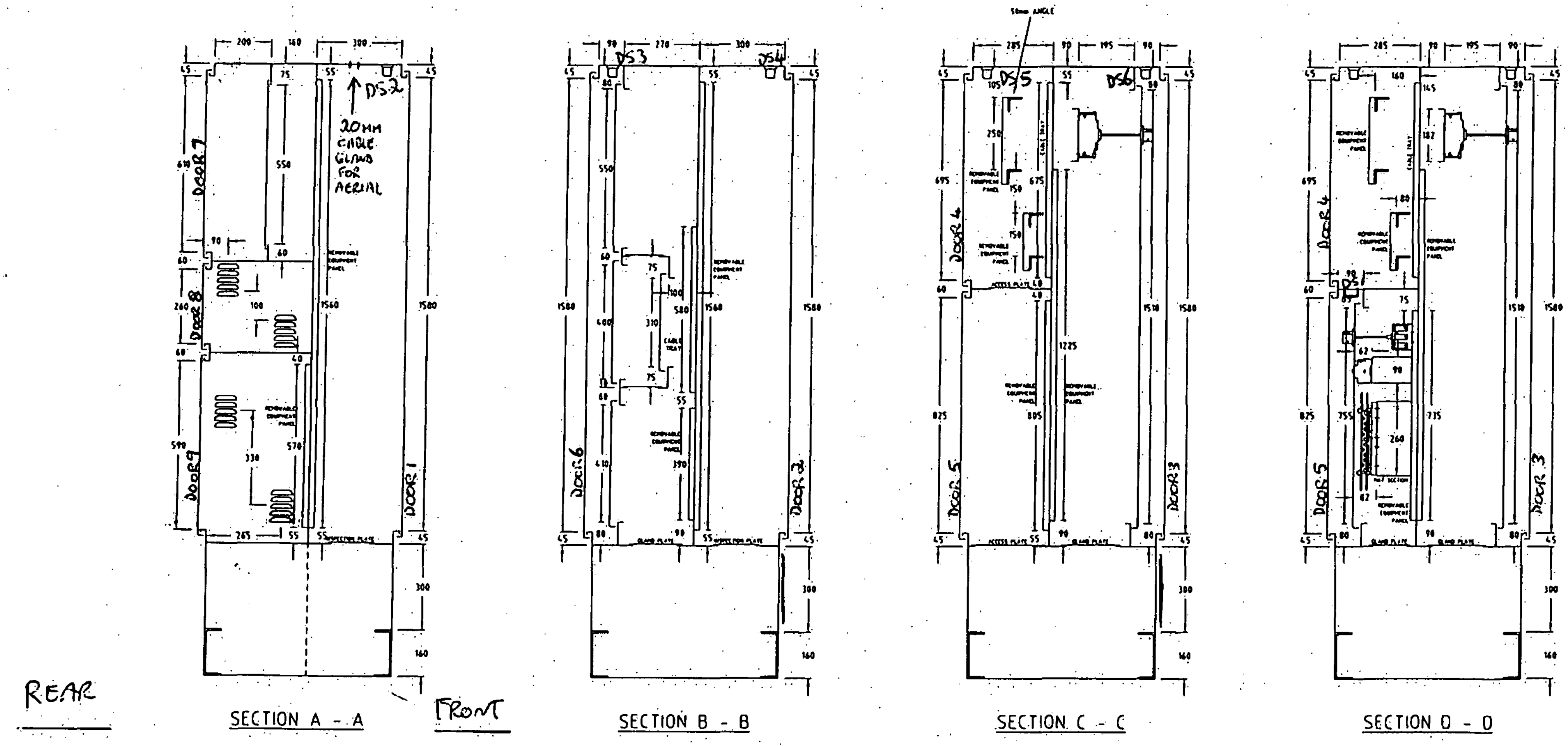
SCALE	N.T.S.
DESIGNED	B.J.
TRACED	M.W.
CHECKED	
DATE	07-05-09
APPROVED	
CLIENT NAME	TENIX
JOB No.	C34100

J. & P. RICHARDSON
INDUSTRIES PTY LTD – 114 CAMPBELL AVE WACOL 4076
ELECTRICAL CONTRACTORS & ENGINEERS ABN 23 001 952 325
Ph(07)3271 2911 Fax(07)3271 3623 Email JPR@JPR.COM.AU

TITLE
SP087 SAINT ACHS STREET
SEWAGE PUMP STATION
SWITCHBOARD
GENERAL ARRANGEMENT

DRAWING No
E09-C34100/A1

AMENDMENT



FILE NAME:

HAVE YOU ASSESSED THE RISK ASSOCIATED WITH THIS WORK? REPORT PROMPTLY ANY CONDITION LIABLE TO CAUSE AN ACCIDENT REMEMBER YOU ARE RESPONSIBLE FOR YOUR SAFETY

LAST AMENDMENT DATE:

LETTER	DESCRIPTION	DATE	AM'D BY	CHK'D

SCALE	N.T.S.
DESIGNED	B.J.
TRACED	M.W.
CHECKED	
DATE	07-05-09
APPROVED	
CLIENT NAME	TENIX
JOB No.	C34100

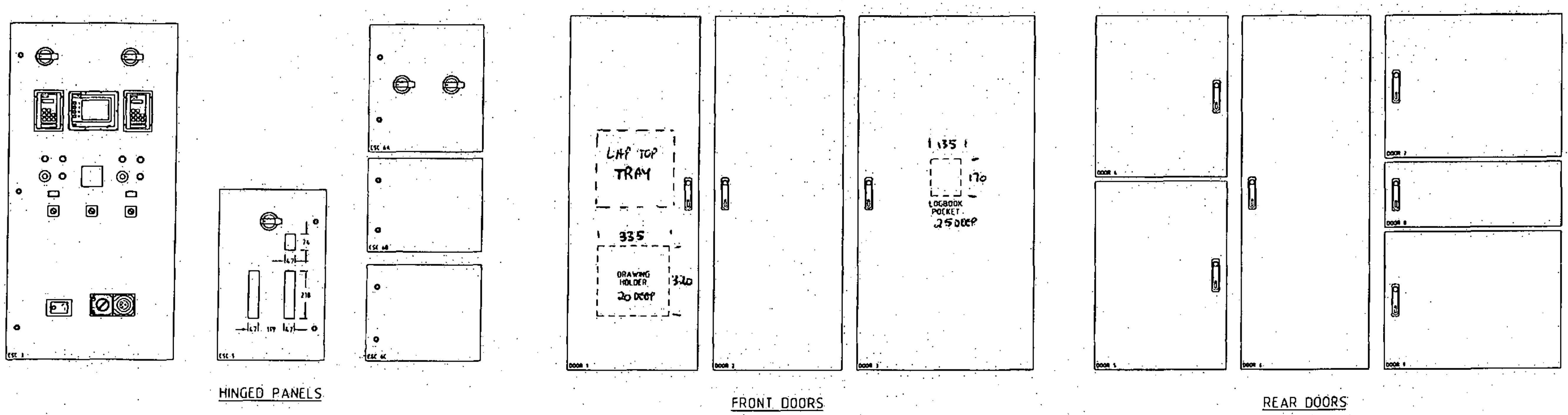
J. & P. RICHARDSON

INDUSTRIES PTY LTD - 114 CAMPBELL AVE WACOL 4076 ELECTRICAL CONTRACTORS & ENGINEERS. ABN 23 001 952 325 Ph(07)3271 2911 Fax(07)3271 3623 Email JPR@JPR.COM.AU

TITLE
SP087 SAINT ACHS STREET
SEWAGE PUMP STATION
SWITCHBOARD
GENERAL ARRANGEMENT

DRAWING No.
E09-C34100/A2

AMENDMENT



FILE NAME:

HAVE YOU ASSESSED THE RISK ASSOCIATED WITH THIS WORK?
REPORT PROMPTLY ANY CONDITION LIABLE TO CAUSE AN ACCIDENT REMEMBER.
YOU ARE RESPONSIBLE FOR YOUR SAFETY

LAST AMENDMENT DATE:

LETTER	DESCRIPTION	DATE	AM'D. BY	CHK'D

SCALE	N.T.S.
DESIGNED	B.J.
TRACED	M.W.
CHECKED	
DATE	07-05-09
APPROVED	
CLIENT NAME	IENIX
JOB No.	C34100

J. & P. RICHARDSON INDUSTRIES PTY LTD – 114 CAMPBELL AVE WACOL 4076
ELECTRICAL CONTRACTORS & ENGINEERS ABN 23 001 952 325
Ph(07)3271 2911 Fax(07)3271 3623 Email JPR@JPR.COM.AU

TITLE
SP087 SAINT ACHS STREET
SEWAGE PUMP STATION
SWITCHBOARD
GENERAL ARRANGEMENT

DRAWING No
E09-C34100/A3

AMENDMENT

APPENDIX C – HYDROSTATIC TESTING RECORDS

C1 - Rob Carr Pty Ltd

SEWER MAIN PRESSURE TEST

NATA

M & D Pipe Testing Pty Ltd
ACN: 124 334 201
NATA ACCREDITED
13 Casablanca Court
Burleigh Waters. QLD. 4220.
0424 309 234

This document is issued in accordance with NATA's accreditation requirements.

CLIENT Rob Carr Pty Ltd

LOCATION: St Vincent Rd. Banyo.

PLAN No.: 486/5/6-0024-006
REV.: 0
DATE: 13-11-2008
APPROVAL: JVH

INSPECTION DATE: 29-6-2008

REMARKS: Tested to WASA specifications

INSPECT. RESULT: Pass

AUTHORISED SIGNATORY: ....

SIGNATORY NAME: MATTHEW YOUNG

DATE OF ISSUE: 6-7-2009

INSPECTION REPORT NUMBER: 00000SM97

PROCEDURE DOCUMENT NUMBER: PROC0004

INSPECTION DETAILS

LOCATION: St Vincent Rd, Banyo.

LINE DETAILS	MH 1/01 to MH 1A/01	MH 1A/01 to MH 2/01	MH 2/01 to MH 3/01	MH 3/01 to MH 4/01	MH 4/01 to MH 5/01
PIPE DIAMETER	400mm	400mm	400mm	400mm	400mm
PIPE LENGTH	4 metres	100.538 metres	99.424 metres	93.945 metres	18.344 metres
PIPE MATERIAL TYPE	Keramo VC	Keramo VC	Keramo VC	Keramo VC	Keramo VC
TEST PRESSURE	23.6kPa	23.6kPa	23.6kPa	23.6kPa	23.6kPa
TIME TO DROP 7kPA	>10 minutes	>21 minutes	>21 minutes	>21 minutes	>10 minutes
RESULT	Pass	Pass	Pass	Pass	Pass

AUTHORISED SIGNATORY: ....

SIGNATORY NAME: MATTHEW YOUNG

DATE: 25-6-2009..

C2 - Dormway Pty Ltd

DORMWAY SEWER PRESSURE TESTING

Project ST ACHS BANYO SEWER **Job No** 2253

Job Address

Test Duration (sec)	Test Pressure (kPa)	Allowable Loss (kPa)
20MINS	-45KPA	2 KPA.

Date	Dia (mm)	Location (eg M/H 1 to M/H 2)		Time (sec)	Pressure Start	Pressure Finish	Pass	Fail
30-6-09	DN450	M/H 5/1	M/H 6/1	1200	-45 kPa	-45 kPa	✓	
12-5-09	DN450	M/H 6/1	M/H 7/1	1200	-45 kPa	-45 kPa	✓	
12-5-09	DN 450	M/H 7/1	M/H 8/1	3600	-45 kPa	-44 kPa	✓	
11-5-09	DN450	M/H 8/1	M/H 9/1	3600	-45 kPa	-45 kPa	✓	
22-5-09	DN450	M/H 9/1	M/H 10/1	1200	-45 kPa	-45 kPa	✓	
22-5-09	DN450	M/H 10/1	M/H 11/1	1200	-45 kPa	-45 kPa	✓	
22-5-09	DN450	M/H 11/1	M/H 12/1	1200	-45 kPa	-45 kPa	✓	
30-6-09	DN450	M/H 12/1	M/H 13/1	1200	-45 kPa	-45 kPa	✓	
30-6-09	DN450	M/H 13/1	M/H 14/1	1200	-45 kPa	-45 kPa	✓	
30-6-09	DN450	M/H 14/1	M/H 15/1	1200	-45 kPa	-45 kPa	✓	
30-6-09	DN450	M/H 15/1	M/H 16/1	1200	-45 kPa	-45 kPa	✓	
9-7-09	DN450	M/H 16/1	M/H 17/1	1200	-45 kPa	-45 kPa	✓	
9-7-09	DN450	M/H 16/1	M/H OVERFLOW	1200	-45 kPa	-45 kPa	✓	
		M/H	M/H		kPa	kPa		
		M/H	M/H		kPa	kPa		
		M/H	M/H		kPa	kPa		
		M/H	M/H		kPa	kPa		
		M/H	M/H		kPa	kPa		
		M/H	M/H		kPa	kPa		
		M/H	M/H		kPa	kPa		
		M/H	M/H		kPa	kPa		
		M/H	M/H		kPa	kPa		
		M/H	M/H		kPa	kPa		
		M/H	M/H		kPa	kPa		
		M/H	M/H		kPa	kPa		

Comments: TEST PRESSURE -45KPA FOR 20MIN
ALLOWABLE LOSS 2KPA.

Dormway Representative: **Sign Name:**

Client Representative: FRANK TONKING **Sign Name:** F. Tonking

253

PIPELINE TESTING SERVICES

a division of RT & DM Spring Pty Ltd (as trustee for Spring Family Trust)
QBSA Lic No 45799 ACN 009 976 550 ABN 90 779 113 321
31 Smallwood Street Underwood QLD 4119
Ph: 07 3841 5100 Fax: 07 3219 0659

NATA

Customer: Dormway Pty Ltd
39 Kenway Crescent
UNDERWOOD QLD 4119

Job No: 57200

Job Address: *St Achs Street*
NUDGEE

Client Order No: 28/07/09

Appointment Time: 13194

Site Contact Name & Number: Frank 0402 192 544

Phone When Going: *YES WHEN GOING T*

DESCRIPTION OF WORK
Vacuum test 4 M/Hs as directed.

M/H VACUUM TEST CERTIFICATE

Test Duration (sec)	Test Pressure (kPa)	Allowable Loss (kPa)	Work Instruction used for this test: 3.8A
AS SPEC	-33.5	-3.5	Page 1 of 1

Date	M/H Dia (mm)	M/H Depth	M/H Number	Time (sec)	Pressure Start	Pressure Finish	Pass	Fail
28-7-09	1200	1600	M/H 15/01	20	-33.5 kPa	-33 kPa	/	
28-7-09	1200	3050	M/H 11/01	33	-33.5 kPa	-33.5 kPa	/	
28-7-09	1200	3270	M/H 6/01	33	-33.5 kPa	-32.5 kPa	/	
			M/H		kPa	kPa		
			M/H		kPa	kPa		
			M/H		kPa	kPa		
			M/H		kPa	kPa		
			M/H		kPa	kPa		
			M/H		kPa	kPa		
			M/H		kPa	kPa		

Sign Name D Hert

Print Name DAVID HERT.

Field Services Officer:

Test Unit No. 14

Date: 28.7.09

Copies to be returned to OFFICE
Original to be given to CUSTOMER
This certificate supersedes all previous certificates.
This test document must not be copied, except in full

QA Form No. 20
Issue Date: 31/8/06

NATA This document is issued in accordance with NATA's accreditation requirements.
NATA Accredited Laboratory No. 13586

APPENDIX D – CALLIBRATION OF EQIPMENT USED DURING HYDROSTATIC TESTING

Insteng P/l Trading as

Able Instrument Service

ACN 054 764 742 ABN 99 054 764 742

Unit 6 10-12 Babdoyle St • PO Box 4035 LOGANHOLME QLD 4129
Telephone: (07) 3801 1232 • Facsimile: (07) 3801 3731
ableinst@bigpond.com

Calibration Report On

100 mm Industrial Pressure Gauge

Description
Make: Rhomberg
Type: Direct Mount, Bottom Entry
Serial No: 9905
Scale Range: -100/0 kPa, 0/30"Hg
Scale Interval: 1 kPa, 0.2"Hg

Standard Used
Type: Hg Manometer
Serial No: 16131
Range: 0/61"Hg

Certificate No: **6714**
Date: 7/11/2008

Submitted For: Dormway Pty Ltd

STANDARD READINGS	OBSERVED READINGS INCREASING	CORRECTION	OBSERVED READINGS DECREASING	CORRECTION
KPa	KPa	KPa	KPa	KPa
-20	-19	-1	-19.5	-0.5
-40	-39.5	-0.5	-39.5	-0.5
-60	-59.5	-0.5	-59.5	-0.5
-80	-79.5	-0.5	-80	NIL
-100	-100	NIL	---	---

Remarks:

Gauge Tapped Lightly At Each Reading.
Gauge Tested In Accordance With AS2845.3-1993.
And Conforms To AS1349-1986.
Gauge Case Vented To Atmosphere During Test.

Testing Officer
K.Mc Callum

sw

Complete the standard longitudinal tabulation providing details of curve lengths, I.L., depth to invert and F.S.L. and the chainage at the curve tangent points.

9 Installation of PE Sewers

PE sewers shall be installed in accordance with the requirements for non-pressure pipelines specified in WSA –01 Polyethylene Pipeline Code. Due to the high expansion characteristics of PE, the differences in diurnal temperatures shall be allowed for when installing the sewers.

10 Testing of PE Sewers and MSs

10.1 CCTV Inspection

All PE sewers and maintenance shafts shall be inspected by CCTV after all backfilling operations have been satisfactory completed and all junctions are installed. This inspection is required to ensure that the pipe is without any construction defects, the pipe has no internal flow obstructions and all approved junctions are in right location. Further the inspection will verify the information provided with the 'As Constructed' drawings.

Amndt No. 3 Apr '08

CCTV inspections shall comply with the following requirements:

- Appendix F of the latest version of the WSAA Conduit Inspection Reporting Code of Australia WSA 05. This includes all requirements outlined in Section 2 of the Code in relation to CCTV operator qualification, CCTV camera equipment and accuracy, camera operation, data display on recorded images and the inspection report:
- The sewer shall be cleaned prior to the CCTV inspection.
- Two sets of digital video files (MPEG 1 or MPEG 2 format), digital photographs (JPEG format) of certain defects as stated in Appendix F of WSA 05 and a digital file with the coding information (WinCan format or other digital formats stated in future editions of the WSA 05 standard) on CD or DVD medium shall be provided."

10.2 Vacuum Testing

All components of the sewer including MS's and property connection sewers shall be subject to vacuum testing.

The vacuum test shall be carried out in accordance with the following procedure:

- apply a negative pressure of approximately 50kPa.
- close the valve, shut off the pump and allow the pressure to stabilise for 3 minutes.
- when the pressure has stabilised at or below the starting test vacuum of 45kPa, commence the test by allowing the pressure to drop to 45kPa at which point the time recording begins,
- record the vacuum drop over a 20 minute period.

Accept the sewer under test if the vacuum loss is less than 2kPa. If the test fails, re-apply the vacuum to identify leaks and rectify all defects prior to conducting further tests.

11 Authorised Products - Nusewers

APPENDIX E – ROB CARR ITP's & QULAITY ASSURANCE

RC ROB CARR PTY LTD

Inspection and Test Plan

PROJECT: QLD026STA -St Achs Gravity Sewer	LOCATION: Banyo, QLD	ITP PREPARED BY: Dennis Chow	ITP FORM: ITP-02-07
CLIENT: Tenix Alliance	CONTRACT # 7103-01	ITP REVIEWED BY: Angelo Soumboulidis	ITP REVISION 0
ITP ACTIVITY: Maintenance Hole Construction (IN SITU)	ACTIVITY LOCATION: 2/1	APPROVED BY: Rob Carr	

No	Project Work/Test Activity or Deliverable	Inspection Type	Inspection Frequency	Inspection Date	Acceptance Criteria and Records to be kept	Inspected By RC	TA	BCC	Notes
1	Work Method available and signed off	H	Prior to start	28/4/09	* Comply with OH&S Act * Record - (i) Signed WMS	[signature]	[signature]		
2	Prepare ground beneath and around base of M/H using 10/20mm aggregate to required level	I	Prior to F/W	30/4/09	* Comply with Sewerage Code of Australia * Record - (i) Daily Diary (ii) Delivery Docket * Client inspection as required	[signature]	[signature]		
3	Placement of steel reinforcing mesh / rebar at base of shaft. Tie in starter bars as per design requirements	I	Once	N/A	* Survey base. Tolerances Horizontal +/- 100mm, Vertical +/- 30mm. * Visual inspection of formwork * Inspect for strength and rigidity * Min design grade to be maintained * Record - (i) Daily Diary (ii) This ITP				
4	Insert polystyrene core ends into pipe ends and polystyrene chase between the core ends to form channel	W	Prior to F/W	N/A	* Polystyrene chase suits internal diameter of pipe * Record - (i) Supplier docket (ii) This ITP				
5a	Pre concrete pour inspection	H	Once prior to pour	30/4/09	* Client Representative to be given 48 hours notice prior to concrete pour * Client Representative to inspect reinforcement and formwork where applicable	[signature]	[signature]		
6	Pour concrete to construct M/H base	H	Once	30/4/09	* Comply with AS3600, AS1379 * Comply with mix/slump design (Water Authority Specs) * Concrete chase suits pipe ID * As per IFC drawings & within specified tolerances * Correct projections where applicable * Correct concrete grade to be used * Concrete not to contain calcium chloride * Slump conforming, no water added on-site * Record - (i) Supplier docket (ii) This ITP	[signature]	[signature]		
6a	Concrete Testing (AS3600)	W	Once per 25m3	N/A	* Compression samples to be taken (3 cylinders total - Tests 1 @7days and 2 @28 days) * Concrete chase suits pipe ID * Record - (i) Supplier Docket (ii) This ITP (iii) Test Results				
7	Tie in steel reinforcing rebar and place for walls as per design requirements - allow for starter bars roof as per drawing	I	Once	N/A	* Comply with AS3600 – Concrete Structures * Comply with AS3610 – Formwork for Concrete * Check bar size, spacing & no. of * Concrete cover * Rigidly supported by plastic (tipped) bar chairs or by concrete blocks of the same grade as concrete pour * Bar chairs or concrete blocks securely tied * As per IFC drawings within specified tolerances * Record - (i) Supplier docket (ii) This ITP				

COPY

ITP-0207

Page 1 of 3

ROB CARR PTY LTD

Inspection and Test Plan

PROJECT: QLD026STA -St Achs Gravity Sewer	**LOCATION:** Banyo, QLD	**ITP PREPARED BY:** Dennis Chow	**ITP FORM:** ITP-02-07
CLIENT: Tenix Alliance	**CONTRACT #** 7103-01	**ITP REVIEWED BY:** Angelo Soumboulidis	**ITP REVISION** 0
ITP ACTIVITY: Maintenance Hole Construction (IN SITU)	**ACTIVITY LOCATION:** 2/1	**APPROVED BY:** Rob Carr	

No	Project Work/Test Activity or Deliverable	Inspection Type	Inspection Frequency	Inspection Date	Acceptance Criteria and Records to be kept	Inspected By RC	Inspected By TA	Inspected By BCC	Notes
8	Form inside wall using timber formwork or equivalent	I	Prior to F/W	1/6/09	* Comply with AS3600 – Concrete Structures * Comply with AS3610 – Formwork for Concrete * Check bar size, spacing & no. of * Concrete cover * Rigidly supported by plastic (tipped) bar chairs or by concrete blocks of the same grade as concrete pour * Bar chairs or concrete blocks securely tied * As per IFC drawings within specified tolerances * Record - (i) Supplier docket (ii) This ITP				
9	Form external wall using timber formwork or equivalent	I	Prior to F/W	1/6/09	* Comply with AS3600 – Concrete Structures * Comply with AS3610 – Formwork for Concrete * Check bar size, spacing & no. of * Concrete cover * Rigidly supported by plastic (tipped) bar chairs or by concrete blocks of the same grade as concrete pour * Bar chairs or concrete blocks securely tied * As per IFC drawings within specified tolerances * Record - (i) Supplier docket (ii) This ITP				
10	Brace formwork using steel tie-rods and tension appropriately	I	Prior to F/W	1/6/09	* Comply with AS3600 – Concrete Structures * Comply with AS3610 – Formwork for Concrete * Record - (i) This ITP (ii) IFC Dwg				
10a	Pre concrete pour inspection	H	Once prior to pour	1/6/09	* Client Representative to be given **48 hours notice prior to concrete pour** * Client Representative to inspect reinforcement and formwork where applicable				
11	Pour concrete to construct M/H Walls	H	Once	1/6/09	* Comply with mix/slump design (Water Authority Specs) * Concrete chase suits pipe ID * Record - (i) Supplier docket (ii) This ITP				
11a	Concrete Testing (AS3600)	W	Once per 25m3	N/A	* Compression samples to be taken (3 cylinders total - Tests 1 @7days and 2 @28 days) * Concrete chase suits pipe ID * Record - (i) Supplier Docket (ii) This ITP (iii) Test Results				
12	Tie in steel reinforcing rebar and place for roof and allow as per design requirements	I	Once	N/A	* Comply with AS3600 – Concrete Structures * Comply with AS3610 – Formwork for Concrete * Record - (i) Supplier docket (ii) This ITP (iii) IFC Dwg				
12a	Pre concrete pour inspection	H	Once prior to pour		* Client Representative to be given notice prior to concrete pour * Client Representative to inspect reinforcement and formwork where applicable				

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RC ROB CARR PTY LTD

Inspection and Test Plan

PROJECT: QLD026STA - St Achs Gravity Sewer		**LOCATION:** Banyo, QLD			**ITP PREPARED BY:** Dennis Chow	**ITP FORM:** ITP-02-07		
CLIENT: Tenix Alliance		**CONTRACT #** 7103-01			**ITP REVIEWED BY:** Angelo Soumboulidis	**ITP REVISION** 0		
ITP ACTIVITY: Maintenance Hole Construction (IN SITU)		**ACTIVITY LOCATION:**			**APPROVED BY:** Rob Carr			

No	Project Work/Test Activity or Deliverable	Inspection Type	Inspection Frequency	Inspection Date	Acceptance Criteria and Records to be kept	Inspected By			Notes
						RC	TA	BCC	
13	Pour concrete to construct M/H top slab and lid. Install M/H cover and frame. Raise cover using timber packers to ensure desired SL is reached PLACE + BED ASPRO + LID	H	Once	2/6/09	* Comply with AS3600 – Concrete Structures * Comply with AS3610 – Formwork for Concrete * Check bar size, spacing & no. of * Concrete cover * Rigidly supported by plastic (tipped) bar chairs or by concrete blocks of the same grade as concrete pour * Bar chairs or concrete blocks securely tied * As per IFC drawings within specified tolerances * Record - (i) Supplier docket (ii) This ITP	[signature]	[signature]		
13a	Concrete Testing (AS3600)	W	Once per 25m3	N/A.	* Compression samples to be taken (3 cylinders total - Tests 1 @7days and 2 @28 days) * Concrete chase suits pipe ID * Record - (i) Supplier Docket (ii) This ITP (iii) Test Results				
14	Backfill and compact around M/H progressively until desired surface level is reached	T	During compaction		* Visual and measure * Compaction testing to Water Authority Specs * 1 compaction test each 500mm layer, 98% copmp * Record (i) Compaction Test Results - NATA (a) This ITP * Compaction test results to be submitted to Client				
15	Epoxy coat walls, benching and base	I	Various		* Visual Inspection of formwork * Comply with Manufacturer Work Method * Record - (i) Supplier ITP (ii) This ITP				
16	Vacuum Test	H	N/A		* Record - (i) Supplier ITP (ii) This ITP				

Contractor Representative Signoff

I certify that the works listed in this ITP have been constructed in accordance with Water Authority and or Council Standards and the Contract Specifications

Name Angelo Soumboulidis Signature

Position Contract Manager Date

LEGEND:
H - HOLD, I - INSPECT
T - TEST, W - WITNESS
RC - Rob Carr Pty Ltd, TA - Tenix Alliance
BCC - Brisbane City Council

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ITP-0207

Page 3 of 3

ROB CARR PTY LTD.

Inspection and Test Plan

PROJECT: QLD026STA -St Achs Gravity Sewer	**LOCATION:** Banyo, QLD	**ITP PREPARED BY:** Dennis Chow	**ITP FORM:** ITP-02-07
CLIENT: Tenix Alliance	**CONTRACT #** 7103-01	**ITP REVIEWED BY:** Angelo Soumboulidis	**ITP REVISION** 0
ITP ACTIVITY: Maintenance Hole Construction (IN SITU)	**ACTIVITY LOCATION:** 4/1	**APPROVED BY:** Rob Carr	

No	Project Work/Test Activity or Deliverable	Inspection Type	Inspection Frequency	Inspection Date	Acceptance Criteria and Records to be kept	Inspected By			Notes
						RC	TA	BCC	
1	Work Method available and signed off	H	Prior to start	28/4/09	* Comply with OH&S Act * Record - (i) Signed WMS				
2	Prepare ground beneath and around base of M/H using 10/20mm aggregate to required level	I	Prior to F/W	27/5/09	* Comply with Sewerage Code of Australia * Record - (i) Daily Diary (ii) Delivery Docket * Client inspection as required				
3	Placement of steel reinforcing mesh / rebar at base of shaft. Tie in starter bars as per design requirements	I	Once	N/A	* Survey base. Tolerances: Horizontal +/- 100mm, Vertical +/- 30mm. * Visual Inspection of formwork * Inspect for strength and rigidity * Min design grade to be maintained * Record - (i) Daily Diary (ii) This ITP				
4	Insert polystyrene core ends into pipe ends and polystyrene chase between the core ends to form channel	W	Prior to F/W	N/A	* Polystyrene chase suits internal diameter of pipe * Record - (i) Supplier docket (ii) This ITP				
5a	Pre concrete pour inspection	H	Once prior to pour		* Client Representative to be given **48 hours notice prior to concrete pour** * Client Representative to inspect reinforcement and formwork where applicable				
6	Pour concrete to construct M/H base	H	Once	28/5/09	* Comply with AS3600, AS1379 * Comply with mix/slump design (Water Authority Specs) * Concrete chase suits pipe ID * As per IFC drawings & within specified tolerances * Correct projections where applicable * Correct concrete grade to be used * Concrete not to contain calcium chloride * Slump conforming, no water added on-site * Record - (i) Supplier docket (ii) This ITP				
6a	Concrete Testing (AS3600)	W	Once per 25m3	N/A	* Compression samples to be taken (3 cylinders total - Tests 1 @7days and 2 @28 days) * Concrete chase suits pipe ID * Record - (i) Supplier Docket (ii) This ITP (iii) Test Results				
7	Tie in steel reinforcing rebar and place for walls as per design requirements - allow for starter bars roof as per drawing	I	Once	N/A	* Comply with AS3600 – Concrete Structures * Comply with AS3610 – Formwork for Concrete * Check bar size, spacing & no. of * Concrete cover * Rigidly supported by plastic (tipped) bar chairs or by concrete blocks of the same grade as concrete pour * Bar chairs or concrete blocks securely tied * As per IFC drawings within specified tolerances * Record - (i) Supplier docket (ii) This ITP				

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Page 1 of 3

RC ROB CARR PTY LTD

Inspection and Test Plan

PROJECT: QLD026STA - St Achs Gravity Sewer	**LOCATION:** Banyo, QLD	**ITP PREPARED BY:**	Denna Chow	**ITP FORM:**	ITP-02-07
CLIENT: Tenix Alliance	**CONTRACT #** 7103-01	**ITP REVIEWED BY:**	Angelo Soumboulidis	**ITP REVISION**	0
ITP ACTIVITY: Maintenance Hole Construction (IN SITU)	**ACTIVITY LOCATION:** 4/1	**APPROVED BY:**	Rob Carr		

No	Project Work/Test Activity or Deliverable	Inspection Type	Inspection Frequency	Inspection Date	Acceptance Criteria and Records to be kept	Inspected By RC	Inspected By TA	Inspected By BCC	Notes
8	Form inside wall using timber formwork or equivalent	I	Prior to F/W	28/5/09	* Comply with AS3600 – Concrete Structures * Comply with AS3610 – Formwork for Concrete * Check bar size, spacing & no. of * Concrete cover * Rigidly supported by plastic (lipped) bar chairs or by concrete blocks of the same grade as concrete pour * Bar chairs or concrete blocks securely tied * As per IFC drawings within specified tolerances * Record - (i) Supplier docket (ii) This ITP				
9	Form external wall using timber formwork or equivalent	I	Prior to F/W	28/5/09	* Comply with AS3600 – Concrete Structures * Comply with AS3610 – Formwork for Concrete * Check bar size, spacing & no. of * Concrete cover * Rigidly supported by plastic (lipped) bar chairs or by concrete blocks of the same grade as concrete pour * Bar chairs or concrete blocks securely tied * As per IFC drawings within specified tolerances * Record - (i) Supplier docket (ii) This ITP				
10	Brace formwork using steel tie-rods and tension appropriately	I	Prior to F/W	28/5/09	* Comply with AS3600 – Concrete Structures * Comply with AS3610 – Formwork for Concrete * Record - (i) This ITP (ii) IFC Dwg				
10a	Pre concrete pour inspection	H	Once prior to pour	28/5/09	* Client Representative to be given **48 hours notice prior to concrete pour** * Client Representative to inspect reinforcement and formwork where applicable				
11	Pour concrete to construct M/H Walls FIRST LIFT	H	Once	28/5/09	* Comply with mix/slump design (Water Authority Specs) * Concrete chase suits pipe ID * Record - (i) Supplier docket (ii) This ITP				
11a	Concrete Testing (AS3600) TEST FIRST LIFT 1.2m High	W	Once per 25m3	28/5/09	* Compression samples to be taken (3 cylinders total - Tests 1 @7days and 2 @28 days) * Concrete chase suits pipe ID * Record - (i) Supplier Docket (ii) This ITP (iii) Test Results				
12	Tie in steel reinforcing rebar and place for roof and allow as per design requirements	I	Once	28/5/09	* Comply with AS3600 – Concrete Structures * Comply with AS3610 – Formwork for Concrete * Record - (i) Supplier docket (ii) This ITP (iii) IFC Dwg				
12a	Pre concrete pour inspection	H	Once prior to pour	28/5/09	* Client Representative to be given notice prior to concrete pour * Client Representative to inspect reinforcement and formwork where applicable				
12B	SECOND LIFT @ 1.2m			30/5/09					

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Page 2 of 3

RC ROB CARR PTY LTD

Inspection and Test Plan

PROJECT: QLD026STA -St Achs Gravity Sewer	**LOCATION:** Banyo, QLD	**ITP PREPARED BY:** Dennis Chow	**ITP FORM:** ITP-02-07
CLIENT: Tenix Alliance	**CONTRACT #** 7103-01	**ITP REVIEWED BY:** Angelo Soumboulidis	**ITP REVISION** 0
ITP ACTIVITY: Maintenance Hole Construction (IN SITU)	**ACTIVITY LOCATION:** 4/1	**APPROVED BY:** Rob Carr	

No	Project Work/Test Activity or Deliverable	Inspection Type	Inspection Frequency	Inspection Date	Acceptance Criteria and Records to be kept	Inspected By RC	Inspected By TA	Inspected By BCC	Notes
13	Pour concrete to construct M/H top slab and lid. Install M/H cover and frame. Raise cover using timber packers to ensure desired SL is reached	H	Once	30/5/09	* Comply with AS3600 – Concrete Structures * Comply with AS3610 – Formwork for Concrete * Check bar size, spacing & no. of * Concrete cover * Rigidly supported by plastic (tipped) bar chairs or by concrete blocks of the same grade as concrete pour * Bar chairs or concrete blocks securely tied * As per IFC drawings within specified tolerances * Record - (i) Supplier docket (ii) This ITP				
13a	Concrete Testing (AS3600)	W	Once per 25m3	N/A	* Compression samples to be taken (3 cylinders total - Tests 1 @7days and 2 @28 days) * Concrete chase suits pipe ID * Record - (i) Supplier Docket (ii) This ITP (iii) Test Results				
14	Backfill and compact around M/H progressively until desired surface level is reached	T	During compaction	30/5/09	* Visual and measure * Compaction testing to Water Authority Specs * 1 compaction test each 500mm layer, 98% copmp * Record (i) Compaction Test Results - NATA (ii) This ITP * Compaction test results to be submitted to Client				8 to 1 STAB SAND
15	Epoxy coat walls, benching and base	I	Various		* Visual Inspection of formwork * Comply with Manufacturer Work Method * Record - (i) Supplier ITP (ii) This ITP				
16	Vacuum Test	H	N/A		* Record - (i) Supplier ITP (ii) This ITP				

Contractor Representative Signoff

I certify that the works listed in this ITP have been constructed in accordance with Water Authority and or Council Standards and the Contract Specifications.	Name: Angelo Soumboulidis	Signature	**LEGEND:** H - HOLD I - INSPECT T - TEST, W - WITNESS RC - Rob Carr Pty Ltd TA - Tenix Alliance BCC - Brisbane City Council
	Position: Contract Manager	Date	

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Page 3 of 3

RC ROB CARR PTY. LTD.

Inspection and Test Plan

PROJECT: QLD026STA -St Achs Gravity Sewer	**LOCATION:** Banyo, QLD	**ITP PREPARED BY:** Dennis Chow	**ITP FORM:** ITP-02-03
CLIENT: Tenix Alliance	**CONTRACT #** 7103-01	**ITP REVIEWED BY:** Angelo Soumboulidis	**ITP REVISION:** 0
ITP ACTIVITY: Microtunnelling	**ACTIVITY LOCATION:** 1A/1 to 2A/1	**APPROVED BY:** Rob Carr	

No	Project Work/Test Activity or Deliverable	Inspection Type	Inspection Frequency	Inspection Date	Acceptance Criteria and Records to be kept	Inspected By RC	Inspected By TA	Inspected By BCC	Notes
1	Survey * Check IL * Check alignment and grade	H	Once prior to start	27/5/09	* Inspect cable connections * Surveyor to provide tunnel centerline * Check line and alignment of jacking frame * Record - (i) Surveyor records (ii) This ITP				USHER + CO.
2	Work Method available and signed off	H	Once prior to start	5/5/09	* Comply with OH&S Act * Record - (i) Signed WMS				
3	Laser Calibration	W	Once prior to start	16/3/09	* Comply with Manufacturer's Specification * Record - (i) Calibration certificate (ii) This ITP				
4	Setup TBM * Lower jacking frame, stabilise & setup laser * Connect Slurry tank, pumps & cables	H	Once prior to start	29/5/09	* Inspect cable connections * Check stability and alignment of jacking frame * Check laser setup (i.e. Line, level & position) - Surveyor to check level and line * Record - (i) Surveyor records (ii) This ITP				
5	Commence Microtunnelling * Push head and lead steel into shaft wall * Push jacking pipe progressively behind head	H	Various	1/6/09	* Comply with Tolerances: Vertical +/- 25mm, Horizontal +/- 100mm * Ensure clean ends, continuity, good seal * Laser line checks once per shift (record on log sheet) * Ensure jacking forces do not exceed max allowable * Weekly submission of Jacking log * Record - (i) Jacking Log (ii) Supplier Docket (iii) ITP				
6	Microtunnelling * Notification if Tunnel Bore Exceeds 10mm off Alignment	H	Various		* MTBM Operator to notify Engineer or Project Manager or Construction Manager immediately * Engineer or Project Manager or Construction Manager to issue a site instruction for the purpose of recovery grade				
7	Complete Microtunnelling * Push through reception shaft wall * Retrieve drilling head	I	Various	4/6/09	* Comply with GCCC Specification * Ensure clean ends, continuity, good seal * Maintain satisfactory slurry flow and jacking pressure * Record - (i) Jacking Log (ii) This ITP				
8	Grout Annulus (Where Required) * Pump grout between casing pipe and carrier pipe	W	Once upon completing grouting	N/A	* Comply with Work Method * Comply with mix/slump design (Water Authority Specs) * Record - (i) Supplier Docket (ii) This ITP				
9	CCTV Inspection of pipe	W	Once upon completing CCTV		* Inspect inside of pipe ensuring no leaks or cracks exist * Record - (i) CCTV Tape (ii) Sewrat Report (iii) This ITP				
10	Pressure Test pipe (Where Required)	H	Once upon completing testing		* Comply with Contract Specification * Comply with Water Authority Requirements * Record - (i) Test Results - NATA (ii) This ITP				

Contractor Representative Signoff

I certify that the works listed in this ITP have been constructed in accordance with Water Authority and or Council Standards and the Contract Specifications.	Name: Angelo Soumboulidis Position: Contract Manager	Signature Date		LEGEND: H - HOLD, I - INSPECT T - TEST W - WITNESS RC - Rob Carr Pty Ltd, TA- Tenix Alliance BCC - Brisbane City Council

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Page 1 of 1

ROB CARR PTY. LTD

Inspection and Test Plan

PROJECT: QLD026STA -St Achs Gravity Sewer	**LOCATION:** Banyo, QLD	**ITP PREPARED BY:** Dennis Chow	**ITP FORM:** ITP-02-03
CLIENT: Tenix Alliance	**CONTRACT #** 7103-01	**ITP REVIEWED BY:** Angelo Soumboulidis	**ITP REVISION:** 0
ITP ACTIVITY: Microtunnelling	**ACTIVITY LOCATION:** 2A/1 to 2/1	**APPROVED BY:** Rob Carr	

No	Project Work/Test Activity or Deliverable	Inspection Type	Inspection Frequency	Inspection Date	Acceptance Criteria and Records to be kept	Inspected By RC	Inspected By TA	Inspected By BCC	Notes
1	Survey * Check IL * Check alignment and grade	H	Once prior to start	27/5/09	* Inspect cable connections * Surveyor to provide tunnel centerline * Check line and alignment of jacking frame * Record - (i) Surveyor records (ii) This ITP				USHER + CO.
2	Work Method available and signed off	H	Once prior to start	5/5/09	* Comply with OH&S Act * Record - (i) Signed WMS				
3	Laser Calibration	W	Once prior to start	16/3/09	* Comply with Manufacturer's Specification * Record - (i) Calibration certificate (ii) This ITP				
4	Setup TBM * Lower jacking frame, stabilise & setup laser * Connect Slurry tank, pumps & cables	H	Once prior to start	5/6/09	* Inspect cable connections * Check stability and alignment of jacking frame * Check laser setup (i.e. Line, level & position) - Surveyor to check level and line * Record - (i) Surveyor records (ii) This ITP				
5	Commence Microtunnelling * Push head and lead steel into shaft wall * Push jacking pipe progressively behind head	H	Various	5/6/09	* Comply with Tolerances Vertical +/- 25mm, Horizontal +/- 100mm * Ensure clean ends, continuity, good seal * Laser line checks once per shift (record on log sheet) * Ensure jacking forces do not exceed max allowable * Weekly submission of Jacking log * Record - (i) Jacking Log (ii) Supplier Docket (iii) ITP				
6	Microtunnelling * Notification if Tunnel Bore Exceeds 10mm off Alignment	H	Various	N/A	* MTBM Operator to notify Engineer or Project Manager or Construction Manager immediately * Engineer or Project Manager or Construction Manager to issue a site instruction for the purpose of recovery grade				
7	Complete Microtunnelling * Push through reception shaft wall * Retrieve drilling head	I	Various	5/6/09	* Comply with GCCC Specification * Ensure clean ends, continuity, good seal * Maintain satisfactory slurry flow and jacking pressure * Record - (i) Jacking Log (ii) This ITP				
8	Grout Annulus (Where Required) * Pump grout between casing pipe and carrier pipe	W	Once upon completing grouting	N/A	* Comply with Work Method * Comply with mix/slump design (Water Authority Specs) * Record - (i) Supplier Docket (ii) This ITP				
9	CCTV Inspection of pipe	W	Once upon completing CCTV		* Inspect inside of pipe ensuring no leaks or cracks exist * Record - (i) CCTV Tape (ii) Sewrat Report (iii) This ITP				
10	Pressure Test pipe (Where Required)	H	Once upon completing testing		* Comply with Contract Specification * Comply with Water Authority Requirements * Record - (i) Test Results - NATA (ii) This ITP				

Contractor Representative Signoff

I certify that the works listed in this ITP have been constructed in accordance with Water Authority and or Council Standards and the Contract Specifications.

Name: Angelo Soumboulidis
Position: Contract Manager
Signature
Date

LEGEND:
H - HOLD I - INSPECT
T - TEST W - WITNESS
RC - Rob Carr Pty Ltd, TA- Tenix Alliance
BCC - Brisbane City Council

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Inspection and Test Plan

PROJECT: QLD026STA - St Achs Gravity Sewer	**LOCATION:** Banyo, QLD	**ITP PREPARED BY:** Dennis Chow	**ITP FORM:** ITP-02-03
CLIENT: Tenix Alliance	**CONTRACT #** 7103-01	**ITP REVIEWED BY:** Angelo Soumboulidis	**ITP REVISION:** 0
ITP ACTIVITY: Microtunnelling	**ACTIVITY LOCATION:** 2/1 to 4/1	**APPROVED BY:** Rob Carr	

No	Project Work/Test Activity or Deliverable	Inspection Type	Inspection Frequency	Inspection Date	Acceptance Criteria and Records to be kept	Inspected By RC	Inspected By TA	Inspected By BCC	Notes
1	Survey * Check IL * Check alignment and grade	H	Once prior to start	7/5/09 8/5/09	* Inspect cable connections * Surveyor to provide tunnel centerline * Check line and alignment of jacking frame * Record - (i) Surveyor records (ii) This ITP				
2	Work Method available and signed off	H	Once prior to start	5/5/09	* Comply with OH&S Act * Record - (i) Signed WMS				
3	Laser Calibration	W	Once prior to start	16/3/09	* Comply with Manufacturer's Specification * Record - (i) Calibration certificate (ii) This ITP				
4	Setup TBM * Lower jacking frame, stabilise & setup laser * Connect Slurry tank, pumps & cables	H	Once prior to start	8/5/09	* Inspect cable connections * Check stability and alignment of jacking frame * Check laser setup (i.e. Line, level & position) - Surveyor to check level and line * Record - (i) Surveyor records (ii) This ITP				
5	Commence Microtunnelling * Push head and lead steel into shaft wall * Push jacking pipe progressively behind head	H	Various	11/5/09	* Comply with Tolerances: Vertical +/- 25mm, Horizontal +/- 100mm * Ensure clean ends, continuity, good seal * Laser line checks once per shift (record on log sheet) * Ensure jacking forces do not exceed max allowable * Weekly submission of Jacking log * Record - (i) Jacking Log (ii) Supplier Docket (iii) ITP				
6	Microtunnelling * Notification if Tunnel Bore Exceeds 10mm off Alignment	H	Various		* MTBM Operator to notify Engineer or Project Manager or Construction Manager immediately * Engineer or Project Manager or Construction Manager to issue a site instruction for the purpose of recovery grade				
7	Complete Microtunnelling * Push through reception shaft wall * Retrieve drilling head	I	Various	27/5/09	* Comply with GCCC Specification * Ensure clean ends, continuity, good seal * Maintain satisfactory slurry flow and jacking pressure * Record - (i) Jacking Log (ii) This ITP				
8	Grout Annulus (Where Required) * Pump grout between casing pipe and carrier pipe	W	Once upon completing grouting	N/A	* Comply with Work Method * Comply with mix/slump design (Water Authority Specs) * Record - (i) Supplier Docket (ii) This ITP				
9	CCTV Inspection of pipe	W	Once upon completing CCTV		* Inspect inside of pipe ensuring no leaks or cracks exist * Record - (i) CCTV Tape (ii) Sewral Report (iii) This ITP				
10	Pressure Test pipe (Where Required)	H	Once upon completing testing		* Comply with Contract Specification * Comply with Water Authority Requirements * Record - (i) Test Results - NATA (ii) This ITP				

Contractor Representative Signoff

I certify that the works listed in this ITP have been constructed in accordance with Water Authority and or Council Standards and the Contract Specifications.

Name	Angelo Soumboulidis	Signature	
Position:	Contract Manager	Date	

LEGEND
H - HOLD I - INSPECT
T - TEST, W - WITNESS
RC - Rob Carr Pty Ltd, TA- Tenix Alliance
BCC - Brisbane City Council

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Page 1 of 1

ROB CARR PTY LTD

Inspection and Test Plan

PROJECT: QLD026STA -St Achs Gravity Sewer	**LOCATION:** Banyo, QLD	**ITP PREPARED BY:** Dennis Chow	**ITP FORM:** ITP-02-03
CLIENT: Tenix Alliance	**CONTRACT #** 7103-01	**ITP REVIEWED BY:** Angelo Soumboulidis	**ITP REVISION:** 0
ITP ACTIVITY: Microtunneling	**ACTIVITY LOCATION:** 5/1 to 4/1	**APPROVED BY:** Rob Carr	

No	Project Work/Test Activity or Deliverable	Inspection Type	Inspection Frequency	Inspection Date	Acceptance Criteria and Records to be kept	Inspected By RC	Inspected By TA	Inspected By BCC	Notes
1	Survey * Check IL * Check alignment and grade	H	Once prior to start	27/4/09	* Inspect cable connections * Surveyor to provide tunnel centerline * Check line and alignment of jacking frame * Record - (i) Surveyor records (ii) This ITP				
2	Work Method available and signed off	H	Once prior to start	28/4/09	* Comply with OH&S Act * Record - (i) Signed WMS				
3	Laser Calibration	W	Once prior to start	16/3/09	* Comply with Manufacturer's Specification * Record - (i) Calibration certificate (ii) This ITP				
4	Setup TBM * Lower jacking frame, stabilise & setup laser * Connect Slurry tank, pumps & cables	H	Once prior to start	27/4/09	* Inspect cable connections * Check stability and alignment of jacking frame * Check laser setup (i.e. Line, level & position) - Surveyor to check level and line * Record - (i) Surveyor records (ii) This ITP				
5	Commence Microtunnelling * Push head and lead steel into shaft wall * Push jacking pipe progressively behind head	H	Various	27/4/09	* Comply with Tolerances Vertical +/- 25mm, Horizontal +/- 100mm * Ensure clean ends, continuity, good seal * Laser line checks once per shift (record on log sheet) * Ensure jacking forces do not exceed max allowable * Weekly submission of Jacking log * Record - (i) Jacking Log (ii) Supplier Docket (iii) ITP				
6	Microtunnelling * Notification if Tunnel Bore Exceeds 10mm off Alignment	H	Various		* MTBM Operator to notify Engineer or Project Manager or Construction Manager immediately * Engineer or Project Manager or Construction Manager to issue a site instruction for the purpose of recovery grade				
7	Complete Microtunnelling * Push through reception shaft wall * Retrieve drilling head	I	Various	2/6/09	* Comply with GCCC Specification * Ensure clean ends, continuity, good seal * Maintain satisfactory slurry flow and jacking pressure * Record - (i) Jacking Log (ii) This ITP				
8	Grout Annulus (Where Required) * Pump grout between casing pipe and carrier pipe	W	Once upon completing grouting	N/A	* Comply with Work Method * Comply with mix/slump design (Water Authority Specs) * Record - (i) Supplier Docket (ii) This ITP				
9	CCTV Inspection of pipe	W	Once upon completing CCTV		* Inspect inside of pipe ensuring no leaks or cracks exist * Record - (i) CCTV Tape (ii) Sewral Report (iii) This ITP				
10	Pressure Test pipe (Where Required)	H	Once upon completing testing		* Comply with Contract Specification * Comply with Water Authority Requirements * Record - (i) Test Results - NATA (ii) This ITP				

Contractor Representative Signoff

I certify that the works listed in this ITP have been constructed in accordance with Water Authority and or Council Standards and the Contract Specifications.	Name	Angelo Soumboulidis	Signature	
	Position	Contract Manager	Date	

LEGEND:
H - HOLD, I - INSPECT
T - TEST W - WITNESS
RC - Rob Carr Pty Ltd TA- Tenix Alliance
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Page 1 of 1

RC ROB CARR PTY LTD

Inspection and Test Plan

PROJECT: QLD026STA -St Achs Gravity Sewer	**LOCATION:** Banyo, QLD	**ITP PREPARED BY:** Dennis Chow	**ITP FORM:** ITP-02-02
CLIENT: Tenix Alliance	**CONTRACT #** 7103-01	**ITP REVIEWED BY:** Angelo Soumboulidis	**ITP REVISION:** 0
ITP ACTIVITY: Shaft Excavation	**ACTIVITY LOCATION:** 1A/1	**APPROVED BY:** Rob Carr	

No	Project Work/Test Activity or Deliverable	Inspection Type	Inspection Frequency	Inspection Date	Acceptance Criteria and Records to be kept	Inspected By RC	TA	BCC	Notes
1	Work Method available and signed off	H	Once prior to start	5/5/09	* Comply with OH&S Act * Record - (i) Signed WMS				
2	Underground Services Check * Pipe Locator * Service Locator * DBYD Search	H	Once prior to start	27/5/09	* Record - (i) DBYD drawings (ii) Call Enquiry (iii) This ITP				PROVAC
3	Survey	W	Once, prior to commencement of excavation	27/5/09	* Design drawings to be checked by certified surveyor * Set out by certified surveyor * Record - (i) Survey Drawings (ii) This ITP				USHER + CO
4	Install Environmental Controls as per TJH SEP	H	Once after every rain event	28/5/09	* Comply with Site Environmental Plan * Record - (i) Checklist (ii) This ITP				
5	Traffic devices in place in accordance with Traffic Management Plan	W	Prior to start	N/A	* Comply with Traffic Management Plan * Record - i)Site Diary ii) This ITP				
6	Saw cut asphalt / concrete surface	W	Once	N/A	* Dimensions to suit TBM equipment (4.5m x 3.5m min) * Review Council specs to ensure adequate cut depth * Record - (i) This ITP				
7	Permit to Dig	H	Once prior to start & Monthly thereafter	28/5/09	* Record - (i) DBYD drawings (ii) Call Enquiry (iii) This ITP * Client Permit to Dig Signed off				
8	Excavate Shaft	I	Various	28/5/09 29/5/09	* Dimensions to suit TBM equipment (4.5m x 3.5m min) * Comply with Contract Design and OH&S Regulation * Record - (i) Operator ticket (ii) Plant Check (iii) ITP * Dispose of unsuitable materrial / Stockpile material as required				
9	Offsite Disposal	W	Once prior to start	29/5/09	* Approval & description of dump location * Evidence of council approval for fill location				NUDGEE
10	Acid Sulphate Testing	H	As Required		* Soil tested for acid sulphates * Liming rates to be determined by test				
11	Support Shaft	I	Various	28/5/09	* Comply with Supplier Work Method * Certified Sheet Pile Design, Certified Steel Shoring Box * Record - (i) Engineer Signoff (ii) Supplier Cert (iii) ITP				

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RC ROB CARR PTY. LTD.

Inspection and Test Plan

PROJECT: QLD026STA -St Achs Gravity Sewer	**LOCATION:** Banyo, QLD	**ITP PREPARED BY:** Dennis Chow	**ITP FORM:** ITP-02-02
CLIENT: Tenix Alliance	**CONTRACT #** 7103-01	**ITP REVIEWED BY:** Angelo Soumbouldis	**ITP REVISION:** 0
ITP ACTIVITY: Shaft Excavation	**ACTIVITY LOCATION:** 1A/1	**APPROVED BY:** Rob Carr	

No	Project Work/Test Activity or Deliverable	Inspection Type	Inspection Frequency	Inspection Date	Acceptance Criteria and Records to be kept	Inspected By RC	Inspected By TA	Inspected By BCC	Notes
12	Install Handrails & Toe Boards	W	Once upon completing shaft	29/5/09	* Comply with OH&S Regulation * Record - (i) This ITP	[signature]	[signature]		
13	Install appropriate access / exit point	I	Once upon completing shaft	29/5/09	* Inspect location, support of access point * Ladder to 5.5m deep (with 2m cage), Cert Scaffolding * Record - (i) Scaffold Certification (ii) This ITP	[signature]	[signature]		TEMP EXTENSION LADDER
14	Backfill	W	Various		* Walls of excavation treated where required * Treated spoil placed back in excavation				
15	Subgrade Compaction	H	Once per layer per 500m2		* Subgrade Compaction (see below for reference) * Refer project specifications * Refer AS3798 Table 8.1 * Record - (i) This ITP (ii) NATA Test Results * Compaction test results to be submitted to Client				

Contractor Representative Signoff

I certify that the works listed in this ITP have been constructed in accordance with Water Authority and or Council Standards and the Contract Specifications.

Name: Angelo Soumbouldis — Signature:

Position: Contract Manager — Date:

LEGEND:
H - HOLD, I - INSPECT
T - TEST, W - WITNESS
RC - Rob Carr Pty Ltd, TA - Tenix Alliance
BCC - Brisbane City Council

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ITP-0202

Page 2 of 2

RC ROB CARR PTY LTD

Inspection and Test Plan

PROJECT: QLD026STA -St Achs Gravity Sewer	**LOCATION:** Banyo, QLD	**ITP PREPARED BY:** Dennis Chow	**ITP FORM:** ITP-02-02
CLIENT: Tenix Alliance	**CONTRACT #** 7103-01	**ITP REVIEWED BY:** Angelo Soumboulidis	**ITP REVISION:** 0
ITP ACTIVITY: Shaft Excavation	**ACTIVITY LOCATION:** 2A/1	**APPROVED BY:** Rob Carr	

No	Project Work/Test Activity or Deliverable	Inspection Type	Inspection Frequency	Inspection Date	Acceptance Criteria and Records to be kept	Inspected By			Notes
						RC	TA	BCC	
1	Work Method available and signed off	H	Once prior to start	5/5/09	* Comply with OH&S Act * Record - (i) Signed WMS				
2	Underground Services Check * Pipe Locator * Service Locator * DBYD Search	H	Once prior to start	7/5/09 27/5/09	* Record - (i) DBYD drawings (ii) Call Enquiry (iii) This ITP				PROVAC
3	Survey	W	Once, prior to commencement of excavation	27/5/09	* Design drawings to be checked by certified surveyor * Set out by certified surveyor * Record - (i) Survey Drawings (ii) This ITP				USHER + CO
4	Install Environmental Controls as per TJH SEP	H	Once after every rain event	5/5/09	* Comply with Site Environmental Plan * Record - (i) Checklist (ii) This ITP				
5	Traffic devices in place in accordance with Traffic Management Plan	W	Prior to start	7/5/09	* Comply with Traffic Management Plan * Record - i)Site Diary ii) This ITP				
6	Saw cut asphalt / concrete surface	W	Once	3/6/09	* Dimensions to suit TBM equipment (4.5m x 3.5m min) * Review Council specs to ensure adequate cut depth * Record - (i) This ITP				
7	Permit to Dig	H	Once prior to start & Monthly thereafter		* Record - (i) DBYD drawings (ii) Call Enquiry (iii) This ITP * Client Permit to Dig Signed off				
8	Excavate Shaft	I	Various	3/6/09	* Dimensions to suit TBM equipment (4.5m x 3.5m min) * Comply with Contract Design and OH&S Regulation * Record - (i) Operator ticket (ii) Plant Check (iii) ITP * Dispose of unsuitable material / Stockpile material as required				
9	Offsite Disposal	W	Once prior to start	3/6/09	* Approval & description of dump location * Evidence of council approval for fill location				NUDGEE
10	Acid Sulphate Testing	H	As Required		* Soil tested for acid sulphates * Liming rates to be determined by test				
11	Support Shaft	I	Various	3/6/09	* Comply with Supplier Work Method * Certified Sheet Pile Design, Certified Steel Shoring Box * Record - (i) Engineer Signoff (ii) Supplier Cert (iii) ITP				

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Page 1 of 2

ROB CARR PTY LTD

Inspection and Test Plan

PROJECT: QLD026STA -St Achs Gravity Sewer	LOCATION: Banyo, QLD	ITP PREPARED BY:	Dennis Chow	ITP FORM:	ITP-02-02
CLIENT: Tenix Alliance	CONTRACT # 7103-01	ITP REVIEWED BY:	Angelo Soumboulidis	ITP REVISION:	0
ITP ACTIVITY: Shaft Excavation	ACTIVITY LOCATION: 2A/1	APPROVED BY:	Rob Carr		

No	Project Work/Test Activity or Deliverable	Inspection Type	Inspection Frequency	Inspection Date	Acceptance Criteria and Records to be kept	Inspected By RC	Inspected By TA	Inspected By BCC	Notes
12	Install Handrails & Toe Boards	W	Once upon completing shaft	3/6/09	* Comply with OH&S Regulation * Record - (i) This ITP	[signature]	[signature]		
13	Install appropriate access / exit point	I	Once upon completing shaft	3/6/09	* Inspect location, support of access point * Ladder to 5.5m deep (with 2m cage), Cert Scaffolding * Record - (i) Scaffold Certification (ii) This ITP	[signature]	[signature]		TEMP LADDER
14	Backfill	W	Various		* Walls of excavtion treated where required * Treated spoil placed back in excavation				
15	Subgrade Compaction	H	Once per layer per 500m2		* Subgrade Compaction (see below for reference) * Refer project specifications * Refer AS3798 Table 8.1 * Record - (i) This ITP (ii) NATA Test Results * Compaction test results to be submitted to Client				

Contractor Representative Signoff

I certify that the works listed in this ITP have been constructed in accordance with Water Authority and or Council Standards and the Contract Specifications.	Name	Angelo Soumboulidis	Signature	
	Position	Contract Manager	Date	

LEGEND:
H - HOLD, I - INSPECT
T - TEST, W - WITNESS
RC - Rob Carr Pty Ltd, TA - Tenix Alliance
BCC - Brisbane City Council

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ITP-0202

Page 2 of 2

RC ROB CARR PTY LTD

Inspection and Test Plan

PROJECT: QLD026STA -St Achs Gravity Sewer	**LOCATION:** Banyo, QLD	**ITP PREPARED BY:** Dennis Chow	**ITP FORM:** ITP-02-02
CLIENT: Tenix Alliance	**CONTRACT #** 7103-01	**ITP REVIEWED BY:** Angelo Soumboulidis	**ITP REVISION:** 0
ITP ACTIVITY: Shaft Excavation 2/1	**ACTIVITY LOCATION:** 2/1	**APPROVED BY:** Rob Carr	

No	Project Work/Test Activity or Deliverable	Inspection Type	Inspection Frequency	Inspection Date	Acceptance Criteria and Records to be kept	Inspected By RC	Inspected By TA	Inspected By BCC	Notes
1	Work Method available and signed off	H	Once prior to start	5/5/09	* Comply with OH&S Act * Record - (i) Signed WMS	[illegible]	SDM.		
2	Underground Services Check * Pipe Locator * Service Locator * DBYD Search	H	Once prior to start	7/5/09	* Record - (i) DBYD drawings (ii) Call Enquiry (iii) This ITP	[illegible]	SDM.		PROVAC
3	Survey	W	Once, prior to commencement of excavation	6/5/09	* Design drawings to be checked by certified surveyor * Set out by certified surveyor * Record - (i) Survey Drawings (ii) This ITP	[illegible]	SDM		USHER + CO
4	Install Environmental Controls as per TJH SEP	H	Once after every rain event	5/5/09	* Comply with Site Environmental Plan * Record - (i) Checklist (ii) This ITP	[illegible]	SDM		
5	Traffic devices in place in accordance with Traffic Management Plan	W	Prior to start	7/5/09	* Comply with Traffic Management Plan * Record - i)Site Diary ii) This ITP	[illegible]	SDM		LOCATION TRAFFIC CONTROL
6	Saw cut asphalt / concrete surface	W	Once	7/5/09	* Dimensions to suit TBM equipment (4.5m x 3.5m min) * Review Council specs to ensure adequate cut depth * Record - (i) This ITP	[illegible]	SDM.		
7	Permit to Dig	H	Once prior to start & Monthly thereafter	5/5/09	* Record - (i) DBYD drawings (ii) Call Enquiry (iii) This ITP * Client Permit to Dig Signed off	[illegible]	SDM		
8	Excavate Shaft	I	Various	7/5/09 8/5/09	* Dimensions to suit TBM equipment (4.5m x 3.5m min) * Comply with Contract Design and OH&S Regulation * Record - (i) Operator ticket (ii) Plant Check (iii) ITP * Dispose of unsuitable material / Stockpile material as required	[illegible]	SDM		
9	Offsite Disposal	W	Once prior to start	7/5/09	* Approval & description of dump location * Evidence of council approval for fill location	[illegible]	SDM		NUDGEE
10	Acid Sulphate Testing	H	As Required		* Soil tested for acid sulphates * Liming rates to be determined by test				
11	Support Shaft	I	Various	7/5/09 8/5/09	* Comply with Supplier Work Method * Certified Sheet Pile Design, Certified Steel Shoring Box * Record - (i) Engineer Signoff (ii) Supplier Cert (iii) ITP	[illegible]	SDM.		

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ITP-0202

Page 1 of 2

ROB CARR PTY. LTD.

Inspection and Test Plan

PROJECT: QLD026STA -St Achs Gravity Sewer	**LOCATION:** Banyo, QLD	**ITP PREPARED BY:** Dennis Chow	**ITP FORM:** ITP-02-02
CLIENT: Tenix Alliance	**CONTRACT #** 7103-01	**ITP REVIEWED BY:** Angelo Soumboulidis	**ITP REVISION:** 0
ITP ACTIVITY: Shaft Excavation	**ACTIVITY LOCATION:** 2/1	**APPROVED BY:** Rob Carr	

No	Project Work/Test Activity or Deliverable	Inspection Type	Inspection Frequency	Inspection Date	Acceptance Criteria and Records to be kept	Inspected By RC	TA	BCC	Notes
12	Install Handrails & Toe Boards	W	Once upon completing shaft	8/5/09	* Comply with OH&S Regulation * Record - (i) This ITP				
13	Install appropriate access / exit point	I	Once upon completing shaft	8/5/09	* Inspect location, support of access point * Ladder to 5.5m deep (with 2m cage), Cert Scaffolding * Record - (i) Scaffold Certification (ii) This ITP				
14	Backfill	W	Various		* Walls of excavation treated where required * Treated spoil placed back in excavation				
15	Subgrade Compaction	H	Once per layer per 500m2		* Subgrade Compaction (see below for reference) * Refer project specifications * Refer AS3798 Table 8.1 * Record - (i) This ITP (ii) NATA Test Results * Compaction test results to be submitted to Client				

Contractor Representative Signoff

I certify that the works listed in this ITP have been constructed in accordance with Water Authority and or Council Standards and the Contract Specifications.	Name: Angelo Soumboulidis	Signature	**LEGEND:** H - HOLD, I - INSPECT T - TEST, W - WITNESS RC - Rob Carr Pty Ltd, TA - Tenix Alliance BCC - Brisbane City Council
	Position: Contract Manager	Date	

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ITP-0202

Page 2 of 2

ROB CARR PTY LTD

Inspection and Test Plan

PROJECT: QLD026STA - St Achs Gravity Sewer	**LOCATION:** Banyo, QLD	**ITP PREPARED BY:** Dennis Chow	**ITP FORM:** ITP-02-02
CLIENT: Tenix Alliance	**CONTRACT #:** 7103-01	**ITP REVIEWED BY:** Angelo Soumboulidis	**ITP REVISION:** 0
ITP ACTIVITY: Shaft Excavation	**ACTIVITY LOCATION:** 4/1	**APPROVED BY:** Rob Carr	

No	Project Work/Test Activity or Deliverable	Inspection Type	Inspection Frequency	Inspection Date	Acceptance Criteria and Records to be kept	Inspected By RC	TA	BCC	Notes
1	Work Method available and signed off	H	Once prior to start	28/4/09	* Comply with OH&S Act * Record - (i) Signed WMS				
2	Underground Services Check * Pipe Locator * Service Locator * DBYD Search	H	Once prior to start	23/4/09	* Record - (i) DBYD drawings (ii) Call Enquiry (iii) This ITP				PROVAC
3	Survey	W	Once, prior to commencement of excavation	29/4/09	* Design drawings to be checked by certified surveyor * Set out by certified surveyor * Record - (i) Survey Drawings (ii) This ITP				USHER + CO
4	Install Environmental Controls as per TJH SEP	H	Once after every rain event	6/5/09	* Comply with Site Environmental Plan * Record - (i) Checklist (ii) This ITP				
5	Traffic devices in place in accordance with Traffic Management Plan	W	Prior to start	6/5/09	* Comply with Traffic Management Plan * Record - i)Site Diary ii) This ITP				LOCATION TRAFFIC CONTROL
6	Saw cut asphalt / concrete surface	W	Once	6/5/09	* Dimensions to suit TBM equipment (4.5m x 3.5m min) * Review Council specs to ensure adequate cut depth * Record - (i) This ITP				
7	Permit to Dig	H	Once prior to start & Monthly thereafter	5/5/09	* Record - (i) DBYD drawings (ii) Call Enquiry (iii) This ITP * Client Permit to Dig Signed off				
8	Excavate Shaft	I	Various	6/5/09	* Dimensions to suit TBM equipment (4.5m x 3.5m min) * Comply with Contract Design and OH&S Regulation * Record - (i) Operator ticket (ii) Plant Check (iii) ITP. * Dispose of unsuitable material / Stockpile material as required				
9	Offsite Disposal	W	Once prior to start	6/5/09	* Approval & description of dump location * Evidence of council approval for fill location				NUDGEE LANDFILL
10	Acid Sulphate Testing	H	As Required		* Soil tested for acid sulphates * Liming rates to be determined by test				
11	Support Shaft	I	Various	6/5/09	* Comply with Supplier Work Method * Certified Sheet Pile Design, Certified Steel Shoring Box * Record - (i) Engineer Signoff (ii) Supplier Cert (iii) ITP				

ITP-0202

Page 1 of 2

ROB CARR PTY LTD

Inspection and Test Plan

PROJECT: QLD026STA - St Achs Gravity Sewer	LOCATION: Banyo, QLD	ITP PREPARED BY: Dennis Chow	ITP FORM: ITP-02-02
CLIENT: Tenix Alliance	CONTRACT # 7103-01.	ITP REVIEWED BY: Angelo Soumboulidis	ITP REVISION: 0
ITP ACTIVITY: Shaft Excavation.	ACTIVITY LOCATION: 4/1	APPROVED BY: Rob Carr	

No	Project Work/Test Activity or Deliverable	Inspection Type	Inspection Frequency	Inspection Date	Acceptance Criteria and Records to be kept	Inspected By RC	TA	BCC	Notes
12	Install Handrails & Toe Boards	W	Once upon completing shaft	N/A	* Comply with OH&S Regulation * Record - (i) This ITP * SHAFT COVERED WITH ROAD PLATE	[signature]			
13	Install appropriate access / exit point	I	Once upon completing shaft	N/A	* Inspect location, support of access point * Ladder to 5.5m deep (with 2m cage), Cert Scaffolding * Record - (i) Scaffold Certification (ii) This ITP	[signature]			TEMP LADDER ACCESS
14	Backfill	W	Various		* Walls of excavtion treated where required * Treated spoil placed back in excavation				
15	Subgrade Compaction	H	Once per layer per 500m2		* Subgrade Compaction (see below for reference) * Refer project specifications * Refer AS3798 Table 8.1 * Record - (i) This ITP (ii) NATA Test Results * Compaction test results to be submitted to Client				

Contractor Representative Signoff

I certify that the works listed in this ITP have been constructed in accordance with Water Authority and or Council Standards and the Contract Specifications.

Name: Angelo Soumboulidis
Position: Contract Manager
Signature
Date

LEGEND:
H - HOLD, I - INSPECT
T - TEST, W - WITNESS
RC - Rob Carr Pty Ltd, TA - Tenix Alliance
BCC - Brisbane City Council

ITP-0202

Page 2 of 2

ROB CARR PTY LTD

Inspection and Test Plan

PROJECT: QLD026STA - St Achs Gravity Sewer	LOCATION: Banyo, QLD	ITP PREPARED BY: Dennis Chow	ITP FORM: ITP-02-02
CLIENT: Tenix Alliance	CONTRACT # 7103-01	ITP REVIEWED BY: Angelo Soumboulidis	ITP REVISION: 0
ITP ACTIVITY: Shaft Excavation	ACTIVITY LOCATION: 9/1	APPROVED BY: Rob Carr	

No	Project Work/Test Activity or Deliverable	Inspection Type	Inspection Frequency	Inspection Date	Acceptance Criteria and Records to be kept	Inspected By RC	Inspected By TA	Inspected By BCC	Notes
1	Work Method available and signed off	H	Once prior to start	28/4/09	* Comply with OH&S Act * Record - (i) Signed WMS				
2	Underground Services Check * Pipe Locator * Service Locator * DBYD Search	H	Once prior to start	23/4/09	* Record - (i) DBYD drawings (ii) Call Enquiry (iii) This ITP				PROVAC
3	Survey	W	Once, prior to commencement of excavation	29/4/09	* Design drawings to be checked by certified surveyor * Set out by certified surveyor. * Record - (i) Survey Drawings (ii) This ITP				USHER + CO
4	Install Environmental Controls as per TJH SEP	H	Once after every rain event	28/4/09	* Comply with Site Environmental Plan * Record - (i) Checklist (ii) This ITP				
5	Traffic devices in place in accordance with Traffic Management Plan	W	Prior to start	N/A	* Comply with Traffic Management Plan * Record - i)Site Diary ii) This ITP				
6	Saw cut asphalt / concrete surface	W	Once	N/A	* Dimensions to suit TBM equipment (4.5m x 3.5m min) * Review Council specs to ensure adequate cut depth * Record - (i) This ITP				
7	Permit to Dig	H	Once prior to start & Monthly thereafter	28/4/09	* Record - (i) DBYD drawings (ii) Call Enquiry (iii) This ITP * Client Permit to Dig Signed off				
8	Excavate Shaft	I	Various	29/4/09	* Dimensions to suit TBM equipment (4.5m x 3.5m min) * Comply with Contract Design and OH&S Regulation * Record - (i) Operator ticket (ii) Plant Check (iii) ITP * Dispose of unsuitable material / Stockpile material as required				
9	Offsite Disposal	W	Once prior to start	29/4/09	* Approval & description of dump location * Evidence of council approval for fill location				NEW CHUM
10	Acid Sulphate Testing	H	As Required	29/4/09	* Soil tested for acid sulphates * Liming rates to be determined by test				OFF SITE DISPOSAL
11	Support Shaft	I	Various	29/4/09	* Comply with Supplier Work Method * Certified Sheet Pile Design, Certified Steel Shoring Box * Record - (i) Engineer Signoff (ii) Supplier Cert (iii) ITP				

ITP-0202

Page 1 of 2

ROB CARR PTY. LTD.

Inspection and Test Plan

PROJECT: QLD026STA -St Achs Gravity Sewer	LOCATION: Banyo, QLD	ITP PREPARED BY: Dennis Chow	ITP FORM: ITP-02-02
CLIENT: Tenix Alliance	CONTRACT # 7103-01	ITP REVIEWED BY: Angelo Soumboulidis	ITP REVISION: 0
ITP ACTIVITY: Shaft Excavation	ACTIVITY LOCATION: 5/1	APPROVED BY: Rob Carr	

No.	Project Work/Test Activity or Deliverable	Inspection Type	Inspection Frequency	Inspection Date	Acceptance Criteria and Records to be kept	Inspected By RC	Inspected By TA	Inspected By BCC	Notes
12	Install Handrails & Toe Boards	W	Once upon completing shaft	29/4/09	* Comply with OH&S Regulation * Record - (i) This ITP	[signature]	[signature]		
13	Install appropriate access / exit point	I	Once upon completing shaft	29/4/09	* Inspect location, support of access point * Ladder to 5.5m deep (with 2m cage), Cert Scaffolding * Record - (i) Scaffold Certification (ii) This ITP	[signature]	[signature]		TEMP EXTENSION LADDER
14	Backfill	W	Various	5/5/09	* Walls of excavtion treated where required * Treated spoil placed back in excavation	[signature]			
15	Subgrade Compaction COMPACTION WHEEL ON EXCAVATOR *REQUIRES RE-DIG BY OTHERS FOR M/H CONSTRUCTION 5/1	H	Once per layer per 500m2	5/5/09 6/5/09	* Subgrade Compaction (see below for reference) * Refer project specifications * Refer AS3798 Table 8.1 * Record - (i) This ITP (ii) NATA Test Results * Compaction test results to be submitted to Client	[signature]			NO TESTING.

Contractor Representative Signoff

I certify that the works listed in this ITP have been constructed in accordance with Water Authority and or Council Standards and the Contract Specifications.	Name: Angelo Soumboulidis Position: Contract Manager	Signature Date	LEGEND: H - HOLD, I - INSPECT T - TEST, W - WITNESS RC - Rob Carr Pty Ltd, TA - Tenix Alliance BCC - Brisbane City Council

ITP-0202

Page 2 of 2

SEWER VACUUM MANHOLE TEST

M & D Pipe Testing Pty Ltd
ACN: 124 334 201
NATA ACCREDITED
12 Casablanca Court,
Burleigh Waters QLD 4220
0424 309 234

NATA

CLIENT: Rob Carr Pty Ltd

LOCATION: St Vincents Rd, Banyo.

PLAN No.: 486/5/6-0024
REV.: O
DATE: 13-11-2008
APPROVAL: JVH

INSPECTION DATE: 29-7-2009

REMARKS: Tested to WSA 02-2002 specifications. Manhole did not drop pressure under test.

INSPECT. RESULT: Pass

AUTHORISED SIGNATORY: ....
SIGNATORY NAME: MATTHEW YOUNG

DATE OF ISSUE: 31-7-2009

INSPECTION REPORT NUMBER: 00000SV54

INSPECTION DETAILS

LOCATION: **St Vincents Rd, Banyo.**

MANHOLE ID NUMBER	MH 2/01					
NUMBER OF MANHOLES IN TEST	1					
DEPTH OF MANHOLE	3.697metres					
DIAMETER OF MANHOLE	1200mm					
TYPE OF MANHOLE	In-Situ					
INITIAL TEST PRESSURE	-33.8kPa					
SPECIFIED TEST TIME	30 seconds					
TIME TO DROP TO -30kPA	>30 seconds					
RESULT	Pass					

AUTHORISED SIGNATORY: ....

SIGNATORY NAME: **MATTHEW YOUNG**

DATE: **31-7-2009**..

MORRISON GEOTECHNIC PTY LTD
www.morrisongeo.com.au

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■ SUNSHINE COAST
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Maroochydore Qld 4558
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F: 07 5479 1633
maroochydorelab@morrisongeo.com.au

MORRISON GEOTECHNIC
ABN 51 009 878 899
RPEUQ 2241

Dry Density Ratio Report

Client :	ROB CARR PTY LTD	Report Number:	09D/101 - 1
Address:	P O BOX 396 WELSHPOOL WA 6986		
Job Number :	09D/101	Report Date :	05/06/2009
Project :	TRENCH BACKFILL	Order Number:	
Location :	CNR RAILWAY PARADE & VINCENTS STREET , BANYO	Test Method:	AS1289.5.4.1

Page 1 of 1

Lab No :	122129	122130	122131	
ID No :	1	2	3	
Lot No :	-	-	-	
Item No :	-	-	-	
Date Sampled :	3/6/2009	3/6/2009	3/6/2009	
Date/Time Tested :	3/6/2009 / -	3/6/2009 / -	3/6/2009 / -	
Material Source :	Imported	Imported	Imported	
For Use As :	Trench Backfill	Trench Backfill	Trench Backfill	
Sample Location :	Stormwater Line 0.3m West of 2A 3m Below Final Level	Stormwater Line 0.3m South of 2A 2m Below Final Level	Stormwater Line 0.3m North of 2A 1m Below Final Level	
Test/Layer Depth (mm)	150 /	150 /	150 /	
Max Size (mm) :	19.0	19.0	19.0	
Oversize Wet (%) :	-	-	-	
Oversize Dry (%) :	-	-	-	
Field Moisture (%) :	4.9	7.5	5.8	
MDR No :	122129	122130	122131	
Assigned MDR :	No	No	No	
Field Dry Density :	2.193	2.132	2.174	
MDD (t/m³) :	2.24	2.20	2.21	
OMC (%) :	6.5	7.5	7.5	
Variation from OMC	2% dry of omc	0% wet of omc	1.5% dry of omc	
Field Density Method :	AS1289.5.8.1	AS1289.5.8.1	AS1289.5.8.1	
MC Method :	AS1289.2.1.1	AS1289.2.1.1	AS1289.2.1.1	
Compactive Effort :	Modified	Modified	Modified	
Moisture Ratio(%) / Spec :	73 / -	102.5 / -	77.5 / -	
Dry Density Ratio (%) :	98.0	97.0	98.5	
Min Dry Dens Ratio (%)	95	95	95	

Remarks :

NATA — This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IEC 17025.	APPROVED SIGNATORY Mick Morrison (Brisbane) NATA Accred No: 1169	FORM NUMBER REP ANUC-1-13

TECHNICAL SERVICES, BRISBANE
ABN 90 009 679 734
19 Nott Street, South Brisbane Qld 4101
P.O. Box 3250, South Brisbane QLD 4101
PHONE: (07) 30172800
FAX. (07) 38448860

JUN 2009
BY: ....
Q 00265 TA

Hanson
HEIDELBERGCEMENT Group

CLIENT ROB CARR PTY LTD
UNIT 16/10 BURNSIDE ROAD
ORMEAU, QLD 4208

Report No. 64032557
Sample Date : 12-06-09
Page 1 of 1
INTERIM REPORT

PROJECT CNR TUFNELL RD (ST VINCENTS RD)
ST VINCENTS RD
Cross Street: TUFNELL RD
BANYO, QLD 4014

This report replaces all previous issues of Report Number : 64032557

CONCRETE CYLINDER COMPRESSIVE STRENGTH REPORT (1)
AS1012.9

Batch Details						Specimen Details										
Plant Truck	F'c MAS Slump	Delivery Docket	Batch Time Sample Time	Actual Slump 2nd Slump (2)	Sample Method Comp (3,4,5,6)	Sample No	Date Tested	Dimensions Avg Dia. (mm) (8)	Hght (mm)	Mass per Unit Vol (Kg/m3) (7,8)	Cap (9)	Initial Curing (hrs)	Std Curing (days) (10)	Age Days or Hrs	Strength (MPa)	Mark
3106 PCC4478	S32MPa 20.0 mm 80 mm	49425463 T2660846	09:59 10:31	80 -	7 2 1 E	33644201A	19/06/09	99.9	197	2380	G	25	6	7D	45.5	N
Casting Authority : Sample Remarks						Product Description : PMP WC.45 32/20/080 WATERSEWER Location MAN HOLE BANYO RAIL WORKSHOP – MH1										
3106 PLC4564	S32MPa 20.0 mm 80 mm	49429908 T2660846	15 13 15 36	90 -	7.2.1 E	33644401A	19/06/09	100 1	198	2480	G	20	6	7D	47.5	N
Casting Authority Sample Remarks						Product Description : PMP WC.45 32/20/080 WATERSEWER Location 1A WALLS – MH1A										

REPORT REMARKS Failure Mode N = Normal Condition Prior

* NON STD INITIAL CURING REASON

Note 1 All tests carried out to relevant parts of AS1012 unless noted otherwise
Note 2 Slump tests to AS1012.3 1.
Note 3 The clause shown indicates the sample method from AS1012 1
Note 4 Compaction method to AS1012.8.1 Clause 7
Note 5 The prefix no. gives the no. of strokes, blows per layer or time (sec) of vibration per layer
Note 6 Compaction code, H = Hand Rodding, I = Int. Vibration, E = Ext. Vibration, R = Ramming.
Note 7 Density of hardened concrete reported to AS1012 12 1
Note 8 Specimens uncapped and saturated surface dry.
Note 9 Cap Type R = Rubber, S = Sulphur, D = Double Rubber, U = Double Sulphur, G = End Ground, N = No Capping
Note 10 Curing to AS1012.8 1 Clause 9.1(b) Tropical Zone
Note 11 Air Content (if reported) to AS1012.4 2.

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Run Date 22/6/09 9:22 AM
Form Number CER002.0
Version 3 0 : 05/06

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HEIDELBERGCEMENT Group

CLIENT	**ROB CARR PTY LTD** **UNIT 16/10 BURNSIDE ROAD** **ORMEAU, QLD 4208**	**Report No.** **Sample Date :** **Page** **FINAL REPORT**	**64032557** **12-06-09** **1 of 1**
PROJECT	**CNR TUFNELL RD (ST VINCENTS RD)** **ST VINCENTS RD** **Cross Street: TUFNELL RD** **BANYO, QLD 4014**	This report replaces all previous issues of Report Number : 64032557	

CONCRETE CYLINDER COMPRESSIVE STRENGTH REPORT (1)
AS1012.9

Batch Details						Specimen Details										
Plant Truck	F'c MAS Slump	Delivery Docket	Batch Time Sample Time	Actual Slump 2nd Slump (2)	Sample Method Comp (3,4,5,6)	Sample No	Date Tested	Dimensions (8) Avg Dia (mm)	Hght (mm)	Mass per Unit Vol (Kg/m3) (7,8)	Cap (9)	Initial Curing (hrs)	Std Curing (days) (10)	Age Days or Hrs	Strength (MPa)	Mark
3106	S32MPa	49425463	09:59	80	7.2.1	33644201A	19/06/09	99.9	197	2380	G	25	6	7D	45.5	N
PCC4478	20.0 mm	T2660846	10:31	-	E	33644201B	10/07/09	99.8	199	2380	G	25	27	28D	58.5	N
	80 mm					33644201C	10/07/09	100.6	197	2380	G	25	27	28D	56.5	N
Casting Authority :						Product Description	PMP WC.45 32/20/080 WATERSEWER									
Sample Remarks						Location	MAN HOLE BANYO RAIL WORKSHOP – MH1									
3106	S32MPa	49429808	15:13	80	7 2 1	33644401A	19/06/09	100 1	198	2480	G	20	6	7D	47.5	N
PLC4564	20 0 mm	T2660846	15:36	-	E	33644401B	10/07/09	100.1	198	2380	G	20	27	28D	64.0	N
	80 mm					33644401C	10/07/09	99.8	198	2400	G	20	27	28D	64.0	N
Casting Authority :						Product Description	PMP WC.45 32/20/080 WATERSEWER									
Sample Remarks						Location	1A WALLS – MH1A									

REPORT REMARKS	**Failure Mode** **N = Normal**	**Condition Prior**
* **NON STD INITIAL CURING**		
* **REASON**		

Note 1 All tests carried out to relevant parts of AS1012 unless noted otherwise.
Note 2 Slump tests to AS1012.3.1.
Note 3 The clause shown indicates the sample method from AS1012.1
Note 4 Compaction method to AS1012.8 1 Clause 7.
Note 5 The prefix no. gives the no of strokes, blows per layer or time (sec) of vibration per layer
Note 6 Compaction code H = Hand Rodding, I = Int. Vibration, E = Ext. Vibration, R = Ramming
Note 7 Density of hardened concrete reported to AS1012.12.1
Note 8 Specimens uncapped and saturated surface dry
Note 9 Cap Type R = Rubber, S = Sulphur, D = Double Rubber, U = Double Sulphur, G = End Ground, N = No Capping.
Note 10 Curing to AS1012 8 1 Clause 9 1(b) Tropical Zone
Note 11 Air Content (if reported) to AS1012 4 2.

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QLD 0265TA

CLIENT ROB CARR PTY LTD
UNIT 16/10 BURNSIDE ROAD
ORMEAU, QLD 4208

Report No. 64032604
Sample Date : 13-06-09
Page 1 of 1
INTERIM REPORT

PROJECT CNR TUFNELL RD (ST VINCENTS RD)
ST VINCENTS RD
Cross Street: TUFNELL RD
BANYO, QLD 4014

This report replaces all previous issues of Report Number : 64032604

CONCRETE CYLINDER COMPRESSIVE STRENGTH REPORT (1)
AS1012.9

Batch Details						Specimen Details											
Plant Truck	F'c MAS Slump	Delivery Docket	Batch Time Sample Time	Actual Slump 2nd Slump (2)	Sample Method Comp (3,4,5,6)	Sample No	Date Tested	Dimensions Avg Dia (mm) (6)	Dimensions Hght (mm) (6)	Mass per Unit Vol (Kg/m3) (7,8)	Cap (9)	Initial Curing (hrs)	Std Curing (days) (10)	Age Days or Hrs	Strength (MPa)	Mark
3106 PLC4617	S32MPa 20 0 mm 80 mm	49433306 T2662139	09:58 10 15	85 -	7.2 1 E	33165201A	20/06/09	100 7	198	2360	G	50*	6	7D	37.5	N

Casting Authority .

Sample Remarks

Product Description PMP WC.45 32/20/080 WATERSEWER
Location MANHOLE 1A

REPORT REMARKS Failure Mode
N = Normal

Condition Prior

* NON STD INITIAL CURING
* REASON

Min Amb Temp: 10C Max Amb Temp: 21C
Cylinders left on site over weekend

Note 1 All tests carried out to relevant parts of AS1012 unless noted otherwise
Note 2 Slump tests to AS1012.3.1
Note 3 The clause shown indicates the sample method from AS1012.1
Note 4 Compaction method to AS1012.8.1 Clause 7
Note 5 The prefix no. gives the no. of strokes, blows per layer or time (sec) of vibration per layer
Note 6 Compaction code H = Hand Rodding, I = Int Vibration, E = Ext. Vibration, R = Ramming
Note 7 Density of hardened concrete reported to AS1012 12 1
Note 8 Specimens uncapped and saturated surface dry
Note 9 Cap Type R = Rubber, S = Sulphur, D = Double Rubber, U = Double Sulphur, G = End Ground, N = No Capping
Note 10 Curing to AS1012.8 1 Clause 9.1(b) Tropical Zone
Note 11 Air Content (if reported) to AS1012 4.2.

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BY: Diana

Hanson HEIDELBERGCEMENT Group

CLIENT	**ROB CARR PTY LTD UNIT 16/10 BURNSIDE ROAD ORMEAU, QLD 4208**	**Report No. Sample Date : Page FINAL REPORT**	**64032604 13-06-09 1 of 1**
PROJECT	**CNR TUFNELL RD (ST VINCENTS RD) ST VINCENTS RD Cross Street: TUFNELL RD BANYO, QLD 4014**	This report replaces all previous issues of Report Number : 64032604	

CONCRETE CYLINDER COMPRESSIVE STRENGTH REPORT (1)
AS1012.9

Batch Details						Specimen Details											
Plant Truck	F'c MAS Slump	Delivery Docket	Batch Time Sample Time	Actual Slump 2nd Slump (2)	Sample Method Comp (3,4,5,6)	Sample No	Date Tested	Dimensions Avg Dia (mm) (8)	Dimensions Hght (mm) (8)	Mass per Unit Vol (Kg/m3) (7,8)	Cap (9)	Initial Curing (hrs)	Std Curing (days) (10)	Age Days or Hrs	Strength (MPa)	Mark
3106 PLC4617	S32MPa 20.0 mm 80 mm	49433306 T2862139	09:58 10:15	85 -	7 2.1 E	33165201A	20/06/09	100.7	198	2360	G	50*	5	7D	37.5	N
						33165201B	11/07/09	100.4	199	2360	G	50*	26	28D	51.5	N
						33165201C	11/07/09	100 4	196	2380	G	50*	26	28D	52.8	N

Casting Authority :

Sample Remarks :

Product Description : PMP WC.45 32/20/080 WATERSEWER

Location : MANHOLE 1A

REPORT REMARKS	Failure Mode N = Normal	Condition Prior
* NON STD INITIAL CURING * REASON	Min Amb Temp: 10C Max Amb Temp: 21C Cylinders left on site over weekend	

Note 1 All tests carried out to relevant parts of AS1012 unless noted otherwise
Note 2 Slump tests to AS1012 3.1.
Note 3 The clause shown indicates the sample method from AS1012 1
Note 4 Compaction method to AS1012.8 1 Clause 7.
Note 5 The prefix no. gives the no of strokes, blows per layer or time (sec) of vibration per layer.
Note 6 Compaction code H = Hand Rodding, I = Int Vibration, E = Ext. Vibration, R = Ramming.
Note 7 Density of hardened concrete reported to AS1012.12 1.
Note 8 Specimens uncapped and saturated surface dry.
Note 9 Cap Type R = Rubber, S = Sulphur, D = Double Rubber, U = Double Sulphur; G = End Ground; N = No Capping.
Note 10 Curing to AS1012.8.1 Clause 9 1(b) Tropical Zone
Note 11 Air Content (if reported) to AS1012.4 2.

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HEIDELBERGCEMENT Group

CLIENT	ROB CARR PTY LTD UNIT 16/10 BURNSIDE ROAD ORMEAU, QLD 4208	Report No. Sample Date : Page INTERIM REPORT	64032456 09-06-09 1 of 1
PROJECT	(ST VINCENTS RD) ST VINCENTS RD Cross Street: TUFNELL RD BANYO, QLD 4014	This report replaces all previous issues of Report Number : 64032456	

CONCRETE CYLINDER COMPRESSIVE STRENGTH REPORT (1)
AS1012.9

Batch Details						Specimen Details										
Plant Truck	F'c MAS Slump	Delivery Docket	Batch Time Sample Time	Actual Slump 2nd Slump (2)	Sample Method Comp (3,4,5,6)	Sample No	Date Tested	Dimensions (6) Avg Dia (mm)	Dimensions (6) Hght (mm)	Mass per Unit Vol (Kg/m3) (7,8)	Cap (9)	Initial Curing (hrs)	Std Curing (days) (10)	Age Days or Hrs	Strength (MPa)	Mark
3106 PLC4578	S32MPa 20.0 mm 80 mm	49403845 T2657395	13:43 13:58	00	7 2 1 E	33643501A	16/06/09	100 2	195	2360	G	20	6	70	43.0	N

Casting Authority Sample Remarks	Product Description PMP WC.45 32/20/080 WATERSEWER Location SEWER WALLS, MANHOLE MH 2/1

QR 4Round

REPORT REMARKS — Failure Mode: N = Normal — Condition Prior	This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IEC 17025 The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/National Standards
* NON STD INITIAL CURING * REASON	NATA Accredited Laboratory Number : 415

Note 1 All tests carried out to relevant parts of AS1012 unless noted otherwise
Note 2 Slump tests to AS1012 3 1
Note 3 The clause shown indicates the sample method from AS1012 1
Note 4 Compaction method to AS1012 8 1 Clause 7
Note 5 The prefix no gives the no of strokes, blows per layer or time (sec) of vibration per layer
Note 6 Compaction code H = Hand Rodding, I = Int Vibration, E = Ext. Vibration, R = Ramming
Note 7 Density of hardened concrete reported to AS1012 12 1.
Note 8 Specimens uncapped and saturated surface dry
Note 9 Cap Type R = Rubber, S = Sulphur, D = Double Rubber U = Double Sulphur, G = End Ground, N = No Capping
Note 10 Curing to AS1012 8 1 Clause 9.1(b) Tropical Zone
Note 11 Air Content (if reported) to AS1012 4 2

Approved Signatory RICHARD CUSACK	Run Date 17/6/09 8.09 AM
Form Number CER002 0	Version 3 0 05/08

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CLIENT	**ROB CARR PTY LTD** **UNIT 16/10 BURNSIDE ROAD** **ORMEAU, QLD 4208**	**Report No.** **Sample Date :** **Page** **FINAL REPORT**	**64032456** **09-06-09** **1 of 1**
PROJECT	**(ST VINCENTS RD)** **ST VINCENTS RD** **Cross Street: TUFNELL RD** **BANYO, QLD 4014**	This report replaces all previous issues of Report Number : 64032456	

CONCRETE CYLINDER COMPRESSIVE STRENGTH REPORT (1)
AS1012.9

Batch Details						Specimen Details											
Plant Truck	F'c MAS Slump	Delivery Docket	Batch Time Sample Time	Actual Slump 2nd Slump (2)	Sample Method Comp (3,4,5,6)	Sample No	Date Tested	Dimensions Avg Dia. (mm) (8)	Hght (mm)	Mass per Unit Vol (Kg/m3) (7,8)	Cap (9)	Initial Curing (hrs)	Std Curing (days) (10)	Age Days or Hrs	Strength (MPa)	Mark
3106 PLC4578	S32MPa 20.0 mm 80 mm	49403845 T2657395	13:43 13:58	90 .	7.2 1 E	33643501A	15/06/09	100 2	195	2360	G	20	6	7D	43.0	N
						33643501B	07/07/09	100.4	199	2400	G	20	27	28D	58.0	N
						33643501C	07/07/09	100 6	197	2380	G	20	27	28D	60.0	N

Casting Authority . Sample Remarks	Product Description PMP WC.45 32/20/080 WATERSEWER Location SEWER WALLS MANHOLE MH 2 / 1

REPORT REMARKS	Failure Mode N = Normal	Condition Prior
* NON STD INITIAL CURING * REASON		

Note 1 All tests carried out to relevant parts of AS1012 unless noted otherwise
Note 2 Slump tests to AS1012.3.1.
Note 3 The clause shown indicates the sample method from AS1012 1.
Note 4 Compaction method to AS1012.8 1 Clause 7.
Note 5 The prefix no gives the no of strokes, blows per layer or time (sec) of vibration per layer.
Note 6 Compaction code H = Hand Rodding, I = Int. Vibration, E = Ext. Vibration, R = Ramming.
Note 7 Density of hardened concrete reported to AS1012 12.1
Note 8 Specimens uncapped and saturated surface dry
Note 9 Cap Type R = Rubber, S = Sulphur, D = Double Rubber, U = Double Sulphur, G = End Ground, N = No Capping.
Note 10 Curing to AS1012.8.1 Clause 9 1(b) Tropical Zone
Note 11 Air Content (if reported) to AS1012.4.2

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Dennis
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CLIENT	ROB CARR PTY LTD UNIT 16/10 BURNSIDE ROAD ORMEAU, QLD 4208	Report No. Sample Date : Page INTERIM REPORT	64032945 24-06-09 1 of 1
PROJECT	CNR TUFNELL RD (ST VINCENTS RD) ST VINCENTS RD Cross Street: TUFNELL RD BANYO, QLD 4014	This report replaces all previous issues of Report Number : 64032945	

CONCRETE CYLINDER COMPRESSIVE STRENGTH REPORT (1)
AS1012.9

Batch Details						Specimen Details										
Plant Truck	F'c MAS Slump	Delivery Docket	Batch Time Sample Time	Actual Slump 2nd Slump (2)	Sample Method Comp (3,4,5,6)	Sample No.	Date Tested	Dimensions Avg Dia (mm) (8)	Hght (mm)	Mass per Unit Vol (Kg/m3) (7,8)	Cap (9)	Initial Curing (hrs)	Std Curing (days) (10)	Age Days or Hrs	Strength (MPa)	Mark
3106 PLC4617	S32MPa 20.0 mm 80 mm	49497139 T2670891	10:13 10:45	85 -	7.2.1 E	33200401A	01/07/09	100 0	198	2380	G	25	6	7D	41.5	N

Casting Authority :

Sample Remarks

Product Description : PMP WC.45 32/20/080 WATERSEWER

Location : MANHOLE 13

MH 311

REPORT REMARKS	Failure Mode N = Normal	Condition Prior
NON STD INITIAL CURING		
REASON		

Note 1 All tests carried out to relevant parts of AS1012 unless noted otherwise
Note 2. Slump tests to AS1012.3.1
Note 3 The clause shown indicates the sample method from AS1012 1
Note 4 Compaction method to AS1012.8.1 Clause 7.
Note 5 The prefix no. gives the no. of strokes, blows per layer or time (sec) of vibration per layer
Note 6 Compaction code H = Hand Rodding, I = Int Vibration, E = Ext, Vibration R = Ramming.
Note 7 Density of hardened concrete reported to AS1012.12 1
Note 8 Specimens uncapped and saturated surface dry.
Note 9 Cap Type R = Rubber, S = Sulphur, D = Double Rubber, U = Double Sulphur, G = End Ground, N = No Capping
Note 10 Curing to AS1012 8 1 Clause 9.1(b) Tropical Zone
Note 11 Air Content (if reported) to AS1012.4.2

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CLIENT ROB CARR PTY LTD
UNIT 16/10 BURNSIDE ROAD
ORMEAU, QLD 4208

Report No. 64032127
Sample Date : 29-05-09
Page 1 of 1
INTERIM REPORT

PROJECT CNR OF MEREDITH ST (ST VINCENTS RD)
ST VINCENTS RD
Cross Street: MEREDITH ST
BANYO, QLD 4014

This report replaces all previous issues of Report Number : 64032127

CONCRETE CYLINDER COMPRESSIVE STRENGTH REPORT (1)
AS1012.9

Batch Details						Specimen Details										
Plant Truck	F'c MAS Slump	Delivery Docket	Batch Time Sample Time	Actual Slump 2nd Slump (2)	Sample Method Comp (3,4,5,6)	Sample No.	Date Tested	Dimensions Avg Dia (mm) (8)	Dimensions Hght (mm)	Mass per Unit Vol (Kg/m3) (7,8)	Cap (9)	Initial Curing (hrs)	Std Curing (days) (10)	Age Days or Hrs	Strength (MPa)	Mark
3099 PCC4679	S32MPa 20 0 mm 60 mm	49351387 T2648834	12:24 12:55	70 -	7.2.1 E	33642001A	05/06/09	100.2	197	2380	G	23	6	7D	40.0	N

Casting Authority .

Sample Remarks :

Product Description : PMP WC.45 32/20/060 WATERSEWER

Location . WALL SEWER

MH411

REPORT REMARKS	Failure Mode	Condition Prior
	N = Normal	

NON STD INITIAL CURING REASON

- Note 1 All tests carried out to relevant parts of AS1012 unless noted otherwise.
- Note 2 Slump tests to AS1012.3.1.
- Note 3 The clause shown indicates the sample method from AS1012.1
- Note 4 Compaction method to AS1012.8.1 Clause 7.
- Note 5 The prefix no. gives the no. of strokes, blows per layer or time (sec) of vibration per layer.
- Note 6 Compaction code H = Hand Rodding, I = Int. Vibration, E = Ext. Vibration, R = Ramming.
- Note 7 Density of hardened concrete reported to AS1012 12.1
- Note 8 Specimens uncapped and saturated surface dry
- Note 9 Cap Type R = Rubber, S = Sulphur, D = Double Rubber, U = Double Sulphur, G = End Ground, N = No Capping
- Note 10 Curing to AS1012.8.1 Clause 9.1(b) Tropical Zone
- Note 11 Air Content (if reported) to AS1012 4.2.

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CLIENT	ROB CARR PTY LTD UNIT 16/10 BURNSIDE ROAD ORMEAU, QLD 4208	Report No. Sample Date : Page FINAL REPORT	64032127 29-05-09 1 of 1
PROJECT	CNR OF MEREDITH ST (ST VINCENTS RD) ST VINCENTS RD Cross Street: MEREDITH ST BANYO, QLD 4014	This report replaces all previous issues of Report Number : 64032127	

CONCRETE CYLINDER COMPRESSIVE STRENGTH REPORT (1)
AS1012.9

Batch Details						Specimen Details											
Plant Truck	F'c MAS Slump	Delivery Docket	Batch Time Sample Time	Actual Slump 2nd Slump (2)	Sample Method Comp (3,4,5,6)	Sample No	Date Tested	Dimensions Avg Dia. (mm) (8)	Dimensions Hght (mm) (8)	Mass per Unit Vol (Kg/m3) (7,8)	Cap (9)	Initial Curing (hrs)	Std Curing (days) (10)	Age Days or Hrs	Strength (MPa)	Mark
3099 PCC4679	S32MPa 20.0 mm 60 mm	49351387 T2648834	12:24 12:55	70 -	7.2.1 E	33642001A	05/06/09	100.2	197	2380	G	23	8	7D	40.0	N
						33642001B	26/06/09	100.5	198	2360	G	23	27	28D	54.0	N
						33642001C	26/06/09	100.1	199	2380	G	23	27	28D	55.0	N

Casting Authority :

Sample Remarks :

Product Description : PMP WC.45 32/20/060 WATERSEWER

Location : WALL SEWER MH 4/1

REPORT REMARKS — Failure Mode: N = Normal — Condition Prior

NON STD INITIAL CURING REASON

Note 1 All tests carried out to relevant parts of AS1012 unless noted otherwise
Note 2 Slump tests to AS1012.3.1
Note 3 The clause shown indicates the sample method from AS1012 1
Note 4 Compaction method to AS1012 8 1 Clause 7
Note 5 The prefix no. gives the no of strokes, blows per layer or time (sec) of vibration per layer.
Note 6 Compaction code H = Hand Rodding, I = Int Vibration, E = Ext. Vibration, R = Ramming
Note 7 Density of hardened concrete reported to AS1012 12 1
Note 8 Specimens uncapped and saturated surface dry
Note 9 Cap Type R = Rubber, S = Sulphur, D = Double Rubber, U = Double Sulphur, G = End Ground, N = No Capping
Note 10 Curing to AS1012 8.1 Clause 9.1(b) Tropical Zone
Note 11 Air Content (if reported) to AS1012.4.2

NATA

This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IEC 17025

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/National Standards

NATA Accredited Laboratory Number : 415

Approved Signatory RICHARD CUSACK — Run Date 27/6/09 8:06 AM
Form Number CER002.0 — Version 3 0 05/06

APPENDIX F – DORMWAY ITP & QULAITY ASSURANCE

Dormway Pty Ltd		**SEWER RETICULATION**	ITP No…2253-02…….	Dorm-Form-02-06
Inspection & Test Plan	Reviewed By________________	Date__2.03.09___	Job No…2253:….	Revision 1 2.03.09

Project: …St Achs Sewer Upgrade BANYO Activity: **Excavation Pipelaying & Backfilling**	Section / Stage / Lot ………………………… MH 5/1 – 6/1 ………………………………	Key No Point Number C/R Contractor Representative H Hold Point W Witness Point Sup Superintendent/Client/Representative Superintendent……………………………………………………

No. H/W	**Inspection Test Activity** ***Include Q H&S and E***	**Type of Test / Frequency / Test Procedure and Acceptance Criteria** *Modify National Specification or Code to include Water Business Requirements if necessary*	**Inspection/Test by:**				**Records / Results or other Evidence**	**Signed Superintendent C/R or Special Comment**
				C/R		**Sup**		
1 H	**PMP Approved**	Tenix Approval					PMP	
2W	**Set out marked and all services pegged or marked**	Visual and Measure where necessary		X			Diary Entry	
3	**Trench Width and Depth Checked & within tolerance**	WSA-03 Part 3 Cl 15 BW Drg No 486/5/7-0024-032		X			Diary Entry	
4	**Pipe Embedment, Surround & Overlay Depth & Compact**	Measure Depth. WSA-03 Part 3 Cl 16,20 BW Drg No 486/5/7-0024-032		X			Diary Entry.	
5 H	**Pipe Laid, Level and Grade in Tolerance**	Measure, Tolerances checked, WSA-03 Cl 23		X			As Constructed Records	
6 W	**Pipe Joints, Electrofusion Couplings**	Each Joint and Assembly Inspect Visually Witness Marks and Deflection Limits. Ends of pipe checked pre Installation, welding and cool down as per manufacturers instructions		X			Diary Entry	
7H	**Detection Tape In Place**	Inspect Visually. WSA-03 Part 4 Construction Section 8 & Std Drawings		X			Diary Entry	
8	**Form Manholes**	WSA-03 Part 3 Cl 15 & BW Drg No 486/5/7-0024-032		X			Dairy Entry	
9W	**Pour Manholes**	WSA-03 Part 3 Cl 18 & BW Drg No 486/5/7-0024-032		X			Test Reports	

Dormway Pty Ltd **SEWER RETICULATION** ITP No...2253-02....... Dorm-Form-02-06
Inspection & Test Plan Reviewed By________________ Date 2.03.09 Job No...2253..... Revision 1 2.03.09

No. H/W	Inspection Test Activity *Include Q H&S and E*	Type of Test / Frequency / Test Procedure and Acceptance Criteria *Modify National Specification or Code to include Water Business Requirements if necessary*	Inspection/Test by:				Records / Results or other Evidence	Signed Superintendent C/R or Special Comment
				C/R	B/R	Sup		
10	**VacuumTesting of Pipeline**	WSA-03 Part 3 Cl 15 & BW Drg No 486/5/7-0024-032		X			Test Report	
11 W	**Backfill Trench Material Used**	Each Trench Visual Inspect Material WSA-03 Part 4 Construction Section 11& Std Draw's		X			Diary Entry or Checklist	~~CQA 12.6.09~~
12 H	**Backfill Trench Compaction**	Measure Compaction as Specified & Where Specified WSA-03 Part 4 Construction		X			Test Result	CQA 12.6.09
13 H	**CCTV Inspection**	BCC Nusewer Spec Cl 10		X			Report	
14 H	**Reinstatement of Roadway**	WSA-03 Part 3 Cl 15 & BW Drg No 486/5/7-0024-032		X			Diary Entry	
15 H	**As Constructed Plans**	WSA-03 Part 3 Cl 26 BCC Amend.				X	Drawings	

No	Amendment to ITP	Date	Reviewed By	Validation
	NOTES * ROB CARR PIPELINE at DS 5/01 43mm low (I.L.)			Verification that Works have been completed in accordance with, Specifications and the Inspection and Test Plans
				Contractor Representative
				Date________________

Dormway Pty Ltd **Inspection & Test Plan**	Reviewed By________	**SEWER RETICULATION** Date 2.03.09	ITP No...2253-02....... Job No...2253.....	Dorm-Form-02-06 Revision 1 2.03.09

Project: ...St Achs Sewer Upgrade BANYO Activity: **Excavation Pipelaying & Backfilling**	Section / Stage / Lot .... MH 6/1 – 7/1	Key No Point Number C/R Contractor Representative H Hold Point W Witness Point Sup Superintendent/Client/Representative Superintendent..............

No. H/W	**Inspection Test Activity** ***Include Q H&S and E***	**Type of Test / Frequency / Test Procedure and Acceptance Criteria** *Modify National Specification or Code to include Water Business Requirements if necessary*	**Inspection/Test by:**	**C/R**		**Sup**	**Records / Results or other Evidence**	**Signed Superintendent C/R or Special Comment**
1 H	**PMP Approved**	Tenix Approval				[signature]	PMP	[signatures]
2W	**Set out marked and all services pegged or marked**	Visual and Measure where necessary		X			Diary Entry	[signatures]
3	**Trench Width and Depth Checked & within tolerance**	WSA-03 Part 3 Cl 15 BW Drg No 486/5/7-0024-032		X		[signature]	Diary Entry	[signatures]
4	**Pipe Embedment, Surround & Overlay Depth & Compact**	Measure Depth. WSA-03 Part 3 Cl 16,20 BW Drg No 486/5/7-0024-032		X		[signature]	Diary Entry	[signatures]
5 H	**Pipe Laid, Level and Grade in Tolerance**	Measure, Tolerances checked, WSA-03 Cl 23		X			As Constructed Records	[signature]
6 W	**Pipe Joints, Electrofusion Couplings**	Each Joint and Assembly Inspect Visually Witness Marks and Deflection Limits. Ends of pipe checked pre Installation, welding and cool down as per manufacturers instructions		X		[signature]	Diary Entry	[signatures]
7H	**Detection Tape In Place**	Inspect Visually. WSA-03 Part 4 Construction Section 8 & Std Drawings		X		[signature]	Diary Entry	[signatures]
8	**Form Manholes**	WSA-03 Part 3 Cl 15 & BW Drg No 486/5/7-0024-032		X		[signature]	Dairy Entry	[signatures]
9W	**Pour Manholes**	WSA-03 Part 3 Cl 18 & BW Drg No 486/5/7-0024-032		X		[signature]	~~Test Reports~~ Dockets	[signatures]

Dormway Pty Ltd		**SEWER RETICULATION**	ITP No...2253-02.......	Dorm-Form-02-06
Inspection & Test Plan	Reviewed By__________	Date__2.03.09___	Job No...2253.....	Revision 1 2.03.09

No. H/W	Inspection Test Activity *Include Q H&S and E*	Type of Test / Frequency / Test Procedure and Acceptance Criteria *Modify National Specification or Code to include Water Business Requirements if necessary*	Inspection/Test by:				Records / Results or other Evidence	Signed Superintendent C/R or Special Comment
				C/R	B/R	Sup		
10	**VacuumTesting of Pipeline**	WSA-03 Part 3 Cl 15 & BW Drg No 486/5/7-0024-032		X			Test Report	27.4.09
11 W	**Backfill Trench Material Used**	Each Trench Visual Inspect Material WSA-03 Part 4 Construction Section 11& Std Draw's		X			Diary Entry or Checklist	
12 H	**Backfill Trench Compaction**	Measure Compaction as Specified & Where Specified WSA-03 Part 4 Construction		X			Test Result CQA.	
13 H	**CCTV Inspection**	BCC Nusewer Spec Cl 10		X			Report	27.04.09
14 H	**Reinstatement of Roadway**	WSA-03 Part 3 Cl 15 & BW Drg No 486/5/7-0024-032		X			Diary Entry	
15 H	**As Constructed Plans**	WSA-03 Part 3 Cl 26 BCC Amend.				X	Drawings	

No	Amendment to ITP	Date	Reviewed By	Validation
				Verification that Works have been completed in accordance with, Specifications and the Inspection and Test Plans
				Contractor Representative
				Date__________

Dormway Pty Ltd	**SEWER RETICULATION**	ITP No…2253-02…….	Dorm-Form-02-06
Inspection & Test Plan Reviewed By________	Date _2.03.09___	Job No…2253…..	Revision 1 2.03.09

Project: …St Achs Sewer Upgrade BANYO Activity: **Excavation Pipelaying & Backfilling**	Section / Stage / Lot ……………………… MH 7/1 – 8/1	Key No Point Number C/R Contractor Representative H Hold Point W Witness Point Sup Superintendent/Client/Representative Superintendent………………………………………

No. H/W	Inspection Test Activity *Include Q H&S and E*	Type of Test / Frequency / Test Procedure and Acceptance Criteria *Modify National Specification or Code to include Water Business Requirements if necessary*	Inspection/Test by:				Records / Results or other Evidence	Signed Superintendent C/R or Special Comment
				C/R		Sup		
1 H	**PMP Approved**	Tenix Approval				X	PMP	[signature]
2W	**Set out marked and all services pegged or marked**	Visual and Measure where necessary		X			Diary Entry	[signature]
3	**Trench Width and Depth Checked & within tolerance**	WSA-03 Part 3 Cl 15 BW Drg No 486/5/7-0024-032		X			Diary Entry	[signature]
4	**Pipe Embedment, Surround & Overlay Depth & Compact**	Measure Depth. WSA-03 Part 3 Cl 16,20 BW Drg No 486/5/7-0024-032		X			Diary Entry	[signature]
5 H	**Pipe Laid, Level and Grade in Tolerance**	Measure, Tolerances checked, WSA-03 Cl 23		X			As Constructed Records.	[signature]
6 W	**Pipe Joints, Electrofusion Couplings**	Each Joint and Assembly Inspect Visually Witness Marks and Deflection Limits. Ends of pipe checked pre Installation, welding and cool down as per manufacturers instructions		X			Diary Entry	[signature]
7H	**Detection Tape In Place**	Inspect Visually. WSA-03 Part 4 Construction Section 8 & Std Drawings		X			Diary Entry	[signature]
8	**Form Manholes**	WSA-03 Part 3 Cl 15 & BW Drg No 486/5/7-0024-032		X			Dairy Entry	[signature]
9W	**Pour Manholes**	WSA-03 Part 3 Cl 18 & BW Drg No 486/5/7-0024-032		X			Test Reports	[signature]

Dormway Pty Ltd **SEWER RETICULATION** ITP No...2253-02....... Dorm-Form-02-06
Inspection & Test Plan Reviewed By________________ Date 2.03.09 Job No...2253..... Revision:1 2.03.09

No. H/W	Inspection Test Activity *Include Q H&S and E*	Type of Test / Frequency / Test Procedure and Acceptance Criteria *Modify National Specification or Code to include Water Business Requirements if necessary*	Inspection/Test by:	C/R	B/R	Sup	Records / Results or other Evidence	Signed Superintendent C/R or Special Comment
10	**VacuumTesting of Pipeline**	WSA-03 Part 3 Cl 15 & BW Drg No 486/5/7-0024-032		X			Test Report	[signature]
11 W	**Backfill Trench Material Used**	Each Trench Visual Inspect Material WSA-03 Part 4 Construction Section 11& Std Draw's		X		X	Diary Entry or Checklist	[signature]
12 H	**Backfill Trench Compaction**	Measure Compaction as Specified & Where Specified WSA-03 Part 4 Construction		X			Test Result	[signature]
13 H	**CCTV Inspection**	BCC Nusewer Spec Cl 10		X			Report	[signature]
14 H	**Reinstatement of Roadway**	WSA-03 Part 3 Cl 15 & BW Drg No 486/5/7-0024-032		X			Diary Entry	
15 H	**As Constructed Plans**	WSA-03 Part 3 Cl 26 BCC Amend.				X	Drawings	

No	Amendment to ITP	Date	Reviewed By	Validation
				Verification that Works have been completed in accordance with, Specifications and the Inspection and Test Plans
				Contractor Representative
				Date________

Dormway Pty Ltd	**SEWER RETICULATION**	ITP No…2253-02…….	Dorm-Form-02-06
Inspection & Test Plan Reviewed By________	Date 2.03.09	Job No…2253……	Revision 1 2.03.09

Project: …St Achs Sewer Upgrade BANYO Activity: **Excavation Pipelaying & Backfilling**	Section / Stage / Lot ……… MH 8/1 - 9/1	Key No Point Number C/R Contractor Representative H Hold Point W Witness Point Sup Superintendent/Client/Representative Superintendent………

No. H/W	**Inspection Test Activity** ***Include Q H&S and E***	**Type of Test / Frequency / Test Procedure and Acceptance Criteria** *Modify National Specification or Code to include Water Business Requirements if necessary*	**Inspection/Test by:**				**Records / Results or other Evidence**	**Signed Superintendent C/R or Special Comment**
				C/R		**Sup**		
1 H	**PMP Approved**	Tenix Approval				X	PMP	
2W	**Set out marked and all services pegged or marked**	Visual and Measure where necessary		X			Diary Entry	
3	**Trench Width and Depth Checked & within tolerance**	WSA-03 Part 3 Cl 15 BW Drg No 486/5/7-0024-032		X			Diary Entry	
4	**Pipe Embedment, Surround & Overlay Depth & Compact**	Measure Depth. WSA-03 Part 3 Cl 16,20 BW Drg No 486/5/7-0024-032		X			Diary Entry	
5 H	**Pipe Laid, Level and Grade in Tolerance**	Measure, Tolerances checked, WSA-03 Cl 23		X			As Constructed Records	
6 W	**Pipe Joints, Electrofusion Couplings**	Each Joint and Assembly Inspect Visually Witness Marks and Deflection Limits. Ends of pipe checked pre Installation, welding and cool down as per manufacturers instructions		X			Diary Entry	
7H	**Detection Tape In Place**	Inspect Visually. WSA-03 Part 4 Construction Section 8 & Std Drawings		X			Diary Entry	
8	**Form Manholes**	WSA-03 Part 3 Cl 15 & BW Drg No 486/5/7-0024-032		X			Dairy Entry	
9W	**Pour Manholes**	WSA-03 Part 3 Cl 18 & BW Drg No 486/5/7-0024-032		X			Test Reports	

Dormway Pty Ltd	**SEWER RETICULATION**	ITP No:..2253-02.......	Dorm-Form-02-06
Inspection & Test Plan Reviewed By________	Date 2.03.09	Job No...2253.....	Revision 1 2.03.09

No. H/W	Inspection Test Activity *Include Q H&S and E*	Type of Test / Frequency / Test Procedure and Acceptance Criteria *Modify National Specification or Code to include Water Business Requirements if necessary*	Inspection/Test by:				Records / Results or other Evidence	Signed Superintendent C/R or Special Comment
				C/R	B/R	Sup		
10	**VacuumTesting of Pipeline**	WSA-03 Part 3 Cl 15 & BW Drg No 486/5/7-0024-032		X			Test Report	
11 W	**Backfill Trench Material Used**	Each Trench Visual Inspect Material WSA-03 Part 4 Construction Section 11& Std Draw's		X		X	Diary Entry or Checklist	
12 H	**Backfill Trench Compaction**	Measure Compaction as Specified & Where Specified WSA-03 Part 4 Construction		X			Test Result	
13 H	**CCTV Inspection**	BCC Nusewer Spec Cl 10		X			Report	
14 H	**Reinstatement of Roadway**	WSA-03 Part 3 Cl 15 & BW Drg No 486/5/7-0024-032		X			Diary Entry	
15 H	**As Constructed Plans**	WSA-03 Part 3 Cl 26 BCC Amend.				X	Drawings	

No	Amendment to ITP	Date	Reviewed By	Validation
				Verification that Works have been completed in accordance with, Specifications and the Inspection and Test Plans
				Contractor Representative
				Date________

Dormway Pty Ltd **Inspection & Test Plan**	Reviewed By	**SEWER RETICULATION** Date 2.03.09	ITP No…2253-02…… Job No…2253…..	Dorm-Form-02-06 Revision 1 2.03.09

Project: …St Achs Sewer Upgrade BANYO Activity: **Excavation Pipelaying & Backfilling**	Section / Stage / Lot ……… MH 9/1 – 10/1	Key No Point Number C/R Contractor Representative H Hold Point W Witness Point Sup Superintendent/Client/Representative Superintendent………

No. H/W	Inspection Test Activity *Include Q H&S and E*	Type of Test / Frequency / Test Procedure and Acceptance Criteria *Modify National Specification or Code to include Water Business Requirements if necessary*	Inspection/Test by:	C/R		Sup	Records / Results or other Evidence	Signed Superintendent C/R or Special Comment
1 H	**PMP Approved**	Tenix Approval				X	PMP	[signature]
2W	**Set out marked and all services pegged or marked**	Visual and Measure where necessary		X			Diary Entry	[signature]
3	**Trench Width and Depth Checked & within tolerance**	WSA-03 Part 3 Cl 15 BW Drg No 486/5/7-0024-032		X			Diary Entry	[signature]
4	**Pipe Embedment, Surround & Overlay Depth & Compact**	Measure Depth. WSA-03 Part 3 Cl 16,20 BW Drg No 486/5/7-0024-032		X			Diary Entry	[signature]
5 H	**Pipe Laid, Level and Grade in Tolerance**	Measure, Tolerances checked, WSA-03 Cl 23		X			As Constructed Records	[signature]
6 W	**Pipe Joints, Electrofusion Couplings**	Each Joint and Assembly Inspect Visually Witness Marks and Deflection Limits. Ends of pipe checked pre Installation, welding and cool down as per manufacturers instructions		X			Diary Entry	[signature]
7H	**Detection Tape In Place**	Inspect Visually. WSA-03 Part 4 Construction Section 8 & Std Drawings		X			Diary Entry	[signature]
8	**Form Manholes**	WSA-03 Part 3 Cl 15 & BW Drg No 486/5/7-0024-032		X			Dairy Entry	[signature]
9W	**Pour Manholes**	WSA-03 Part 3 Cl 18 & BW Drg No 486/5/7-0024-032		X			Test Reports	[signature]

Dormway Pty Ltd **Inspection & Test Plan**	Reviewed By________	**SEWER RETICULATION** Date__2.03.09____	ITP No..:2253-02....... Job No...2253.....	Dorm-Form-02-06 Revision 1 2:03.09

No. H/W	Inspection Test Activity *Include Q H&S and E*	**Type of Test / Frequency / Test Procedure and Acceptance Criteria** *Modify National Specification or Code to include Water Business Requirements if necessary*	Inspection/Test by:				Records / Results or other Evidence	Signed Superintendent C/R or Special Comment
				C/R	B/R	Sup		
10	**VacuumTesting of Pipeline**	WSA-03 Part 3 Cl 15 & BW Drg No 486/5/7-0024-032		X			Test Report	[signature]
11 W	**Backfill Trench Material Used**	Each Trench Visual Inspect Material WSA-03 Part 4 Construction Section 11& Std Draw's		X		X	Diary Entry or Checklist	[signature]
12 H	**Backfill Trench Compaction**	Measure Compaction as Specified & Where Specified WSA-03 Part 4 Construction		X			Test Result	[signature]
13 H	**CCTV Inspection**	BCC Nusewer Spec Cl 10		X			Report	[signature]
14 H	**Reinstatement of Roadway**	WSA-03 Part 3 Cl 15 & BW Drg No 486/5/7-0024-032		X			Diary Entry	
15 H	**As Constructed Plans**	WSA-03 Part 3 Cl 26 BCC Amend.				X	Drawings	

No	Amendment to ITP	Date	Reviewed By	Validation
				Verification that Works have been completed in accordance with. Specifications and the Inspection and Test Plans
				Contractor Representative
				Date________

Dormway Pty Ltd **Inspection & Test Plan**	Reviewed By________	**SEWER RETICULATION** Date 2.03.09	ITP No...2253-02....... Job No...2253.....	Dorm-Form-02-06 Revision 1 2.03.09

Project: ...St Achs Sewer Upgrade BANYO Activity: **Excavation Pipelaying & Backfilling**	Section / Stage / Lot .... MH 10/1 – 11/1	Key: No Point Number; H Hold Point; W Witness Point; C/R Contractor Representative; Sup Superintendent/Client/Representative. Superintendent..............

No. H/W	**Inspection Test Activity** ***Include Q H&S and E***	**Type of Test / Frequency / Test Procedure and Acceptance Criteria** *Modify National Specification or Code to Include Water Business Requirements if necessary*	**Inspection/Test by:**				**Records / Results or other Evidence**	**Signed Superintendent C/R or Special Comment**
				C/R		**Sup**		
1.H	**PMP Approved**	Tenix Approval				X	PMP	
2W.	**Set out marked and all services pegged or marked**	Visual and Measure where necessary		X			Diary Entry	
3	**Trench Width and Depth Checked & within tolerance**	WSA-03 Part 3 Cl 15 BW Drg No 486/5/7-0024-032		X			Diary Entry	
4	**Pipe Embedment, Surround & Overlay Depth & Compact**	Measure Depth. WSA-03 Part 3 Cl 16,20 BW Drg No 486/5/7-0024-032		X			Diary Entry	
5.H	**Pipe Laid, Level and Grade in Tolerance**	Measure, Tolerances checked, WSA-03 Cl 23		X			As Constructed Records	
6 W	**Pipe Joints, Electrofusion Couplings**	Each Joint and Assembly Inspect Visually Witness Marks and Deflection Limits. Ends of pipe checked pre Installation, welding and cool down as per manufacturers instructions		X			Diary Entry	
7H	**Detection Tape In Place**	Inspect Visually. WSA-03 Part 4 Construction Section 8 & Std Drawings		X			Diary Entry	
8	**Form Manholes**	WSA-03 Part 3 Cl 15 & BW Drg No 486/5/7-0024-032		X			Dairy Entry	
9W	**Pour Manholes**	WSA-03 Part 3 Cl 18 & BW Drg No 486/5/7-0024-032		X			Test Reports	

Dormway Pty Ltd		**SEWER RETICULATION**	ITP No...2253-02.......	Dorm-Form-02-06
Inspection & Test Plan	Reviewed By__________	Date__2.03.09__	Job No...2253.....	Revision 1 2.03.09

No. H/W	Inspection Test Activity *Include Q H&S and E*	Type of Test / Frequency / Test Procedure and Acceptance Criteria *Modify National Specification or Code to include Water Business Requirements if necessary*	Inspection/Test by:				Records / Results or other Evidence	Signed Superintendent C/R or Special Comment
				C/R	B/R	Sup		
10	**VacuumTesting of Pipeline**	WSA-03 Part 3 Cl 15 & BW Drg No 486/5/7-0024-032		X			Test Report	
11 W	**Backfill Trench Material Used**	Each Trench Visual Inspect Material WSA-03 Part 4 Construction Section 11& Std Draw's		X		X	Diary Entry or Checklist	Tenix & BCC checked material need inspected for some amount.
12 H	**Backfill Trench Compaction**	Measure Compaction as Specified & Where Specified WSA-03 Part 4 Construction		X			Test Result	
13 H	**CCTV Inspection**	BCC Nusewer Spec Cl 10		X			Report	
14 H	**Reinstatement of Roadway**	WSA-03 Part 3 Cl 15 & BW Drg No 486/5/7-0024-032		X			Diary Entry	
15 H	**As Constructed Plans**	WSA-03 Part 3 Cl 26 BCC Amend.				X	Drawings	

No	Amendment to ITP	Date	Reviewed By	Validation
				Verification that Works have been completed in accordance with, Specifications and the Inspection and Test Plans
				Contractor Representative
				Date__________

Dormway Pty Ltd **Inspection & Test Plan**	Reviewed By____	**SEWER RETICULATION** Date__2.03.09__	ITP No...2253-02:...... Job No...2253.....	Dorm-Form-02-06 Revision 1 2.03.09

Project: ...St Achs Sewer Upgrade BANYO Activity: **Excavation Pipelaying & Backfilling**	Section / Stage / Lot .... MH 1V/1 – 12/1	Key No Point Number C/R Contractor Representative H Hold Point W Witness Point Sup Superintendent/Client/Representative Superintendent........

No. H/W	Inspection Test Activity *Include Q H&S and E*	Type of Test / Frequency / Test Procedure and Acceptance Criteria *Modify National Specification or Code to include Water Business Requirements if necessary*	Inspection/Test by:	C/R		Sup	Records / Results or other Evidence	Signed Superintendent C/R or Special Comment
1 H	**PMP Approved**	Tenix Approval				X	PMP	
2W	**Set out marked and all services pegged or marked**	Visual and Measure where necessary		X			Diary Entry	change location 13/1 Tenix.
3	**Trench Width and Depth Checked & within tolerance**	WSA-03 Part 3 Cl 15 BW Drg No 486/5/7-0024-032		X			Diary Entry	
4	**Pipe Embedment, Surround & Overlay Depth & Compact**	Measure Depth. WSA-03 Part 3 Cl 16,20 BW Drg No 486/5/7-0024-032		X			Diary Entry	
5 H	**Pipe Laid, Level and Grade in Tolerance**	Measure, Tolerances checked, WSA-03 Cl 23		X			As Constructed Records	
6 W	**Pipe Joints, Electrofusion Couplings**	Each Joint and Assembly Inspect Visually Witness Marks and Deflection Limits. Ends of pipe checked pre Installation, welding and cool down as per manufacturers instructions		X			Diary Entry	
7H	**Detection Tape In Place**	Inspect Visually. WSA-03 Part 4 Construction Section 8 & Std Drawings		X			Diary Entry	
8	**Form Manholes**	WSA-03 Part 3 Cl 15 & BW Drg No 486/5/7-0024-032		X			Dairy Entry	
9W	**Pour Manholes**	WSA-03 Part 3 Cl 18 & BW Drg No 486/5/7-0024-032		X			Test Reports	

Dormway Pty Ltd **SEWER RETICULATION** ITP No...2253-02....... Dorm-Form-02-06
Inspection & Test Plan Reviewed By________ Date 2.03.09 Job No...2253..... Revision 1 2.03.09

No. H/W	Inspection Test Activity *Include Q H&S and E*	Type of Test / Frequency / Test Procedure and Acceptance Criteria *Modify National Specification or Code to include Water Business Requirements if necessary*	Inspection/Test by:				Records / Results or other Evidence	Signed Superintendent C/R or Special Comment
				C/R	B/R	Sup		
10	**VacuumTesting of Pipeline**	WSA-03 Part 3 Cl 15 & BW Drg No 486/5/7-0024-032		X			Test Report	[illegible]
11 W	**Backfill Trench Material Used**	Each Trench Visual Inspect Material WSA-03 Part 4 Construction Section 11& Std Draw's		X		X	Diary Entry or Checklist	[illegible]
12 H	**Backfill Trench Compaction**	Measure Compaction as Specified & Where Specified WSA-03 Part 4 Construction		X			Test Result	[illegible]
13 H	**CCTV Inspection**	BCC Nusewer Spec Cl 10		X			Report	[illegible]
14 H	**Reinstatement of Roadway**	WSA-03 Part 3 Cl 15 & BW Drg No 486/5/7-0024-032		X			Diary Entry	
15 H	**As Constructed Plans**	WSA-03 Part 3 Cl 26 BCC Amend.				X	Drawings	

No	Amendment to ITP	Date	Reviewed By	Validation
				Verification that Works have been completed in accordance with, Specifications and the Inspection and Test Plans
				Contractor Representative
				Date________

Dormway Pty Ltd **Inspection & Test Plan**	Reviewed By________	**SEWER RETICULATION** Date__2.03.09__	ITP No...2253-02:...... Job No...2253.....	Dorm-Form-02-06 Revision 1 2.03.09

Project: ...St Achs Sewer Upgrade BANYO Activity: **Excavation Pipelaying & Backfilling**	Section / Stage / Lot .... MH 12/1 – 13/1	Key No Point Number C/R Contractor Representative H Hold Point W Witness Point Sup Superintendent/Client/Representative Superintendent..........

No. H/W	**Inspection Test Activity** *Include Q H&S and E*	**Type of Test / Frequency / Test Procedure and Acceptance Criteria** *Modify National Specification or Code to include Water Business Requirements if necessary*	**Inspection/Test by:**	**C/R**		**Sup**	**Records / Results or other Evidence**	**Signed Superintendent C/R or Special Comment**
1 H	**PMP Approved**	Tenix Approval				X	PMP	[signature]
2W	**Set out marked and all services pegged or marked**	Visual and Measure where necessary		X			Diary Entry	[signature]
3	**Trench Width and Depth Checked & within tolerance**	WSA-03 Part 3 Cl 15 BW Drg No 486/5/7-0024-032		X			Diary Entry	[signature]
4	**Pipe Embedment, Surround & Overlay Depth & Compact**	Measure Depth. WSA-03 Part 3 Cl 16,20 BW Drg No 486/5/7-0024-032		X			Diary Entry	[signature]
5 H	**Pipe Laid, Level and Grade in Tolerance**	Measure, Tolerances checked, WSA-03 Cl 23		X			As Constructed Records	[signature]
6 W	**Pipe Joints, Electrofusion Couplings**	Each Joint and Assembly Inspect Visually Witness Marks and Deflection Limits. Ends of pipe checked pre Installation, welding and cool down as per manufacturers instructions		X			Diary Entry	[signature]
7H	**Detection Tape In Place**	Inspect Visually. WSA-03 Part 4 Construction Section 8 & Std Drawings		X			Diary Entry	[signature]
8	**Form Manholes**	WSA-03 Part 3 Cl 15 & BW Drg No 486/5/7-0024-032		X			Dairy Entry	[signature]
9W	**Pour Manholes**	WSA-03 Part 3 Cl 18 & BW Drg No 486/5/7-0024-032		X			Test Reports	[signature]

Dormway Pty Ltd **SEWER RETICULATION** ITP No…2253-02……. Dorm-Form-02-06
Inspection & Test Plan Reviewed By__________________ Date__2.03.09___ Job No…2253….. Revision 1 2.03.09

No. H/W	Inspection Test Activity *Include Q H&S and E*	Type of Test / Frequency / Test Procedure and Acceptance Criteria *Modify National Specification or Code to include Water Business Requirements if necessary*	Inspection/Test by:				Records / Results or other Evidence	Signed Superintendent C/R or Special Comment
				C/R	B/R	Sup		
10.	**VacuumTesting of Pipeline**	WSA-03 Part 3 Cl 15 & BW Drg No 486/5/7-0024-032		X			Test Report	
11 W	**Backfill Trench Material Used**	Each Trench Visual Inspect Material WSA-03 Part 4 Construction Section 1.1& Std Draw's		X		X	Diary Entry or Checklist	
12 H	**Backfill Trench Compaction**	Measure Compaction as Specified & Where Specified WSA-03 Part 4 Construction		X			Test Result	
13 H	**CCTV Inspection**	BCC Nusewer Spec Cl 10		X			Report	
14 H	**Reinstatement of Roadway**	WSA-03 Part 3 Cl 15 & BW Drg No 486/5/7-0024-032		X			Diary Entry	
15 H	**As Constructed Plans**	WSA-03 Part 3 Cl 26 BCC Amend.				X	Drawings	

No	Amendment to ITP	Date	Reviewed By	Validation
				Verification that Works have been completed in accordance with, Specifications and the Inspection and Test Plans
				Contractor Representative
				Date________________

Dormway Pty Ltd **Inspection & Test Plan**	Reviewed By_____	**SEWER RETICULATION** Date 2.03.09	ITP No...2253-02....... Job No...2253.....	Dorm-Form-02-06 Revision 1 2.03.09

Project: ...St Achs Sewer Upgrade BANYO Activity: **Excavation Pipelaying & Backfilling**	Section / Stage / Lot .... MH 13/1 – 14/1	Key No Point Number — C/R Contractor Representative H Hold Point W Witness Point — Sup Superintendent/Client/Representative Superintendent..........

No. H/W	Inspection Test Activity *Include Q H&S and E*	Type of Test / Frequency / Test Procedure and Acceptance Criteria *Modify National Specification or Code to include Water Business Requirements if necessary*	Inspection/Test by:	C/R		Sup	Records / Results or other Evidence	Signed Superintendent C/R or Special Comment
1.H	**PMP Approved**	Tenix Approval				X	PMP	[signature]
2W	**Set out marked and all services pegged or marked**	Visual and Measure where necessary		X			Diary Entry	[signature]
3	**Trench Width and Depth Checked & within tolerance**	WSA-03 Part 3 Cl 15 BW Drg No 486/5/7-0024-032		X			Diary Entry	[signature]
4	**Pipe Embedment, Surround & Overlay Depth & Compact**	Measure Depth. WSA-03 Part 3 Cl 16,20 BW Drg No 486/5/7-0024-032		X			Diary Entry	[signature]
5 H	**Pipe Laid, Level and Grade in Tolerance**	Measure, Tolerances checked, WSA-03 Cl 23		X			As Constructed Records	[signature]
6 W	**Pipe Joints, Electrofusion Couplings**	Each Joint and Assembly Inspect Visually Witness Marks and Deflection Limits. Ends of pipe checked pre Installation, welding and cool down as per manufacturers instructions		X			Diary Entry	[signature]
7H	**Detection Tape In Place**	Inspect Visually. WSA-03 Part 4 Construction Section 8 & Std Drawings		X			Diary Entry	[signature]
8	**Form Manholes**	WSA-03 Part 3 Cl 15 & BW Drg No 486/5/7-0024-032		X			Dairy Entry	[signature]
9W	**Pour Manholes**	WSA-03 Part 3 Cl 18 & BW Drg No 486/5/7-0024-032		X			Test Reports	[signature]

Dormway Pty Ltd	**SEWER RETICULATION**	ITP No…2253-02…….	Dorm-Form-02-06
Inspection & Test Plan Reviewed By________	Date _2.03.09___	Job No…2253…..	Revision 1 2.03.09

No. H/W	**Inspection Test Activity** ***Include Q H&S and E***	**Type of Test / Frequency / Test Procedure and Acceptance Criteria** *Modify National Specification or Code to include Water Business Requirements if necessary*	**Inspection/Test by:**				**Records / Results or other Evidence**	**Signed Superintendent C/R or Special Comment**
				C/R	**B/R**	**Sup**		
10	**VacuumTesting of Pipeline**	WSA-03 Part 3 Cl 15 & B.W Drg No 486/5/7-0024-032		X			Test Report	
11 W	**Backfill Trench Material Used**	Each Trench Visual Inspect Material WSA-03 Part 4 Construction Section 11& Std Draw's		X		X	Diary Entry or Checklist	
12 H	**Backfill Trench Compaction**	Measure Compaction as Specified & Where Specified WSA-03 Part 4 Construction		X			Test Result	
13 H	**CCTV Inspection**	BCC Nusewer Spec Cl 10		X			Report	
14 H	**Reinstatement of Roadway**	WSA-03 Part 3 Cl 15 & BW Drg No 486/5/7-0024-032		X			Diary Entry	
15 H	**As Constructed Plans**	WSA-03 Part 3 Cl 26 BCC Amend.				X	Drawings	

No	**Amendment to ITP**	**Date**	**Reviewed By**	**Validation**
				Verification that Works have been completed in accordance with, Specifications and the Inspection and Test Plans
				Contractor Representative
				Date________

Dormway Pty Ltd		**SEWER RETICULATION**	ITP No...2253-02.......	Dorm-Form-02-06
Inspection & Test Plan	Reviewed By________	Date 2.03.09	Job No...2253.....	Revision 1 2.03.09

Project: ...St Achs Sewer Upgrade BANYO Activity: **Excavation Pipelaying & Backfilling**	Section / Stage / Lot .... MH 14/1 – 15/1	Key No Point Number C/R Contractor Representative H Hold Point W Witness Point Sup Superintendent/Client/Representative Superintendent..........

No. H/W	Inspection Test Activity *Include Q H&S and E*	Type of Test / Frequency / Test Procedure and Acceptance Criteria *Modify National Specification or Code to include Water Business Requirements if necessary*	Inspection/Test by:				Records / Results or other Evidence	Signed Superintendent C/R or Special Comment
				C/R		Sup		
1 H	**PMP Approved**	Tenix Approval				X	PMP	
2W	**Set out marked and all services pegged or marked**	Visual and Measure where necessary		X			Diary Entry	
3	**Trench Width and Depth Checked & within tolerance**	WSA-03 Part 3 Cl 15 BW Drg No 486/5/7-0024-032		X			Diary Entry	
4	**Pipe Embedment, Surround & Overlay Depth & Compact**	Measure Depth. WSA-03 Part 3 Cl 16,20 BW Drg No 486/5/7-0024-032		X			Diary Entry	
5 H	**Pipe Laid, Level and Grade in Tolerance**	Measure, Tolerances checked, WSA-03 Cl 23		X			As Constructed Records	
6 W	**Pipe Joints, Electrofusion Couplings**	Each Joint and Assembly Inspect Visually Witness Marks and Deflection Limits. Ends of pipe checked pre Installation, welding and cool down as per manufacturers instructions		X			Diary Entry	
7H	**Detection Tape In Place**	Inspect Visually. WSA-03 Part 4 Construction Section 8 & Std Drawings		X			Diary Entry	
8	**Form Manholes**	WSA-03 Part 3 Cl 15 & BW Drg No 486/5/7-0024-032		X			Dairy Entry	
9W	**Pour Manholes**	WSA-03 Part 3 Cl 18 & BW Drg No 486/5/7-0024-032		X			Test Reports	

Dormway Pty Ltd Inspection & Test Plan	SEWER RETICULATION Reviewed By________ Date 2.03.09	ITP No...2253-02....... Job No...2253.....	Dorm-Form-02-06 Revision 1 2.03.09

No. H/W	Inspection Test Activity *Include Q H&S and E*	Type of Test / Frequency / Test Procedure and Acceptance Criteria *Modify National Specification or Code to include Water Business Requirements if necessary*	Inspection/Test by:	C/R	B/R	Sup	Records / Results or other Evidence	Signed Superintendent C/R or Special Comment
10	**VacuumTesting of Pipeline**	WSA-03 Part 3 Cl 15 & BW Drg No 486/5/7-0024-032		X			Test Report	[signature]
11 W	**Backfill Trench Material Used**	Each Trench Visual Inspect Material WSA-03 Part 4 Construction Section 11& Std Draw's		X		X	Diary Entry or Checklist	[signature]
12 H	**Backfill Trench Compaction**	Measure Compaction as Specified & Where Specified WSA-03 Part 4 Construction		X			Test Result	[signature]
13 H	**CCTV Inspection**	BCC Nusewer Spec Cl 10		X			Report	[signature]
14 H	**Reinstatement of Roadway**	WSA-03 Part 3 Cl 15 & BW Drg No 486/5/7-0024-032		X			Diary Entry	
15 H	**As Constructed Plans**	WSA-03 Part 3 Cl 26 BCC Amend.				X	Drawings	

No	Amendment to ITP	Date	Reviewed By	Validation
				Verification that Works have been completed in accordance with, Specifications and the Inspection and Test Plans
				Contractor Representative
				Date________

Dormway Pty Ltd	**SEWER RETICULATION**		ITP No...2253-02.......	Dorm-Form-02-06
Inspection & Test Plan	Reviewed By	Date 2.03.09	Job No...2253.....	Revision 1 2.03.09

Project: ...St Achs Sewer Upgrade BANYO Activity: **Excavation Pipelaying & Backfilling**	Section / Stage / Lot .... MH15/1 – 16/1	Key No Point Number C/R Contractor Representative H Hold Point W Witness Point Sup Superintendent/Client/Representative Superintendent..

No. H/W	**Inspection Test Activity** ***Include Q H&S and E***	**Type of Test / Frequency / Test Procedure and Acceptance Criteria** *Modify National Specification or Code to include Water Business Requirements if necessary*	**Inspection/Test by:**	**C/R**		**Sup**	**Records / Results or other Evidence**	**Signed Superintendent C/R or Special Comment**
1 H	**PMP Approved**	Tenix Approval				X	PMP	[signature]
2W	**Set out marked and all services pegged or marked**	Visual and Measure where necessary		X			Diary Entry	[signature]
3	**Trench Width and Depth Checked & within tolerance**	WSA-03 Part 3 Cl 15 BW Drg No 486/5/7-0024-032		X			Diary Entry	[signature]
4	**Pipe Embedment, Surround & Overlay Depth & Compact**	Measure Depth. WSA-03 Part 3 Cl 16,20 BW Drg No 486/5/7-0024-032		X			Diary Entry	[signature]
5 H	**Pipe Laid, Level and Grade in Tolerance**	Measure, Tolerances checked, WSA-03 Cl 23		X			As Constructed Records	[signature]
6 W	**Pipe Joints, Electrofusion Couplings**	Each Joint and Assembly Inspect Visually Witness Marks and Deflection Limits. Ends of pipe checked pre Installation, welding and cool down as per manufacturers instructions		X			Diary Entry	[signature]
7H	**Detection Tape In Place**	Inspect Visually. WSA-03 Part 4 Construction Section 8 & Std Drawings		X			Diary Entry	[signature]
8	**Form Manholes**	WSA-03 Part 3 Cl 15 & BW Drg No 486/5/7-0024-032		X			Dairy Entry	[signature]
9W	**Pour Manholes**	WSA-03 Part 3 Cl 18 & BW Drg No 486/5/7-0024-032		X			Test Reports	[signature]

Dormway Pty Ltd Inspection & Test Plan	SEWER RETICULATION Reviewed By______ Date__2:03.09___	ITP No…2253-02……. Job No…2253…..	Dorm-Form-02-06 Revision 1 2:03.09

No. H/W	Inspection Test Activity *Include Q H&S and E*	Type of Test / Frequency / Test Procedure and Acceptance Criteria *Modify National Specification or Code to include Water Business Requirements if necessary*	Inspection/Test by:	C/R	B/R	Sup	Records / Results or other Evidence	Signed Superintendent C/R or Special Comment
10	**VacuumTesting of Pipeline**	WSA-03 Part 3 Cl 15 & BW Drg No 486/5/7-0024-032		X			Test Report	[signature]
11 W	**Backfill Trench Material Used**	Each Trench Visual Inspect Material WSA-03 Part 4 Construction Section 11& Std Draw's		X		X	Diary Entry or Checklist	[signature]
12 H	**Backfill Trench Compaction**	Measure Compaction as Specified & Where Specified WSA-03 Part 4 Construction		X			Test Result	[signature]
13 H	**CCTV Inspection**	BCC Nusewer Spec Cl 10		X			Report	[signature]
14 H	**Reinstatement of Roadway**	WSA-03 Part 3 Cl 15 & BW Drg No 486/5/7-0024-032		X			Diary Entry	
15 H	**As Constructed Plans**	WSA-03 Part 3 Cl 26 BCC Amend.				X	Drawings	

No	Amendment to ITP	Date	Reviewed By	Validation
				Verification that Works have been completed in accordance with, Specifications and the Inspection and Test Plans
				______
				Contractor Representative
				Date______

Dormway Pty Ltd **Inspection & Test Plan** Reviewed By________	**SEWER RETICULATION** Date 2.03.09	ITP No…2253-02…… Job No…2253…..	Dorm-Form-02-06 Revision 1 2.03.09

Project: …St Achs Sewer Upgrade BANYO Activity: **Excavation Pipelaying & Backfilling**	Section / Stage / Lot ……… MH 16/1 – 17/1	Key No Point Number C/R Contractor Representative H Hold Point W Witness Point Sup Superintendent/Client/Representative Superintendent………

No. H/W	Inspection Test Activity *Include Q H&S and E*	Type of Test / Frequency / Test Procedure and Acceptance Criteria *Modify National Specification or Code to include Water Business Requirements if necessary*	Inspection/Test by:				Records / Results or other Evidence	Signed Superintendent C/R or Special Comment
				C/R		Sup		
1 H	**PMP Approved**	Tenix Approval				X	PMP	
2W	**Set out marked and all services pegged or marked**	Visual and Measure where necessary		X			Diary Entry	
3	**Trench Width and Depth Checked & within tolerance**	WSA-03 Part 3 Cl 15 BW Drg No 486/5/7-0024-032		X			Diary Entry	
4	**Pipe Embedment, Surround & Overlay Depth & Compact**	Measure Depth. WSA-03 Part 3 Cl 16,20 BW Drg No 486/5/7-0024-032		X			Diary Entry	
5 H	**Pipe Laid, Level and Grade in Tolerance**	Measure, Tolerances checked, WSA-03 Cl 23		X			As Constructed Records	
6 W	**Pipe Joints, Electrofusion Couplings**	Each Joint and Assembly Inspect Visually Witness Marks and Deflection Limits. Ends of pipe checked pre Installation, welding and cool down as per manufacturers instructions		X			Diary Entry	
7H	**Detection Tape In Place**	Inspect Visually. WSA-03 Part 4 Construction Section 8 & Std Drawings		X			Diary Entry	
8	**Form Manholes**	WSA-03 Part 3 Cl 15 & BW Drg No 486/5/7-0024-032		X			Dairy Entry	
9W	**Pour Manholes**	WSA-03 Part 3 Cl 18 & BW Drg No 486/5/7-0024-032		X			Test Reports	

Dormway Pty Ltd	**SEWER RETICULATION**	ITP No…2253-02…….	Dorm-Form-02-06
Inspection & Test Plan Reviewed By____________	Date__2.03.09____	Job No…2253…..	Revision 1 2.03.09

No. H/W	**Inspection Test Activity** ***Include Q H&S and E***	**Type of Test / Frequency / Test Procedure and Acceptance Criteria** *Modify National Specification or Code to include Water Business Requirements if necessary*	**Inspection/Test by:**				**Records / Results or other Evidence**	**Signed Superintendent C/R or Special Comment**
				C/R	**B/R**	**Sup**		
10	**VacuumTesting of Pipeline**	WSA-03 Part 3 Cl 15 & BW Drg No 486/5/7-0024-032		X			Test Report	
11 W	**Backfill Trench Material Used**	Each Trench Visual Inspect Material WSA-03 Part 4 Construction Section 11& Std Draw's		X		X	Diary Entry or Checklist	
12 H	**Backfill Trench Compaction**	Measure Compaction as Specified & Where Specified WSA-03 Part 4 Construction		X			Test Result	
13 H	**CCTV Inspection**	BCC Nusewer Spec Cl 10		X			Report	
14 H	**Reinstatement of Roadway**	WSA-03 Part 3 Cl 15 & BW Drg No 486/5/7-0024-032		X			Diary Entry	
15 H	**As Constructed Plans**	WSA-03 Part 3 Cl 26 BCC Amend.				X	Drawings	

No	**Amendment to ITP**	**Date**	**Reviewed By**	**Validation**
				Verification that Works have been completed in accordance with, Specifications and the Inspection and Test Plans
				Contractor Representative
				Date__________

Dormway Pty Ltd **Inspection & Test Plan**	Reviewed By________	**SEWER RETICULATION** Date 2.03.09	ITP No...2253-02....... Job No...2253.....	Dorm-Form-02-06 Revision 1 2.03.09

Project:....St Achs Sewer Upgrade BANYO Activity: **Excavation Pipelaying & Backfilling**	Section / Stage / Lot .... MH 16/1 – 81379 PART LINE ONLY AWAITING BREAK IN	Key No Point Number C/R Contractor Representative H Hold Point W Witness Point Sup Superintendent/Client/Representative Superintendent........

No. H/W	**Inspection Test Activity** ***Include Q H&S and E***	**Type of Test / Frequency / Test Procedure and Acceptance Criteria** *Modify National Specification or Code to include Water Business Requirements if necessary*	**Inspection/Test by:**				**Records / Results or other Evidence**	**Signed Superintendent C/R or Special Comment**
				C/R		**Sup**		
1 H	**PMP Approved**	Tenix Approval				X	PMP	[signature]
2W	**Set out marked and all services pegged or marked**	Visual and Measure where necessary		X			Diary Entry	[signature]
3	**Trench Width and Depth Checked & within tolerance**	WSA-03 Part 3 Cl 15 BW Drg No 486/5/7-0024-032		X			Diary Entry	[signature]
4	**Pipe Embedment, Surround & Overlay Depth & Compact**	Measure Depth. WSA-03 Part 3 Cl 16,20 BW Drg No 486/5/7-0024-032		X			Diary Entry	[signature]
5 H	**Pipe Laid, Level and Grade in Tolerance**	Measure, Tolerances checked, WSA-03 Cl 23		X			As Constructed Records	[signature]
6 W	**Pipe Joints, Electrofusion Couplings** BOX CULVERT	Each Joint and Assembly Inspect Visually Witness Marks and Deflection Limits. Ends of pipe checked pre Installation, welding and cool down as per manufacturers instructions		X			Diary Entry	[signature]
7H	**Detection Tape In Place**	Inspect Visually. WSA-03 Part 4 Construction Section 8 & Std Drawings		X			Diary Entry	[signature]
8	**Form Manholes**	WSA-03 Part 3 Cl 15 & BW Drg No 486/5/7-0024-032		X			Dairy Entry	[signature]
9W	**Pour Manholes**	WSA-03 Part 3 Cl 18 & BW Drg No 486/5/7-0024-032		X			Test Reports	[signature]

Dormway Pty Ltd	**SEWER RETICULATION**	ITP No...2253-02.......	Dorm-Form-02-06
Inspection & Test Plan Reviewed By________	Date 2.03.09	Job No...2253.....	Revision 1 2.03.09

No. H/W	Inspection Test Activity *Include Q H&S and E*	Type of Test / Frequency / Test Procedure and Acceptance Criteria *Modify National Specification or Code to include Water Business Requirements if necessary*	Inspection/Test by:				Records / Results or other Evidence	Signed Superintendent C/R or Special Comment
				C/R	B/R	Sup		
10	**Vacuum Testing of Pipeline**	WSA-03 Part 3 Cl 15 & BW Drg No 486/5/7-0024-032		X	NA		Test Report	
11 W	**Backfill Trench Material Used**	Each Trench Visual Inspect Material WSA-03 Part 4 Construction Section 11& Std Draw's		X		X	Diary Entry or Checklist	
12 H	**Backfill Trench Compaction**	Measure Compaction as Specified & Where Specified WSA-03 Part 4 Construction		X			Test Result	
13 H	**CCTV Inspection**	BCC Nusewer Spec Cl 10		X			Report	
14 H	**Reinstatement of Roadway**	WSA-03 Part 3 Cl 15 & BW Drg No 486/5/7-0024-032		X			Diary Entry	
15 H	**As Constructed Plans**	WSA-03 Part 3 Cl 26 BCC Amend.				X	Drawings	

No	Amendment to ITP	Date	Reviewed By	Validation
				Verification that Works have been completed in accordance with, Specifications and the Inspection and Test Plans
				Contractor Representative
				Date________

Test D 2253

CIVIL QUALITY ASSURANCE (QLD) PTY. LTD.

GEOTECHNICAL CONSULTANTS

1/18 LEANNE CRESCENT, LAWNTON, QLD 4501
OFFICE: (07) 3881 3511 FAX: (07) 3881 3513

CQA/R/21B

FIELD DENSITY RATIO (HILF) TEST REPORT (A.S.)

CLIENT:	DORMWAY PTY LTD	REPORT NO:	32
PROJECT:	RAILWAY PARADE, BANYO	JOB NO:	CQA/09/111
JOB DESCRIPTION:	TRENCH BACKFILL	DATE:	22 July 2009

SAMPLE NUMBER	D/09/9381		D/09/9382		D/09/9383		D/09/9384	
DATE/TIME TESTED	02/07/09, 9.15am		02/07/09, 9.20am		02/07/09, 9.25am		02/07/09, 9.30am	
DEPTH OF TEST (mm)	150		150		150		150	
DEPTH OF LAYER (mm)	-		-		-		-	
LAYER TERMINOLOGY	STF98		STF99		STF100		STF101	
TEST LOCATION	MH 12/01-13/01, 5m off 13/01		MH 12/01-13/01, 6m off 13/01		MH 12/01-13/01, 7m off 13/01		MH 12/01-13/01, 8m off 13/01	
TEST ELEVATION	0.8m above pipe		1.2m above pipe		1.6m above pipe		Final level	
SOIL DESCRIPTION	Silty Gravelly Sandy Clay		Silty Gravelly Sandy Clay		Silty Gravelly Sandy Clay		Silty Gravelly Sandy Clay	
OVERSIZE SIEVE (mm)	19.0		19.0		19.0		19.0	
OVERSIZE - WET BASIS (%)	16.0		13.0		12.0		20.0	
FIELD MOISTURE CONTENT (%)	17.0		16.0		17.0		17.0	
OPTIMUM MOISTURE CONTENT (%)	15.0		13.5		15.0		14.5	
MOISTURE VARIATION (%)	2.0		2.0		2.0		2.5	
FIELD WET DENSITY (t/m^3)	2.08		2.09		2.04		2.05	
PEAK CONVERTED WET DENSITY (t/m^3)	2.19		2.17		2.15		2.14	
HILF DENSITY RATIO / SPEC (%)	95.0	95	96.0	95	95.0	95	95.5	95

TEST PROCEDURE	Field A.S. 1289 5.8.1 Laboratory A.S. 1289 5.7.1 (Standard Compaction); 2.1.1			
TERMINOLOGY LEGEND	(S) Subgrade (LSB) Lower Subbase	(B) Base Course (SB) Subbase Course (F) Fill	(SF) Select Fill (AF) Allotment Fill (STF) Sewer Trench Fill	(EF) Embankment Fill (SWTF) Stormwater Trench Fill

- Field testing and selection of test locations carried out in general accordance with AS 3798 Level 2 guidelines.
  Test locations were not professionally surveyed therefore recorded locations should be considered as approximate only.

NATA
ACCREDITED FOR TECHNICAL COMPETENCE

This document is issued in accordance with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 17025.

AY
D SIGNATORY
ditation No. 4991

CIVIL QUALITY ASSURANCE (QLD) PTY. LTD.
GEOTECHNICAL CONSULTANTS
1/18 LEANNE CRESCENT, LAWNTON, QLD 4501
OFFICE: (07) 3881 3511 FAX: (07) 3881 3513

CQA/R/21B

FIELD DENSITY RATIO (HILF) TEST REPORT (A.S.)

CLIENT: DORMWAY PTY LTD REPORT NO: 33

PROJECT: RAILWAY PARADE, BANYO JOB NO: CQA/09/111

JOB DESCRIPTION: TRENCH BACKFILL DATE: 22 July 2009

SAMPLE NUMBER	D/09/9385		D/09/9386		D/09/9387		D/09/9388	
DATE/TIME TESTED	02/07/09, 9.35am		02/07/09, 9.40am		02/07/09, 9.45am		02/07/09, 9.50am	
DEPTH OF TEST (mm)	150		150		150		150	
DEPTH OF LAYER (mm)	-		-		-		-	
LAYER TERMINOLOGY	STF102		STF103		STF1104		STF105	
TEST LOCATION	MH 13/01-14/01, 15m off 13/01		MH 13/01-14/01, 16m off 13/01		MH 13/01-14/01, 17m off 13/01		MH 13/01-14/01, 3m off 14/01	
TEST ELEVATION	0.8m above pipe		1.2m above pipe		Final level		0.8m above pipe	
SOIL DESCRIPTION	Silty Sandy Gravelly Clay		Silty Sandy Gravelly Clay		Silty Sandy Gravelly Clay		Silty Gravelly Sandy Clay	
OVERSIZE SIEVE (mm)	19.0		19.0		19.0		19.0	
OVERSIZE - WET BASIS (%)	19.0		16.0		14.0		6.0	
FIELD MOISTURE CONTENT (%)	11.0		11.0		11.0		13.0	
OPTIMUM MOISTURE CONTENT(%)	14.5		13.0		12.5		11.5	
MOISTURE VARIATION (%)	-3.0		-2.0		-1.5		1.5	
FIELD WET DENSITY (t/m^3)	2.34		2.27		2.38		2.13	
PEAK CONVERTED WET DENSITY (t/m^3)	2.19		2.19		2.16		2.24	
HILF DENSITY RATIO / SPEC (%)	107.0	95	103.5	95	110.5	95	95.0	95

TEST PROCEDURE	Field A.S. 1289 5.8.1 Laboratory A.S. 1289 5.7.1 (Standard Compaction), 2.1.1
TERMINOLOGY LEGEND	(S) Subgrade (LSB) Lower Subbase (B) Base Course (SB) Subbase Course (F) Fill (SF) Select Fill (AF) Allotment Fill (STF) Sewer Trench Fill (EF) Embankment Fill (SWTF) Stormwater Trench Fill

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FIELD DENSITY RATIO (HILF) TEST REPORT (A.S.)

CLIENT:	DORMWAY PTY LTD	REPORT NO:	34
PROJECT:	RAILWAY PARADE, BANYO	JOB NO:	CQA/09/111
JOB DESCRIPTION:	TRENCH BACKFILL	DATE:	22 July 2009

SAMPLE NUMBER	D/09/9389		D/09/9390		D/09/9391		D/09/9392	
DATE/TIME TESTED	02/07/09, 9.55am		02/07/09, 10.00am		02/07/09, 10.05am		02/07/09, 10.10am	
DEPTH OF TEST (mm)	150		150		150		150	
DEPTH OF LAYER (mm)	-		-		-		-	
LAYER TERMINOLOGY	STF106		STF107		STF1108		STF109	
TEST LOCATION	MH 13/01-14/01, 4m off 14/01		MH 13/01-14/01, 5m off 14/01		MH 14/01-15/01, 9m off 14/01		MH 14/01-15/01, 10m off 14/01	
TEST ELEVATION	1.2m above pipe		Final level		0.8m above pipe		Final level	
SOIL DESCRIPTION	Silty Gravelly Sandy Clay		Silty Gravelly Sandy Clay		Gravelly Silty Sandy Clay		Gravelly Silty Sandy Clay	
OVERSIZE SIEVE (mm)	19.0		19.0		19.0		19.0	
OVERSIZE - WET BASIS (%)	11.0		-		-		-	
FIELD MOISTURE CONTENT (%)	13.5		14.0		12.5		13.0	
OPTIMUM MOISTURE CONTENT(%)	11.5		12.0		12.5		11.0	
MOISTURE VARIATION (%)	2.0		1.5		0.0		2.0	
FIELD WET DENSITY (t/m^3)	2.14		2.15		2.08		2.07	
PEAK CONVERTED WET DENSITY (t/m^3)	2.24		2.22		2.19		2.17	
HILF DENSITY RATIO / SPEC (%)	96.0	95	97.0	95	95.5	95	95.5	95

TEST PROCEDURE	Field A.S. 1289 5.8.1 Laboratory A.S. 1289 5.7.1 (Standard Compaction), 2.1.1			
TERMINOLOGY LEGEND	(S) Subgrade (LSB) Lower Subbase	(B) Base Course (SB) Subbase Course (F) Fill	(SF) Select Fill (AF) Abutment Fill (STF) Sewer Trench Fill	(EF) Embankment Fill (SWTF) Stormwater Trench Fill

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FIELD DENSITY RATIO (HILF) TEST REPORT (AS)

CLIENT:	DORMWAY PTY LTD	REPORT NO:	35
PROJECT:	RAILWAY PARADE, BANYO	JOB NO:	CQA/09/111
JOB DESCRIPTION:	TRENCH BACKFILL	DATE:	22 July 2009

SAMPLE NUMBER	D/09/9393							
DATE/TIME TESTED	02/07/09, 10.00am							
DEPTH OF TEST (mm)	150							
DEPTH OF LAYER (mm)	-							
LAYER TERMINOLOGY	STF110							
TEST LOCATION	MH 15/01-16/01, 3m off 15/01							
TEST ELEVATION	Final level							
SOIL DESCRIPTION	Gravelly Sandy Clay							
OVERSIZE SIEVE (mm)	19.0							
OVERSIZE - WET BASIS (%)	-							
FIELD MOISTURE CONTENT (%)	13.0							
OPTIMUM MOISTURE CONTENT(%)	12.0							
MOISTURE VARIATION (%)	1.0							
FIELD WET DENSITY (t/m^3)	2.24							
PEAK CONVERTED WET DENSITY (t/m^3)	2.24							
HILF DENSITY RATIO / SPEC (%)	**100.0**	**95**						

TEST PROCEDURE	Field A.S. 1289 5.8.1 Laboratory A.S. 1289 5.7.1 (Standard Compaction), 2.1.1			
TERMINOLOGY LEGEND	(S) Subgrade (LSB) Lower Subbase	(B) Base Course (SB) Subbase Course (F) Fill	(SF) Select Fill (AF) Allotment Fill (STF) Sewer Trench Fill	(EF) Embankment Fill (SWTF) Stormwater Trench Fill

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FIELD DENSITY RATIO (HILF) TEST REPORT (A.S.)

CLIENT:	DORMWAY PTY LTD	REPORT NO:	26
PROJECT:	RAILWAY PARADE, BANYO	JOB NO:	CQA/09/111
JOB DESCRIPTION:	TRENCH BACKFILL	DATE:	30 June 2009

SAMPLE NUMBER	D/09/4096		D/09/4097		D/09/4098		D/09/4099	
DATE/TIME TESTED	12/06/09, 12.05pm		12/06/09, 12.10pm		12/06/09, 12.15pm		12/06/09, 12.20pm	
DEPTH OF TEST (mm)	150		150		150		150	
DEPTH OF LAYER (mm)	-		-		-		-	
LAYER TERMINOLOGY	STF85		STF86		STF87		STF88	
TEST LOCATION	MH 5/1-6/1, 17m off 6/1		MH 5/1-6/1, 18m off 6/1		MH 5/1-6/1, 19m off 6/1		MH 5/1-6/1, 20m off 6/1	
TEST ELEVATION	1.6m above pipe		2.0m above pipe		2.4m above pipe		Final level	
SOIL DESCRIPTION	Sandy Clay		Sandy Clay		Sandy Clay		Sandy Clay	
OVERSIZE SIEVE (mm)	19.0		19.0		19.0		19.0	
OVERSIZE - WET BASIS (%)	-		-		-		-	
FIELD MOISTURE CONTENT (%)	29.5		29.0		28.5		32.0	
OPTIMUM MOISTURE CONTENT(%)	25.0		24.0		24.0		27.5	
MOISTURE VARIATION (%)	4.5		5.0		4.5		4.5	
FIELD WET DENSITY (t/m^3)	1.91		1.94		1.93		1.94	
PEAK CONVERTED WET DENSITY (t/m^3)	2.03		1.99		2.04		1.91	
HILF DENSITY RATIO / SPEC (%)	**96.0**	**95**	**97.5**	**95**	**95.0**	**95**	**99.5**	**95**

TEST PROCEDURE	Field A.S. 1289 5.8.1 Laboratory A.S. 1289 5.7.1 (Standard Compaction); 2.1.1			
TERMINOLOGY LEGEND	(S) Subgrade (LSB) Lower Subbase	(B) Base Course (SB) Subbase Course (F) Fill	(SF) Select Fill (AF) Allotment Fill (STF) Sewer Trench Fill	(EF) Embankment Fill (SWTF) Stormwater Trench Fill

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FIELD DENSITY RATIO (HILF) TEST REPORT (A.S.)

CLIENT:	DORMWAY PTY LTD	REPORT NO:	27
PROJECT:	RAILWAY PARADE, BANYO	JOB NO:	CQA/09/111
JOB DESCRIPTION:	TRENCH BACKFILL	DATE:	26 June 2009

SAMPLE NUMBER	D/09/3879		D/09/3880					
DATE/TIME TESTED	19/06/09, 11.00am		19/06/09, 11.05am					
DEPTH OF TEST (mm)	150		150					
DEPTH OF LAYER (mm)	-		-					
LAYER TERMINOLOGY	STF89		STF90					
TEST LOCATION	MH 12/1-13/1, 5m off 12/1		MH 12/1-13/1, 7m off 12/1					
TEST ELEVATION	0.8m above pipe		1.2m above pipe					
SOIL DESCRIPTION	Silty Sandy Clay		Silty Sandy Clay					
OVERSIZE SIEVE (mm)	19.0		19.0					
OVERSIZE - WET BASIS (%)	-		-					
FIELD MOISTURE CONTENT (%)	22.0		22.0					
OPTIMUM MOISTURE CONTENT (%)	19.5		19.5					
MOISTURE VARIATION (%)	2.5		2.5					
FIELD WET DENSITY (t/m³)	1.79		1.81					
PEAK CONVERTED WET DENSITY (t/m³)	2.09		2.06					
HILF DENSITY RATIO / SPEC (%)	85.5(FA)	95	88.0(FA)	95				

TEST PROCEDURE	Field	A.S. 1289 5.8.1
	Laboratory	A.S. 1289 5.7.1 (Standard Compaction); 2.1.1

TERMINOLOGY LEGEND	(S) Subgrade (LSB) Lower Subbase (FA) Failure	(B) Base Course (SB) Subbase Course (F) Fill	(SF) Select Fill (AF) Allotment Fill (STF) Sewer Trench Fill	(EF) Embankment Fill (SWTF) Stormwater Trench Fill

- Field testing and selection of test locations carried out in general accordance with AS 3798 Level 2 guidelines.
- Test locations were not professionally surveyed therefore recorded locations should be considered as approximate only.
- The above results were faxed as preliminary to Dormway Pty Ltd on 22/6/09.

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FIELD DENSITY RATIO (HILF) TEST REPORT (A.S.)

CLIENT: DORMWAY PTY LTD | REPORT NO: 28

PROJECT: RAILWAY PARADE, BANYO | JOB NO: CQA/09/111

JOB DESCRIPTION: TRENCH BACKFILL | DATE: 30 June 2009

SAMPLE NUMBER	D/09/4100		D/09/4101		D/09/4102		D/09/4103	
DATE/TIME TESTED	14/06/09, 10.00am		14/06/09, 10.05am		14/06/09, 10.10am		14/06/09, 10.15am	
DEPTH OF TEST (mm)	150		150		150		150	
DEPTH OF LAYER (mm)	-		-		-		-	
LAYER TERMINOLOGY	STF91		STF92		STF93		STF94	
TEST LOCATION	MH 11/1-12/1, 10m off 11/1		MH 11/1-12/1, 12m off 11/1		MH 11/1-12/1, 14m off 11/1		MH 11/1-12/1, 16m off 11/1	
TEST ELEVATION	0.8m above pipe		1.2m above pipe		1.6m above pipe		2.0m above pipe	
SOIL DESCRIPTION	Gravelly Silty Sandy Clay		Gravelly Silty Sandy Clay		Gravelly Silty Sandy Clay		Gravelly Silty Sandy Clay	
OVERSIZE SIEVE (mm)	19.0		19.0		19.0		19.0	
OVERSIZE - WET BASIS (%)	-		-		-		-	
FIELD MOISTURE CONTENT (%)	19.5		24.0		23.5		18.5	
OPTIMUM MOISTURE CONTENT(%)	17.5		20.0		20.0		15.5	
MOISTURE VARIATION (%)	1.5		4.0		4.0		3.5	
FIELD WET DENSITY (t/m^3)	2.03		2.05		1.98		2.05	
PEAK CONVERTED WET DENSITY (t/m^3)	2.09		2.10		2.09		2.15	
HILF DENSITY RATIO / SPEC (%)	97.5	95	98.0	95	95.0	95	95.0	95

TEST PROCEDURE	Field A.S. 1289 5.8.1 Laboratory A.S. 1289 5.7.1 (Standard Compaction), 2.1.1
TERMINOLOGY LEGEND	(S) Subgrade (LSB) Lower Subbase; (B) Base Course (SB) Subbase Course (F) Fill; (SF) Select Fill (AF) Allotment Fill (STF) Sewer Trench Fill; (EF) Embankment Fill (SWTF) Stormwater Trench Fill

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FIELD DENSITY RATIO (HILF) TEST REPORT (A.S.)

CLIENT:	DORMWAY PTY LTD	REPORT NO:	29
PROJECT:	RAILWAY PARADE, BANYO	JOB NO:	CQA/09/111
JOB DESCRIPTION:	TRENCH BACKFILL	DATE:	30 June 2009

SAMPLE NUMBER	D/09/4104	D/09/4105		
DATE/TIME TESTED	24/06/09, 10.30am	24/06/09, 10.35am		
DEPTH OF TEST (mm)	150	150		
DEPTH OF LAYER (mm)	-	-		
LAYER TERMINOLOGY	STF95	STF96		
TEST LOCATION	5m off 12/1, 2m left of 12/1	7m off 12/1, 2m left of 12/1		
TEST ELEVATION	Existing Ground	Existing Ground		
SOIL DESCRIPTION	Gravelly Silty Sandy Clay	Gravelly Silty Sandy Clay		
OVERSIZE SIEVE (mm)	19.0	19.0		
OVERSIZE - WET BASIS (%)	-	-		
FIELD MOISTURE CONTENT (%)	21.0	18.5		
OPTIMUM MOISTURE CONTENT(%)	18.0	13.5		
MOISTURE VARIATION (%)	2.5	5.0		
FIELD WET DENSITY (t/m^3)	1.98	2.06		
PEAK CONVERTED WET DENSITY (t/m^3)	2.05	2.12		
HILF DENSITY RATIO / SPEC (%)	96.5 / -	97.0 / -		

TEST PROCEDURE

Field A.S. 1289 5.8.1
Laboratory A.S. 1289 5.7.1 (Standard Compaction), 2.1.1

TERMINOLOGY LEGEND

(S) Subgrade; (LSB) Lower Subbase; (B) Base Course; (SB) Subbase Course; (F) Fill; (SF) Select Fill; (AF) Allotment Fill; (STF) Sewer Trench Fill; (EF) Embankment Fill; (SWTF) Stormwater Trench Fill

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FIELD DENSITY RATIO (HILF) TEST REPORT (A.S.)

CLIENT: DORMWAY PTY LTD — REPORT NO: 31

PROJECT: RAILWAY PARADE, BANYO — JOB NO: CQA/09/111

JOB DESCRIPTION: TRENCH BACKFILL — DATE: 30 June 2009

SAMPLE NUMBER	D/09/4110			
DATE/TIME TESTED	26/06/09, 9.00am			
DEPTH OF TEST (mm)	150			
DEPTH OF LAYER (mm)	-			
LAYER TERMINOLOGY	STF97			
TEST LOCATION	MH 13/1-14/1, 20m off 14/1			
TEST ELEVATION	Existing Ground			
SOIL DESCRIPTION	Clayey Sand			
OVERSIZE SIEVE (mm)	19.0			
OVERSIZE - WET BASIS (%)	-			
FIELD MOISTURE CONTENT (%)	22.0			
OPTIMUM MOISTURE CONTENT(%)	13.5			
MOISTURE VARIATION (%)	8.5			
FIELD WET DENSITY (t/m³)	1.82			
PEAK CONVERTED WET DENSITY (t/m³)	2.27			
HILF DENSITY RATIO / SPEC (%)	80.0 / -			

TEST PROCEDURE
Field A.S. 1289 5.8.1
Laboratory A.S. 1289 5.7.1 (Standard Compaction), 2.1.1

TERMINOLOGY LEGEND
(S) Subgrade; (LSB) Lower Subbase; (B) Base Course; (SB) Subbase Course; (F) Fill; (SF) Select Fill; (AF) Allotment Fill; (STF) Sewer Trench Fill; (EF) Embankment Fill; (SWTF) Stormwater Trench Fill

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FIELD DENSITY RATIO (HILF) TEST REPORT (A.S.)

CLIENT: DORMWAY PTY LTD — REPORT NO: 1

PROJECT: RAILWAY PARADE, BANYO — JOB NO: CQA/09/111

JOB DESCRIPTION: TRENCH BACKFILL — DATE: 28 April 2009

SAMPLE NUMBER	D/09/2463			
DATE/TIME TESTED	27/03/09, 10.20am			
DEPTH OF TEST (mm)	150			
DEPTH OF LAYER (mm)	-			
LAYER TERMINOLOGY	STFI			
TEST LOCATION	MH 6/1-7/1, 20m off 6/1			
TEST ELEVATION	Final level			
SOIL DESCRIPTION	Sandy Clayey Gravel			
OVERSIZE SIEVE (mm)	19.0			
OVERSIZE - WET BASIS (%)	-			
FIELD MOISTURE CONTENT (%)	5.0			
OPTIMUM MOISTURE CONTENT(%)	8.5			
MOISTURE VARIATION (%)	-3.5			
FIELD WET DENSITY (t/m^3)	2.39			
PEAK CONVERTED WET DENSITY (t/m^3)	2.32			
HILF DENSITY RATIO / SPEC (%)	**103.5** / **95**			

TEST PROCEDURE	Field	A.S. 1289 5.8.1
	Laboratory	A.S. 1289 5.7.1 (Standard Compaction), 2.1.1

TERMINOLOGY LEGEND: (S) Subgrade; (LSB) Lower Subbase; (B) Base Course; (SB) Subbase Course; (F) Fill; (SF) Select Fill; (AF) Allotment Fill; (STFI) Sewer Trench Fill; (EF) Embankment Fill; (SWTF) Stormwater Trench Fill

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FIELD DENSITY RATIO (HILF) TEST REPORT (A.S.)

CLIENT:	DORMWAY PTY LTD	REPORT NO:	2
PROJECT:	RAILWAY PARADE, BANYO	JOB NO:	CQA/09/111
JOB DESCRIPTION:	TRENCH BACKFILL	DATE:	30 April 2009

SAMPLE NUMBER	D/09/2623		D/09/2624		D/09/2625		D/09/2626	
DATE/TIME TESTED	23/04/09, 11.00am		23/04/09, 11.05am		23/04/09, 11.10am		23/04/09, 11.15am	
DEPTH OF TEST (mm)	150		150		150		150	
DEPTH OF LAYER (mm)	-		-		-		-	
LAYER TERMINOLOGY	STF2		STF3		STF4		STF5	
TEST LOCATION	MH 6/1-7/1, 40m off 6/1		MH 6/1-7/1, 36m off 6/1		MH 6/1-7/1, 33m off 6/1		MH 6/1-7/1, 30m off 6/1	
TEST ELEVATION	0.8m above pipe		1.2m above pipe		1.6m above pipe		2.0m above pipe	
SOIL DESCRIPTION	Gravelly Sandy Clay		Gravelly Sandy Clay		Gravelly Sandy Clay		Gravelly Sandy Clay	
OVERSIZE SIEVE (mm)	19.0		19.0		19.0		19.0	
OVERSIZE - WET BASIS (%)	-		-		-		-	
FIELD MOISTURE CONTENT (%)	25.5		26.5		26.5		25.5	
OPTIMUM MOISTURE CONTENT (%)	23.0		24.0		24.0		23.0	
MOISTURE VARIATION (%)	2.5		2.5		2.0		2.5	
FIELD WET DENSITY (t/m^3)	2.05		2.03		2.01		1.99	
PEAK CONVERTED WET DENSITY (t/m^3)	2.05		2.05		2.05		2.05	
HILF DENSITY RATIO / SPEC (%)	**100.0**	**95**	**99.0**	**95**	**98.0**	**95**	**97.0**	**95**

TEST PROCEDURE	Field A.S. 1289 5.8.1 Laboratory A.S. 1289 5.7.1 (Standard Compaction), 2.1.1			
TERMINOLOGY LEGEND	(S) Subgrade (LSB) Lower Subbase	(B) Base Course (SB) Subbase Course (F) Fill	(SF) Select Fill (AF) Allotment Fill (STF) Sewer Trench Fill	(EF) Embankment Fill (SWTF) Stormwater Trench Fill

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CQA/R/21B

FIELD DENSITY RATIO (HILF) TEST REPORT (A.S.)

CLIENT: DORMWAY PTY LTD — REPORT NO: 3

PROJECT: RAILWAY PARADE, BANYO — JOB NO: CQA/09/111

JOB DESCRIPTION: TRENCH BACKFILL — DATE: 30 April 2009

SAMPLE NUMBER	D/09/2627	D/09/2628	D/09/2629	
DATE/TIME TESTED	23/04/09, 11.20am	23/04/09, 11.25am	23/04/09, 11.30am	
DEPTH OF TEST (mm)	150	150	150	
DEPTH OF LAYER (mm)	-	-	-	
LAYER TERMINOLOGY	STF6	STF7	STF8	
TEST LOCATION	MH 6/1-7/1, 27m off 6/1	MH 6/1-7/1, 24m off 6/1	MH 6/1-7/1, 21m off 6/1	
TEST ELEVATION	2.4m above pipe	2.8m above pipe	3.2m above pipe	
SOIL DESCRIPTION	Silty Gravel	Silty Gravel	Silty Gravel	
OVERSIZE SIEVE (mm)	19.0	19.0	19.0	
OVERSIZE - WET BASIS (%)	-	-	-	
FIELD MOISTURE CONTENT (%)	4.0	4.0	4.0	
OPTIMUM MOISTURE CONTENT(%)	7.0	7.0	7.0	
MOISTURE VARIATION (%)	-3.0	-3.0	-3.0	
FIELD WET DENSITY (t/m^3)	2.35	2.36	2.37	
PEAK CONVERTED WET DENSITY (t/m^3)	2.27	2.32	2.34	
HILF DENSITY RATIO / SPEC (%)	103.5 / 95	102.0 / 95	101.5 / 95	

TEST PROCEDURE
Field A.S. 1289 5.8.1
Laboratory A.S. 1289 5.7.1 (Standard Compaction), 2.1.1

TERMINOLOGY LEGEND
(S) Subgrade (LSB) Lower Subbase (B) Base Course (SB) Subbase Course (F) Fill (SF) Select Fill (AF) Allotment Fill (STF) Sewer Trench Fill (EF) Embankment Fill (SWTF) Stormwater Trench Fill

- Field testing and selection of test locations carried out in general accordance with AS 3798 Level 2 guidelines.
- Test locations were not professionally surveyed therefore recorded locations should be considered as approximate only.

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CQA/R/21B

FIELD DENSITY RATIO (HILF) TEST REPORT (A.S.)

CLIENT:	DORMWAY PTY LTD	REPORT NO:	4
PROJECT:	RAILWAY PARADE, BANYO	JOB NO:	CQA/09/111
JOB DESCRIPTION:	TRENCH BACKFILL	DATE:	30 April 2009

SAMPLE NUMBER	D/09/2630		D/09/2631		D/09/2632		D/09/2633	
DATE/TIME TESTED	27/04/09, 11.00am		27/04/09, 11.05am		27/04/09, 11.10am		27/04/09, 11.15am	
DEPTH OF TEST (mm)	150		150		150		150	
DEPTH OF LAYER (mm)	-		-		-		-	
LAYER TERMINOLOGY	STF9		STF10		STF11		STF12	
TEST LOCATION	MH 6/1-7/1, 42m off 6/1		MH 6/1-7/1, 44m off 6/1		MH 6/1-7/1, 46m off 6/1		MH 6/1-7/1, 48m off 6/1	
TEST ELEVATION	Final level		3.4m above pipe		3.0m above pipe		2.6m above pipe	
SOIL DESCRIPTION	Silty Sandy Gravel		Silty Sandy Clay		Silty Sandy Gravel		Silty Gravelly Clay	
OVERSIZE SIEVE (mm)	19.0		19.0		19.0		19.0	
OVERSIZE - WET BASIS (%)	-		-		-		-	
FIELD MOISTURE CONTENT (%)	3.0		4.5		5.0		24.5	
OPTIMUM MOISTURE CONTENT(%)	7.0		7.5		8.0		23.0	
MOISTURE VARIATION (%)	-4.0		-3.0		-3.5		1.5	
FIELD WET DENSITY (t/m^3)	2.45		2.45		2.44		2.09	
PEAK CONVERTED WET DENSITY (t/m^3)	2.41		2.43		2.38		2.08	
HILF DENSITY RATIO / SPEC (%)	**101.5**	**95**	**100.5**	**95**	**102.5**	**95**	**100.5**	**95**
TEST PROCEDURE	Field A.S. 1289 5.8.1 Laboratory A.S. 1289 5.7.1 (Standard Compaction), 2.1.1							
TERMINOLOGY LEGEND	(S) Subgrade (LSB) Lower Subbase		(B) Base Course (SB) Subbase Course (F) Fill		(SF) Select Fill (AF) Allotment Fill (STF) Sewer Trench Fill		(EF) Embankment Fill (SWTF) Stormwater Trench Fill	

- Field testing and selection of test locations carried out in general accordance with AS 3798 Level 2 guidelines.
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CQA/R/21B

FIELD DENSITY RATIO (HILF) TEST REPORT (A.S.)

CLIENT: DORMWAY PTY LTD — REPORT NO: 5

PROJECT: RAILWAY PARADE, BANYO — JOB NO: CQA/09/111

JOB DESCRIPTION: TRENCH BACKFILL — DATE: 30 April 2009

SAMPLE NUMBER	D/09/2634		D/09/2635		D/09/2636		D/09/2637	
DATE/TIME TESTED	27/04/09, 11.20am		27/04/09, 11.25am		27/04/09, 11.30am		27/04/09, 11.35am	
DEPTH OF TEST (mm)	150		150		150		150	
DEPTH OF LAYER (mm)	-		-		-		-	
LAYER TERMINOLOGY	STF13		STF14		STF15		STF16	
TEST LOCATION	MH 6/1-7/1, 50m off 6/1		MH 6/1-7/1, 52m off 6/1		MH 6/1-7/1, 54m off 6/1		MH 6/1-7/1, 56m off 6/1	
TEST ELEVATION	2.2m above pipe		1.8m above pipe		1.4m above pipe		0.8m above pipe	
SOIL DESCRIPTION	Silty Gravelly Clay		Silty Gravelly Clay		Silty Gravelly Clay		Silty Gravelly Clay	
OVERSIZE SIEVE (mm)	19.0		19.0		19.0		19.0	
OVERSIZE - WET BASIS (%)	-		-		5.0		-	
FIELD MOISTURE CONTENT (%)	29.0		29.5		19.5		32.5	
OPTIMUM MOISTURE CONTENT(%)	27.5		27.5		18.5		28.0	
MOISTURE VARIATION (%)	2.0		2.0		1.0		4.5	
FIELD WET DENSITY (t/m^3)	2.01		2.04		2.06		2.02	
PEAK CONVERTED WET DENSITY (t/m^3)	2.00		2.02		2.15		1.99	
HILF DENSITY RATIO / SPEC (%)	**100.5**	**95**	**100.5**	**95**	**96.0**	**95**	**101.5**	**95**

TEST PROCEDURE	Field A.S. 1289 5.8.1 Laboratory A.S. 1289 5.7.1 (Standard Compaction), 2.1.1			
TERMINOLOGY LEGEND	(S) Subgrade (LSB) Lower Subbase	(B) Base Course (SB) Subbase Course (F) Fill	(SF) Select Fill (AF) Allotment Fill (STF) Sewer Trench Fill	(EF) Embankment Fill (SWTF) Stormwater Trench Fill

- Field testing and selection of test locations carried out in general accordance with AS 3798 Level 2 guidelines.
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CQA/R/218

FIELD DENSITY RATIO (HILF) TEST REPORT (A.S.)

CLIENT: DORMWAY PTY LTD — REPORT NO: 6

PROJECT: RAILWAY PARADE, BANYO — JOB NO: CQA/09/111

JOB DESCRIPTION: TRENCH BACKFILL — DATE: 12 May 2009

SAMPLE NUMBER	D/09/2833		D/09/2834		D/09/2835		D/09/2836	
DATE/TIME TESTED	29/04/09, 1.00pm		29/04/09, 1.10pm		29/04/09, 1.20pm		29/04/09, 1.30pm	
DEPTH OF TEST (mm)	150		150		150		150	
DEPTH OF LAYER (mm)	-		-		-		-	
LAYER TERMINOLOGY	STF17		STF18		STF19		STF20	
TEST LOCATION	MH 6/1-7/1, 5m off 7/1		MH 6/1-7/1, 6m off 7/1		MH 6/1-7/1, 7m off 7/1		MH 6/1-7/1, 8m off 7/1	
TEST ELEVATION	0.8m above pipe		1.2m above pipe		1.6m above pipe		2.0m above pipe	
SOIL DESCRIPTION	Gravelly Silty Clay		Gravelly Silty Clay		Gravelly Silty Clay		Gravelly Silty Clay	
OVERSIZE SIEVE (mm)	19.0		19.0		19.0		19.0	
OVERSIZE - WET BASIS (%)	-		-		-		-	
FIELD MOISTURE CONTENT (%)	20.0		19.0		23.5		20.0	
OPTIMUM MOISTURE CONTENT(%)	21.0		21.0		26.0		22.0	
MOISTURE VARIATION (%)	-1.0		-2.0		-2.5		-2.0	
FIELD WET DENSITY (t/m^3)	2.08		2.09		2.09		2.08	
PEAK CONVERTED WET DENSITY (t/m^3)	2.16		2.18		2.14		2.18	
HILF DENSITY RATIO / SPEC (%)	**96.0**	**95**	**96.0**	**95**	**97.5**	**95**	**95.5**	**95**

TEST PROCEDURE	Field A.S. 1289 5.8.1 Laboratory A.S. 1289 5.7.1 (Standard Compaction), 2.1.1
TERMINOLOGY LEGEND	(S) Subgrade; (LSB) Lower Subbase; (B) Base Course; (SB) Subbase Course; (F) Fill; (SF) Select Fill; (AF) Allotment Fill; (STF) Sewer Trench Fill; (EF) Embankment Fill; (SWTF) Stormwater Trench Fill

- Field testing and selection of test locations carried out in general accordance with AS 3798 Level 2 guidelines.
- Test locations were not professionally surveyed therefore recorded locations should be considered as approximate only.
- The above results were faxed as preliminary to Dormway Pty Ltd on 12/5/09.

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CQA/R/21B

FIELD DENSITY RATIO (HILF) TEST REPORT (A.S.)

CLIENT:	DORMWAY PTY LTD	REPORT NO:	7
PROJECT:	RAILWAY PARADE, BANYO	JOB NO:	CQA/09/111
JOB DESCRIPTION:	TRENCH BACKFILL	DATE:	12 May 2009

SAMPLE NUMBER	D/09/2837		D/09/2838		D/09/2839			
DATE/TIME TESTED	29/04/09, 1.40pm		29/04/09, 1.50pm		29/04/09, 2.00pm			
DEPTH OF TEST (mm)	150		150		150			
DEPTH OF LAYER (mm)	-		-		-			
LAYER TERMINOLOGY	STF21		STF22		STF23			
TEST LOCATION	MH 6/1-7/1, 9m off 7/1		MH 6/1-7/1, 10m off 7/1		MH 6/1-7/1, 11m off 7/1			
TEST ELEVATION	2.4m above pipe		2.8m above pipe		Final level			
SOIL DESCRIPTION	Gravelly Silty Clay		Gravelly Silty Clay		Silty Clayey Gravel			
OVERSIZE SIEVE (mm)	19.0		19.0		19.0			
OVERSIZE - WET BASIS (%)	-		-		-			
FIELD MOISTURE CONTENT (%)	20.0		20.5		8.0			
OPTIMUM MOISTURE CONTENT(%)	22.0		22.5		10.0			
MOISTURE VARIATION (%)	-2.0		-2.0		-2.0			
FIELD WET DENSITY (t/m^3)	2.15		2.08		2.38			
PEAK CONVERTED WET DENSITY (t/m^3)	2.18		2.19		2.45			
HILF DENSITY RATIO / SPEC (%)	**99.0**	**95**	**95.0**	**95**	**97.0**	**95**		

TEST PROCEDURE	Field A.S. 1289 5.8.1 Laboratory A.S. 1289 5.7.1 (Standard Compaction), 2.1.1.
TERMINOLOGY LEGEND	(S) Subgrade (LSB) Lower Subbase (B) Base Course (SB) Subbase Course (F) Fill (SF) Select Fill (AF) Allotment Fill (STF) Sewer Trench Fill (EF) Embankment Fill (SWTF) Stormwater Trench Fill

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CQA/R/21B

FIELD DENSITY RATIO (HILF) TEST REPORT (A.S.)

CLIENT: DORMWAY PTY LTD — REPORT NO: 8

PROJECT: RAILWAY PARADE, BANYO — JOB NO: CQA/09/111

JOB DESCRIPTION: TRENCH BACKFILL — DATE: 21 May 2009

SAMPLE NUMBER	D/09/3144		D/09/3145		D/09/3146		D/09/3147	
DATE/TIME TESTED	01/05/09, 1.00pm		01/05/09, 1.05pm		01/05/09, 1.10pm		01/05/09, 1.15pm	
DEPTH OF TEST (mm)	150		150		150		150	
DEPTH OF LAYER (mm)	-		-		-		-	
LAYER TERMINOLOGY	STF24		STF25		STF26		STF27	
TEST LOCATION	MH 7/01-8/01, 40m off 8/01		MH 7/01-8/01, 41m off 8/01		MH 7/01-8/01, 42m off 8/01		MH 7/01-8/01, 43m off 8/01	
TEST ELEVATION	0.8m above pipe		1.2m above pipe		1.6m above pipe		2.0m above pipe	
SOIL DESCRIPTION	Gravelly Sandy Clay		Sandy Clay		Sandy Clay		Silty Sandy Clay	
OVERSIZE SIEVE (mm)	19.0		19.0		19.0		19.0	
OVERSIZE - WET BASIS (%)	-		-		-		-	
FIELD MOISTURE CONTENT (%)	21.5		24.0		23.5		25.5	
OPTIMUM MOISTURE CONTENT(%)	21.5		23.0		23.0		25.5	
MOISTURE VARIATION (%)	0.0		1.0		0.5		0.0	
FIELD WET DENSITY (t/m^3)	1.99		2.02		1.95		1.94	
PEAK CONVERTED WET DENSITY (t/m^3)	2.07		2.03		2.02		2.04	
HILF DENSITY RATIO / SPEC (%)	**95.5**	**95**	**99.5**	**95**	**96.5**	**95**	**95.5**	**95**

<u>TEST PROCEDURE</u>
Field A.S. 1289 5.8.1
Laboratory A.S. 1289 5.7.1 (Standard Compaction), 2.1.1

<u>TERMINOLOGY LEGEND</u>
(S) Subgrade (LSB) Lower Subbase (B) Base Course (SB) Subbase Course (F) Fill (SF) Select Fill (AF) Allotment Fill <u>(STF) Sewer Trench Fill</u> (EF) Embankment Fill (SWTF) Stormwater Trench Fill

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CQA/R/21B

FIELD DENSITY RATIO (HILF) TEST REPORT (A.S.)

CLIENT: DORMWAY PTY LTD — REPORT NO: 9

PROJECT: RAILWAY PARADE, BANYO — JOB NO: CQA/09/111

JOB DESCRIPTION: TRENCH BACKFILL — DATE: 21 May 2009

SAMPLE NUMBER	D/09/3148		D/09/3149		D/09/3150		D/09/3151	
DATE/TIME TESTED	01/05/09, 1.20pm		01/05/09, 1.25pm		01/05/09, 1.30pm		01/05/09, 1.35pm	
DEPTH OF TEST (mm)	150		150		150		150	
DEPTH OF LAYER (mm)	-		-		-		-	
LAYER TERMINOLOGY	STF28		STF29		STF30		STF31	
TEST LOCATION	MH 7/01-8/01, 44m off 8/01		MH 7/01-8/01, 45m off 8/01		MH 7/01-8/01, 46m off 8/01		MH 7/01-8/01, 47m off 8/01	
TEST ELEVATION	2.4m above pipe		2.8m above pipe		3.2m above pipe		Final level	
SOIL DESCRIPTION	Sandy Clay		Sandy Clay		Silty Gravel		Silty Gravel	
OVERSIZE SIEVE (mm)	19.0		19.0		19.0		19.0	
OVERSIZE - WET BASIS (%)	-		-		-		-	
FIELD MOISTURE CONTENT (%)	26.5		24.0		5.0		5.5	
OPTIMUM MOISTURE CONTENT(%)	26.0		22.5		7.0		7.5	
MOISTURE VARIATION (%)	0.5		1.0		-2.0		-2.0	
FIELD WET DENSITY (t/m^3)	2.03		2.05		2.34		2.39	
PEAK CONVERTED WET DENSITY (t/m^3)	2.01		2.06		2.53		2.51	
HILF DENSITY RATIO / SPEC (%)	**101.0**	**95**	**99.5**	**95**	**92.5**	**95**	**95.0**	**95**

TEST PROCEDURE
Field A.S. 1289 5.8.1
Laboratory A.S. 1289 5.7.1 (Standard Compaction), 2.1.1

TERMINOLOGY LEGEND
(S) Subgrade, (LSB) Lower Subbase, (B) Base Course, (SB) Subbase Course, (F) Fill, (SF) Select Fill, (AF) Allotment Fill, (STF) Sewer Trench Fill, (EF) Embankment Fill, (SWTF) Stormwater Trench Fill

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CQA/R/21B

FIELD DENSITY RATIO (HILF) TEST REPORT (A.S.)

CLIENT:	DORMWAY PTY LTD	REPORT NO:	10
PROJECT:	RAILWAY PARADE, BANYO	JOB NO:	CQA/09/111
JOB DESCRIPTION:	TRENCH BACKFILL	DATE:	21 May 2009

SAMPLE NUMBER	D/09/3152		D/09/3153		D/09/3154		D/09/3155	
DATE/TIME TESTED	06/05/09, 10:20am		06/05/09, 10.25am		06/05/09, 10.30am		06/05/09, 10.35am	
DEPTH OF TEST (mm)	150		150		150		150	
DEPTH OF LAYER (mm)	-		-		-		-	
LAYER TERMINOLOGY	STF32		STF33		STF34		STF35	
TEST LOCATION	MH 8/01-9/01, 11m off 8/01		MH 8/01-9/01, 12m off 8/01		MH 8/01-9/01, 12.5m off 8/01		MH 8/01-9/01, 13m off 8/01	
TEST ELEVATION	0.8m above pipe		1.2m above pipe		1.6m above pipe		2.0m above pipe	
SOIL DESCRIPTION	Silty Clay		Silty Clay		Silty Clay		Silty Clay	
OVERSIZE SIEVE (mm)	19.0		19.0		19.0		19.0	
OVERSIZE - WET BASIS (%)	-		-		-		-	
FIELD MOISTURE CONTENT (%)	24.5		24.5		23.5		28.5	
OPTIMUM MOISTURE CONTENT(%)	22.5		22.5		21.0		26.0	
MOISTURE VARIATION (%)	1.5		2.0		3.0		2.5	
FIELD WET DENSITY (t/m^3)	1.97		1.98		2.01		2.00	
PEAK CONVERTED WET DENSITY (t/m^3)	2.02		2.02		2.08		2.02	
HILF DENSITY RATIO / SPEC (%)	**97.0**	**95**	**98.0**	**95**	**97.0**	**95**	**98.5**	**95**

TEST PROCEDURE	Field A.S. 1289 5.8.1 Laboratory A.S. 1289 5.7.1 (Standard Compaction), 2.1.1
TERMINOLOGY LEGEND	(S) Subgrade (LSB) Lower Subbase (B) Base Course (SB) Subbase Course (F) Fill (SF) Select Fill (AF) Allotment Fill (STF) Sewer Trench Fill (EF) Embankment Fill (SWTF) Stormwater Trench Fill

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FIELD DENSITY RATIO (HILF) TEST REPORT (A.S.)

CLIENT: DORMWAY PTY LTD — REPORT NO: 11

PROJECT: RAILWAY PARADE, BANYO — JOB NO: CQA/09/111

JOB DESCRIPTION: TRENCH BACKFILL — DATE: 21 May 2009

SAMPLE NUMBER	D/09/3156		D/09/3157		D/09/3158		D/09/3159	
DATE/TIME TESTED	06/05/09, 10.40am		06/05/09, 10.45am		06/05/09, 10.50am		06/05/09, 10.55am	
DEPTH OF TEST (mm)	150		150		150		150	
DEPTH OF LAYER (mm)	-		-		-		-	
LAYER TERMINOLOGY	STF36		STF37		STF38		STF39	
TEST LOCATION	MH 8/01-9/01, 13.5m off 8/01		MH 8/01-9/01, 14m off 8/01		MH 8/01-9/01, 14.5m off 8/01		MH 8/01-9/01, 15m off 8/01	
TEST ELEVATION	2.4m above pipe		2.8m above pipe		3.2m above pipe		Final level	
SOIL DESCRIPTION	Gravelly Silty Clay		Gravelly Silty Clay		Silty Clay		Gravelly Silty Clay	
OVERSIZE SIEVE (mm)	19.0		19.0		19.0		19.0	
OVERSIZE - WET BASIS (%)	-		-		-		-	
FIELD MOISTURE CONTENT (%)	22.5		19.0		12.5		26.0	
OPTIMUM MOISTURE CONTENT(%)	19.5		19.5		13.0		24.5	
MOISTURE VARIATION (%)	3.0		-0.5		-0.5		1.5	
FIELD WET DENSITY (t/m^3)	2.04		2.09		2.09		2.06	
PEAK CONVERTED WET DENSITY (t/m^3)	2.07		2.13		2.14		2.05	
HILF DENSITY RATIO / SPEC (%)	**98.5**	**95**	**98.5**	**95**	**98.0**	**95**	**100.5**	**95**

TEST PROCEDURE
Field A.S. 1289 5.8.1
Laboratory A.S. 1289 5.7.1 (Standard Compaction), 2.1.1

TERMINOLOGY LEGEND
(S) Subgrade (LSB) Lower Subbase (B) Base Course (SB) Subbase Course (F) Fill (SF) Select Fill (AF) Allotment Fill (STF) Sewer Trench Fill (EF) Embankment Fill (SWTF) Stormwater Trench Fill

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CQA/R/21B

FIELD DENSITY RATIO (HILF) TEST REPORT (A.S.)

CLIENT:	DORMWAY PTY LTD	REPORT NO:	12
PROJECT:	RAILWAY PARADE, BANYO	JOB NO:	CQA/09/111
JOB DESCRIPTION:	TRENCH BACKFILL	DATE:	21 May 2009

SAMPLE NUMBER	D/09/3160		D/09/3161		D/09/3162		D/09/3163	
DATE/TIME TESTED	08/05/09, 10.30am		08/05/09, 10.35am		08/05/09, 10.40am		08/05/09, 10.45am	
DEPTH OF TEST (mm)	150		150		150		150	
DEPTH OF LAYER (mm)	-		-		-		-	
LAYER TERMINOLOGY	STF40		STF41		STF42		STF43	
TEST LOCATION	MH 8/1-9/1, 41m off 8/1		MH 8/1-9/1, 44m off 8/1		MH 8/1-9/1, 46m off 8/1		MH 8/1-9/1, 48m off 8/1	
TEST ELEVATION	0.8m above pipe		1.2m above pipe		1.6m above pipe		2.0m above pipe	
SOIL DESCRIPTION	Silty Sandy Clay		Silty Sandy Clay		Silty Sandy Clay		Silty Sandy Clay	
OVERSIZE SIEVE (mm)	19.0		19.0		19.0		19.0	
OVERSIZE - WET BASIS (%)	-		-		-		-	
FIELD MOISTURE CONTENT (%)	24.5		25.5		26.5		24.0	
OPTIMUM MOISTURE CONTENT(%)	25.0		26.0		26.5		23.5	
MOISTURE VARIATION (%)	-0.5		-0.5		0.0		0.0	
FIELD WET DENSITY (t/m^3)	2.02		2.03		1.96		1.96	
PEAK CONVERTED WET DENSITY (t/m^3)	1.97		2.00		2.04		2.04	
HILF DENSITY RATIO / SPEC (%)	**102.5**	**95**	**101.5**	**95**	**96.0**	**95**	**96.0**	**95**

TEST PROCEDURE	Field A.S. 1289 5.8.1 Laboratory A.S. 1289 5.7.1 (Standard Compaction), 2.1.1			
TERMINOLOGY LEGEND	(S) Subgrade (LSB) Lower Subbase	(B) Base Course (SB) Subbase Course (F) Fill	(SF) Select Fill (AF) Allotment Fill (STF) Sewer Trench Fill	(EF) Embankment Fill (SWTF) Stormwater Trench Fill

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CQA/R/21B

FIELD DENSITY RATIO (HILF) TEST REPORT (A.S.)

CLIENT: DORMWAY PTY LTD | REPORT NO: 13

PROJECT: RAILWAY PARADE, BANYO | JOB NO: CQA/09/111

JOB DESCRIPTION: TRENCH BACKFILL | DATE: 21 May 2009

SAMPLE NUMBER	D/09/3164		D/09/3165		D/09/3166		D/09/3167	
DATE/TIME TESTED	08/05/09, 10.50am		08/05/09, 10.55am		08/05/09, 11.00am		08/05/09, 11.05am	
DEPTH OF TEST (mm)	150		150		150		150	
DEPTH OF LAYER (mm)	-		-		-		-	
LAYER TERMINOLOGY	STF44		STF45		STF46		STF47	
TEST LOCATION	MH 8/1-9/1, 50m off 8/1		MH 8/1-9/1, 52m off 8/1		MH 8/1-9/1, 54m off 8/1		MH 8/1-9/1, 56m off 8/1	
TEST ELEVATION	2.4m above pipe		2.8m above pipe		3.2m above pipe		3.6m above pipe	
SOIL DESCRIPTION	Silty Sandy Clay		Silty Gravel		Silty Gravel		Silty Gravel	
OVERSIZE SIEVE (mm)	19.0		19.0		19.0		19.0	
OVERSIZE - WET BASIS (%)	-		-		-		5.0	
FIELD MOISTURE CONTENT (%)	24.5		5.0		5.0		5.0	
OPTIMUM MOISTURE CONTENT(%)	24.5		8.0		8.5		7.5	
MOISTURE VARIATION (%)	0.0		-2.5		-4.0		-3.0	
FIELD WET DENSITY (t/m^3)	1.99		2.44		2.46		2.45	
PEAK CONVERTED WET DENSITY (t/m^3)	2.03		2.51		2.47		2.50	
HILF DENSITY RATIO / SPEC (%)	**98.0**	**95**	**97.5**	**95**	**99.5**	**95**	**98.0**	**95**

TEST PROCEDURE
Field A.S. 1289 5.8.1
Laboratory A.S. 1289 5.7.1 (Standard Compaction), 2.1.1

TERMINOLOGY LEGEND
(S) Subgrade (LSB) Lower Subbase
(B) Base Course (SB) Subbase Course (F) Fill
(SF) Select Fill (AF) Allotment Fill (STF) Sewer Trench Fill
(EF) Embankment Fill (SWTF) Stormwater Trench Fill

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FIELD DENSITY RATIO (HILF) TEST REPORT (A.S.)

CLIENT:	DORMWAY PTY LTD	REPORT NO:	14
PROJECT:	RAILWAY PARADE, BANYO	JOB NO:	CQA/09/111
JOB DESCRIPTION:	TRENCH BACKFILL	DATE:	21 May 2009

SAMPLE NUMBER	D/09/3168							
DATE/TIME TESTED	08/05/09, 11.10am							
DEPTH OF TEST (mm)	150							
DEPTH OF LAYER (mm)	-							
LAYER TERMINOLOGY	STF48							
TEST LOCATION	MH 8/1-9/1, 58m off 8/1							
TEST ELEVATION	Final level							
SOIL DESCRIPTION	Silty Gravel							
OVERSIZE SIEVE (mm)	19.0							
OVERSIZE - WET BASIS (%)	-							
FIELD MOISTURE CONTENT (%)	4.5							
OPTIMUM MOISTURE CONTENT(%)	7.5							
MOISTURE VARIATION (%)	-2.5							
FIELD WET DENSITY (t/m^3)	2.44							
PEAK CONVERTED WET DENSITY (t/m^3)	2.48							
HILF DENSITY RATIO / SPEC (%)	**98.0**	**95**						

TEST PROCEDURE	Field A.S. 1289 5.8.1 Laboratory A.S. 1289 5.7.1 (Standard Compaction), 2.1.1			
TERMINOLOGY LEGEND	(S) Subgrade (LSB) Lower Subbase	(B) Base Course (SB) Subbase Course (F) Fill	(SF) Select Fill (AF) Allotment Fill (STF) Sewer Trench Fill	(EF) Embankment Fill (SWTF) Stormwater Trench Fill

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FIELD DENSITY RATIO (HILF) TEST REPORT (A.S.)

CLIENT:	DORMWAY PTY LTD	REPORT NO:	15
PROJECT:	RAILWAY PARADE, BANYO	JOB NO:	CQA/09/111
JOB DESCRIPTION:	TRENCH BACKFILL	DATE:	21 May 2009

SAMPLE NUMBER	D/09/3169		D/09/3170		D/09/3171		D/09/3172	
DATE/TIME TESTED	13/05/09, 11.40am		13/05/09, 11.50am		13/05/09, 11:55am		13/05/09, 12.00pm	
DEPTH OF TEST (mm)	150		150		150		150	
DEPTH OF LAYER (mm)	-		-		-		-	
LAYER TERMINOLOGY	STF49		STF50		STF51		STF52	
TEST LOCATION	MH 9/01-10/01, 20m off 9/01		MH 9/01-10/01; 21m off 9/01		MH 9/01-10/01, 22m off 9/01		MH 9/01-10/01, 23m off 9/01	
TEST ELEVATION	0.8m above pipe		1.2m above pipe		1.6m above pipe		2.0m above pipe	
SOIL DESCRIPTION	Silty Clay		Silty Clay		Silty Clay		Silty Clay	
OVERSIZE SIEVE (mm)	19.0		19.0		19.0		19.0	
OVERSIZE - WET BASIS (%)	-		-		-		-	
FIELD MOISTURE CONTENT (%)	27.0		27.5		27.5		27.0	
OPTIMUM MOISTURE CONTENT(%)	25.0		25.5		25.5		25.5	
MOISTURE VARIATION (%)	2.0		2.0		2.0		1.5	
FIELD WET DENSITY (t/m^3)	1.99		1.98		1.98		1.98	
PEAK CONVERTED WET DENSITY (t/m^3)	2.03		2.02		2.02		2.00	
HILF DENSITY RATIO / SPEC (%)	**98.0**	**95**	**98.0**	**95**	**98.0**	**95**	**98.5**	**95**

TEST PROCEDURE	Field A.S. 1289 5.8.1 Laboratory A.S. 1289 5.7.1 (Standard Compaction), 2.1.1			
TERMINOLOGY LEGEND	(S) Subgrade (LSB) Lower Subbase	(B) Base Course (SB) Subbase Course (F) Fill	(SF) Select Fill (AF) Allotment Fill (STF) Sewer Trench Fill	(EF) Embankment Fill (SWTF) Stormwater Trench Fill

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FIELD DENSITY RATIO (HILF) TEST REPORT (A.S.)

CLIENT:	DORMWAY PTY LTD	REPORT NO:	16
PROJECT:	RAILWAY PARADE, BANYO	JOB NO:	CQA/09/111
JOB DESCRIPTION:	TRENCH BACKFILL	DATE:	21 May 2009

SAMPLE NUMBER	D/09/3173		D/09/3174		D/09/3175		D/09/3176	
DATE/TIME TESTED	13/05/09, 12.05pm		13/05/09, 12.10pm		13/05/09, 12.15pm		13/05/09, 12.20pm	
DEPTH OF TEST (mm)	150		150		150		150	
DEPTH OF LAYER (mm)	-		-		-		-	
LAYER TERMINOLOGY	STF53		STF54		STF55		STF56	
TEST LOCATION	MH 9/01-10/01, 24m off 9/01		MH 9/01-10/01, 25m off 9/01		MH 9/01-10/01, 26m off 9/01		MH 9/01-10/01, 27m off 9/01	
TEST ELEVATION	2.4m above pipe		2.8m above pipe		3.2m above pipe		3.6m above pipe	
SOIL DESCRIPTION	Silty Clay		Silty Clay		Silty Clay		Silty Clay	
OVERSIZE SIEVE (mm)	19.0		19.0		19.0		19.0	
OVERSIZE - WET BASIS (%)	-		-		-		-	
FIELD MOISTURE CONTENT (%)	28.0		28.5		28.5		26.5	
OPTIMUM MOISTURE CONTENT(%)	26.0		26.5		27.0		24.5	
MOISTURE VARIATION (%)	2.0		2.0		1.5		2.0	
FIELD WET DENSITY (t/m^3)	1.94		1.97		1.95		1.98	
PEAK CONVERTED WET DENSITY (t/m^3)	2.00		2.00		2.00		2.01	
HILF DENSITY RATIO / SPEC (%)	**97.0**	**95**	**98.5**	**95**	**97.5**	**95**	**98.0**	**95**

TEST PROCEDURE	Field A.S. 1289 5.8.1 Laboratory A.S. 1289 5.7.1 (Standard Compaction), 2.1.1			
TERMINOLOGY LEGEND	(S) Subgrade (LSB) Lower Subbase	(B) Base Course (SB) Subbase Course (F) Fill	(SF) Select Fill (AF) Allotment Fill (STF) Sewer Trench Fill	(EF) Embankment Fill (SWTF) Stormwater Trench Fill

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CQA/R/21B

FIELD DENSITY RATIO (HILF) TEST REPORT (A.S.)

CLIENT: DORMWAY PTY LTD — REPORT NO: 17

PROJECT: RAILWAY PARADE, BANYO — JOB NO: CQA/09/111

JOB DESCRIPTION: TRENCH BACKFILL — DATE: 21 May 2009

SAMPLE NUMBER	D/09/3177			
DATE/TIME TESTED	13/05/09, 12.25pm			
DEPTH OF TEST (mm)	150			
DEPTH OF LAYER (mm)	-			
LAYER TERMINOLOGY	STF57			
TEST LOCATION	MH 9/01-10/01, 28m off 9/01			
TEST ELEVATION	Final level			
SOIL DESCRIPTION	Silty Clay			
OVERSIZE SIEVE (mm)	19.0			
OVERSIZE - WET BASIS (%)	-			
FIELD MOISTURE CONTENT (%)	28.5			
OPTIMUM MOISTURE CONTENT(%)	26.5			
MOISTURE VARIATION (%)	2.0			
FIELD WET DENSITY (t/m^3)	1.97			
PEAK CONVERTED WET DENSITY (t/m^3)	1.99			
HILF DENSITY RATIO / SPEC (%)	99.0 / 95			

TEST PROCEDURE — Field: A.S. 1289 5.8.1; Laboratory: A.S. 1289 5.7.1 (Standard Compaction), 2.1.1

TERMINOLOGY LEGEND — (S) Subgrade; (LSB) Lower Subbase; (B) Base Course; (SB) Subbase Course; (F) Fill; (SF) Select Fill; (AF) Allotment Fill; (STF) Sewer Trench Fill; (EF) Embankment Fill; (SWTF) Stormwater Trench Fill

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FIELD DENSITY RATIO (HILF) TEST REPORT (A.S.)

CLIENT: DORMWAY PTY LTD — REPORT NO: 18

PROJECT: RAILWAY PARADE, BANYO — JOB NO: CQA/09/111

JOB DESCRIPTION: TRENCH BACKFILL — DATE: 21 May 2009

SAMPLE NUMBER	D/09/3178		D/09/3179		D/09/3180		D/09/3181	
DATE/TIME TESTED	14/05/09, 11.45am		14/05/09, 11.50am		14/05/09, 11.55am		14/05/09, 12.00pm	
DEPTH OF TEST (mm)	150		150		150		150	
DEPTH OF LAYER (mm)	-		-		-		-	
LAYER TERMINOLOGY	STF58		STF59		STF60		STF61	
TEST LOCATION	MH 9/01-10/01, 20m off 10/01		MH 9/01-10/01, 25m off 10/01		MH 9/01-10/01, 30m off 10/01		MH 9/01-10/01, 35m off 10/01	
TEST ELEVATION	0.8m above pipe		1.2m above pipe		1.6m above pipe		2.0m above pipe	
SOIL DESCRIPTION	Silty Clay		Silty Clay		Silty Clay		Silty Clay	
OVERSIZE SIEVE (mm)	19.0		19.0		19.0		19.0	
OVERSIZE - WET BASIS (%)	-		-		-		-	
FIELD MOISTURE CONTENT (%)	26.0		23.5		25.0		24.5	
OPTIMUM MOISTURE CONTENT(%)	24.0		21.5		23.5		23.0	
MOISTURE VARIATION (%)	2.5		2.0		2.0		1.5	
FIELD WET DENSITY (t/m^3)	1.98		1.99		1.99		1.98	
PEAK CONVERTED WET DENSITY (t/m^3)	2.04		2.09		2.05		2.05	
HILF DENSITY RATIO / SPEC (%)	**96.5**	**95**	**95.0**	**95**	**97.0**	**95**	**96.5**	**95**

TEST PROCEDURE
Field A.S. 1289 5.8.1
Laboratory A.S. 1289 5.7.1 (Standard Compaction), 2.1.1

TERMINOLOGY LEGEND
(S) Subgrade (LSB) Lower Subbase
(B) Base Course (SB) Subbase Course (F) Fill
(SF) Select Fill (AF) Allotment Fill (STF) Sewer Trench Fill
(EF) Embankment Fill (SWTF) Stormwater Trench Fill

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FIELD DENSITY RATIO (HILF) TEST REPORT (A.S.)

CLIENT:	DORMWAY PTY LTD	REPORT NO:	19
PROJECT:	RAILWAY PARADE, BANYO	JOB NO:	CQA/09/111
JOB DESCRIPTION:	TRENCH BACKFILL	DATE:	21 May 2009

SAMPLE NUMBER	D/09/3182								
DATE/TIME TESTED	14/05/09, 12.05pm								
DEPTH OF TEST (mm)	150								
DEPTH OF LAYER (mm)	-								
LAYER TERMINOLOGY	STF62								
TEST LOCATION	MH 9/01-10/01, 40m off 10/01								
TEST ELEVATION	2.4m above pipe								
SOIL DESCRIPTION	Silty Clay								
OVERSIZE SIEVE (mm)	19.0								
OVERSIZE - WET BASIS (%)	-								
FIELD MOISTURE CONTENT (%)	25.5								
OPTIMUM MOISTURE CONTENT(%)	24.0								
MOISTURE VARIATION (%)	1.5								
FIELD WET DENSITY (t/m^3)	1.95								
PEAK CONVERTED WET DENSITY (t/m^3)	2.04								
HILF DENSITY RATIO / SPEC (%)	**95.0**	**95**							

TEST PROCEDURE	Field A.S. 1289 5.8.1 Laboratory A.S. 1289 5.7.1 (Standard Compaction), 2.1.1.
TERMINOLOGY LEGEND	(S) Subgrade (LSB) Lower Subbase (B) Base Course (SB) Subbase Course (F) Fill (SF) Select Fill (AF) Allotment Fill (STF) Sewer Trench Fill (EF) Embankment Fill (SWTF) Stormwater Trench Fill

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FIELD DENSITY RATIO (HILF) TEST REPORT (A.S.)

CLIENT:	DORMWAY PTY LTD	REPORT NO:	20
PROJECT:	RAILWAY PARADE, BANYO	JOB NO:	CQA/09/111
JOB DESCRIPTION:	TRENCH BACKFILL	DATE:	10 June 2009

SAMPLE NUMBER	D/09/3511		D/09/3512		D/09/3513		D/09/3514	
DATE/TIME TESTED	26/05/09, 10.30am		26/05/09, 10.35am		26/05/09, 11.00am		26/05/09, 11.05am	
DEPTH OF TEST (mm)	150		150		150		150	
DEPTH OF LAYER (mm)	-		-		-		-	
LAYER TERMINOLOGY	STF63		STF64		STF65		STF66	
TEST LOCATION	MH 10/01-11/01, 20m off 10/01		MH 10/01-11/01, 22m off 10/01		MH 10/01-11/01, 24m off 10/01		MH 10/01-11/01, 26m off 10/01	
TEST ELEVATION	0.8m above pipe		1.2m above pipe		1.6m above pipe		2.0m above pipe	
SOIL DESCRIPTION	Gravelly Sandy Clay		Gravelly Sandy Clay		Gravelly Sandy Clay		Silty Gravelly Clay	
OVERSIZE SIEVE (mm)	19.0		19.0		19.0		19.0	
OVERSIZE - WET BASIS (%)	-		-		-		-	
FIELD MOISTURE CONTENT (%)	16.0		25.0		24.0		26.0	
OPTIMUM MOISTURE CONTENT(%)	16.0		25.0		23.0		26.0	
MOISTURE VARIATION (%)	0.5		0.0		0.5		0.0	
FIELD WET DENSITY (t/m^3)	2.08		2.08		2.06		2.08	
PEAK CONVERTED WET DENSITY (t/m^3)	2.19		2.00		2.11		1.95	
HILF DENSITY RATIO / SPEC (%)	95.0	95	103.5	95	97.5	95	107.0	95

TEST PROCEDURE	Field A.S. 1289 5.8.1 Laboratory A.S. 1289 5.7.1 (Standard Compaction), 2.1.1			
TERMINOLOGY LEGEND	(S) Subgrade (LSB) Lower Subbase	(B) Base Course (SB) Subbase Course (F) Fill	(SF) Select Fill (AF) Allotment Fill (STF) Sewer Trench Fill	(EF) Embankment Fill (SWTF) Stormwater Trench Fill

- Field testing and selection of test locations carried out in general accordance with AS 3798 Level 2 guidelines.
- Test locations were not professionally surveyed therefore recorded locations should be considered as approximate only.

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CIVIL QUALITY ASSURANCE (QLD) PTY. LTD.

GEOTECHNICAL CONSULTANTS

1/18 LEANNE CRESCENT, LAWNTON; QLD 4501
OFFICE: (07) 3881 3511 FAX: (07) 3881 3513.

CQA/R/21B

FIELD DENSITY RATIO (HILF) TEST REPORT (A.S.)

CLIENT: DORMWAY PTY LTD — REPORT NO: 21

PROJECT: RAILWAY PARADE, BANYO — JOB NO: CQA/09/111

JOB DESCRIPTION: TRENCH BACKFILL — DATE: 10 June 2009

SAMPLE NUMBER	D/09/3515		D/09/3516		D/09/3517			
DATE/TIME TESTED	26/05/09, 11.10am		26/05/09, 11.15am		26/05/09, 11.20am			
DEPTH OF TEST (mm)	150		150		150			
DEPTH OF LAYER (mm)	-		-		-			
LAYER TERMINOLOGY	STF67		STF68		STF69			
TEST LOCATION	MH 10/01-11/01, 28m off 10/01		MH 10/01-11/01, 30m off 10/01		MH 10/01-11/01, 32m off 10/01			
TEST ELEVATION	2.4m above pipe		2.8m above pipe		3.2m above pipe			
SOIL DESCRIPTION	Silty Gravelly Clay		Silty Gravelly Clay		Silty Gravelly Clay			
OVERSIZE SIEVE (mm)	19.0		19.0		19.0			
OVERSIZE - WET BASIS (%)	-		-		-			
FIELD MOISTURE CONTENT (%)	29.5		29.5		19.5			
OPTIMUM MOISTURE CONTENT(%)	27.5		27.0		19.5			
MOISTURE VARIATION (%)	1.5		2.0		0.0			
FIELD WET DENSITY (t/m^3)	1.93		1.93		2.05			
PEAK CONVERTED WET DENSITY (t/m^3)	1.96		1.98		2.15			
HILF DENSITY RATIO / SPEC (%)	100.5	95	97.5	95	95.5	95		

TEST PROCEDURE	Field A.S. 1289 5.8.1 Laboratory A.S. 1289 5.7.1 (Standard Compaction), 2.1.1
TERMINOLOGY LEGEND	(S) Subgrade (LSB) Lower Subbase (B) Base Course (SB) Subbase Course (F) Fill (SF) Select Fill (AF) Allotment Fill (STF) Sewer Trench Fill (EF) Embankment Fill (SWTF) Stormwater Trench Fill

- Field testing and selection of test locations carried out in general accordance with AS 3798 Level 2 guidelines.
- Test locations were not professionally surveyed therefore recorded locations should be considered as approximate only.

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GEOTECHNICAL CONSULTANTS

1/18 LEANNE CRESCENT, LAWNTON, QLD 4501
OFFICE: (07) 3881 3511 FAX: (07) 3881 3513.

CQA/R/21B

FIELD DENSITY RATIO (HILF) TEST REPORT (A.S.)

CLIENT:	DORMWAY PTY LTD	REPORT NO:	22
PROJECT:	RAILWAY PARADE, BANYO	JOB NO:	CQA/09/111
JOB DESCRIPTION:	TRENCH BACKFILL	DATE:	10 June 2009

SAMPLE NUMBER	D/09/3518		D/09/3519		D/09/3520		D/09/3521	
DATE/TIME TESTED	27/05/09, 11.00am		27/05/09, 11.05am		27/05/09, 11.10am		27/05/09, 11.15am	
DEPTH OF TEST (mm)	150		150		150		150	
DEPTH OF LAYER (mm)	-		-		-		-	
LAYER TERMINOLOGY	STF70		STF71		STF72		STF73	
TEST LOCATION	MH 10/01-11/01, 3m off 11/01		MH 10/01-11/01, 4m off 11/01		MH 10/01-11/01, 5m off 11/01		MH 10/01-11/01, 6m off 11/01	
TEST ELEVATION	0.8m above pipe		1.2m above pipe		1.6m above pipe		2.0m above pipe	
SOIL DESCRIPTION	Sandy Silty Gravel		Sandy Silty Gravel		Sandy Silty Gravel		Sandy Silty Gravel	
OVERSIZE SIEVE (mm)	19.0		19.0		19.0		19.0	
OVERSIZE - WET BASIS (%)	2.0		3.0		3.0		2.0	
FIELD MOISTURE CONTENT (%)	4.5		4.0		4.5		7.0	
OPTIMUM MOISTURE CONTENT(%)	8.0		7.5		8.0		9.0	
MOISTURE VARIATION (%)	-4.0		-3.5		-3.5		-2.0	
FIELD WET DENSITY (t/m^3)	2.40		2.39		2.44		2.25	
PEAK CONVERTED WET DENSITY (t/m^3)	2.49		2.50		2.50		2.46	
HILF DENSITY RATIO / SPEC (%)	96.0	95	95.5	95	97.5	95	91.5(FA)	95

TEST PROCEDURE	Field	A.S. 1289 5.8.1
	Laboratory	A.S. 1289 5.7.1 (Standard Compaction), 2.1.1

TERMINOLOGY LEGEND	(S) Subgrade	(B) Base Course	(SF) Select Fill	(EF) Embankment Fill
	(LSB) Lower Subbase	(SB) Subbase Course	(AF) Allotment Fill	(SWTF) Stormwater Trench Fill
	(FA) Failure	(F) Fill	(STF) Sewer Trench Fill	

- Field testing and selection of test locations carried out in general accordance with AS 3798 Level 2 guidelines.
- Test locations were not professionally surveyed therefore recorded locations should be considered as approximate only.
- The above results were faxed as preliminary to Dormway Pty Ltd on 03/06/09.

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GEOTECHNICAL CONSULTANTS
1/18 LEANNE CRESCENT, LAWNTON, QLD 4501
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CQA/R/21B

FIELD DENSITY RATIO (HILF) TEST REPORT (A.S.)

CLIENT:	DORMWAY PTY LTD	REPORT NO:	23
PROJECT:	RAILWAY PARADE, BANYO	JOB NO:	CQA/09/111
JOB DESCRIPTION:	TRENCH BACKFILL	DATE:	10 June 2009

SAMPLE NUMBER	D/09/3522		D/09/3523		D/09/3524		
DATE/TIME TESTED	27/05/09, 11.20am		27/05/09, 11.25am		27/05/09, 11.30am		
DEPTH OF TEST (mm)	150		150		150		
DEPTH OF LAYER (mm)	-		-		-		
LAYER TERMINOLOGY	STF74		STF75		STF76		
TEST LOCATION	MH 10/01-11/01, 7m off 11/01		MH 10/01-11/01, 8m off 11/01		MH 10/01-11/01, 9m off 11/01		
TEST ELEVATION	2.4m above pipe		2.8m above pipe		Final level		
SOIL DESCRIPTION	Sandy Silty Gravel		Sandy Silty Gravel		Sandy Silty Gravel		
OVERSIZE SIEVE (mm)	19.0		19.0		19.0		
OVERSIZE - WET BASIS (%)	10.0		10.0		7.0		
FIELD MOISTURE CONTENT (%)	6.0		6.0		5.5		
OPTIMUM MOISTURE CONTENT(%)	8.0		8.0		8.5		
MOISTURE VARIATION (%)	-2.0		-2.0		-2.5		
FIELD WET DENSITY (t/m^3)	2.32		2.34		2.29		
PEAK CONVERTED WET DENSITY (t/m^3)	2.46		2.48		2.49		
HILF DENSITY RATIO / SPEC (%)	**94.5(FA)**	**95**	**94.5(FA)**	**95**	**92.0(FA)**	**95**	

TEST PROCEDURE	Field	A.S. 1289 5.8.1
	Laboratory	A.S. 1289 5.7.1 (Standard Compaction); 2.1.1

TERMINOLOGY LEGEND			
(S) Subgrade	(B) Base Course	(SF) Select Fill	(EF) Embankment Fill
(LSB) Lower Subbase	(SB) Subbase Course	(AF) Allotment Fill	(SWTF) Stormwater Trench Fill
(FA) Failure	(F) Fill	(STF) Sewer Trench Fill	

- Field testing and selection of test locations carried out in general accordance with AS 3798 Level 2 guidelines.
- Test locations were not professionally surveyed therefore recorded locations should be considered as approximate only.
- The above results were faxed as preliminary to Dormway Pty Ltd on 03/06/09.

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CQA/R/21B

FIELD DENSITY RATIO (HILF) TEST REPORT (A.S.)

CLIENT:	DORMWAY PTY LTD	REPORT NO:	24
PROJECT:	RAILWAY PARADE, BANYO	JOB NO:	CQA/09/111
JOB DESCRIPTION:	TRENCH BACKFILL	DATE:	30 June 2009

SAMPLE NUMBER	D/09/4088		D/09/4089		D/09/4090		D/09/4091	
DATE/TIME TESTED	12/06/09, 11.25am		12/06/09, 11:30am		12/06/09, 11.35am		12/06/09, 11.40am	
DEPTH OF TEST (mm)	150		150		150		150	
DEPTH OF LAYER (mm)	-		-		-		-	
LAYER TERMINOLOGY	STF77		STF78		STF79		STF80	
TEST LOCATION	MH 5/1-6/1, 20m off 5/1		MH 5/1-6/1, 21m off 5/1		MH 5/1-6/1, 22m off 5/1		MH 5/1-6/1, 23m off 5/1	
TEST ELEVATION	0.8m above pipe		1.2m above pipe		1.6m above pipe		2.0m above pipe	
SOIL DESCRIPTION	Gravelly Clay		Gravelly Clay		Gravelly Clay		Sandy Gravelly Clay	
OVERSIZE SIEVE (mm)	19.0		19.0		19.0		19.0	
OVERSIZE - WET BASIS (%)	-		-		-		-	
FIELD MOISTURE CONTENT (%)	33.0		35.5		30.5		32.0	
OPTIMUM MOISTURE CONTENT(%)	30.5		33.5		27.5		29.0	
MOISTURE VARIATION (%)	2.5		2.0		3.0		3.0	
FIELD WET DENSITY (t/m^3)	1.85		1.88		1.87		1.86	
PEAK CONVERTED WET DENSITY (t/m^3)	1.78		1.80		1.92		1.92	
HILF DENSITY RATIO / SPEC (%)	104.0	95	104.5	95	98.0	95	97.0	95

TEST PROCEDURE	Field A.S. 1289 5.8.1 Laboratory A.S. 1289 5.7.1 (Standard Compaction), 2.1.1			
TERMINOLOGY LEGEND	(S) Subgrade (LSB) Lower Subbase	(B) Base Course (SB) Subbase Course (F) Fill	(SF) Select Fill (AF) Allotment Fill (STF) Sewer Trench Fill	(EF) Embankment Fill (SWTF) Stormwater Trench Fill

- Field testing and selection of test locations carried out in general accordance with AS 3798 Level 2 guidelines.
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GEOTECHNICAL CONSULTANTS
1/18 LEANNE CRESCENT, LAWNTON, QLD 4501
OFFICE: (07) 3881 3511 FAX: (07) 3881 3513

CQA/R/218

FIELD DENSITY RATIO (HILF) TEST REPORT (A.S.)

CLIENT:	DORMWAY PTY LTD	REPORT NO:	25
PROJECT:	RAILWAY PARADE, BANYO	JOB NO:	CQA/09/111
JOB DESCRIPTION:	TRENCH BACKFILL	DATE:	30 June 2009

SAMPLE NUMBER	D/09/4092		D/09/4093		D/09/4094		D/09/4095	
DATE/TIME TESTED	12/06/09, 11.45am		12/06/09, 11.50am		12/06/09, 11.55am		12/06/09, 12.00pm	
DEPTH OF TEST (mm)	150		150		150		150	
DEPTH OF LAYER (mm)	-		-		-		-	
LAYER TERMINOLOGY	STF81		STF82		STF83		STF84	
TEST LOCATION	MH 5/1-6/1, 24m off 5/1		MH 5/1-6/1, 25m off 5/1		MH 5/1-6/1, 15m off 6/1		MH 5/1-6/1, 16m off 6/1	
TEST ELEVATION	2.4m above pipe		Final level		0.8m above pipe		1.2m above pipe	
SOIL DESCRIPTION	Sandy Clay		Sandy Clay		Sandy Clay		Sandy Clay	
OVERSIZE SIEVE (mm)	19.0		19.0		19.0		19.0	
OVERSIZE - WET BASIS (%)	-		-		-		-	
FIELD MOISTURE CONTENT (%)	32.0		33.5		34.5		30.5	
OPTIMUM MOISTURE CONTENT (%)	27.5		28.0		29.0		26.0	
MOISTURE VARIATION (%)	4.5		5.0		6.0		5.0	
FIELD WET DENSITY (t/m^3)	1.92		1.91		1.89		1.91	
PEAK CONVERTED WET DENSITY (t/m^3)	1.97		1.93		1.94		1.95	
HILF DENSITY RATIO / SPEC (%)	100.0	95	99.0	95	97.5	95	97.5	95

TEST PROCEDURE	Field	A.S. 1289 5.8.1
	Laboratory	A.S. 1289 5.7.1 (Standard Compaction), 2.1.1

TERMINOLOGY LEGEND	(S) Subgrade (LSB) Lower Subbase	(B) Base Course (SB) Subbase Course (F) Fill	(SF) Select Fill (AF) Allotment Fill (STF) Sewer Trench Fill	(EF) Embankment Fill (SWTF) Stormwater Trench Fill

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Holcim (Australia) Pty Ltd - Technical Services

01/03/2010 8:14:14 AM

VTR04 - QC Summary by Plant/Product Plus Early Age

Search: Concrete Plant = Brendale - Excel,Acacia Ridge (Holcim) Concrete Tolling,Brisbane City (Holcim) Concrete Tolling ,Albion (Holcim) Concrete Tolling, Product = es322f335, Date Cast Between 01-Jan-09 And 31-Dec-09

Plant	Product	Slump	Wet	1 Day		3 Day		7 Day					28 Day				
		Avg.	No.	No.	Avg.	No.	Avg.	No.	Min.	Max.	Avg.	S.De	No.	Min.	Max.	Avg.	S.Dev
6601	ES322F335	70	0	0		0		1	20.5	20.5	20.5	0.00	1	34.0	34.0	34.0	0.00
6701	ES322F335	65	0	0		0		2	25.0	31.0	28.0	4.24	2	36.0	41.5	38.8	3.89
6706	ES322F335	70	0	0		0		1	25.0	25.0	25.0	0.00	1	34.0	34.0	34.0	0.00
6710	ES322F335	50	0	0		0		1	26.5	26.5	26.5	0.00	1	37.8	37.8	37.8	0.00

Plant	Density		MPa56		MPa91		Target	Pred	Fc	Diff Fc				Diff Target		
	Avg.	S.Dev.	No.	Avg.	No.	Avg.	Avg.	Avg.	Av	No.	Min.	Max	Avg.	Min.	Max.	Avg.
6601	2380	0.0	0		0				32	1	2.0	2.0	2.0			
6701	2340	0.0	0		0				32	2	4.0	9.5	6.8			
6706	2470	0.0	0		0		36.3	36.1	32	1	2.0	2.0	2.0	-2.3	-2.3	-2.3
6710	2390	0.0	0		0				32	1	5.8	5.8	5.8			

QESTLab by SpectraQEST.com.au - Form: VTR04 -

Page 1 of 1

APPENDIX G – JP RICHARDSON - ITP & QULAITY ASSURANCE

Form No. F1017/3

J. & P. RICHARDSON INDUSTRIES PTY LTD
114 Campbell Avenue, WACOL QLD 4076
Ph: (07) 3271 2911 - Fax: (07) 3271 3623
E-mail: jpr@jpr.com.au

TO QA SECTION OF FILE

SWITCHBOARD & SHEETMETAL INSPECTION REPORT

Customer Name: TENIX
Job No: M34100 S34100
Item: SP 087 SAINT ACHS ST SEWAGE PUMPING SWITCHBOARD
Drawing No: 486/5/7-0101 - 000 — 025

TASK	PRODUCT DETAIL	INSPECTED BY	DATE	PASS / FAIL	CORRECTIVE ACTION REQUEST OR COMMENTS
Design	Documents	BJ	7-5-09	✓	
Drafting	Documents				
Sheetmetal	Switchboard		26-5-09	P	
(Refer F1018 for details)	Doors				
	Cell/Panels				
Painting					
Process	Powder / Wet				
Min DFT (40 STD)					
Cure Test					
Colour Exterior	MIST GREEN		27/05/09	PASS	
Colour Internal					
Colour Panels	WHITE				
Cubicle Erection					
Electrical Fitout		MORANGO	9 Jun 09		
(In accordance with drawings)					
Inspection & Test		E Ensor	12/6/09	Pass	
(Refer to F1019)					
acking					

Comments:

PAINT PLINTH MIST GREEN DAN

All Reqs Are Done! 27/05/09

NOTE: - Manufacture is not to proceed to the next process until the item has passed inspection

Affix Status Here: -

Yellow	Awaiting Inspection
Green	Inspection & Test Passed
Red	Inspection & Test Failed, Awaiting Rectification

Form No. F1018/2

J. & P. RICHARDSON INDUSTRIES PTY. LTD.
114 Campbell Avenue, WACOL QLD 4076
Ph: (07) 3271 2911 - Fax: (07) 3271 3623
E-mail: jpr@jpr.com.au

SWITCHBOARD / SHEETMETAL INSPECTION CHECKLIST

CLIENT: TENIX

JOB NO: 534100

PRODUCT DESCRIPTION: SP087 SAINT ACHS ST. SEWAGE PUMPING SWITCHBOARD

DRAWING & SCHEDULE NUMBERS: 486/5/7-0101-000-025

CONSTRUCTION	QUALITY		COMPLIANCE WITH DRAWINGS		REMARKS OR ACTION
	GOOD	POOR	YES	NO	
1. Folds			✓		
2. Welds			✓		
3. Edges / File			✓		
4. Gauge			✓		
5. Material			✓		
6. Ventilation Openings / Filter Bracket			✓		
7. Equipment Mounting Arrangement			✓		
8. Doors Stiffened			✓		
9. Escutcheons and Lexan Covers			✓		
10. Cable Saddles			✓		
11. Grinding			✓		
12. Door Stays Fitted			✓		
13. Earth Studs			✓	✗	
14. Rubber Retainer				✓	
15. Drawing Holder			✓		
16. Hat Sections			✓		
17. Locking Bars Fitted			✓		
18. External Crevice Welded and Ground			✓		
19. Legend Cards			✓		
20. General Conditions Satisfactory			✓		
21. Cabinet Clean			✓		
22. Job Name and Number Marked			✓		

INSPECTED BY: JBel

DATE: 26-8-09

JB.

AFFIX STATUS HERE	Yellow	Awaiting Inspection
	Green	Inspected/Tested Passed
	Red	Inspected/Tested Awaiting Rectification

J. & P. RICHARDSON INDUSTRIES PTY LTD
114 Campbell Avenue, WACOL QLD 4076
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E-mail: jpr@jpr.com.au

Form No. F1019/8
Page 1 of 6

SWITCHBOARD ELECTRICAL INSPECTION & TEST REPORT

Customer Name:	Tenix		
Project:	Saint Achs St		
JPR Job No:	M 34100	Item:	Sewage Pump Station SP 087
Constructed by:	M Crawford	Tested by:	E Ercor Date: 12/[illegible]/09

Item Check list		To comply with Drawings, Documents & Specification					
Main Functional Unit/s	Qty	✓	Size	✓	Fuses/O/L		
Fuse Fittings	Qty	✓	Size	✓	Fuse Size	✓	
Circuit Breakers	Qty	✓	Size	✓	O/L		
Neutral	Reqd	✓	Size	✓	ID	✓	
Earthing	Checked	✓	Size	✓			
C.T.s	Qty		Rating				
Meters	Qty	✓	Rating	✓			
Contactors	Qty	✓	Rating	✓	Voltage	✓	
Overloads	Qty		Rating		Function		
Relays	Qty	✓	Rating	✓	Voltage	✓	
Timers	Qty	✓	Rating	✓	Voltage	✓	
Control Switches	Qty	✓	Rating	✓	Function	✓	
Push Buttons	Qty	✓	Rating	✓	Function	✓	
Pilot Lights	Qty		Rating		Voltage		
Transformers	Qty		Rating		Voltage		
ATT/VFD/Soft Starter	Qty	✓	Rating	✓	Function	✓	
DC Supply	Qty	✓	Rating	✓	Voltage	✓	
Terminals	Qty	✓	Size	✓	ID	✓	
Engraving	Qty	✓	Size	✓	ID	✓	
Cabling	Type	✓	Size	✓	ID	✓	
Busbars	Type		Size		ID		
Escutcheons / Shrouds	Type	✓	Material	✓	IP rating	✓	
S.A. Metering CTs	Qty		Rating				
S.A Metering Links	Type						
S.A. Meters	Type	✓	Size				
JPR Label	Fitted	✓	Stamped	✓	Safety Stkr	✓	
Legend Card	Qty	✓	Correct				
PLC/Telemetry	Qty	✓	Size	✓			
Power Monitor Relay	Qty		Rating		Function		
General Check List							
IP Sealing	Rating	✓					
Door Latches/Hinges	Qty	✓	Type	✓	Operation	✓	
Ventilation	Required	✓	Type	✓	Operation		
Circuit Schedule	Required		Fitted		Checked		
Terminal Tightness	Power	✓	Control	✓	Result	✓	
Busbar System	Clearances		Joints		ID		
Earth Continuity	Body to E	✓	Doors to E	✓	Panels to E	✓	
Cubicle Cleaned		✓					
Paint Finish Intact		✓					
Polarity Check	R - R	✓	W - W	✓	B - B	✓	
Function	Power	✓	Control	✓	PLC/Telem	✓	
Continuity Check	R - R	✓	W - W	✓	B - B	✓	N - N

Comments:

J. & P. RICHARDSON INDUSTRIES PTY LTD
114 Campbell Avenue, WACOL QLD 4076
Ph: (07) 3271 2911 - Fax: (07) 3271 3623
E-mail: jpr@jpr.com.au

Form No. F101W10
Page 6 of 6

SWITCHBOARD CONTINUITY & INSULATION TEST REPORT

Customer Name: Tenix			
Project: Saint Achs St			
JPR Job No: M 34100	**Switchboard:** Sewage Pump Station SP 087		
Constructed by: M Crawford	**Tested by:** E Ensor	**Date:** 12/6/09	

CONTINUITY TEST

From	To	Red	White	Blue	Neutral

Sketch:

INSULATION TESTS TO SECTION 8 OF AS3439.1

Designation	1000 V Test (MΩ)	2.5 kV Test (1min)	1000 V Test (MΩ)
Red to Earth	500		500
White to Earth	500		500
Blue to Earth	500		500
Neutral to Earth			
Red to White	500		500
Red to Blue	500		500
White to Blue	500		500
Comments:	Mains		Gen

Form No. F1019/8
Page 5 of 6

J. & P. RICHARDSON INDUSTRIES PTY LTD
114 Campbell Avenue, WACOL QLD 4076
Ph: (07) 3271 2911 - Fax: (07) 3271 3623
E-mail: jpr@jpr.com.au

SWITCHBOARD ELECTRICAL INSPECTION & TEST REPORT
EARTH LEAKAGE TEST

Customer Name: Tenix			
JPR Job No: M 34100	**Item:** Sewage Pump Station SP 087		
Constructed by: M Crawford	**Tested by:** E Ensor	**Date:** 12/6/09	
Test Unit	Megger RCDT330		**Other**

Circuit Breaker	Phase	Rated Current (mA)		Trip Current (mA)		Trip Time (mS)	Comments
	R	30		23		30.4	
Q11	W	30		25		30.2	
	B	30		23		25.8	
Q12		30		25		28.2	
Q13		30		25		28.7	
Q16		30		23		27.8	
Q19		30		23		28.3	
Q21		30		23		28.7	

Comments:-

J. & P. RICHARDSON INDUSTRIES PTY LTD
114 Campbell Avenue, WACOL QLD 4076
Ph: (07) 3271 2911 - Fax: (07) 3271 3623
E-mail: jpr@jpr.com.au

Form No. F1019/8
Page 3 of 6

SWITCHBOARD ELECTRICAL INSPECTION & TEST REPORT
VFD & SOFT STARTER SETUP

Customer Name:	Tenix				
Project:	Saint Achs St		Sewage Pump Station		
JPR Job No:	M 34100		**Item:** SP 087		**Drive:**
Constructed by:	M Crawford		**Tested by:** E Ensor		**Date:** 12/6/09
Drive Type:	Emotron MSF 2.0				
Drive Rating:	Softstarter				
Drive Setup Details:					

Parameter		***Setting***		***Function***
200		2		
210		415V		
211		6.7A		
212		3.1 kW		
221		on		PTC
270		1 - Pump 1	2 - Pump 2	Address
271				baudrate
272		1		
273		OFF		
315		sec		Start Time
320		1		Stop Method
325		sec		Stop Time
321		35%		
340		on		Bypass

All other parameters are default settings.

Comments:

FILE: EMC0381/BL 03/01/03 PAGE 1 OF 1

JOB SAFETY ANALYSIS

LIVE LOW VOLTAGE WORK

TESTING SWITCHBOARDS AND CONTROL PANELS WITHIN OUR MANUFACTURING PREMISES

APPROVED BY: Eric McCulloch (WHSO)

LOCATION: WACOL WORKSHOP **DATE:** 11./16./09

AUTHORISATIONS		PERSONAL PROTECTIVE EQUIPMENT	
• Authorisation from person in charge (Signature)	☑ YES	• Long cotton clothing • Insulating work gloves in test • Insulating mats / covers in test • Switchboard rescue kit in test	☑ YES ☑ YES ☑ YES ☑ YES

TASK		
LIVE LOW VOLTAGE WORK	• Isolation points identified and accessible	☑ YES
	• Work area clear of obstructions	☑ YES
	• Unauthorised access prevented to work area	☑ YES
	• P.P.E. is fit for purpose	☑ YES
	• Test equipment is fit for purpose	☑ YES
	• Written authority to proceed has been obtained from a person in charge	☑ YES
TESTING SWITCHBOARDS AND CONTROL PANELS WITHIN OUR MANUFACTURING PREMISES	• JPR authorisation to conduct live work is current	☑ YES
	• Approved dedicated power supply only used for testing.	☑ YES
	• Approved dedicated power supply in current test	☑ YES
OPTION	(A) RCD protected outputs used at power supply	☑ YES
	> RCD protection checked daily prior to use	☑ YES
	> Safety Observer ~~is~~ / is not required	☑ YES
OPTION	(B) Non RCD protected outputs used at power supply	☐ YES
	> Supervisor consulted prior to use	☐ YES
	> Safety Observer is in attendance	☐ YES

I understand and am fully aware of the requirements of this job safety analysis.

Signatures:	1. E W Luor	2.	3.	4.	5.

FILE: EMC0381/BL 03/01/03 PAGE 1 OF 1

JOB SAFETY ANALYSIS

LIVE LOW VOLTAGE WORK

TESTING SWITCHBOARDS AND CONTROL PANELS WITHIN OUR MANUFACTURING PREMISES

APPROVED BY: Eric McCulloch (WHSO)

LOCATION: WACOL WORKSHOP **DATE:** 12.1.61.99

AUTHORISATIONS		PERSONAL PROTECTIVE EQUIPMENT	
• Authorisation from person in charge (Signature)	☑ YES	• Long cotton clothing • Insulating work gloves in test • Insulating mats / covers in test • Switchboard rescue kit in test	☑ YES ☑ YES ☑ YES ☑ YES

TASK		
LIVE LOW VOLTAGE WORK	• Isolation points identified and accessible	☑ YES
	• Work area clear of obstructions	☑ YES
	• Unauthorised access prevented to work area	☑ YES
	• P.P.E. is fit for purpose	☑ YES
	• Test equipment is fit for purpose	☑ YES
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OPTION	(A) RCD protected outputs used at power supply	☑ YES
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OPTION	(B) Non RCD protected outputs used at power supply	☐ YES
	> Supervisor consulted prior to use	☐ YES
	> Safety Observer is in attendance	☐ YES

I understand and am fully aware of the requirements of this job safety analysis.

Signatures:	1. Ed Ensor	2.	3.	4.	5.

APPENDIX H – SUBMERSIBLE PUMP

ITT Water & Wastewater	PERFORMANCE CURVE	PRODUCT NS3102.181	TYPE LT
DATE 2010-04-15	PROJECT St Achs Pump Station - High Leve	CURVE NO 53-423-00-6501	ISSUE 5

	1/1-LOAD	3/4-LOAD	1/2-LOAD
POWER FACTOR	0.82	0.76	0.65
EFFICIENCY	84.0 %	84.5 %	83.5 %
MOTOR DATA	---	---	---

RATED POWER	3.1	kW
STARTING CURRENT	34	A
RATED CURRENT	6.3	A
RATED SPEED	1445	rpm
TOT.MOM.OF INERTIA	0.028	kgm2
NO. OF BLADES	2	

IMPELLER DIAMETER 158 mm

MOTOR #	STATOR	REV
18-11-4AL	67D	10

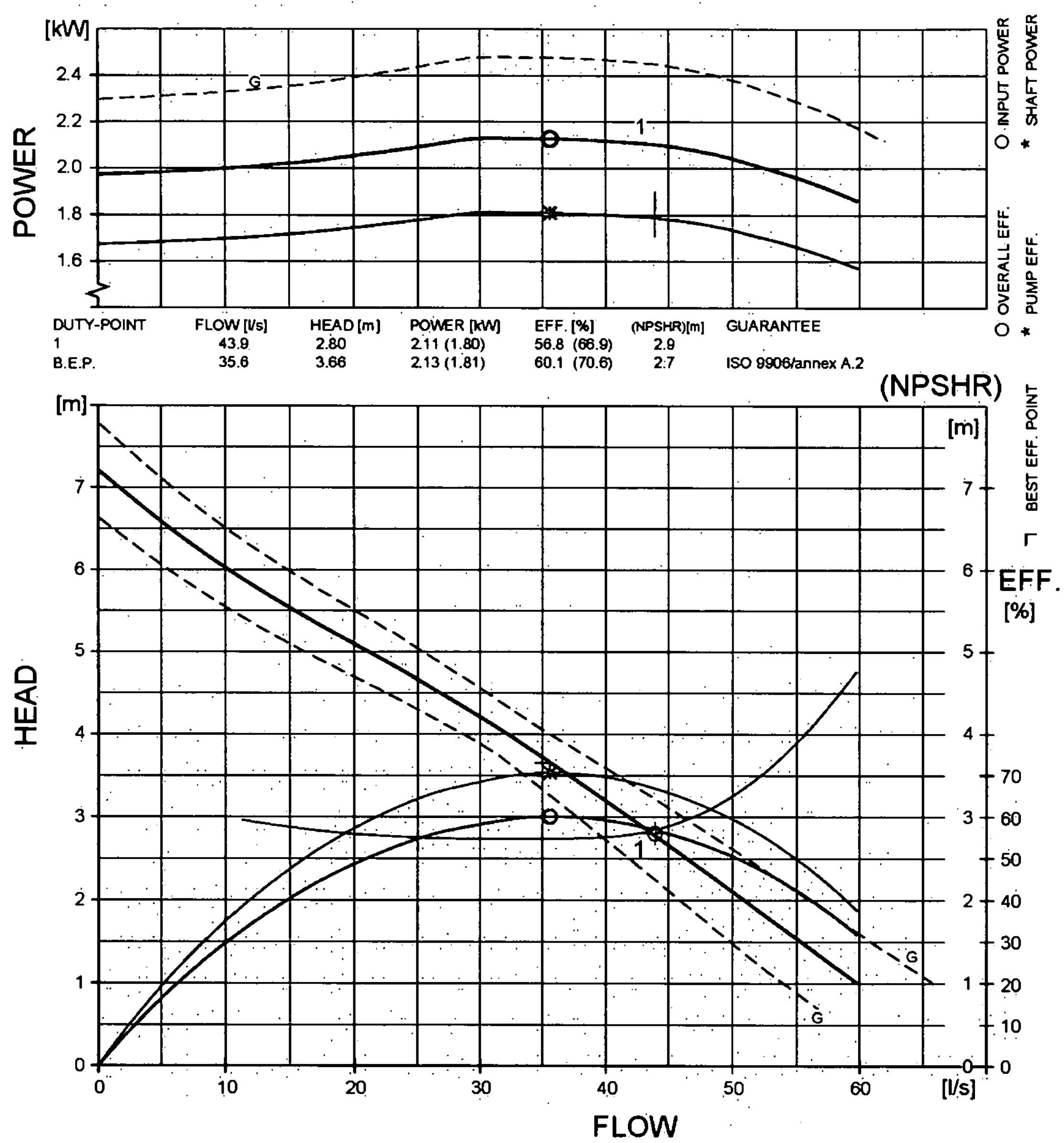
FREQ.	PHASES	VOLTAGE	POLES
50 Hz	3	415 V	4

GEARTYPE	RATIO
---	---

COMMENTS

INLET/OUTLET -/150 mm

IMP. THROUGHLET ---



DUTY-POINT	FLOW [l/s]	HEAD [m]	POWER [kW]	EFF. [%]	(NPSHR)[m]	GUARANTEE
1	43.9	2.80	2.11 (1.80)	56.8 (66.9)	2.9	
B.E.P.	35.6	3.66	2.13 (1.81)	60.1 (70.6)	2.7	ISO 9906/annex A.2

FLYPS3.1.6.5 (20090313)

(NPSHR) = (NPSH3) + margins

Performance with clear water and ambient temp 40 °C

GUARANTEE BETWEEN LIMITS (G) ACC. TO ISO 9906/annex A.2

ITT Water & Wastewater

PERFORMANCE CURVE

PRODUCT	TYPE
NS3102.181	LT

DATE	PROJECT	CURVE NO	ISSUE
2010-04-15	St Achs Pump Station - Low Level	53-423-00-6501	5

	1/1-LOAD	3/4-LOAD	1/2-LOAD
POWER FACTOR	0.82	0.76	0.65
EFFICIENCY	84.0 %	84.5 %	83.5 %
MOTOR DATA	---	---	---

RATED POWER	3.1	kW
STARTING CURRENT	34	A
RATED CURRENT	6.3	A
RATED SPEED	1445	rpm
TOT.MOM.OF INERTIA	0.028	kgm2
NO. OF BLADES	2	

IMPELLER DIAMETER 158 mm

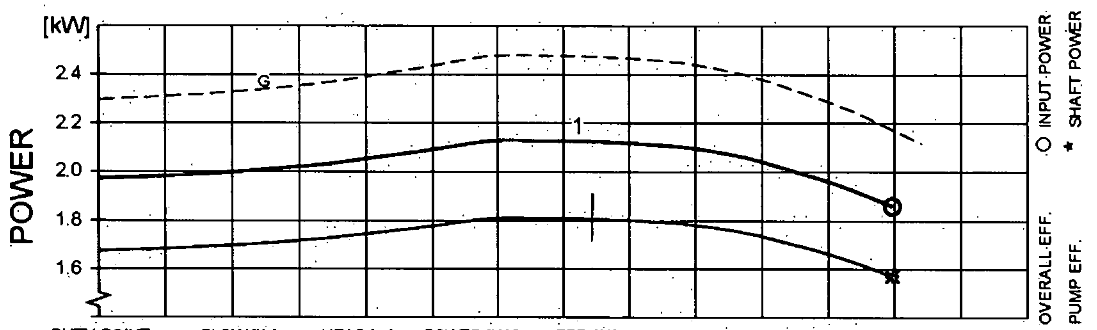
MOTOR #	STATOR	REV
18-11-4AL	67D	10

FREQ.	PHASES	VOLTAGE	POLES
50 Hz	3	415 V	4

GEARTYPE	RATIO
---	---

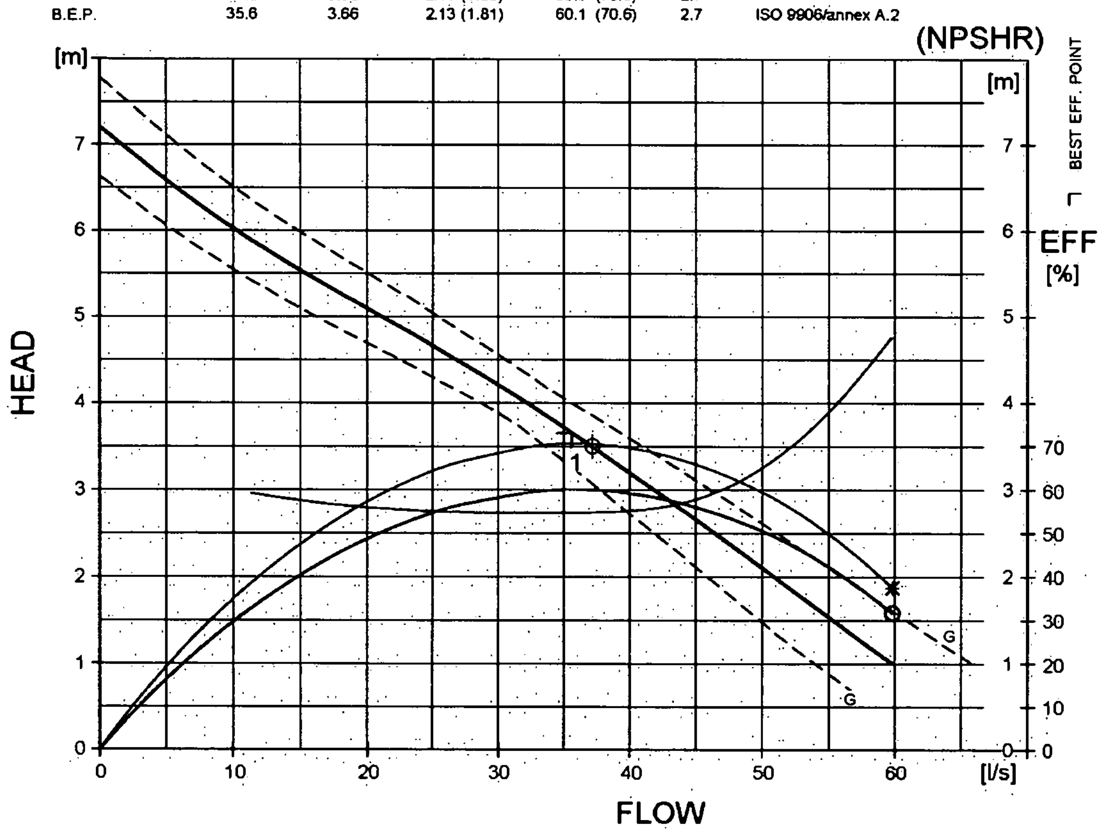
COMMENTS

INLET/OUTLET	IMP. THROUGHLET
-/150 mm	---



DUTY-POINT	FLOW [l/s]	HEAD [m]	POWER [kW]	EFF. [%]	(NPSHR)[m]	GUARANTEE
1	37.2	3.50	2.11 (1.80)	59.9 (70.5)	2.7	
B.E.P.	35.6	3.66	2.13 (1.81)	60.1 (70.6)	2.7	ISO 9906/annex A.2

O OVERALL EFF.
* PUMP EFF.



FLYPS3.1.6.5 (20090313)

(NPSHR) = (NPSH3) + margins

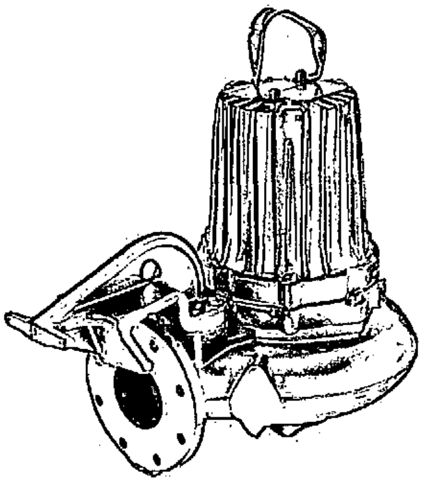
Performance with clear water and ambient temp 40 °C.

GUARANTEE BETWEEN LIMITS (G) ACC. TO

ISO 9906/annex A.2

Technical specification

Submersible pump N 3102, 50 Hz

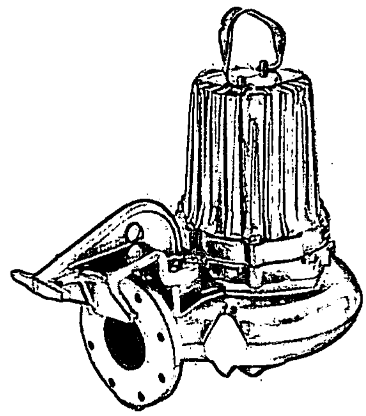


Flygt

ITT Industries

FLYGT

N 3102



N 3102

Product

Submersible pump for pumping clean water, surface water and waste water containing solids or long-fibred material.

Denomination

Product code	3102.181
	(High chromium) 3102.185
Installation	P, S, T, Z, L
Impeller characteristics	LT, MT, SH

Process data

Liquid temperature	max +40 °C
Depth of immersion	max 20 m
The pH of the pumped liquid	pH 5,5-14
Liquid density	max. 1100 kg/m^3

Motor data

Frequency	50 Hz
Insulation class	H (+180 °C)
Voltage variation	
- continuously running	max ± 5%
- intermittent running	max ± 10%
Voltage imbalance between phases	max 2%
No. of starts/hour	max 30

Cable

Direct-on-line start

SUBCAB®	4G2,5 mm^2
	4G2,5+2x1,5 mm^2

Y/D start

SUBCAB®	7G2,5 mm^2
	7G2,5+2x1,5 mm^2

Monitoring equipment

Thermal contacts opening temp.	125 °C

Material

Impeller (.181)	Cast iron
Impeller (.185)	High chromium cast iron
Pump housing	Cast iron
Stator housing	Cast iron
Shaft	Stainless steel
O-rings	Nitrile rubber

Mechanical face seals

Alternative	Inner seal	Outer seal
1	Aluminium oxide/ Corrosion resistant tungsten carbide	Aluminium oxide/ Corrosion resistant tungsten carbide
2	Aluminium oxide/ Corrosion resistant tungsten carbide	Corrosion resistant tungsten carbide/ Corrosion resistant tungsten carbide
3	Corrosion resistant tungsten carbide/ Corrosion resistant tungsten carbide	Aluminium oxide/ Corrosion resistant tungsten carbide
4	Corrosion resistant tungsten carbide/ Corrosion resistant tungsten carbide	Corrosion resistant tungsten carbide/ Corrosion resistant tungsten carbide

Surface Treatment

All cast parts are primed with a water-borne primer. The finishing coat is a high-solid two pack paint.

Weight

See dimensional drawing.

Option

3102.090	Ex. proof design
3102.095	(High chromium) Ex. proof design
Warm liquid version on request	
Leakage sensor in stator housing	FLS
Leakage sensor in oil housing	CLS
Surface treatment	Epoxy treatment
Other cables	
Zinc anodes	

Accessories

Discharge connections, adapters, hose connections and other mechanical accessories.

Electrical accessories such as pump controller, control panels, starters.

See separate booklet or www.flygt.com, for further information.

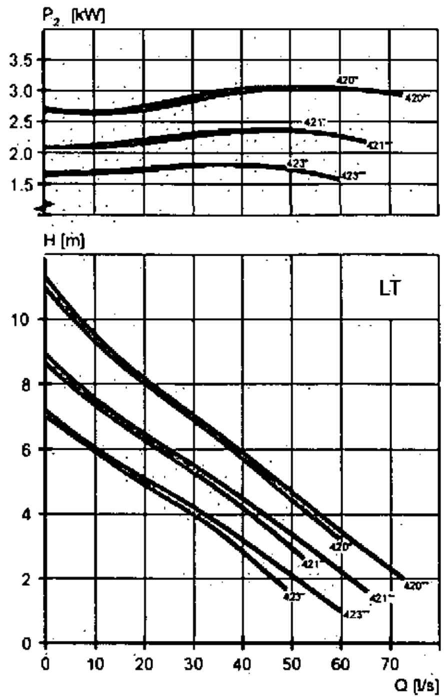
FLYGT **N 3102**

LT-Motor rating and performance curve

Curve/Impeller No	Rated power, kW	Rated current, A	Starting current, A	Power factor cos φ	Ex proof version available	Installation P	S	T	Z	L
400 V, 50 Hz, 3 ~, 1460 r/min										
421	2,4	5,7	40,0	0,71	•			•	•	
423[1]	2,4	5,7	40,0	0,71	•			•	•	
400 V, 50 Hz, 3 ~, 1450 r/min										
420	3,1	6,8	40,0	0,78	•	•	•			
421	3,1	6,8	40,0	0,78	•	•	•			•
423[1]	3,1	6,8	40,0	0,78	•	•	•			•

Y/D starting current is approximately 1/3 of D starting current

[1] *Only 181*



* *Pumphousing with outlet 100 mm*

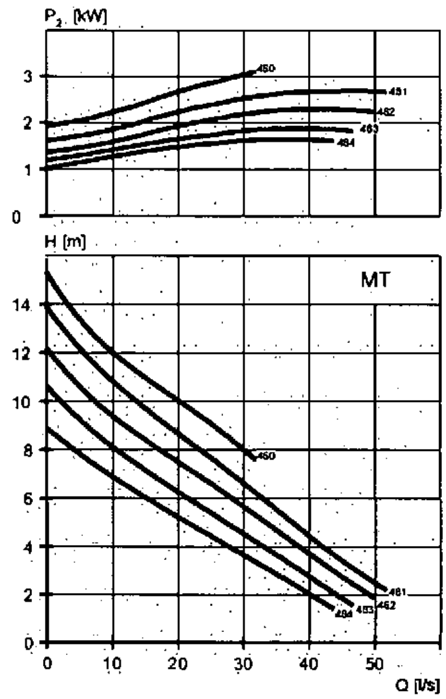
** *Pumphousing with outlet 150 mm*

MT-Motor rating and performance curve

Curve/Impeller No	Rated power, kW	Rated current, A	Starting current, A	Power factor cos φ	Ex proof version available	Installation P	S	T	Z	
400 V, 50 Hz, 3 ~, 1460 r/min										
462[1]	2,4	5,7	40,0	0,71	•			•	•	
463	2,4	5,7	40,0	0,71	•			•	•	
464[1]	2,4	5,7	40,0	0,71	•			•	•	
400 V, 50 Hz, 3 ~, 1450 r/min										
460[1]	3,1	6,8	40,0	0,78	•	•	•			
461	3,1	6,8	40,0	0,78	•	•	•			
462[1]	3,1	6,8	40,0	0,78	•	•	•			
463	3,1	6,8	40,0	0,78	•	•	•			
464[1]	3,1	6,8	40,0	0,78	•	•	•			

Y/D starting current is approximately 1/3 of D starting current

[1] *Only 181*



4

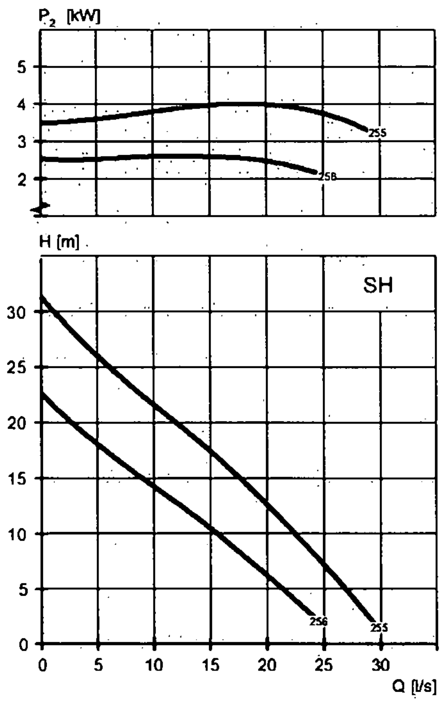
FLYGT

N 3102

SH-Motor rating and performance curve

Curve/Impeller No.	Rated power, kW	Rated current, A	Starting current, A	Power factor cos φ	Ex-proof version available	Installation				
						P	S	T	Z	
400 V, 50 Hz, 3 ~, 2850 r/min, 2 poles										
255	4.2	8.2	52	0,94	•	•	•	•	•	
256	4.2	8.2	52	0,94	•	•	•	•	•	

Y/D starting current is approximately 1/3 of D starting current.



5

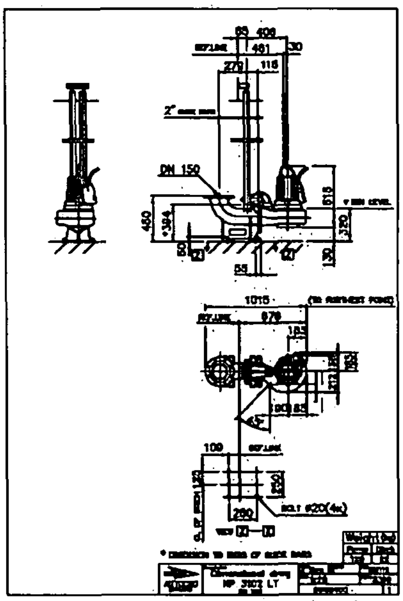
FLYGT **N 3102**

Dimensional drawing

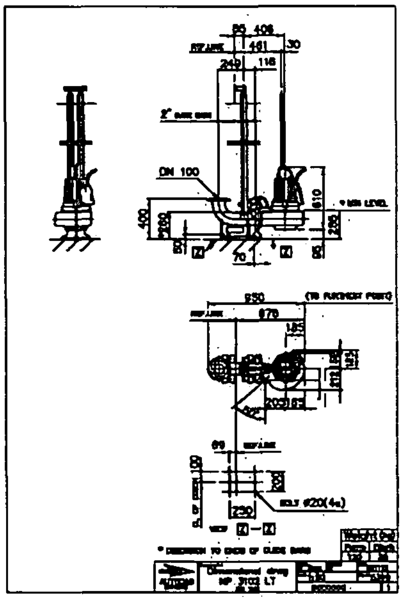
All drawings are available as Acrobat documents (.pdf) and AutoCad drawings (.dwg). Download the drawings from www.flygt.com or contact your ITT Flygt representative for more information.

All dimensions are in mm.

LT, P-installation



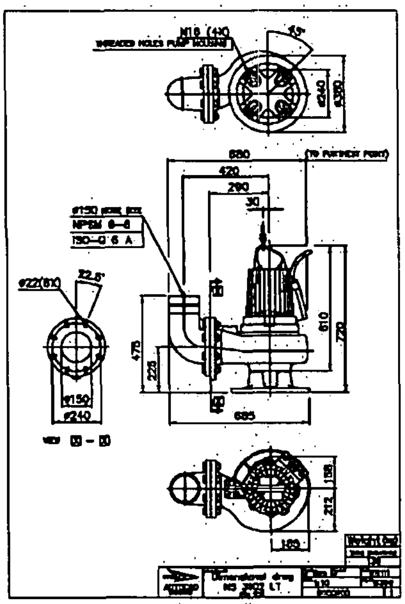
LT, P-installation



FLYGT

N 3102

LT, S-installation



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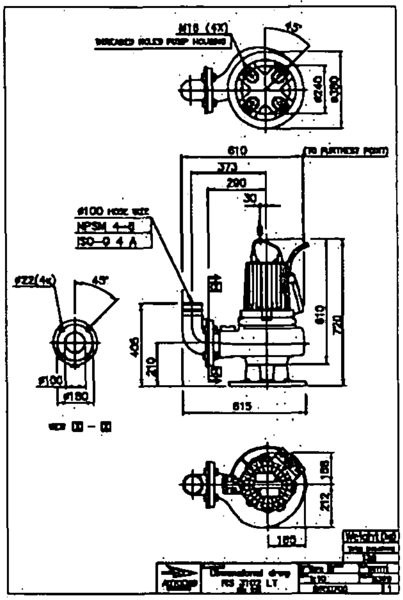

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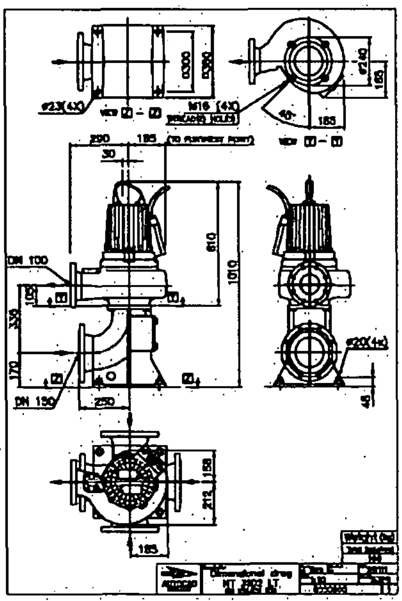
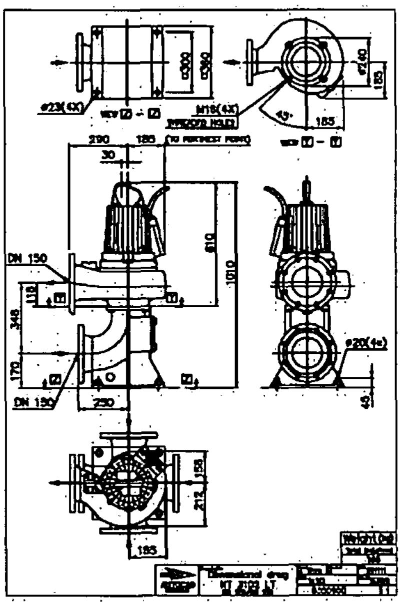


LT, T-installation

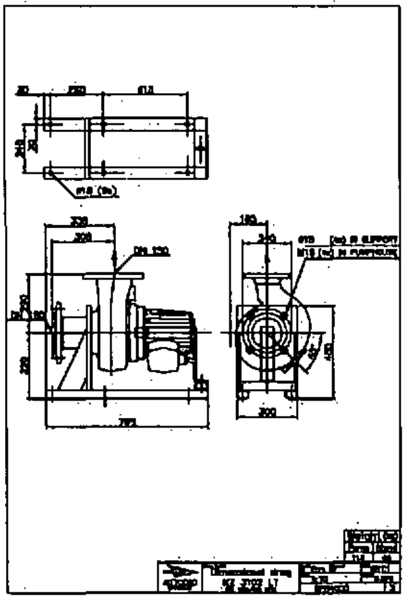


7

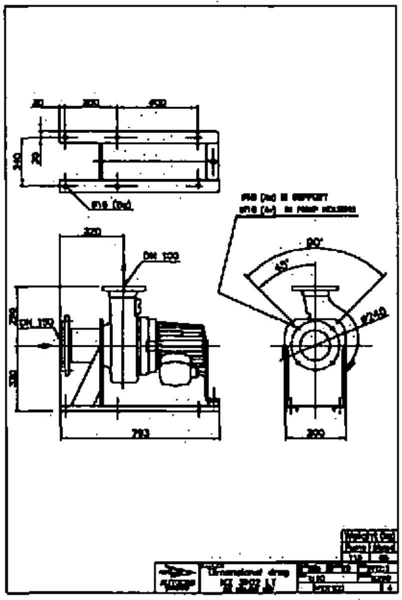
FLYGT

N 3102

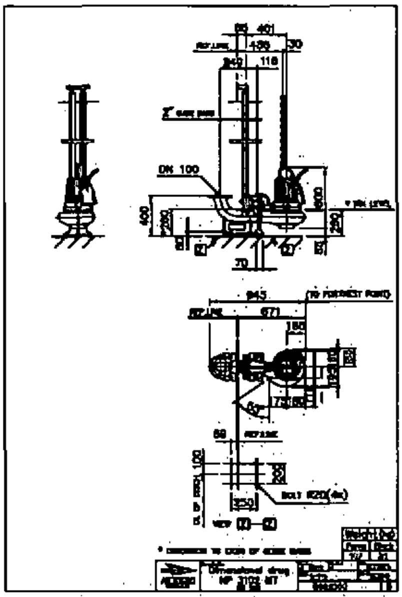
LT, Z-installation



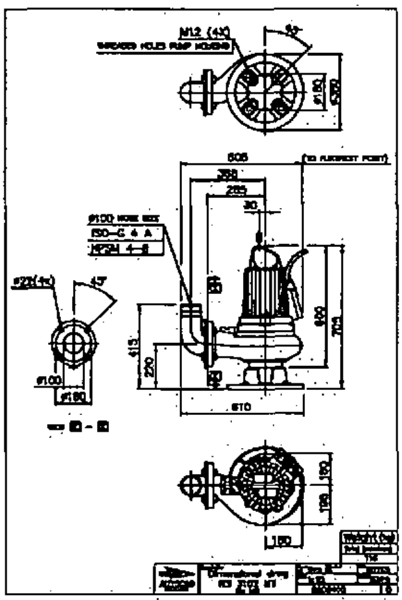
LT, Z-installation



MT, P-installation

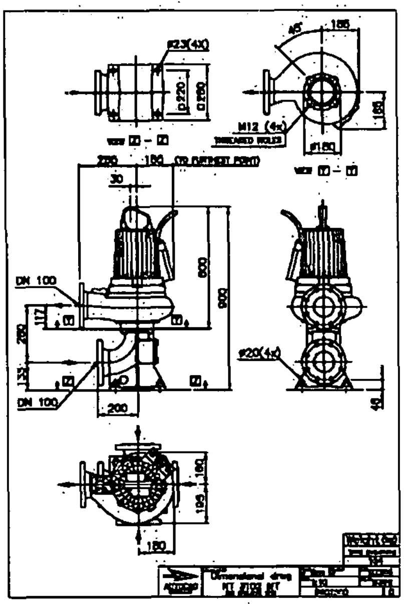


MT, S-installation

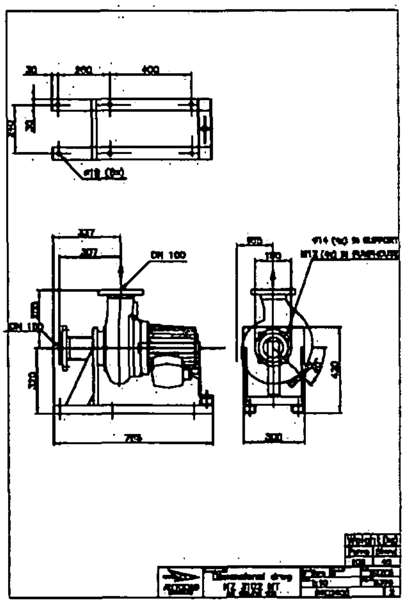


FLYGT **N 3102**

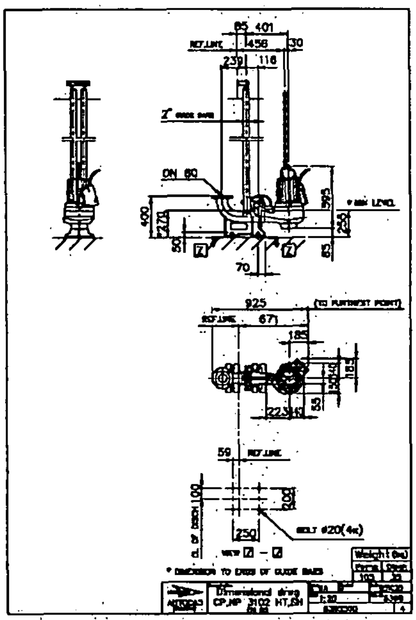
MT, T-installation



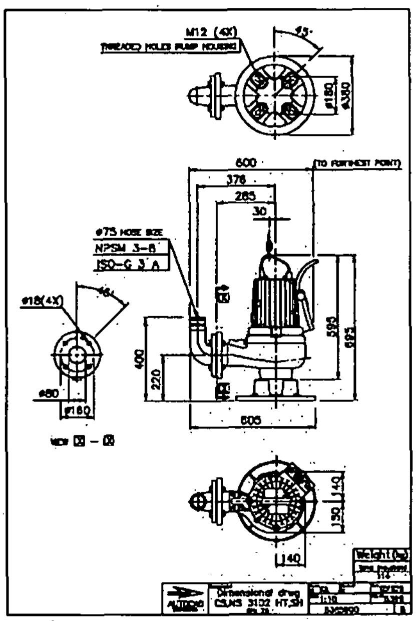
MT, Z-installation



HT- SH, P-installation



HT- SH, S-installation

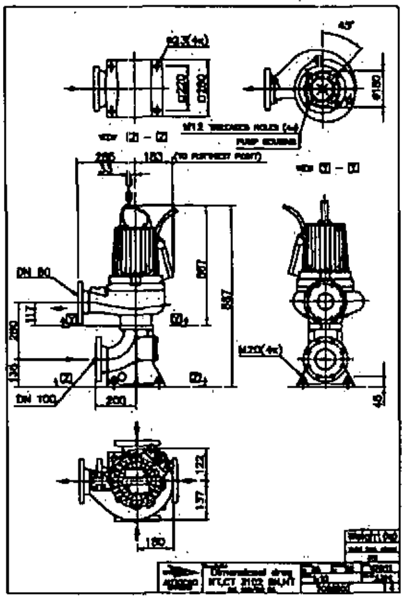


9

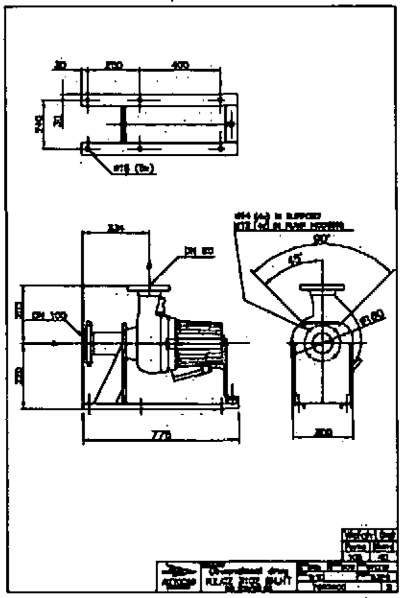
FLYGT

N 3102

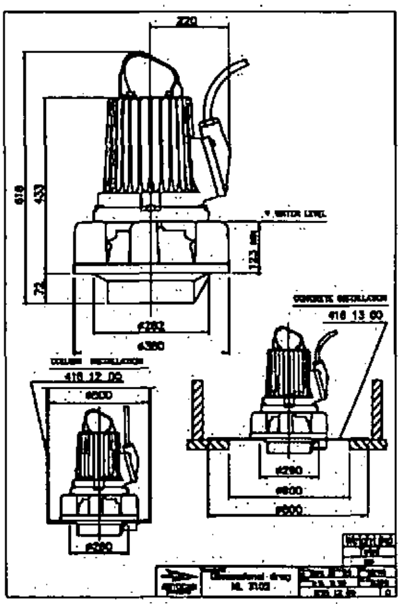
HT-SH, T-installation



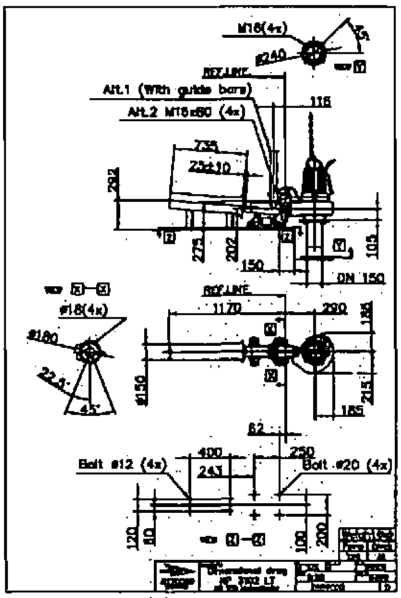
HT-SH, Z-installation



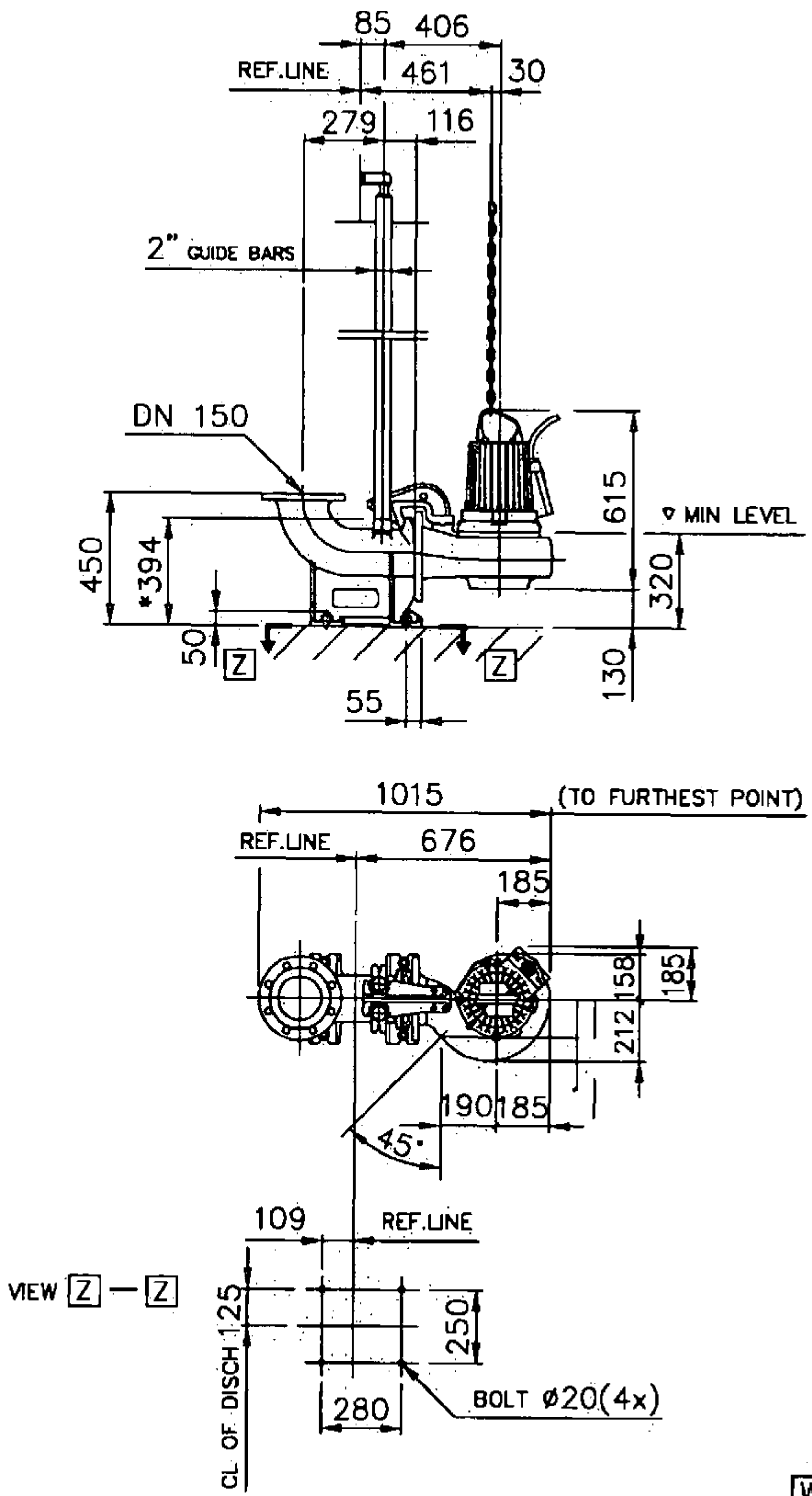
L-installation



LT, P-installation

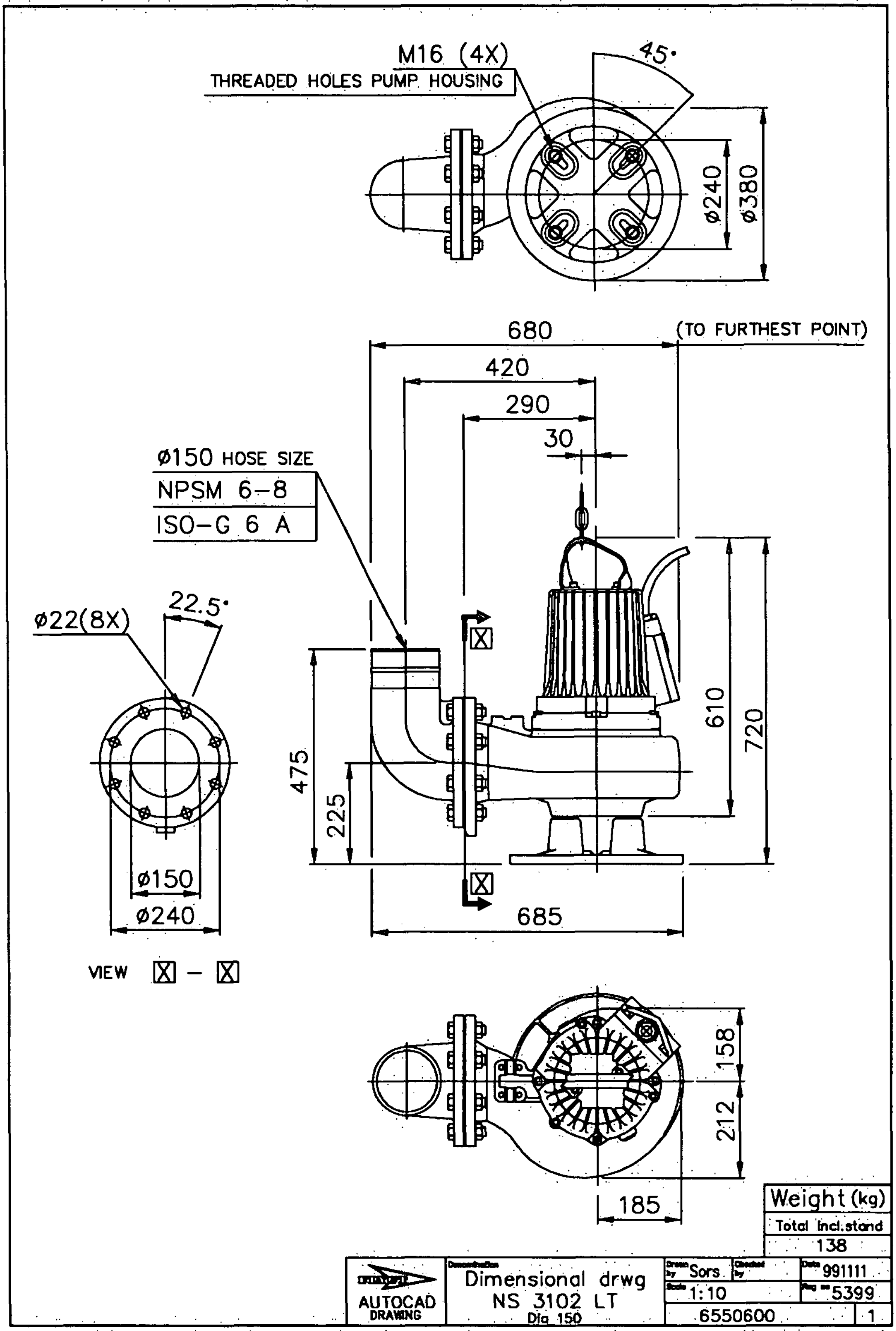


www.flygt.com



Weight (kg)	
Pump	Disch
120	52

AUTOCAD DRAWING	Dimensional drwg NP 3102 LT DN 150	NK	080813
		1:20	5399
		6550400	3


M16 (4X)
THREADED HOLES PUMP HOUSING
45°
Ø240
Ø380
680
(TO FURTHEST POINT)
420
290
30
Ø150 HOSE SIZE
NPSM 6-8
ISO-G 6 A
Ø22(8X)
22.5°
475
225
610
720
685
Ø150
Ø240
VIEW X – X
158
212
185
Weight (kg)
Total incl.stand
138
AUTOCAD DRAWING
Dimensional drwg
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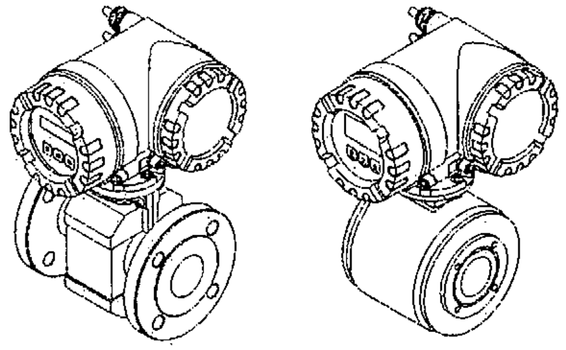
APPENDIX I – ELECTROMAGNETIC FLOWMETER

Level Pressure Flow Temperature Liquid Analysis Registration Systems Components Services Solutions

Brief Operating Instructions

Proline Promag 50

Electromagnetic Flow Measuring System



These Brief Operating Instructions are **not** intended to replace the Operating Instructions provided in the scope of supply.
Detailed information is provided in the Operating Instructions and the additional documentation on the CD-ROM supplied.

The complete device documentation consists of:

- These Brief Operating Instructions
- Depending on the device version:
  - Operating Instructions and the Description of Device Functions
  - Approvals and safety certificates
  - Special safety instructions in accordance with the approvals for the device (e.g. explosion protection, pressure equipment directive etc.)
  - Additional device-specific information

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Endress+Hauser
People for Process Automation

Table of contents

1 Safety instructions

1.1 Designated use

- The measuring device is to be used only for measuring the flow of conductive liquids in closed pipes. A minimum conductivity of 20 μS/cm is required for measuring demineralized water. Most liquids can be measured as of a minimum conductivity of 5 μS/cm.
- Any use other than that described here compromises the safety of persons and the entire measuring system and is, therefore, not permitted.
- The manufacturer is not liable for damage caused by improper or non-designated use.

1.2 Installation, commissioning and operation

- The measuring device must only be installed, connected, commissioned and maintained by qualified and authorized specialists (e.g. electrical technicians) in full compliance with the instructions in these Brief Operating Instructions, the applicable norms, legal regulations and certificates (depending on the application).
- The specialists must have read and understood these Brief Operating Instructions and must follow the instructions they contain. If you are unclear on anything in these Brief Operating Instructions, you must read the Operating Instructions (on the CD-ROM). The Operating Instructions provide detailed information on the measuring device.
- The measuring device should only installed in a de-energized state free from outside loads or strain.
- The measuring device may only be modified if such work is expressly permitted in the Operating Instructions (on the CD-ROM).
- Repairs may only be performed if a genuine spare parts kit is available and this repair work is expressly permitted.
- If performing welding work on the piping, the welding unit may not be grounded by means of the measuring device.

1.3 Operational safety

- The measuring device is designed to meet state-of-the-art safety requirements, has been tested, and left the factory in a condition in which it is safe to operate. Relevant regulations and European standards have been observed.
- Observe the technical data on the nameplate!
- The technical staff must ensure that the measuring device has been correctly wired and grounded as per the wiring diagrams.
- With regard to special fluids, including fluids used for cleaning, Endress+Hauser will be happy to assist in clarifying the corrosion-resistant properties of wetted materials.
  However, minor changes in temperature, concentration or in the degree of contamination in the process may result in variations in corrosion resistance.

For this reason, Endress+Hauser does not accept any responsibility with regard to the corrosion resistance of wetted materials in a specific application. The user is responsible for the choice of suitable wetted materials in the process. A sensor version which allows the sensor housing be monitored should be used for critical fluids.

- Hazardous areas
  Measuring devices for use in hazardous areas are labeled accordingly on the nameplate. Relevant national regulations must be observed when operating the device in hazardous areas. The Ex documentation on the CD-ROM is an integral part of the entire device documentation. The installation regulations, connection data and safety instructions provided in the Ex documentation must be observed. The symbol and name on the front page provides information on the approval and certification (e.g. ⓔ Europe, ◈ USA, ⓒ Canada). The nameplate also bears the documentation number of this Ex documentation (XA***D/../..).
- For measuring systems used in SIL 2 applications, the separate manual on functional safety (on the CD-ROM) must be observed.
- Hygienic applications
  Measuring devices for hygienic applications have their own special labeling. Relevant national regulations must be observed when using these devices.
- Pressure instruments
  Measuring devices for use in systems that need to be monitored are labeled accordingly on the nameplate. Relevant national regulations must be observed when using these devices. The documentation on the CD-ROM for pressure instruments in systems that need to be monitored is an integral part of the entire device documentation. The installation regulations, connection data and safety instructions provided in the Ex documentation must be observed.
- Endress+Hauser will be happy to assist in clarifying any questions on approvals, their application and implementation.

1.4 Safety conventions

⚠ Warning!
"Warning" indicates an action or procedure which, if not performed correctly, can result in injury or a safety hazard. Comply strictly with the instructions and proceed with care.

Caution!
"Caution" indicates an action or procedure which, if not performed correctly, can result in incorrect operation or destruction of the device. Comply strictly with the instructions.

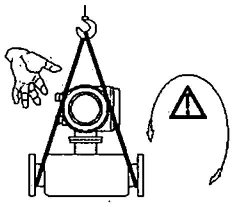
Note!
"Note" indicates an action or procedure which, if not performed correctly, can have an indirect effect on operation or trigger an unexpected response on the part of the device.

2 Installation

2.1 Transporting to the measuring point

- Transport the measuring device to the measuring point in the original packaging.
- Do not remove the covers or caps until immediately before installation.

2.1.1 Transporting flanged devices DN ≤ 300 (≤ 12")



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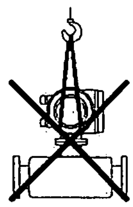
To transport the unit, use slings slung around the process connections or use lugs (if available).

⚠ Warning!
Risk of injury! The device can slip.
The center of gravity of the measuring device may be higher than the holding points of the slings.
Always ensure that the device cannot slip or turn around its axis.



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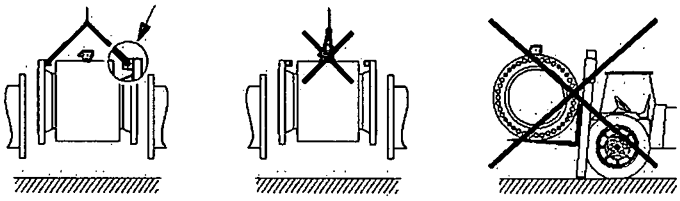
Do not lift measuring devices by the transmitter housing or the connection housing in the case of the remote version. Do not use chains as they could damage the housing.

2.1.2 Transporting flanged devices DN > 300 (> 12")

Use only the metal eyes provided on the flanges to transport, lift or position the sensor in the piping.

Caution!
Do not attempt to lift the sensor with the tines of a fork-lift truck beneath the metal casing! This would buckle the casing and damage the internal magnetic coils.



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2.2 Installation conditions

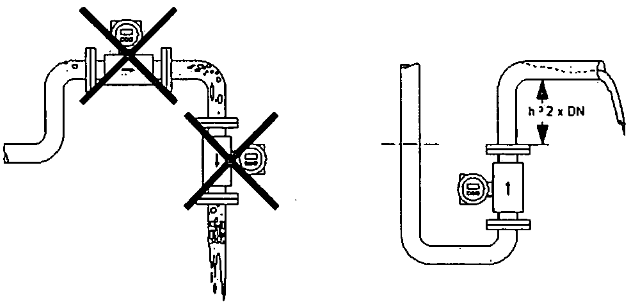
2.2.1 Dimensions

For the dimensions of the measuring device, see the associated Technical Information on the CD-ROM.

2.2.2 Mounting location

The accumulation of air or formation of gas bubbles in the measuring tube can result in an increase in measuring errors.
For this reason **avoid** the following mounting locations in the pipe:

- At the highest point of a pipeline. Risk of air accumulating!
- Directly upstream from a free pipe outlet in a down pipe.



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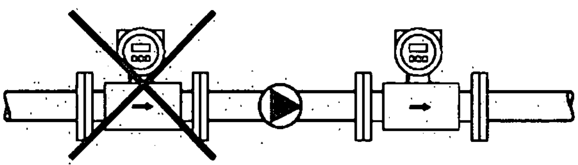
Installation of pumps

Do not install the sensor on the intake side of a pump. This precaution is to avoid low pressure and the consequent risk of damage to the lining of the measuring tube. It might be necessary to use pulse dampers in systems incorporating piston pumps, piston diaphragm pumps or peristaltic pumps.

Information on the measuring system's pressure tightness and resistance to vibration and shock can be found in the Operating Instructions of the CD-ROM.



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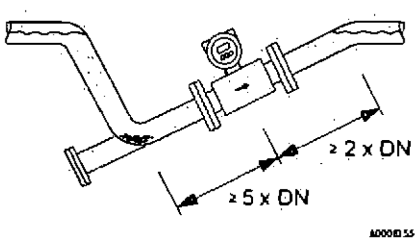
Partially filled pipes

Partially filled pipes with gradients necessitate a drain-type configuration.
The empty pipe detection (EPD) function offers additional protection by detecting empty or partially filled pipes.

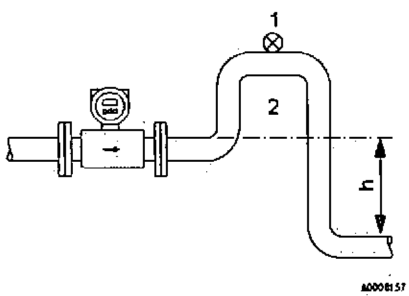
Caution!
Risk of solids accumulating! Do not install the sensor at the lowest point in the drain. It is advisable to install a cleaning valve.



Installation in a partially filled pipe

Down pipes

Install a siphon or a vent valve downstream of the sensor in down pipes longer than 5 meters (16 ft). This precaution is to avoid low pressure and the consequent risk of damage to the lining of the measuring tube. This measure also prevents the system losing prime, which could cause air pockets.
For information on the pressure tightness of the measuring tube lining, see the Operating Instructions on the CD-ROM.



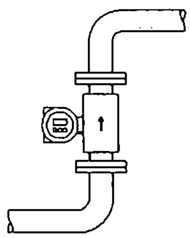
Measures for installation in a down pipe (h > 5 m/16 ft)
1. Vent valve
2. Siphon

2.2.3 Orientation

An optimum orientation helps avoid gas and air accumulations and buildup in the measuring tube. The measuring device, nevertheless, supplies a range of functions and tools to measure problematic fluids correctly:

- Electrode cleaning circuitry (ECC) to prevent electrically conductive deposits in the measuring tube, e.g. for fluids causing buildup
- Empty pipe detection (EPD) for detecting partially filled measuring tubes, e.g. in the case of degassing fluids or varying process pressures
- Exchangeable measuring electrodes for abrasive fluids (only Promag W)

Vertical orientation



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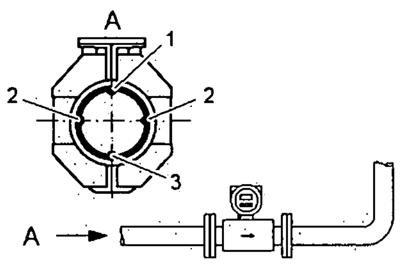
This orientation is optimum for self-emptying piping systems and when using empty pipe detection (EPD) or open electrode detection (OED).

Horizontal orientation

The measuring electrode plane should be horizontal. This prevents brief insulation of the two electrodes by entrained air bubbles.

Caution!
In the case of horizontal orientation, empty pipe detection only works correctly if the transmitter housing is facing upwards. Otherwise there is no guarantee that empty pipe detection will respond if the measuring tube is only partially filled or empty.



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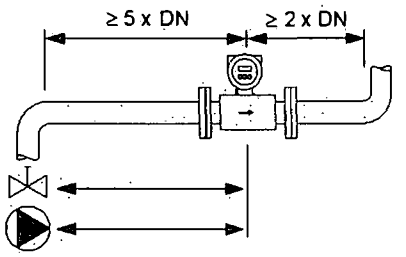
1. EPD electrode for empty pipe detection (not for Promag H, DN 2 to 8, 1/12" to 5/16").
2. Measuring electrodes for signal detection
3. Reference electrode for potential equalization (not for Promag H)

Inlet and outlet runs

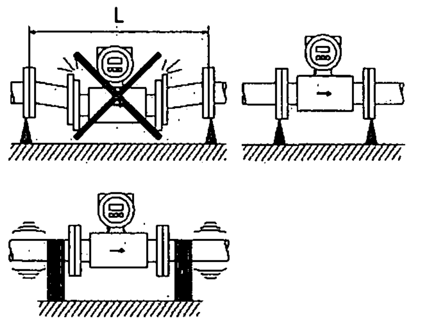
If possible, install the sensor upstream from fittings such as valves, T-pieces, elbows, etc.



The following inlet and outlet runs must be observed in order to meet accuracy specifications:
- Inlet run: ≥ 5 x DN
- Outlet run: ≥ 2 x DN

2.2.4 Vibrations

Secure and fix both the piping and the sensor if vibrations are severe.



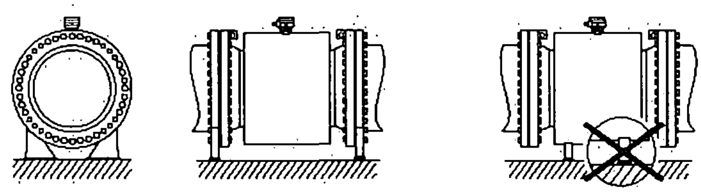
Measures to prevent device vibration
(L > 10 m/33 ft)

Caution!
It is advisable to install the sensor and transmitter separately if vibration is excessively severe. For information on the permitted shock and vibration resistance, see the Operating Instructions on the CD-ROM.

2.2.5 Foundations, supports

If the nominal diameter is DN ≥ 350 (≥ 14"), mount the sensor on a foundation of adequate load-bearing strength.

Caution!
Risk of damage! Do not support the weight of the sensor on the metal casing.
This would buckle the casing and damage the internal magnetic coils.



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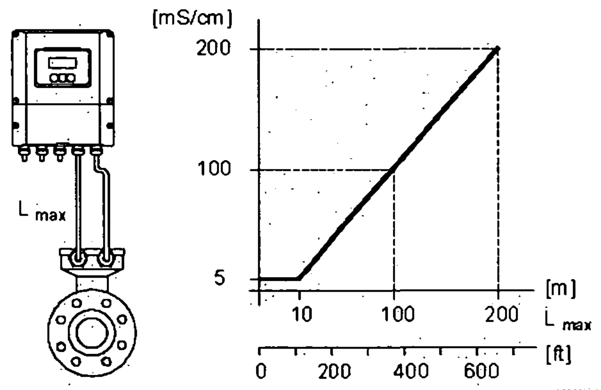
2.2.6 Length of connecting cable

Comply with the following instructions in order to ensure correct measuring results:

- Secure the cable run or route the cable in an armored conduit. Movement of the cable can falsify the measuring signal, particularly if the fluid conductivity is low.
- Route the cable well clear of electrical machines and switching elements.
- Ensure potential equalization between the sensor and transmitter, if necessary.
- The permissible cable length L_{max} depends on the fluid conductivity.



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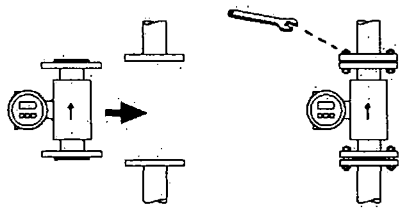
Gray shaded area = permissible range

L_{max} = length of connecting cable in [m]/[ft]

Fluid conductivity in [µS/cm]

2.3 Installing the Promag W sensor



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Note!
Screws, nuts, seals, etc. are not included in the scope of supply and must be supplied by the customer.

The sensor is installed between the two pipe flanges:
- The requisite torques must be observed → Page 14 ff.
- Information on the installation of additional ground disks → Page 11

2.3.1 Seals

Comply with the following instructions when installing seals:
- Hard rubber lining → additional seals are **always** required!
- Polyurethane lining → additional seals are recommended.
- For DIN flanges, only use seals to DIN EN 1514-1.
- Make sure that the mounted seals do not protrude into the piping cross-section.

Caution!
Risk of short circuit!
Do not use electrically conductive sealing compounds such as graphite! An electrically conductive layer could form on the inside of the measuring tube and short-circuit the measuring signal.

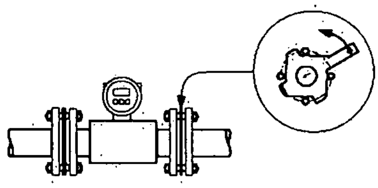
2.3.2 Ground cable (DN 25 to 2000, 1" to 78")

If necessary, special ground cables can be ordered as accessories for potential equalization.

2.3.3 Mounting ground disks (DN 25 to 300, 1" to 12")

Depending on the application conditions, e.g. in the case of lined or floating pipes, it may be necessary to also mount ground disks between the sensor and the pipe flange for potential equalization. Ground disks can be ordered from Endress+Hauser as a separate accessory.

Caution!
- When using ground disks (incl. seals), the face-to-face length is increased! For information on the dimensions, see the associated Technical Information on the CD-ROM.
- Hard rubber lining → additional seals must be mounted both between the sensor and ground disk as well as between the ground disk and pipe flange.
- Polyurethane lining → additional seals must be mounted between the ground disk and pipe flange.



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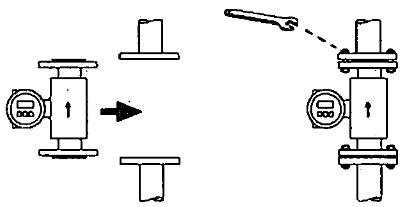
1. Place the ground disk and the additional seals between the measuring device flange and pipe flange (see graphic).
2. Insert the screws through the flange bores. Tighten the nuts so that they are still loose.
3. Now rotate the ground disk as shown in the graphic until the handle strikes the screws. This correctly centers the ground disk automatically.
4. Tighten the screws to the required torque → Page 14
5. Wire the ground disks in accordance with the grounding concept of the plant.

2.4 Installing the Promag P sensor

Caution!

- The plates mounted on the two sensor flanges protect the PTFE which is turned over the flanges and, consequently, should not be removed until immediately prior to mounting the sensor.
- The protective plates must always remain mounted while the device is in storage.
- Make sure that the lining at the flange is not damaged or removed.



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Note!

Screws, nuts, seals, etc. are not included in the scope of supply and must be supplied by the customer.

The sensor is installed between the two pipe flanges:

- The requisite torques must be observed → Page 14 ff.
- Information on the installation of additional ground disks → Page 13

2.4.1 Seals

Comply with the following instructions when installing seals:
- No seals are required for PFA or PFTE measuring tube lining.
- For DIN flanges, only use seals to DIN EN 1514-1.
- Make sure that the mounted seals do not protrude into the piping cross-section.

Caution!
Risk of short circuit! Do not use electrically conductive sealing compounds such as graphite! An electrically conductive layer could form on the inside of the measuring tube and short-circuit the measuring signal.

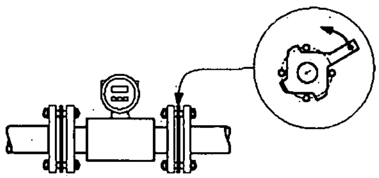
2.4.2 Ground cable (DN 15 to 600, ½" to 24")

If necessary, special ground cables can be ordered as accessories for potential equalization.

2.4.3 Mounting ground disks (DN 15 to 300, ½" to 12")

Depending on the application conditions, e.g. in the case of lined or floating pipes, it may be necessary to also mount ground disks between the sensor and the pipe flange for potential equalization. Ground disks can be ordered from Endress+Hauser as a separate accessory.

Caution!
- When using ground disks (incl. seals), the face-to-face length is increased! For information on the dimensions, see the associated Technical Information on the CD-ROM.
- PTFE and PFA lining → additional seals must be mounted between the ground disk and pipe flange.



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1. Place the ground disk and the additional seal(s) between the device flange and the pipe flange.
2. Insert the screws through the flange bores. Tighten the nuts so that they are still loose.
3. Now rotate the ground disk as shown in the graphic until the handle strikes the screws. This correctly centers the ground disk automatically.
4. Tighten the screws to the required torque → Page 14
5. Wire the ground disks in accordance with the grounding concept of the plant.

2.5 Tightening torques for Promag W and Promag P

- The tightening torques listed below are for lubricated threads only.
- Always tighten the screws uniformly and in diagonally opposite sequence.
- Overtightening the screws will deform the sealing faces or damage the seals.
- The values listed below apply only to pipes not subjected to tensile stress.

2.5.1 Tightening torques for pressure ratings in accordance with EN (DIN)

Nominal diameter [mm]	EN (DIN) Pressure rating [bar]	Screws	Max. tightening torque [Nm] Promag W Hard rubber	Promag W Polyurethane	Promag P PTFE	Promag P PFA
15	PN 40	4 x M 12	–	–	11	–
25	PN 40	4 x M 12	–	15	26	20
32	PN 40	4 x M 16	–	24	41	35
40	PN 40	4 x M 16	–	31	52	47
50	PN 40	4 x M 16	–	40	65	59
65 *	PN 16	8 x M 16	32	27	43	40
65	PN 40	8 x M 16	32	27	43	40
80	PN 16	8 x M 16	40	34	53	48
80	PN 40	8 x M 16	40	34	53	48
100	PN 16	8 x M 16	43	36	57	51
100	PN 40	8 x M 20	59	50	78	70
125	PN 16	8 x M 16	56	48	75	67
125	PN 40	8 x M 24	83	71	111	99
150	PN 16	8 x M 20	74	63	99	85
150	PN 40	8 x M 24	104	88	136	120
200	PN 10	8 x M 20	106	91	141	101
200	PN 16	12 x M 20	70	61	94	67
200	PN 25	12 x M 24	104	92	138	105
250	PN 10	12 x M 20	82	71	110	–
250	PN 16	12 x M 24	98	85	131	–
250	PN 25	12 x M 27	150	134	200	–
300	PN 10	12 x M 20	94	81	125	–
300	PN 16	12 x M 24	134	118	179	–
300	PN 25	16 x M 27	153	138	204	–
350	PN 10	16 x M 20	112	118	188	–
350	PN 16	16 x M 24	152	165	254	–
350	PN 25	16 x M 30	227	252	380	–
400	PN 10	16 x M 24	151	167	260	–
400	PN 16	16 x M 27	193	215	330	–
400	PN 25	16 x M 33	289	326	488	–

Nominal diameter	EN (DIN) Pressure rating	Screws	Max. tightening torque [Nm]			
			Promag W		Promag P	
[mm]	[bar]		Hard rubber	Polyurethane	PTFE	PFA
450	PN 10	20 x M 24	153	133	235	–
450	PN 16	20 x M 27	198	196	300	–
450	PN 25	20 x M 33	256	253	385	–
500	PN 10	20 x M 24	155	171	265	–
500	PN 16	20 x M 30	275	300	448	–
500	PN 25	20 x M 33	317	360	533	–
600	PN 10	20 x M 27	206	219	345	–
600 *	PN 16	20 x M 33	415	443	658	–
600	PN 25	20 x M 36	431	516	731	–
700	PN 10	24 x M 27	246	246	–	–
700	PN 16	24 x M 33	278	318	–	–
700	PN 25	24 x M 39	449	507	–	–
800	PN 10	24 x M 30	331	316	–	–
800	PN 16	24 x M 36	369	385	–	–
800	PN 25	24 x M 45	664	721	–	–
900	PN 10	28 x M 30	316	307	–	–
900	PN 16	28 x M 36	353	398	–	–
900	PN 25	28 x M 45	690	716	–	–
1000	PN 10	28 x M 33	402	405	–	–
1000	PN 16	28 x M 39	502	518	–	–
1000	PN 25	28 x M 52	970	971	–	–
1200	PN 6	32 x M 30	319	299	–	–
1200	PN 10	32 x M 36	564	568	–	–
1200	PN 16	32 x M 45	701	753	–	–
1400	PN 6	36 x M 33	430	398	–	–
1400	PN 10	36 x M 39	654	618	–	–
1400	PN 16	36 x M 45	729	762	–	–
1600	PN 6	40 x M 33	440	417	–	–
1600	PN 10	40 x M 45	946	893	–	–
1600	PN 16	40 x M 52	1007	1100	–	–
1800	PN 6	44 x M 36	547	521	–	–
1800	PN 10	44 x M 45	961	895	–	–
1800	PN 16	44 x M 52	1108	1003	–	–
2000	PN 6	48 x M 39	629	605	–	–
2000	PN 10	48 x M 45	1047	1092	–	–
2000	PN 16	48 x M 56	1324	1261	–	–

* Designed in accordance with EN 1092-1 (not to DIN 2501)

2.5.2 Tightening torques for pressure ratings in accordance with JIS

Nominal diameter	JIS Pressure rating	Screws	Max. tightening torque [Nm]			
			Promag W		Promag P	
[mm]	[bar]		Hard rubber	Polyurethane	PTFE	PFA
15	10K	4 x M 12	–	–	16	–
15	20K	4 x M 12	–	–	16	–
25	10K	4 x M 16	–	19	32	–
25	20K	4 x M 16	–	19	32	–
32	10K	4 x M 16	–	22	38	–
32	20K	4 x M 16	–	22	38	–
40	10K	4 x M 16	–	24	41	–
40	20K	4 x M 16	–	24	41	–
50	10K	4 x M 16	–	33	54	–
50	20K	8 x M 16	–	17	27	–
65	10K	4 x M 16	55	45	74	–
65	20K	8 x M 16	28	23	37	–
80	10K	8 x M 16	29	23	38	–
80	20K	8 x M 20	42	35	57	–
100	10K	8 x M 16	35	29	47	–
100	20K	8 x M 20	56	48	75	–
125	10K	8 x M 20	60	51	80	–
125	20K	8 x M 22	91	79	121	–
150	10K	8 x M 20	75	63	99	–
150	20K	12 x M 22	81	72	108	–
200	10K	12 x M 20	61	52	82	–
200	20K	12 x M 22	91	80	121	–
250	10K	12 x M 22	100	87	133	–
250	20K	12 x M 24	159	144	212	–
300	10K	16 x M 22	74	63	99	–
300	20K	16 x M 24	138	124	183	–

2.5.3 Tightening torques for pressure ratings in accordance with ANSI

Nominal diameter	ANSI Pressure rating	Screws	Max. tightening torque [lbf · ft]			
			Promag W		Promag P	
[inch]	[lbs]		Hard rubber	Polyurethane	PTFE	PFA
½"	Class 150	4 x ½"	–	–	4.4	–
½"	Class 300	4 x ½"	–	–	4.4	–
1"	Class 150	4 x ½"	–	5.2	8.1	7.4

Nominal diameter [inch]	ANSI Pressure rating [lbs]	Screws	Max. tightening torque [lbf · ft]			
			Promag W		Promag P	
			Hard rubber	Polyurethane	PTFE	PFA
1"	Class 300	4 x 5/8"	–	5.9	10	8.9
1½"	Class 150	4 x ½"	–	7.4	18	15
1½"	Class 300	4 x ¾"	–	11	25	23
2"	Class 150	4 x 5/8"	–	16	35	32
2"	Class 300	8 x 5/8"	–	8	17	16
3"	Class 150	4 x 5/8"	44	32	58	49
3"	Class 300	8 x ¾"	28	19	35	31
4"	Class 150	8 x 5/8"	31	23	41	37
4"	Class 300	8 x ¾"	43	30	49	44
6"	Class 150	8 x ¾"	58	44	78	63
6"	Class 300	12 x ¾"	52	38	54	49
8"	Class 150	8 x ¾"	79	59	105	80
10"	Class 150	12 x 7/8"	74	55	100	–
12"	Class 150	12 x 7/8"	98	76	131	–
14"	Class 150	12 x 1"	100	117	192	–
16"	Class 150	16 x 1"	94	111	181	–
18"	Class 150	16 x 1 1/8"	150	173	274	–
20"	Class 150	20 x 1 1/8"	135	160	252	–
24"	Class 150	20 x 1 1/4"	198	226	352	–

2.5.4 Tightening torques for pressure ratings in accordance with AS 2129

Nominal diameter [mm]	AS 2129 Pressure rating	Screws	Max. tightening torque [Nm]	
			Promag W	Promag P
			Hard rubber	PTFE
25	Table E	4 x M 12	–	21
50	Table E	4 x M 16	–	42
80	Table E	4 x M 16	49	–
100	Table E	8 x M 16	38	–
150	Table E	8 x M 20	64	–
200	Table E	8 x M 20	96	–
250	Table E	12 x M 20	98	–
300	Table E	12 x M 24	123	–
350	Table E	12 x M 24	203	–
400	Table E	12 x M 24	226	–
500	Table E	16 x M 24	271	–
600	Table E	16 x M 30	439	–

2.5.5 Tightening torques for pressure ratings in accordance with AS 4087

Nominal diameter [mm]	AS 4087 Pressure rating	Screws	Max. tightening torque [Nm] Promag W Hard rubber	Promag P PTFE
50	PN 16	4 x M 16	–	42
80	PN 16	4 x M 16	49	–
100	PN 16	4 x M 16	76	–
150	PN 16	8 x M 20	52	–
200	PN 16	8 x M 20	77	–
250	PN 16	8 x M 20	147	–
300	PN 16	12 x M 24	103	–
350	PN 16	12 x M 24	203	–
400	PN 16	12 x M 24	226	–
500	PN 16	16 x M 24	271	–
600	PN 16	16 x M 30	393	–

2.5.6 Tightening torques for pressure ratings in accordance with AWWA

Nominal diameter [inch]	AWWA Pressure rating	Screws	Max. tightening torque [lbf · ft] Promag W Hard rubber	Polyurethane
28"	Class D	28 x 1 $^1/_4$"	182	215
30"	Class D	28 x 1 $^1/_4$	212	223
32"	Class D	28 x 1 $^1/_2$"	291	311
36"	Class D	32 x 1 $^1/_2$"	309	317
40"	Class D	36 x 1 $^1/_2$"	310	352
42"	Class D	36 x 1 $^1/_2$"	389	382
48"	Class D	44 x 1 $^1/_2$"	407	392
54"	Class D	44 x 1 $^3/_4$"	538	467
60"	Class D	52 x 1 $^3/_4$"	559	614
66"	Class D	52 x 1 $^3/_4$"	698	704
72"	Class D	60 x 1 $^3/_4$"	719	802
78"	Class D	64 x 2"	629	580

2.6 Installing the Promag H sensor

2.6.1 Seals

When mounting the process connections, make sure that the seals in question are free from dirt and centered correctly.

Caution!

- The screws must be securely tightened in the case of metal process connections. Together with the sensor, the process connection forms a metal connection that ensures defined seal compression.
- With regard to process connections made of plastic material, comply with the max. torques for lubricated threads (7 Nm / 5.2 lbf ft). A seal must always be used between the connection and counterflange for plastic flanges.
- The seals should be replaced periodically depending on the application, particularly if molded seals are used (aseptic version)! The intervals between seal replacement depend on the frequency of the cleaning cycles and the fluid and cleaning temperatures. Replacement seals can be ordered as an accessory.

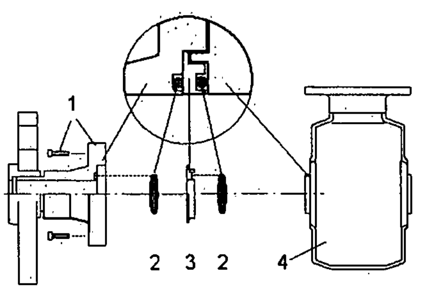
2.6.2 Using and mounting grounding rings (DN 2 to 25, 1/12" to 1")

In the case of process connections made of plastic (e.g. flange connections or adhesive couplings), potential equalization between the sensor and fluid must be ensured via additional grounding rings.
If grounding rings are missing, this can affect accuracy or result in the destruction of the sensor due to electrochemical electrode reduction.

Caution!

- Depending on the order option, appropriate plastic disks are used instead of grounding rings for the process connections. These plastic disks only act as a kind of "place holder" and do not have any potential equalization function whatsoever. In addition, they also assume an important sealing function at the sensor/connection interface. Thus, these plastic disks/seals should never be removed and should always be mounted for process connections without metal grounding rings!
- Grounding rings can be ordered separately from Endress+Hauser as an accessory.
  When ordering, make sure that the grounding rings are compatible with the electrode material. Otherwise there is the risk that electrodes can be damaged by electrochemical corrosion! For information on materials, see the Operating Instructions on the CD-ROM.
- Grounding rings, incl. seals, are mounted inside the process connections.
  The face-to-face length is not affected.

Installing the grounding rings



1 = Process connection hexagonal-headed bolts
2 = O-ring seals
4 = Sensor
3 = Grounding ring or plastic disk (place holder)

a. Release the four hexagonal-headed bolts (1) and remove the process connection from the sensor (4).
b. Remove the plastic disk (3) including the two O-ring seals (2) from the process connection.
c. Insert one of the O-ring seals (2) back into the groove of the process connection.
d. Place the metal grounding ring (3) into the process connection as illustrated.
e. Now insert the second O-ring seal (2) into the groove of the grounding ring.
f. Mount the process connection back onto the sensor. In doing so, make sure to observe the max. torques for lubricated threads (7 Nm) (5.2 lbf ft).

2.6.3 Welding the transmitter into the pipe (weld nipples)

Caution!
Risk of destroying the electronics! Make sure that the welding system is not grounded via the sensor or transmitter.

a. Secure the sensor with a few welding points in the pipe.
   A welding jig suitable for this purpose can be ordered separately as an accessory.
b. Release the screws on the process connection flange and remove the sensor, including the seal, from the pipe.
c. Weld the process connection into the pipe.
d. Mount the sensor back into the pipe.
   In doing so, make sure the seals are clean and correctly positioned.

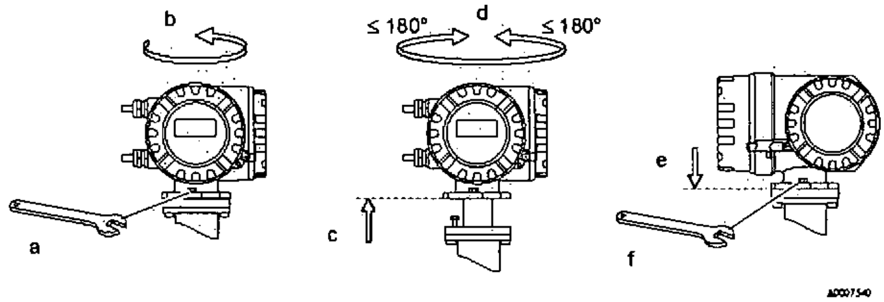
Note!
- When welding is performed correctly with thin-walled pipes carrying food, the seal is not damaged by the heat even when it is mounted. It is recommended, however, to disassemble the sensor and seal.
- For the disassembly work, it must be possible to open the pipe approx. 8 mm (0.31 in) in total.

2.7 Installing the transmitter housing

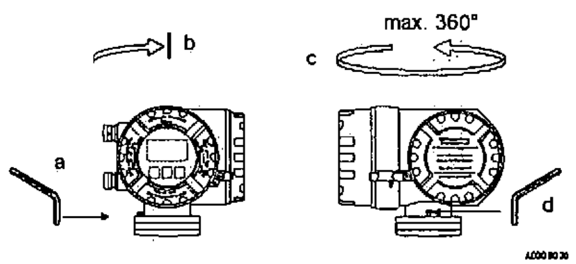
2.7.1 Turning the transmitter housing

Turning the aluminum field housing

Aluminum field housing for non-Ex area



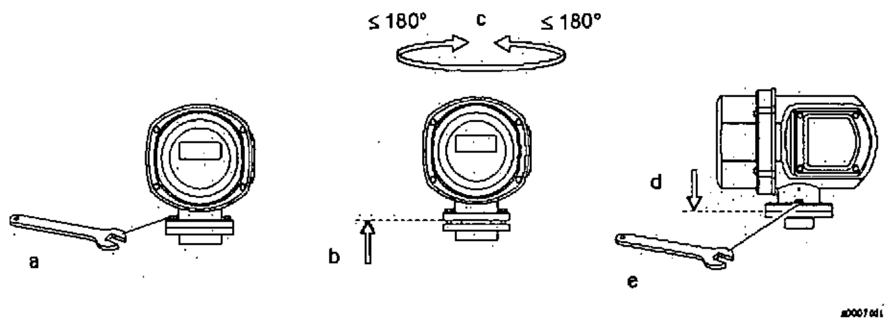
Aluminum field housing for Zone 1 or Class I Div. 1



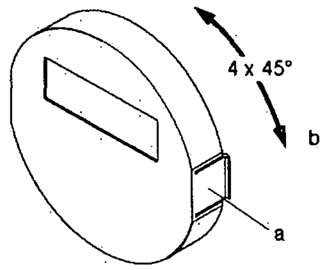
For Zone 1 or Class I Div. 1:

a. Release the setscrew.
b. Turn the transmitter housing gently clockwise until the stop (end of the thread).
c. Turn the transmitter counterclockwise (max. 360°) to the desired position.
d. Retighten the setscrew.

Turning the stainless steel field housing



2.7.2 Turning the onsite display



a. Press in the side latches on the display module and remove the module from the cover plate of the electronics compartment.

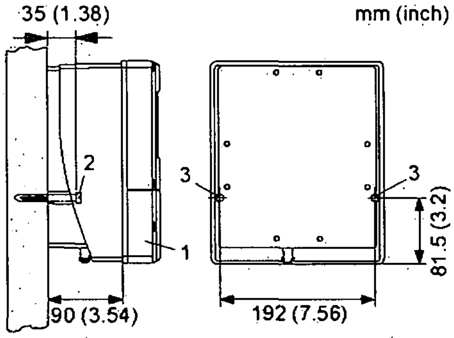
b. Turn the display to the desired position (max. 4 x 45° in both directions) and reset it onto the cover plate of the electronics compartment.

2.7.3 Installing the wall-mount housing

Caution!

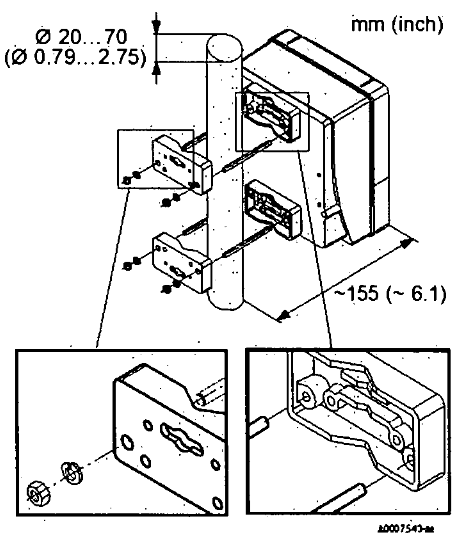
- Make sure that the ambient temperature does not exceed the permitted range.
- Always install the wall-mount housing in such a way that the cable entries point downwards.

Mounted directly on the wall



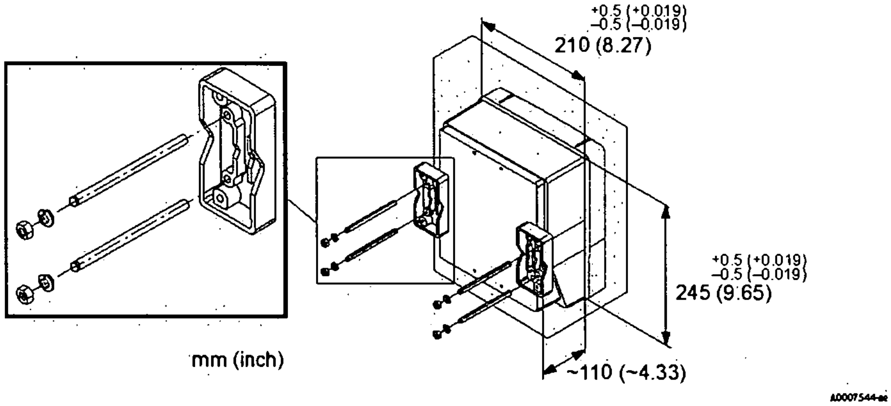
1. Connection compartment
2. Securing screws M6 (max. ø 6.5 mm (0.25"); screw head max. ø 10.5 mm (0.4")
3. Housing bores for securing screws

Pipe mounting



Caution!
Danger of overheating! If the device is mounted on a warm pipe, make sure that the housing temperature does not exceed +60 °C (+140 °F) which is the maximum temperature permitted.

Panel mounting



2.8 Post-installation check

- Is the measuring device damaged (visual inspection)?
- Does the device correspond to specifications at the measuring point, including process temperature and pressure, ambient temperature, minimum fluid conductivity, measuring range, etc.?
- Does the arrow on the sensor nameplate match the actual direction of flow through the pipe?
- Is the position of the measuring electrode plane correct?
- Is the position of the empty pipe detection electrode correct?
- Were all screws tightened to the specified torques when the sensor was installed?
- Were the correct seals used (type, material, installation)?
- Are the measuring point number and labeling correct (visual inspection)?
- Were the inlet and outlet runs respected?
  - Inlet run $\geq$ 5 x DN
  - Outlet run $\geq$ 2 x DN
- Is the measuring device protected against moisture and direct sunlight?
- Is the sensor adequately protected against vibration (attachment, support)? Acceleration up to 2 g by analogy with IEC 600 68-2-8

3 Wiring

Warning!
Risk of electric shock! Components carry dangerous voltages.
- Never mount or wire the measuring device while it is connected to the power supply.
- Before connecting the power supply, check the safety equipment.
- Route the power supply and signal cables so they are securely seated.
- Seal the cable entries and covers tight.

Caution!
Risk of damaging the electronic components!
- Connect the power supply in accordance with the connection data on the nameplate.
- Connect the signal cable in accordance with the connection data in the Operating Instructions or the Ex documentation on the CD-ROM.

In addition, for the remote version

Caution!
Risk of damaging the electronic components!
- Only connect sensors and transmitters with the same serial number.
- Observe the cable specifications of the connecting cable → Operating Instructions on the CD-ROM.

Note!
Install the connecting cable securely to prevent movement.

In addition, for measuring devices with fieldbus communication

Caution!
Risk of damaging the electronic components!
- Observe the cable specification of the fieldbus cable → Operating Instructions on the CD-ROM.
- Keep the stripped and twisted lengths of cable shield as short as possible.
- Screen and ground the signal lines → Operating Instructions on the CD-ROM.
- When using in systems without potential equalization → Operating Instructions on the CD-ROM.

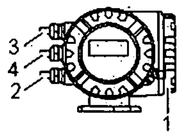
In addition, for Ex-certified measuring devices

Warning!
When wiring Ex-certified measuring devices, all the safety instructions, wiring diagrams, technical information etc. of the related Ex documentation must be observed
→ Ex documentation on the CD-ROM.

3.1 Connecting the various housing types

Wire the unit using the terminal assignment diagram inside the cover.

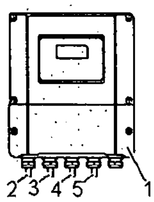
3.1.1 Compact version



A0007545

Transmitter connection:
1 Connection diagram inside the connection compartment cover
2 Power supply cable
3 Signal cable or fieldbus cable
4 Optional

3.1.2 Remote version (transmitter): non-Ex Zone, Ex Zone 2, Class I Div. 2

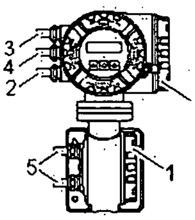


A0007546

Transmitter connection:
1 Connection diagram inside the connection compartment cover
2 Power supply cable
3 Signal cable
4 Fieldbus cable

Connecting the connecting cable (→ Page 27 ff.):
5 Sensor/transmitter connecting cable

3.1.3 Remote version (transmitter): Ex Zone 1, Class I Div. 1

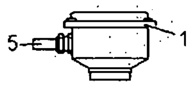


A0008218

Transmitter connection:
1 Connection diagram inside the connection compartment cover
2 Power supply cable
3 Signal cable or fieldbus cable
4 Optional

Connecting the connecting cable (→ Page 27 ff.):
5 Sensor/transmitter connecting cable

3.1.4 Remote version (sensor)



A0008037

Transmitter connection:
1 Connection diagram inside the connection compartment cover

Connecting cable connection:
5 Sensor/transmitter connecting cable

3.2 Connecting the remote version connecting cable

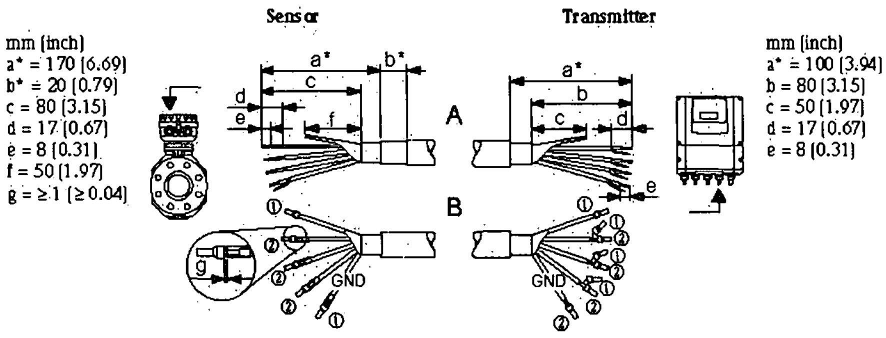
3.2.1 Connecting cable for Promag W and P

Connecting cable termination

Terminate the signal and coil current cables as shown in the figure below (Detail A).
Fit the fine-wire cores with cable end ferrules (Detail B).

Signal cable termination

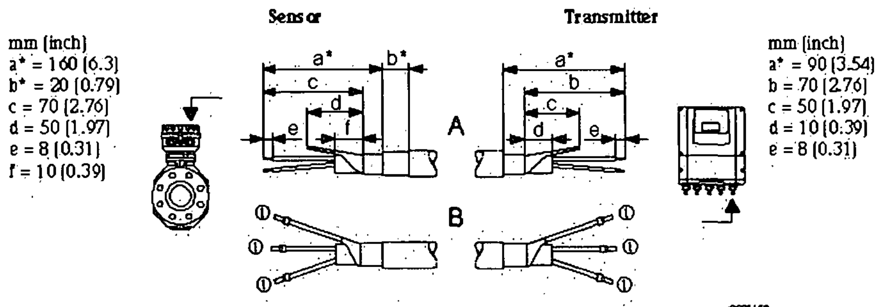
Make sure that the cable end ferrules do not touch the wire shields on the sensor side! Minimum distance = 1 mm (0.04 in), exception "GND" = green cable.



① = Cable end ferrules, red, Ø 1.0 mm (0.04"); ② = Cable end ferrules, white, Ø 0.5 mm (0.02")
* = Stripping for armored cables only

Coil current cable termination

Insulate one core of the three-core cable at the level of the core reinforcement; you only require two cores for the connection.



① = Cable end ferrules, red, Ø 1.0 mm (0.04"); ② = Cable end ferrules, white, Ø 0.5 mm (0.02")
* = Stripping for armored cables only

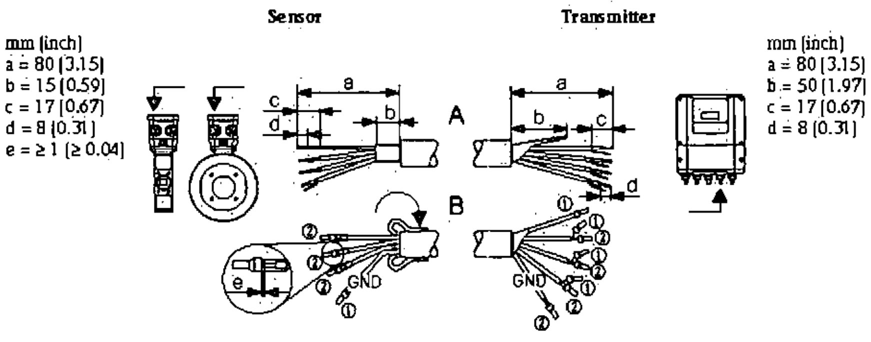
3.2.2 Promag H connecting cable

Connecting cable termination

Terminate the signal and coil current cables as shown in the figure below (Detail A).
Fit the fine-wire cores with cable end ferrules (Detail B).

Signal cable termination

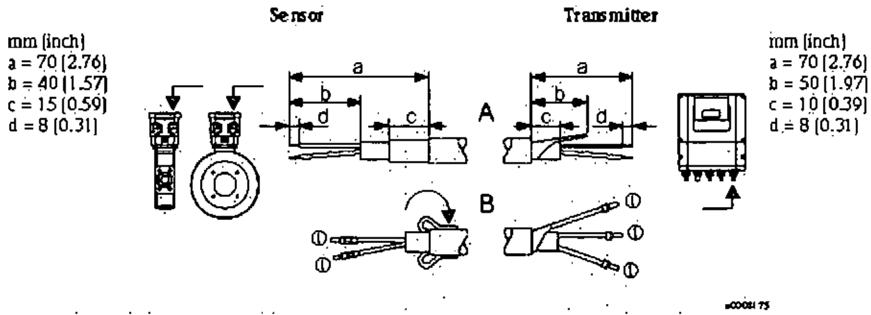
Make sure that the cable end ferrules do not touch the wire shields on the sensor side! Minimum distance = 1 mm (0.04 in), exception "GND" = green cable.



① = Cable end ferrules, red, Ø 1.0 mm (0.04"); ② = Cable end ferrules, white, Ø 0.5 mm (0.02")

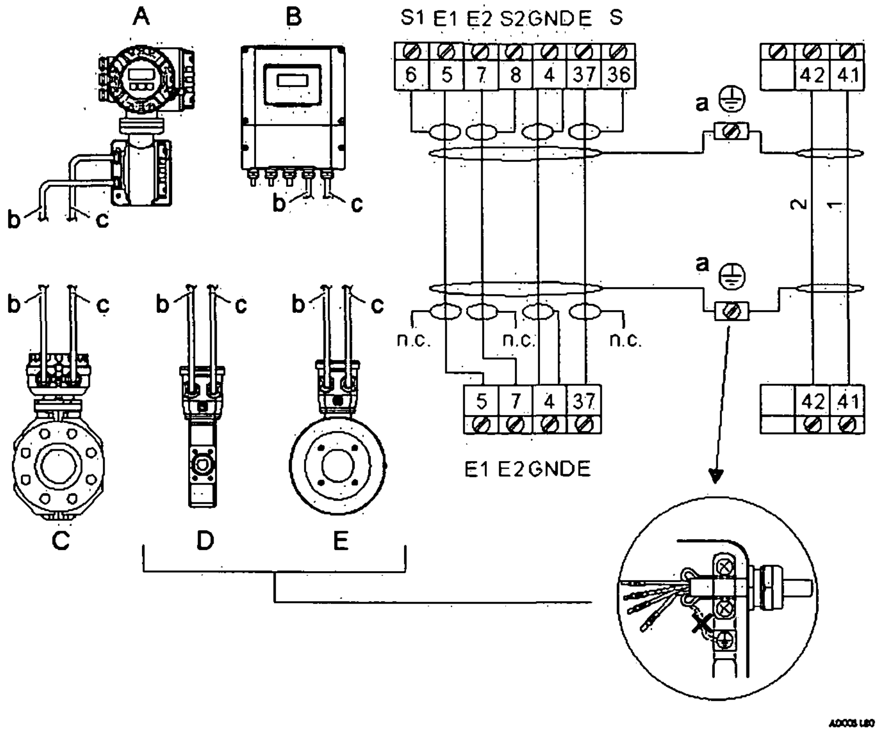
Coil current cable termination

Insulate one core of the three-core cable at the level of the core reinforcement; you only require two cores for the connection.



① = Cable end ferrules, red, Ø 1.0 mm (0.04"); ② = Cable end ferrules, white, Ø 0.5 mm (0.02")

3.2.3 Connecting cable connection



A Transmitter housing on connection housing, remote version
B Wall-mount housing on connection housing, remote version

C Sensor connection housing, remote version for Promag W/P
D Sensor connection housing, remote version for Promag H, DN ≤ 25
E Sensor connection housing, remote version for Promag H, DN ≥ 40

a Ground terminals (are provided for potential equalization connection)
b Coil circuit connecting cable
c Signal circuit connecting cable (electrodes)

n.c. = not connected, isolated cable shields

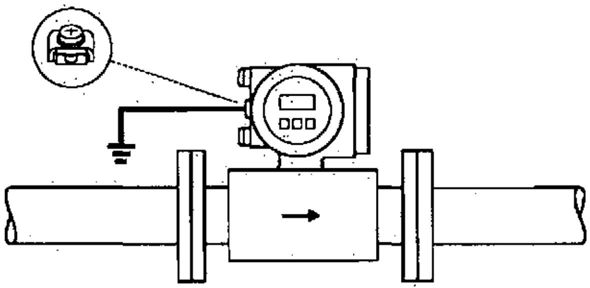
Cable colors for terminal numbers:
5/6 = brown
7/8 = white
4 = green
36/37 = yellow

3.3 Potential equalization

Perfect measurement is only ensured when the medium and the sensor have the same electrical potential. Most sensors have a reference electrode installed as standard, which guarantees the required potential connection. This usually means that the use of ground disks or other measures are unnecessary.

- Promag W
  Reference electrode available as standard.
- Promag P
  - Reference electrode available as standard for electrode material: 1.4435 (AISI 316L), Alloy C-22 and tantalum
  - Reference electrode optionally available for electrode material: Pt/Rh
- Promag H
  - No reference electrode available. There is always an electrical connection to the fluid via the metal process connection.
  - In the case of plastic process connections, potential equalization must be ensured through the use of grounding rings.

Note!
When installing in metal pipes, it is advisable to connect the ground terminal of the transmitter housing to the piping. Pay particular attention to company-internal grounding concepts.



A0004375

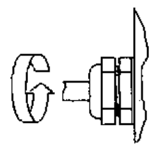
Caution!
For sensors without reference electrodes or without metal process connections, carry out potential equalization as per the instructions for special cases described in the Operating Instructions (see the CD). These special measures are particularly important when standard grounding practice cannot be ensured or extremely strong equalizing currents are expected.

3.4 Degree of protection

The devices meet all the requirements for IP 67.

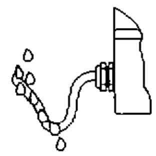
After mounting in the field or service work, the following points have to be observed to ensure that IP 67 protection is retained:

- Install the measuring device in such a way that the cable entries do not point upwards.
- Do not remove the seal from the cable entry.
- Remove all unused cable entries and plug them with suitable drain plugs.



A0007549

Tighten the cable entries correctly.



A0007550

The cables must loop down before they enter the cable entries ("water trap").

3.5 Post-connection check

- Are cables or the device damaged (visual inspection)?
- Does the supply voltage match the information on the nameplate?
- Do the cables used comply with the necessary specifications?
- Do the mounted cables have adequate strain relief and are they routed securely?
- Is the cable type route completely isolated? Without loops and crossovers?
- Are all screw terminals firmly tightened?
- Have all the measures for grounding and potential equalization been correctly implemented?
- Are all cable entries installed, firmly tightened and correctly sealed?
- Cable routed as a "water trap" in loops?
- Are all the housing covers installed and securely tightened?

In addition, for measuring devices with fieldbus communication:

- Are all the connecting components (T-boxes, junction boxes, connectors, etc.) connected with each other correctly?
- Has each fieldbus segment been terminated at both ends with a bus terminator?
- Has the max. length of the fieldbus cable been observed in accordance with the specifications?
- Has the max. length of the spurs been observed in accordance with the specifications?
- Is the fieldbus cable fully shielded and correctly grounded?

4 Hardware settings

This section only deals with the hardware settings needed for commissioning. All other settings (e.g. output configuration, write protection, etc.) are described in the associated Operating Instructions on the CD-ROM.

Note!
No hardware settings are needed for measuring devices with HART or FOUNDATION Fieldbus-type communication.

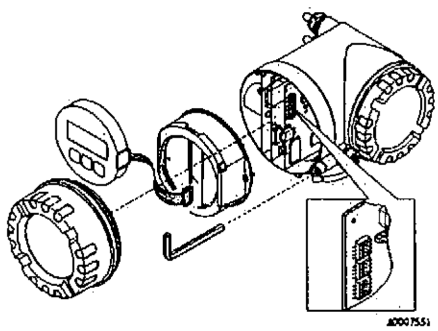
4.1 Device address

Has to be set for measuring devices with the following communication methods:
- PROFIBUS DP/PA

The device address can be configured via:
- Miniature switches → see description below
- Local operation → see **Software settings** section → Page 39

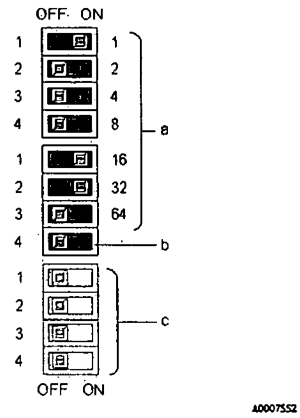
Addressing via miniature switches

Warning!
Risk of electric shock! Risk of damaging the electronic components!
- All the safety instructions for the measuring device must be observed and all the warnings heeded → Page 25.
- Use a workspace, working environment and tools purposely designed for electrostatically sensitive devices.



a. Switch off the power supply before opening the device.
b. Loosen the cheese head screw of the securing clamp with an Allen key (3 mm)
c. Unscrew cover of the electronics compartment from the transmitter housing.
d. Loosen the securing screws of the display module and remove the onsite display (if present).
e. Set the position of the miniature switches on the I/O board using a sharp pointed object.
f. Installation is the reverse of the removal procedure.

PROFIBUS



Device address range: 0 to 126
Factory setting: 126

a. Miniature switches for device address
Example shown:
1+16+32 = device address 49

b. Miniature switches for the address mode (method of addressing):
- OFF (factory setting) = software addressing via local operation/operating program
- ON = hardware addressing via miniature switches

c. Miniature switches not assigned.

4.2 Terminating resistors

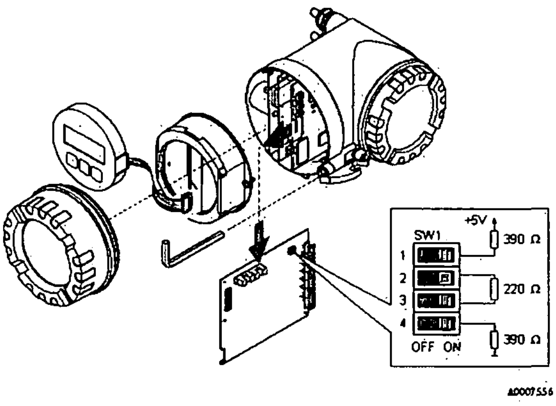
Note!
If the measuring device is used at the end of a bus segment, termination is required.
This can be performed in the measuring device by setting the terminating resistors on the I/O board. Generally, however, it is recommended to use an external bus terminator and not perform termination at the measuring device itself.

Has to be set for measuring devices with the following communication methods:

- PROFIBUS DP
  - Baudrate ≤ 1.5 MBaud → Termination can be performed at the measuring device, see graphic
  - Baudrate > 1.5 MBaud → An external bus terminator must be used

Warning!
Risk of electric shock! Risk of damaging the electronic components!

- All the safety instructions for the measuring device must be observed and all the warnings heeded → Page 25.
- Use a workspace, working environment and tools purposely designed for electrostatically sensitive devices.



Setting the terminating switch SW1 on the I/O board:
ON - ON - ON - ON

5 Commissioning

5.1 Switching on the measuring device

On completion of the installation (successful post-installation check), wiring (successful post-connection check) and after making the necessary hardware settings, where applicable, the permitted power supply (see nameplate) can be switched on for the measuring device.

When the power supply is switched on, the measuring device performs a number of power-up checks and device self-checks. As this procedure progresses the following messages can appear on the onsite display:

Display examples:

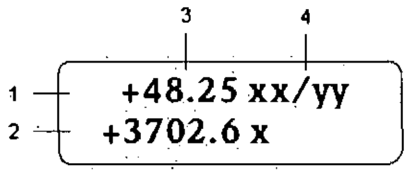
Display	
PROMAG 50 START-UP	Start-up message
▼	
DEVICE SOFTWARE V XX.XX.XX	Displays the current software
▼	
SYSTEM OK → OPERATION	Beginning of operation

The measuring device starts operating as soon as the startup procedure is complete.
Various measured values and/or status variables appear on the display.

Note!
If an error occurs during startup, this is indicated by an error message.
The error messages that occur most frequently when a measuring device is commissioned are described in the Troubleshooting section → Page 39.

5.2 Operation

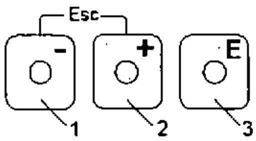
5.2.1 Display elements



Display lines/fields

1. Main line for primary measured values
2. Additional line for additional measured variables/status variables
3. Current measured values
4. Engineering units/time units

5.2.2 Operating elements



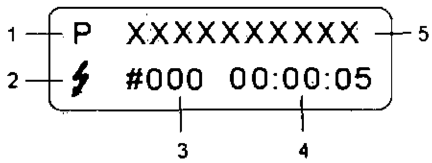
Operating keys

1. (–) Minus key for entering, selecting
2. (+) Plus key for entering, selecting
3. Enter key for calling the function matrix, saving

When the +/– keys are pressed simultaneously (Esc):

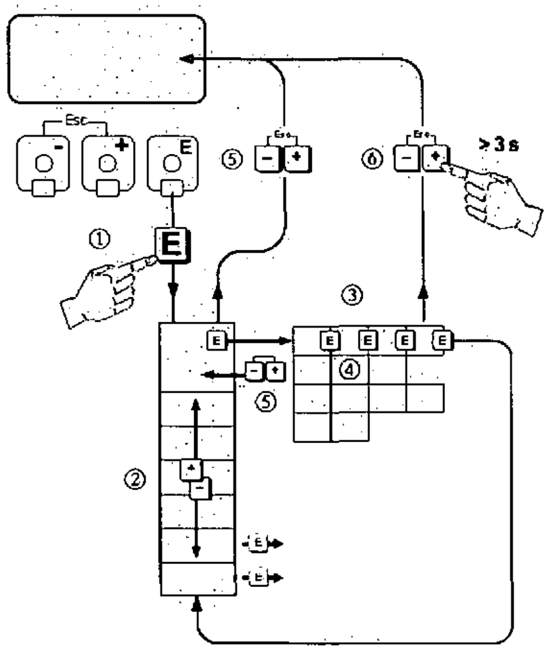
- Exit the function matrix step-by-step:
- > 3 sec. = cancel data input and return to the measured value display

5.2.3 Displaying error messages



1. Type of error:
   P = Process error, S = System error
2. Error message type:
   ϟ = Fault message, ! = Notice message
3. Error number
4. Duration of the last error that occurred:
   Hours: Minutes: Seconds
5. Error designation
   List of all error messages, see associated Operating Instructions on the CD-ROM

5.3 Navigating within the function matrix



1. E → Enter the function matrix (starting with measured value display)
2. +- → Select the group (e.g. OPERATION)
   E → Confirm selection
3. E → Select function (e.g. LANGUAGE)
4. +- → Enter code **50** (only for the first time you access the function matrix)
   E → Confirm entry

   +- → Change function/selection (e.g. ENGLISH)
   E → Confirm selection
5. -+ → Return to measured value display step by step
6. -+ > 3 s → Return immediately to measured value display

5.4 Calling the Commissioning Quick Setup

All the functions needed for commissioning are called up automatically with the Quick Setup. The functions can be changed and adapted to the process in question.

1. E → Enter the function matrix (starting with measured value display)
2. +/- → Select the group QUICK SETUP
   E → Confirm selection
3. QUICK SETUP COMMISSIONING function appears.
4. Intermediate step if configuration is blocked:
   +/- → Enter the code **50** (confirm with E) and thus enable configuration
5. +/- → Go to Commissioning Quick Setup
6. +/- → Select YES
   E → Confirm selection
7. E → Start Commissioning Quick Setup
8. Configure the individual functions/settings:
   - Via +/--key, select option or enter number
   - Via E-key, confirm entry and go to next function
   - Via Esc-key, return to Setup Commissioning function
     (settings already made are retained)

Note!
Observe the following when performing the Quick Setup:
- Configuration selection: Select the ACTUAL SETTING option
- Unit selection: This is not offered again for selection after configuring a unit
- Output selection: This is not offered again for selection after configuring an output
- Automatic configuration of the display: select YES
  - Main line = Mass flow
  - Additional line = Totalizer 1
  - Information line = Operating/system conditions
- If asked whether additional Quick Setups should be executed: select NO

All the available functions of the measuring device and their configuration options as well as additional Quick Setups, if available, are described in detail in the "Description of Device Functions" Operating Instructions. The related Operating Instructions can be found on the CD-ROM.

The measuring device is ready for operation on completion of the Quick Setup.

5.5 Software settings

5.5.1 Device address

Has to be set for measuring devices with the following communication methods:
- PROFIBUS DP/PA → device address range 0 to 126, factory setting 126

The device address can be configured via:
- Miniature switches → see **Hardware settings** → Page 32
- Local operation → see description below

Note!
The COMMISSIONING SETUP must be executed before setting the device address.

Calling the Communication Quick Setup

1. E → Enter the function matrix (starting with measured value display)
2. +/- → Select the group QUICK SETUP
   E → Confirm selection
3. → Select the QUICK SETUP COMMUNICATION function
4. Intermediate step if configuration is blocked: +/- → Enter the code **50** (confirm with E) and thus enable the configuration
5. +/- → Go to Communication Quick Setup
6. +/- → Select YES; E → confirm selection
7. E → Start Communication Quick Setup
8. Configure the individual functions/settings:
   – Via +/--key, select option or enter number
   – Via E-key, confirm entry and go to next function
   – Via Esc-key, return to Setup Commissioning function (settings already made are retained)

All the available functions of the measuring device and their configuration options as well as additional Quick Setups, if available, are described in detail in the "Description of Device Functions" Operating Instructions. The related Operating Instructions can be found on the CD-ROM.

The measuring device is ready for operation on completion of the Quick Setup.

5.6 Troubleshooting

A complete description of all the error messages is provided in the Operating Instructions on the CD-ROM.

Note!
The output signals (e.g. pulse, frequency) of the measuring device must correspond to the higher-order controller.

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APPENDIX J– SWITCHBOARD SURGE DIVERTOR

ERICO

DINLINE ALARM RELAY (DAR)

INSTALLATION INSTRUCTIONS

MODEL NUMBER
DAR 275V

1. PREPARATION

DANGER: *Electrical shock or burn hazard. Installation of this device should only be made by qualified personnel. Failure to lockout electrical power during installation or maintenance can result in fatal electrocution or severe burns. Before making any connections be sure that power has been removed from all associated wiring, electrical panels, and other electrical equipment.*

CAUTION NOTES:

1. *The installation of this device should follow all applicable electrical codes, such as the National Electrical Code.*
2. *Check to make sure line voltage does not exceed DAR275V voltage ratings.*
3. *Follow all instructions to ensure correct and safe operation.*
4. *Do not attempt to open or tamper with the DAR in any way as this may compromise performance and will void warranty. No user serviceable parts are contained.*

2. INTRODUCTION

Selected DSD, TDS & TDF DINLINE Surge Protection Devices include status monitoring circuits which provide visual status display of device capacity. They may also provide a low voltage opto-coupler alarm output circuit that can be connect to the DAR to provide potential free (Form C) change-over contacts. The DAR alarm contacts may be used to provide output to external alarm systems or remote monitoring circuits.

One DAR can be used per DSD/TDS/TDF opto-coupler alarm or up to 16 DSD opto-coupler alarms can be connected in series to the one DAR to provide a common output. It is recommended that the DAR be powered from the same power circuit that feeds the device(s) being monitored, however the DAR can be powered from other circuits. This allows for example, one DAR unit to be connected to separate SPDs that are protecting a three phase circuit.

Note. Depending upon the usage of the DAR output contacts, failure of power to the DAR may be interpreted as a failure of one or more of the SPDs being monitored. Visual inspection of the DAR and SPDs status displays would determine this.

3. MOUNTING

The DAR is designed to clip to 35mm (top hat) DIN rails (standard EN50022). Unless otherwise mechanically restrained, use horizontal DIN rails with the DAR module spring clips to the bottom and the label text the correct way up.

NOTE: The DAR must be installed in an enclosure or panel that:

- *prevents the DAR temperature from exceeding 131°F (55°C)*
- *provides adequate electrical and safety protection*
- *prevents the ingress of moisture and water*
- *allows DAR status indicators to be inspected*

4. ELECTRICAL CONNECTION

The interconnecting wiring should:

- be of size #10 to #14 AWG (2.5mm² to 6mm²) solid or stranded conductor.
- The wire insulation should be stripped back 5/16" (8mm).
- NOTE: Do not use greater than 9inlbs (1Nm) of torque when tightening the terminals.

CONNECTION TO TELECOMMUNICATIONS NETWORKS

The DAR is approved for use in Australia where the alarm contacts may be connected to private lines or building cabling associated with the telecommunications network. NO direct connection to the public switched network should be made.

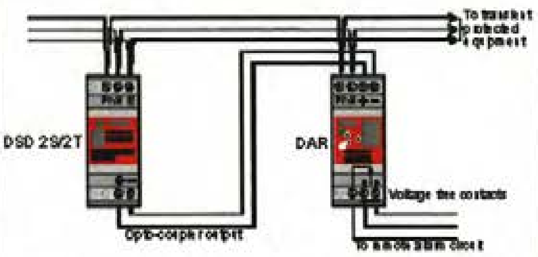
ERICO

DINLINE ALARM RELAY

INSTALLATION INSTRUCTIONS

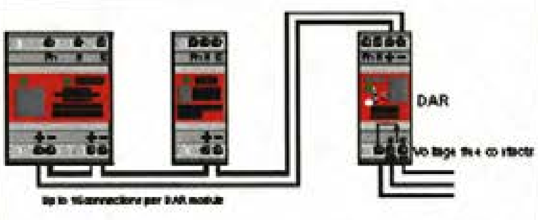
5. INTERCONNECTION

When connecting the DAR to a single opto-coupler output the + terminal of the SPD should connect to the + terminal on the DAR. The – terminal should connect to the – terminal.



+/- terminal connections are polarity sensitive. Do not reverse.

When connecting the DAR to multiple opto-couplers the opto-couplers should be connected in series with + terminal of one connected to the – terminal of the next. The DAR + terminal should connect to + SPD terminal at one end of the series connection and the – DAR terminal connect to the – SPD terminal at the other end of the series connection.



+/- terminal connections are polarity sensitive. Do not reverse.

5. STATUS INDICATION

	✓	/	✗
STATUS	Protection Operational	Protection Alarm	Fault Mode
DISPLAY	Normal Fault	Normal Fault	Normal Fault
EXPLANATION	Normal operation Normal (green) indicator ON Red indicator OFF Relay is energised Power is supplied	DSD in alarm mode, or power to DSD has been removed Normal (green) indicator OFF Red indicator ON Relay is de-energised Power is supplied	Power to DAR removed Protection status unknown Normal (green) indicator OFF Red indicator OFF Relay is de-energised Power is OFF

6. FUSING AND ISOLATION

Overcurrent protection must be installed in the upstream circuit of the power supply to the DAR to provide protection to the unit itself and the wiring in case of fault conditions.

The fuse rating should be based on the wiring size used to connect to the DAR Ph & N terminals. Australian regulations AS3000-1991, Table B2 specifies the following upstream protection for single phase circuits, unenclosed in air.

Cable Size	HRC Fuse or	CB Rewirable Fuse
$1.5mm^2$	16A	12A
$2.5mm^2$	20A	16A
$4mm^2$	25A	20A
$6mm^2$	32A	25A

Where overcurrent protection of the appropriate rating or smaller is already fitted in the upstream circuit, overcurrent protection at the DAR will not be required

6. MAINTENANCE & TESTING

Before removing a DAR unit from service, ensure that the power has been removed. Maintenance, testing and replacement should only be undertaken by qualified personnel.

Testing of a DAR unit which is connected to a fully functional DSD unit can be accomplished by removing power to the DSD only. The DAR Status indication and output contacts should alter from the Normal to Fault condition.

Testing of the DAR unit alone may be accomplished by disconnecting the + / -connections to the unit. When power is applied the DAR "Fault" Status Indicator should be illuminated. By connecting the + / - terminals together, the "Normal" Status Indicator should be illuminated. The output contacts should alter to the appropriate state.

7. USE OF OTHER INTERFACES

Only DAR units are recommended for the interfacing of equipment to the DSD, TDS & TDF opto-coupler alarm output circuit(s). The direct connection of other equipment to these opto-coupler alarm outputs may not provide sufficient isolation or exceed the opto-coupler specifications. This may damage the SPD and/or the connected equipment. Warranty may be voided under such circumstances.

NOTE: *In connecting to the SPD opto-coupler alarm output(s), do not reverse the +/- connections as damage may occur.*

TDS

CRITEC® Transient Discriminating Surge Diverters

ERICO

Surge Protection And Surge Ratings

The stress, which an SPD will experience under surge conditions, is a function of many complex and interrelated parameters. These include:

- Location of the SPD(s) within the structure – are they located at the main distribution board or within the facility at secondary board, or even in front of the end-user equipment?
- Method of coupling the lightning strike to the facility – for example, is this via a direct strike to the structures LPS, or via induction onto building wiring due to a nearby strike?
- Distribution of lightning currents within the structure – for example, what portion of the lightning current enters the earthing system and what remaining portion seeks a path to remote grounds via the power distribution system and equipotential bonding SPDs?
- Type of power distribution system – the distribution of lightning current on a power distribution system is strongly influenced by the grounding practice for the neutral conductor. For example, in the TN-C system with its multiple earthed neutral, a more direct and lower impedance path to ground is provided for lightning currents than in a TT system.
- Additional conductive services connected to the facility – these will carry a portion of the direct lightning current and therefore reduce the portion which flows through the power distribution system via the lightning equipotential bonding SPD.
- Type of waveshape – it is not possible to simply consider the peak current which the SPD will have to conduct, one also has to consider the waveshape of this surge. It is also not possible to simply equate the areas under the current-time curves (also referred to as the action integral) for SPDs under different waveshapes.

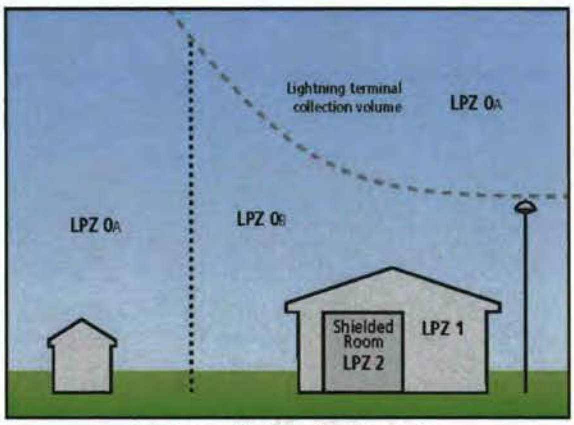
Many attempts have been made to quantify the electrical environment and "threat level" which an SPD will experience at different locations within a facility. The new IEC℠ standard on lightning protection, IEC 62305-4 "Protection against lightning - Part 4: Electrical and electronic systems within structures" has sought to address this issue by considering the highest surge magnitude which may be presented to an SPD based on the lightning protection level (LPL) being considered. For example, this standard postulates that under a LPL I the magnitude of a direct strike to the structure's LPS may be as high as 200kA 10/350. While this level is possible, its statistical probability of occurrence is approximately 1%. In other words, 99% of discharges will be less than this postulated 200 kA peak current level.

An assumption is made that 50% of this current is conducted via the building's earthing system, and 50% returns via the equipotential bonding SPDs connected to a three wire plus neutral power distribution system. It is also assumed that no additional conductive service exists. This implies that the portion of the initial 200 kA discharge experienced by each SPD is 25 kA.

Simplified assumptions of current dispersion are useful in considering the possible threat level, which the SPD(s) may experience, but it is important to keep in context the assumptions being made. In the example above, a lightning discharge of 200kA has been considered. It follows that the threat level to the equipotential bonding SPDs will be less than 25kA for 99% of the time. In addition, it has been assumed that the waveshape of this current component through the SPD(s) will be of the same waveshape as the initial discharge, namely 10/350, while in reality the waveshape have been altered by the impedance of building wiring, etc.

Many standards have sought to base their considerations on field experience collected overtime. For example, the IEEE® guide to the environment C62.41.1 and the recommended practice C62.41.2 present two scenarios of lightning discharge and different exposure levels under each of these depending on the location where the SPD is installed. In this standard, Scenario II depicts a direct strike to the structure, while Scenario I depicts a nearby strike and the subsequent conducted current into a structure via power and data lines. The highest surge exposure considered feasible to an SPD installed at the service entrance to a facility under Scenario I is 10kA 8/20, while under Scenario II it is considered to be 10kA 10/350 (exposure Level 3).

From the above, it is apparent that the selection of the appropriate surge rating for an SPD depends on many complex and interconnected parameters. When addressing such complexities, one needs to keep in mind that one of the more important parameters in selecting an SPD is its limiting voltage performance during the expected surge event, and not the energy withstand which it can handle.



Protection zones defined by specific product application

Advanced Technologies – The ERICO® Advantage

Transient Discriminating Technology

To meet the fundamental requirements of performance, longer service life and greater safety under real world conditions, ERICO has developed Transient Discriminating (TD) Technology.

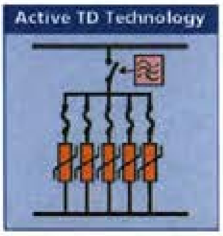
This quantum leap in technology adds a level of "intelligence" to the Surge Protection Device enabling it to discriminate between sustained abnormal over-voltage conditions and true transient or surge events. Not only does this help ensure safe operation under practical application, but it also prolongs the life of the protector since permanent disconnects are not required as a means of achieving internal over-voltage protection.

Traditional Technologies

Conventional SPD technologies utilize metal oxide varistors and/or silicon avalanche diodes to clamp or limit transient events. However, these devices are susceptible to sustained 50/60Hz mains over-voltage conditions which often occur during faults to the utility system. Such occurrences present a significant safety hazard when the suppression device attempts to clamp the peak of each half cycle on the mains over-voltage. This condition can cause the device to rapidly accumulate heat and in turn fail with the possibility of inducing a fire hazard.

The Core of TD Technology

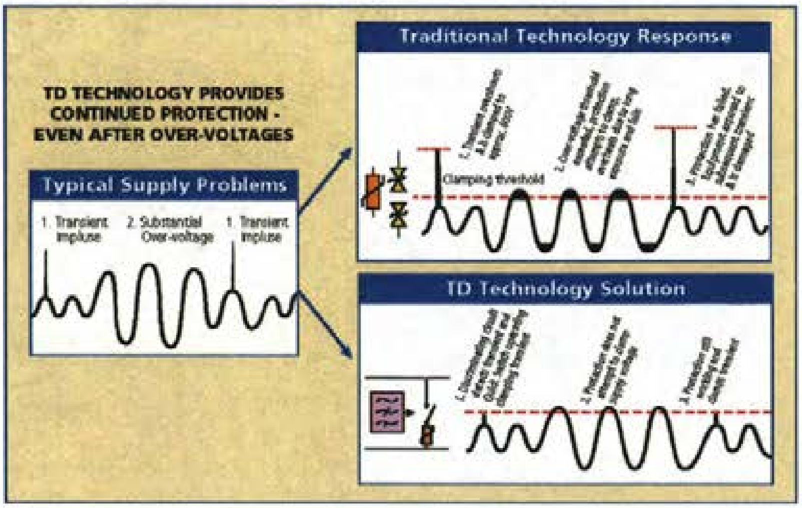
The secret to ERICO's Transient Discriminating Technology is its *active frequency discrimination* circuit. This patented device can discriminate between a temporary over-voltage (TOV) condition and a very fast transient, which is associated with lightning or switching-induced surges. When the transient frequencies are detected, the patented Quick-Switch within TD activates to allow the robust protection to limit the incoming transient. The frequency discriminating circuit that controls the Quick-Switch helps ensure that the SPD device is immune to the effects of a sustained 50 or 60Hz TOV. This allows the device to keep operating, in order to help provide safe and reliable transient protection, even after an abnormal over-voltage condition has occurred.



Meeting & Exceeding UL® Standards

The CRITEC® range of surge protection devices from ERICO® employing TD Technology has been specifically designed to meet and exceed the new safety requirements of UL 1449 Edition 3. To meet the abnormal over-voltage testing of UL 1449 Edition 3, many manufacturers of SPD devices have incorporated fuse or thermal disconnect devices which permanently disconnect all protection from the circuit during an over-voltage event. Transient Discriminating Technology on the other hand will allow the SPD device to experience an abnormal over-voltage up to twice its nominal operating voltage and still remain operational even after this event! This allows the device to help provide safe, reliable and continuous protection to your sensitive electronic equipment. TD Technology is especially recommended for any site where sustained over-voltages are known to occur, and where failure of traditional SPD technologies cannot be tolerated.

The UL 1449 testing standard addresses the safety of an SPD device under temporary and abnormal overvoltage conditions, but does not specifically mandate a design that will give a reliable, long length of service in the real world. Specifically, UL 1449 tests that the SPD remains operational at 10% above nominal supply voltage, allowing SPD manufacturers to design products that permanently disconnect just above that. Most reputable manufacturer's designs allow for up to a 25% overvoltage, while ERICO's TD Technology gives even greater overhead.



3

TDS130

CRITEC® TDS Surge Diverter - TDS130 Series

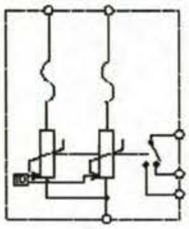
Features

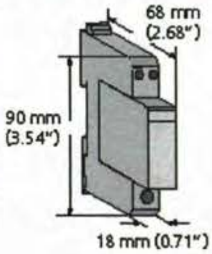
- CRITEC TD Technology with thermal disconnect protection
- Compact package, modular DIN rail mounting for limited space requirements
- Three modes of protection: L-N, L-PE & N-PE
- Indication flags and voltage-free contacts provide remote status monitoring
- Separate plug and base design facilitates replacement of a failed surge module
- 15kA 8/20μs surge rating per mode
- CE, UL® 1449 Edition 3 Listed

Surges and voltage transients are a major cause of expensive electronic equipment failure and business disruption. Damage may result in the loss of capital outlays, such as computers and communications equipment, as well as consequential loss of revenue and profits due to unscheduled system down-time.

The TDS130 series of surge suppressors provide economical and reliable protection from voltage transients on power distribution systems. The TDS130 is specifically designed for the protection of single phase power supplies within instrumentation and control applications. They are conveniently packaged for easy installation on 35 mm DIN rail within control panels.

CRITEC® TD technology helps ensure reliable and continued operation during sustained and abnormal over-voltage events. Internal thermal disconnect devices help ensure safe behavior at end-of life. A visual indicator flag provides user-feedback in the event of such operation. The TDS130 provides a set of optional voltage-free contacts for remote signaling that maintenance is required.





The convenient plug-in module and separate base design facilitates replacement of a failed surge module without needing to undo installation wiring.

Model	TDS1301TR150	TDS1301TR240
Item Number for Europe	702421	702422
Nominal Voltage, U_n	120-150 VAC	220-240 VAC
Max Cont. Operating Voltage, U_c	170VAC	275VAC
Stand-off Voltage	230VAC	440VAC
Frequency	0-100Hz	
Nominal Discharge Current, I_n	8kA 8/20μs per mode	
Max Discharge Current, I_{max}	15kA 8/20μs L-N 15kA 8/20μs L-PE	
Protection Modes	L-G, L-N, N-G	
Technology	TD Technology with thermal disconnect	
Short Circuit Current Rating, I_{sc}	200kAIC	
Back-up Overcurrent Protection	63AgL, if supply > 63A	
Voltage Protection Level, U_p	500V @ 3kA (L+N-G) 800V @ 3kA (L-N)	800V @ 3kA (L+N-G) 1500V @ 3kA (L-N)
Status	N/O, N/C Change-over contact, 250V~/0.5A, max 1.5 mm² (#14AWG) terminals Mechanical flag / remote contacts (R model only)	
Module Width	1 M	
Dimensions H x D x W: mm (in)	90 x 68 x 18 (3.54 x 2.68 x 0.71)	
Weight: kg (lbs)	0.12 (0.26)	
Enclosure	DIN 43 880, UL94V-0 thermoplastic, IP 20 (NEMA-1)	
Connection	1 mm² to 6 mm² (#18AWG to #10AWG) Line and Neutral Terminals ≤25 mm² (#4AWG) stranded ≤35 mm² (#2AWG) solid PE Terminal	
Mounting	35 mm top hat DIN rail	
Temperature	-40°C to 80°C (-40°F to 176°F)	
Humidity	0% to 90%	
Approvals	CE, IEC® 61643-1, UL® 1449 Ed 3 Recognized Component Type 2	
Surge Rated to Meet	ANSI®/IEEE® C62.41.2 Cat A, Cat B IEC 61643-1 Class II UL® 1449 Ed3 In 3kA mode	
Replacement Module	TDS130M150	TDS130M240
Replacement Module (Europe)	702432	702424

4

Features

- CRITEC® TD Technology with thermal disconnect protection
- Compact design fits into DIN distribution panel boards and motor control centers
- 35 mm DIN rail mount – DIN 43 880 profile matches common circuit breakers
- Indication flags and voltage-free contacts provide remote status monitoring
- Separate plug and base design facilitates replacement of a failed surge module
- 50kA 8/20µs maximum surge rating provides protection suitable for sub-distribution panels and a long operational life
- Available in various operating voltages to suit most common power distribution systems
- CE, UL® 1449 Edition 3 Listed

TDS150

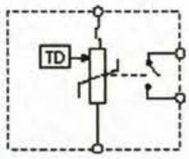
CRITEC® TDS Surge Diverter - TDS150 Series

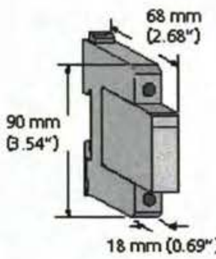
Surges and voltage transients are a major cause of expensive electronic equipment failure and business disruption. Damage may result in the loss of capital outlays, such as computers and communications equipment, as well as consequential loss of revenue and profits due to unscheduled system down-time.

The TDS150 series of surge suppressors provide economical and reliable protection from voltage transients on power distribution systems. They are conveniently packaged for easy installation on 35 mm DIN rail within main distribution panelboards.

CRITEC® TD technology helps ensure reliable and continued operation during sustained and abnormal over-voltage events. Internal thermal disconnect devices help ensure safe behavior at end-of-life. A visual indicator flag provides user-feedback in the event of such operation. As standard, the TDS150 provides a set of voltage-free contacts for remote signaling that maintenance is required.

The convenient plug-in module and separate base design facilitates replacement of a failed surge module without needing to undo installation wiring.





Model	TDS1501SR150	TDS1501SR240	TDS1501SR277	TDS1501SR560
Item Number for Europe	702404	702406	702407	702408
Nominal Voltage, U_o	120-150 VAC	220-240 VAC	240-277 VAC	480-560 VAC
Max Cont. Operating Voltage, U_c	170VAC	275VAC	320VAC	610VAC
Stand-off Voltage	240VAC	440VAC	480VAC	700VAC
Frequency	0-100Hz			
Short Circuit Current Rating, I_{sc}	200kAIC			
Back-up Overcurrent Protection	125A gL, if supply > 100A			
Technology	TD with thermal disconnect			
Max Discharge Current, I_{max}	50kA 8/20µs			
Nominal Discharge Current, I_n	25kA 8/20µs	20kA 8/20		
Protection Modes	Single mode (L-G, L-N or N-G)			
Voltage Protection Level U_p	400V @ 3kA 1.0kV @ In	700V @ 3kA 1.2kV @ In	800V @ 3kA 1.6kV @ In	1.8kV @ 3kA 2.4kV @ In
Status	N/O, N/C Change-over contact, 250V~/0.5A, max 1.5 mm² (#14AWG) terminals Mechanical flag / remote contacts (R model only)			
Dimensions H x D x W: mm (in)	90 x 68 x 18 (3.54 x 2.68 x 0.69)			
Module Width	1 M			
Weight: kg (lbs)	0.12 (0.26)			
Enclosure	DIN 43 880, UL94V-0 thermoplastic, IP 20 (NEMA-1)			
Connection	≤25 mm² (#4AWG) stranded ≤35 mm² (#2AWG) solid			
Mounting	35 mm top hat DIN rail			
Temperature	-40°C to 80°C (-40°F to 176°F)			
Humidity	0% to 90%			
Approvals	CE, IEC® 61643-1, UL® 1449 Ed 3 Recognized Component Type 2			
Surge Rated to Meet	ANSI®/IEEE® C62.41.2 Cat A, Cat B, Cat C ANSI®/IEEE® C62.41.2 Scenario II, Exposure 2, 50kA 8/20µs IEC 61643-1 Class II UL® 1449 Ed3 In 20kA mode			
Replacement Module	TDS150M150	TDS150M240	TDS150M277	TDS150M560

Features

- CRITEC® TD Technology with thermal disconnect protection
- Compact design fits into DIN distribution panel boards and motor control centers
- 35 mm DIN rail mount – DIN 43 880 profile matches common circuit breakers
- Indication flags and voltage-free contacts provide remote status monitoring
- Separate plug and base design facilitates replacement of a failed surge module
- 100kA 8/20µs maximum surge rating provides protection suitable for sub-distribution panels and a long operational life
- Available in various operating voltages to suit most common power distribution systems
- CE, UL® 1449 Edition 3 Listed

TDS1100

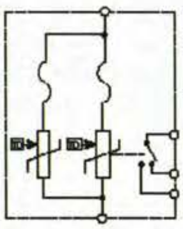
CRITEC® TDS Surge Diverter - TDS1100 Series

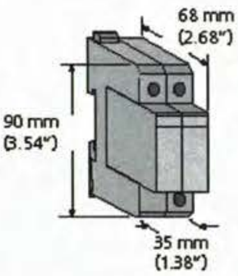
Surges and voltage transients are a major cause of expensive electronic equipment failure and business disruption. Damage may result in the loss of capital outlays, such as computers and communications equipment, as well as consequential loss of revenue and profits due to unscheduled system down-time.

The TDS1100 series of surge suppressors provide economical and reliable protection from voltage transients on power distribution systems. They are conveniently packaged for easy installation on 35 mm DIN rail within main distribution panelboards.

CRITEC® TD technology helps ensure reliable and continued operation during sustained and abnormal over-voltage events. Internal thermal disconnect devices help ensure safe behavior at end-of-life. A visual indicator flag provides user-feedback in the event of such operation. As standard, the TDS1100 provides a set of voltage-free contacts for remote signaling that maintenance is due.

The convenient plug-in module and separate base design facilitates replacement of a failed surge module without needing to undo installation wiring.





Model	TDS11002SR150	TDS11002SR240	TDS11002SR277	TDS11002SR560
Item Number for Europe	702409	702411	702412	702413
Nominal Voltage, U_n	120-150 VAC	220-240 VAC	240-277 VAC	480-560 VAC
Max Cont. Operating Voltage, U_c	170VAC	275VAC	320VAC	610VAC
Stand-off Voltage	240VAC	440VAC	480VAC	700VAC
Frequency	0-100Hz			
Short Circuit Current Rating, I_{sc}	200kAIC			
Back-up Overcurrent Protection	125AgL, if supply > 100A			
Technology	TD with thermal disconnect			
Max Discharge Current, I_{max}	100kA 8/20µs			
Impulse Current, I_{imp}	12.5kA 10/350µs			
Nominal Discharge Current, I_n	50kA 8/20µs	40kA 8/20µs		
Protection Modes	Single mode (L-G, L-N or N-G)			
Voltage Protection Level, U_p	400V @ 3kA 1.0kV @ 20kA	700V @ 3kA 1.2kV @ 20kA	800V @ 3kA 1.6kV @ 20kA	1.8kV @ 3kA 2.4kV @ 20kA
Status	N/O, N/C Change-over contact, 250V~/0.5A, max 1.5 mm² (#14AWG) terminals Mechanical flag / remote contacts (R model only)			
Dimensions H x D x W: mm (in)	90 x 68 x 35 (3.54 x 2.68 x 1.38)			
Module Width	2 M			
Weight: kg (lbs)	0.24 (0.53)			
Enclosure	DIN 43 880, UL94V-0 thermoplastic, IP 20 (NEMA-1)			
Connection	≤25 mm² (#4AWG) stranded ≤35 mm² (#2AWG) solid			
Mounting	35 mm top hat DIN rail			
Temperature	-40°C to 80°C (-40°F to 176°F)			
Humidity	0% to 90%			
Approvals	CE, IEC® 61643-1, UL® 1449 Ed 3 Recognized Component Type 2			
Surge Rated to Meet	ANSI®/IEEE® C62.41.2 Cat A, Cat B, Cat C ANSI®/IEEE® C62.41.2 Scenario II, Exposure 3, 100kA 8/20µs, 10kA 10/350µs IEC 61643-1 Class I and Class II UL® 1449 Ed3 In 20kA mode			
Replacement MOV Module	TDS150M150	TDS150M240	TDS150M277	TDS150M560

Features

- CRITEC® TD Technology with thermal disconnect protection
- Compact design fits into DIN distribution panel boards and motor control centers
- 35 mm DIN rail mount – DIN 43 880 profile matches common circuit breakers
- Indication flags and voltage-free contacts provide remote status monitoring
- Separate plug and base design facilitates replacement of a failed surge module
- 50kA 8/20μs maximum surge rating provides protection suitable for sub-distribution panels and a long operational life
- Available in various operating voltages to suit most common power distribution systems
- CE, UL® 1449 Edition 3 Listed

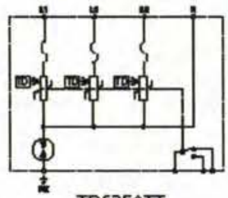
TDS350

CRITEC® TDS Surge Diverter - TDS350 Series

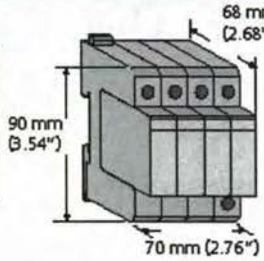
Surges and voltage transients are a major cause of expensive electronic equipment failure and business disruption. Damage may result in the loss of capital outlays, such as computers and communications equipment, as well as consequential loss of revenue and profits due to unscheduled system down-time.

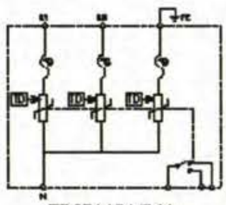
CRITEC® TD technology helps ensure reliable and continued operation during sustained and abnormal over-voltage events. Internal thermal disconnect devices help ensure safe behavior at end-of-life. A visual indicator flag provides user-feedback in the event of such operation. As standard, the TDS provides a set of voltage-free contacts for remote signaling that maintenance is due.

The convenient plug-in module and separate base design facilitates replacement of a failed surge module without needing to undo installation wiring.

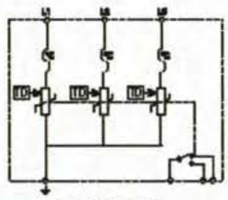


TDS350TT

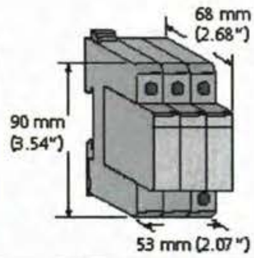




TDS50120/240



TDS350TNC



Model	TDS350TNC150	TDS50120240	TDS350TNC277	TDS350TT150	TDS350TT277
Item Number for Europe	702414	702419	702417	702416	702418
Nominal Voltage, U_n	120-150 VAC		240-277 VAC	120-150 VAC	240-277 VAC
Max Cont. Operating Voltage, U_c	170/295VAC	240/480VAC	320/536VAC	170/295VAC	320/536VAC
Stand-off Voltage	240/415VAC	240/480VAC	480/813VAC	240/415VAC	480/813VAC
Frequency	0-100Hz				
Short Circuit Current Rating, I_{sc}	200kAIC				
Back-up Overcurrent Protection	125AgL, if supply > 100A				
Technology	TD with thermal disconnect				
Max Discharge Current, I_{max}	50kA 8/20μs			12.5kA 10/350μs N-PE 50kA 8/20μs	
Nominal Discharge Current, I_n	25kA 8/20μs		20kA 8/20	25kA 8/20μs	20kA 8/20
Protection Modes	L-N	L-N, N-PE	L-N	L-N, N-PE	
Voltage Protection Level, U_p	400V @ 3kA 1.0kV @ In		800V @ 3kA 1.6kV @ In	400V @ 3kA 1.0kV @ In	800V @ 3kA 1.6kV @ In
Status	N/O, N/C Change-over contact, 250V~/0.5A, max 1.5 mm² (#14AWG) terminals Mechanical flag / remote contacts				
Dimensions H x D x W: mm (in)	90 x 68 x 53 (3.54 x 2.68 x 2.07)			90 x 68 x 70 (3.54 x 2.68 x 2.76)	
Module Width	3 M			4 M	
Weight: kg (lbs)	0.36 (0.79)			0.5 (1.10)	
Enclosure	DIN 43 880, UL94V-0 thermoplastic, IP 20 (NEMA-1)				
Connection	≤25 mm² (#4AWG) stranded ≤35 mm² (#2AWG) solid				
Mounting	35 mm top hat DIN rail				
Temperature	-40°C to 80°C (-40°F to 176°F)				
Humidity	0% to 90%				
Approvals	CE, IEC® 61643-1, UL® 1449 Ed 3 Recognized Component Type 2				
Surge Rated to Meet	ANSI®/IEEE® C62.41.2 Cat A, Cat B, Cat C ANSI®/IEEE® C62.41.2 Scenario II, Exposure 2, 50kA 8/20μs IEC 61643-1 Class II UL® 1449 Ed3 In 20kA mode				
Replacement MOV Module	TDS150M150		TDS150M277	TDS150M150	TDS150M277
Replacement GDT Module	-			SGD112M	
Replacement GDT Module (Europe)	-			702403	

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APPENDIX K– RTU SURGE REDUCTION FILTER

ERITECH

Features

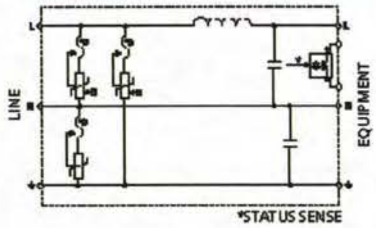
- CRITEC® Transient Discriminating (TD) Technology provides increased service life
- In-line series protection
- High efficiency low pass sine wave filtering – ideal for the protection of switched mode power supplies
- Three modes of protection: L-N, L-PE & N-PE
- 35 mm DIN rail mount – simple installation
- LED status indication and opto-isolated output – for remote status monitoring
- CE, UL® 1449 Ed. 3 Listed

TDF

CRITEC® Transient Discriminating Filter

The TDF series has been specifically designed for process control applications to protect the switched mode power supply units on devices such as PLC controllers, SCADA systems and motor controllers. Units are UL® Recognized and available for 3A, 10A and 20A loads and suitable for 110-120V ac/dc and 220-240Vac circuits.

The TDF is a series connected, single phase surge filter providing an aggregate surge capacity of 50kA (8/20µs) across L-N, L-PE, and N-PE. The low pass filter provides up to 65dB of attenuation to voltage transients. Not only does this reduce the residual let-through voltage, but it also helps further reduce the steep voltage rate-of-rise providing superior protection for sensitive electronic equipment.



Model	TDF3A120V	TDF3A240V	TDF10A120V	TDF10A240V	TDF20A120V	TDF20A240V
Item Number for Europe	700001	700002	700003	700004	700005	700006
Nominal Voltage, U_n	110-120 V	220-240 V	110-120 V	220-240 V	110-120 V	220-240 V
Distribution System	TN-C-S, TN-S					
Max Cont. Operating Voltage, Uc	170VAC	340VAC	170VAC	340VAC	170VAC	340VAC
Stand-off Voltage	240V	400V	240V	400V	240V	400V
Frequency	0-60Hz	50/60Hz	0-60Hz			50/60Hz
Max Line Current, I_L	3 A		10 A		20 A	
Operating Current @ U_n	135 mA	250 mA	240 mA	480 mA	240 mA	480 mA
Max Discharge Current, I_{max}	10kA 8/20µs N-PE 20kA 8/20µs L-N 20kA 8/20µs L-PE					
Protection Modes	All modes protected					
Technology	In-line series low pass sinewave filter TD Technology					
Voltage Protection Level, U_p	500V @ 500A 250V @ 3kA	700V @ 500A 600V @ 3kA	500V @ 500A 250V @ 3kA	700V @ 500A 600V @ 3kA	500V @ 500A 250V @ 3kA	700V @ 500A 600V @ 3kA
Filtering	-62dB @ 100kHz		-65dB @ 100kHz		-53dB @ 100kHz	
Status	Green LED. On=Ok. Isolated opto-coupler output					
Dimensions H x D x W: mm (in)	90 x 68 x 72 (3.54 x 2.68 x 2.83)		90 x 68 x 144 (3.54 x 2.68 x 5.67)			
Module Width	4 M		8 M			
Weight: kg (lbs)	0.7 (1.54)		1.48 (3.25)		1.57 (3.46)	
Enclosure	DIN 43880, UL94V-0 thermoplastic, IP 20 (NEMA®-1)					
Connection	1 mm² to 6 mm² (#18AWG to #10)					
Mounting	35 mm top hat DIN rail					
Back-up Overcurrent Protection	3A		10A		20A	
Temperature	-35°C to 55°C (-31°F to 131°F)					
Humidity	0% to 90%					
Approvals	C-Tick, CE (NOM 3A, 120V), CSA 22.2, UL® 1283, UL® 1449 Ed 3 Recognized Component Type 2					
Surge Rated to Meet	ANSI®/IEEE® C62.41.2 Cat A, Cat B, Cat C					

(1) Opto-coupler output can be connected to DINLINE Alarm Relay (DAR275V) to provide Form C dry contacts.

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ERICO

ERITECH

Features

- In-line series protection
- EMI/RFI noise filtering – protects against industrial electrical noise
- Compact design – fits into motor control and equipment panels
- Three modes of protection: L-N, L-PE & N-PE
- 35 mm DIN rail mount – simple installation
- LED power indicator

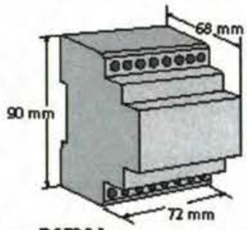
DSF

CRITEC® Dinline Surge Filter

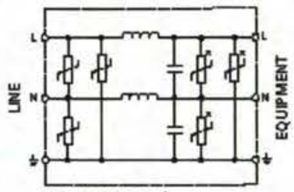
The "two port" DSF series has been specifically designed for process control applications to protect the switched mode power supply units on devices such as PLC controllers, SCADA systems and motor controllers. The 30V unit is suitable for 12V and 24Vac/dc signaling and control systems.

The 6A DSF series incorporates a space efficient, low pass, series filter which provides attenuation to high frequency interference. The larger 20A model provides status indication and a higher surge rating, making this ideal for the protection of higher risk equipment.

DSF6A



DSF20A



*DSF20A275V only

Model	DSF6A30V	DSF6A150V	DSF6A275V	DSF20A275V
Item Number for Europe	702090	701000	701030	701020
Nominal Voltage, U_n	24	110-120 V	220-240 V	
Distribution System	1Ph 2W+G			
System Compatibility	TN-S, TN-C-S			
Max Cont. Operating Voltage, Uc	30VAC, 38VDC	150VAC	275VAC	
Frequency	0-60Hz	50/60Hz		
Max Line Current, I_L	6A			20A
Operating Current @ U_n	7 mA			
Max Discharge Current, I_{max}	4kA 8/20µs	16kA 8/20µs		15kA 8/20µs L-N 15kA 8/20µs L-PE 25kA 8/20µs N-PE
Protection Modes	All modes protected			
Technology	In-line series filter MOV			
Voltage Protection Level, U_p	110V @ 3kA	400V @ 3kA	750V @ 3kA	710V @ 3kA
Filtering	-3dB @ 300kHz			-3dB @ 62kHz
Status	LED power indicator			Status indicator
Dimensions H x D x W: mm(in)	90 x 68 x 36 (3.54 x 2.68 x 1.42)			90 x 68 x 72 (3.54 x 2.68 x 2.83)
Module Width	2 M			4 M
Weight: kg(lb)	0.2 (0.441)			0.7 (1.543)
Enclosure	DIN 43 880, UL94V-0 thermoplastic, IP20 (NEMA-1)			
Connection	1 mm² to 6 mm² (#18AWG to #10AWG)			
Mounting	35 mm top hat DIN rail			
Back-up Overcurrent Protection	6A			20A
Temperature	-35°C to 55°C (-31°F to 131°F)			
Humidity	0% to 90%			
Approvals	C-Tick, CE, NOM, UL® 1449 Ed 3 Recognized Component Type 2	C-Tick, CE		
Surge Rated to Meet	ANSI®/IEEE® C62.41.2 Cat A, Cat B			

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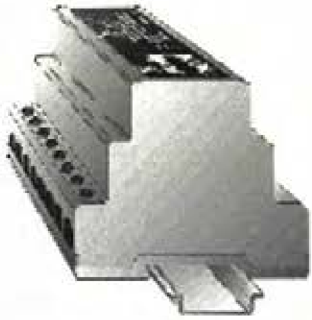
ERICO

TRANSIENT DISCRIMINATING FILTER

INSTALLATION INSTRUCTIONS



MODEL NUMBER
TDF-3A-120V
TDF-10A-120V
TDF-20A-120V
TDF-3A-240V
TDF-10A-240V
TDF-20A-240V

1. PREPARATION

DANGER: *Electrical shock or burn hazard. Installation of this Transient Voltage Surge Suppressor should only be made by qualified personnel. Failure to lockout electrical power during installation or maintenance can result in fatal electrocution or severe burns. Before making any connections to this electrical panel be sure that power has been removed from all associated wiring, electrical panels, and other electrical equipment.*

CAUTION NOTES:

1. *The installation of this Surge Protector should follow all applicable electrical codes, such as the National Electrical Code, or the Canadian Electrical Code.*
2. *Check to make sure line voltage does not exceed Surge Protector voltage requirement.*
3. *Prior to installation ensure that the TDF is of the correct voltage, current, and frequency rating for your application.*
4. *The earth terminal must be connected to a low impedance earth (< 10 ohms) for correct operation.*
5. *Do not perform a "Flash Test" or use a Mega-Ohm Meter (Megger) to test circuits that are protected with TDF modules. Damage may occur to the TDF modules.*
6. *Follow all instructions to ensure correct and safe operation.*
7. *Do not attempt to open or tamper with the TDF units in any way as this may compromise performance and will void warranty.*

2. INTRODUCTION

Transient Discriminating Filters (TDF) are packaged in "DIN 43 880" profile enclosures for simple installation onto 35mm DIN rails. They can be selected for use on distribution systems with nominal RMS voltages of 120Vac or 240Vac at frequencies of 50/60Hz. The 120Vac unit also operates on nominal 125Vdc supplies.

3. QUICK INSTALLATION OVERVIEW

Install in the following manner:

1. Ensure that power is removed from the area and the circuits that will be connected.
2. Snap lock the TDF module to the DIN rail.
3. Install the appropriate upstream overcurrent protection.
4. Connect wiring to the indicated i/p and o/p terminals.
5. Apply power and observe correct operation of the Status Indication, and alarm facilities if provided - see Section 11.

4. PROTECTION CONCEPTS

To optimize effectiveness of the TDF protection, the unprotected and protected wiring should be separated. Wiring from the exposed transient source to the TDF should be considered unprotected and kept approximately 12" (300mm) from all other wiring wherever possible. Wiring on the equipment side of the TDF should be considered protected.

The separation of protected and unprotected wiring is recommended to minimize the risk that transients conducted on unprotected wiring may cross couple onto protected circuits, and diminish the level of protection available from the TDF module.

The terminals on the TDF module are labeled "INPUT/LINE" (unprotected side) and "OUTPUT/LOAD" (protected side) assuming that the source of the transients is on the input side of the TDF module.

For applications where the transient source is on the load side of the TDF module, the TDF should be reverse connected with the INPUT/LINE terminals connected to the load side, toward the source of the transients.

ERICO

TRANSIENT DISCRIMINATING FILTER

5. MOUNTING

TDFs are designed to clip to 35mm DIN rails (standard EN50022). Unless otherwise mechanically restrained, use horizontal DIN rails with the TDF module spring clips to the bottom and the label text the correct way up.

NOTE: *TDFs must be installed in an enclosure or panel that:*

- *prevents the TDF unit temperature from exceeding 122°F (50°C)*
- *provides adequate electrical and safety protection*
- *prevents the ingress of moisture and water*
- *allows TDF status indicators to be inspected*

6. GROUND FAULT CIRCUIT INTERRUPTION (GFCI)

Where GFCI protectors (RCDs/ELCBs) are used, it is preferable that the TDF modules be installed prior to these devices (i.e. upstream). If this is not done, nuisance tripping of the GFCIs may occur during transient activity.

7. CONDUCTOR TERMINATION

Each TDF terminal is designed to accept wire sizes from 10 to 18 AWG (1.5mm² to 6mm²) solid or stranded conductor. The wire insulation should be stripped back 5/16" (8mm).

NOTE: *Do not use greater than 9inlbs (1Nm) of torque when tightening the terminals. For UL compliance, where two wires may need to be terminated into one terminal, the permissible wire size is 18AWG each.*

8. FUSING AND ISOLATION

Overcurrent protection must be installed in the upstream circuit of every TDF to provide protection to the unit itself, the load and the wiring in case of fault situations. The current rating of the breaker or fuse used should be determined according to below. However, the current rating should be less than the rating of the wiring. For example, if a 20A TDF were installed in a circuit with wiring that can carry 15A, then a 15A overcurrent device must be installed upstream to protect both the TDF and wiring from overload.

MAX FUSE SIZES:	*TDF RATING*	*FUSE RATING*
	3A	**4A**
	10A	**10A**
	20A	**20A**

9. STATUS INDICATION

TDF modules have a single Status Indicator on the front panel. When power is applied and full surge capacity is available, the Status Indicator will be illuminated. Should power be applied and the indicator fail to illuminate, the TDF should be replaced, as optimum protection is no longer provided.

10. MAINTENANCE & TESTING

Before removing a TDF module from service, ensure that the power has been removed from the module. Replacement of a TDF module should only be undertaken by qualified personnel.

NOTE: *TDF units should be inspected periodically, and also following any periods of lightning or transient voltage activity. Check the Status Indicator and replace the module if it is not illuminated as detailed in Section 9 STATUS INDICATION.*

11. DINLINE ALARM RELAY (DAR)

The TDF status monitoring circuit which provides the visual Status Indicator, also provides a low voltage opto-coupler alarm output circuit. Should voltage free alarm contacts be required, the ERICO Inc, DINLINE ALARM RELAY (DAR) should be used.

The DAR module provides a fully isolated dry contact alarm output. One DAR can be used per TDF, or up to 16 TDFs can be connected in series to one DAR to provide a common dry contact alarm output.

Ensure that the voltage rating of the alarm wiring is rated in accordance with the other voltages present in the equipment. This would normally be the same voltage rating as that used for the TDF module input wiring.

It is recommended that the DAR unit be powered from the output/load side of the TDF being monitored, however the DAR can be powered from other circuits. This allows for example, one DAR unit to be connected to separate TDFs which are protecting a three phase circuit.

NOTE: *Depending upon the usage of the DAR output contacts, failure of power to the DAR may be interpreted as a failure of one or more TDFs. Visual inspection of the DAR and TDF Status Indicator is required to clarify this situation.*

12. USE OF OTHER INTERFACES

ERICO, Inc. DAR units are recommended for the interfacing of equipment to the TDF opto-coupler alarm output circuit. The direct connection of other equipment to the TDF opto-coupler alarm output circuit may not provide sufficient isolation or exceed the opto-coupler specifications. This may damage the TDF and/or the connected equipment. Warranty may be voided under such circumstances. However, the specifications for TDF alarm output has been provided for those who desire to use the TDF opto-coupler output directly.

The TDF alarm opto-coupler output is available on terminals 3 and 5. Terminal 3 is the positive and 5 is the negative side. This output is an open collector transistor output of the opto-coupler. When the opto-coupler is driven on, it should be arranged to have 2mA flowing through it. For use with 24Vdc circuits, a 12kΩ current limiting burden resistor is required. For use with 12Vdc circuits, a 5.6kΩ current limit resistor is required. For use with 5Vdc circuits, a 2.2kΩ current limit resistor is required.

NOTE: *In connecting to the TDF opto-coupler alarm output, do not reverse the +/- connections or exceed the maximum permissible ratings (30Vdc) as damage may occur.*

APPENDIX L– SWITCBOARD – PHASE FAILURE RELAY

tyco | Electronics | Energy Division **INSTALLATION INSTRUCTIONS**

Page 1 of 2

Ref: IW250PMSH – Rev 6 – March 02

Models Covered

252-PMM	252-PMT	252-PSF	252-PSG
253-PH3	252-PMM	252-PMT	

Introduction

Thermistor Trip Relay (252-PMM & 252-PMT).
The trip inputs are monitored within settable limits. In the event of the input moving outside these limits, the unit will initiate a trip signal via a double pole changeover relay. An illuminated green LED indicates when the thermistor temperature is within normal working limits. The unit is designed such that the alarm relay is energised when normal temperatures are reached.
Model 252-PMM has the facility for manual resetting, so that the trip condition remains after normal operating temperature is reached, until manual intervention occurs.

Phase Balance Relay (252-PSF & 252-PSG)
Trip inputs are monitored within settable limits. In the event of the input moving outside these limits, the unit will initiate a trip signal via a double pole changeover relay. An illuminated red LED indicates that the supply is within limits.

Speed Sensing Relay (253-PH3)
Trip inputs are monitored within settable limits. In the event of the input moving outside these limits, the unit will initiate a trip signal. The illuminated red LED's indicates that the single pole output relays are in an energised state and at normal running speed all three relays should be energised. Units are factory adjusted for normal running speed = 0.75mA output. The meter adjust pot on the product front is used for this requirement, which also ensures the trip levels are set to the calibrated values. Terminal 8 is connected to terminal 5 internally. Terminals 15 and 16 give a 0/1mA signal proportional to speed.

No.1 Relay energises on rising speed
No.2 Relay energises on rising speed
No.3 Relay de-energises on rising speed

This product is designed for use only with magnetic coil inductive sensors.

Warning

- During normal operation, voltages hazardous to life may be present at some of the terminals of this unit. Installation and servicing should be performed only by qualified, properly trained personnel abiding by local regulations. Ensure all supplies are de-energised before attempting connection or other procedures.
- It is recommended adjustments be made with the supplies de-energised, but if this is not possible, then extreme caution should be exercised.
- Terminals should not be user accessible after installation and external installation provisions must be sufficient to prevent hazards under fault conditions.
- This unit is not intended to function as part of a system providing the sole means of fault protection - good engineering practice dictates that any critical function be protected by at least two independent and diverse means.

Never open circuit the secondary winding of an energised current transformer.

Crompton INSTRUMENTS

Protector Trip Relays
DIN Rail & Wall Mounted 250 Series
Thermistor Trip, Speed Sensing & Phase Angle

Installation
The Protector should be installed in a dry position, not in direct sunlight and where the ambient temperature is reasonably stable and will not be outside the range 0 to 60 degrees Celsius. Mounting will normally be on a vertical surface but other positions will not affect the operation. Vibration should be kept to a minimum. The Protectors are designed for mounting on a 35mm rail to DIN 46277. Alternatively they may be screw fixed; a special adaptor is supplied to mount 252 types.

To mount a protector on a DIN rail, the top edge of the cutout on the back is hooked over one edge of the rail and the bottom edge carrying the release clip clicked into place. Check that the unit is firmly fixed. Removal or repositioning may be achieved by levering down the release clip and lifting the unit up and off the rail.

Connection diagrams should be carefully followed to ensure correct polarity and phase rotation where applicable. External voltage transformers may be used on 252-PSF and 252-PSG to extend the range.

252-PMM, 252-PMT & 253-PH3
Pick up, input and output leads should be kept separate from any other wiring.

Setting Controls (252-PSF, 252-PSG)
These products have two calibration facilities that can be set to suit operating requirements and they are factory calibrated as follows:-

1. % unbalance set points
   Voltages of and below 380 volts L-L are calibrated to 1.0% class index of rated voltage. Voltages above 380 volts L-L are calibrated to 1.5% class index of rated voltage.
2. Time Delay
   For all voltage ranges 10% maximum delay.
3. Voltage Withstand
   Continuous overload = 1.35 x rated voltage

Setting Up (all other models)
The calibration marks around the controls are provided as a guide if the installer does not have access to accurate equipment. The maximum error of the calibration marks is typically 10% of the span of the control concerned.

Maintenance
The unit should be inspected to normal standards for this class of equipment. For example remove accumulations of dust and check all connections for tightness and corrosion. In the unlikely event of a repair being necessary it is recommended that the unit be returned to the factory or to the nearest Crompton Instruments Service Centre

Electromagnetic Compatibility
This unit has been designed to provide protection against EM (electro-magnetic) interference in line with requirements of EU and other regulations. Precautions necessary to provide proper operation of this and adjacent equipment will be installation dependent and so the following can only be general guidance:-

- Avoid routing wiring to this unit alongside cables and products that are, or could be, a source of interference.

Page 2 of 2

Ref: IW250PMSH – Rev 6 – March 02

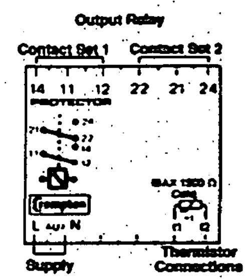
INSTALLATION INSTRUCTIONS

Protector Trip Relays
DIN Rail & Wall Mounted 250 Series
Thermistor Trip, Speed Sensing & Phase Angle

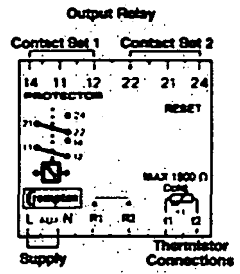
- The auxiliary supply to the unit should not be subject to excessive interference. In some cases, a supply line filter may be required.
- To protect the product against incorrect operation or permanent damage, surge transients must be controlled. It is good EMC practice to suppress differential surges to 2kV or less at the source. The unit has been designed to automatically recover from typical transients, however in extreme circumstances it may be necessary to temporarily disconnect the auxiliary supply for a period of greater than 5 seconds to restore correct operation.
-
- Screened communication and small signal leads are recommended and may be required. These and other connecting leads may require the fitting of RF suppression components, such as ferrite absorbers, line filters etc., if RF fields cause problems.

It is good practice to install sensitive electronic instruments that are performing critical functions in EMC enclosures that protect against electrical interference causing a disturbance in function.

252-PMT

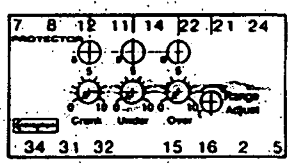


252-PMM

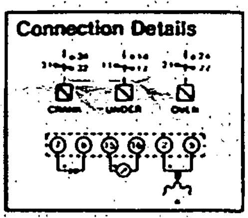


252-PMM can operate in either an automatic or a manual reset mode.
For automatic the reset link R1-R2 is to be disconnected.
For manual the reset link R1-R2 must be inserted.

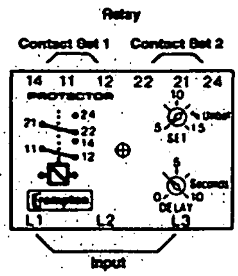
253-PH3



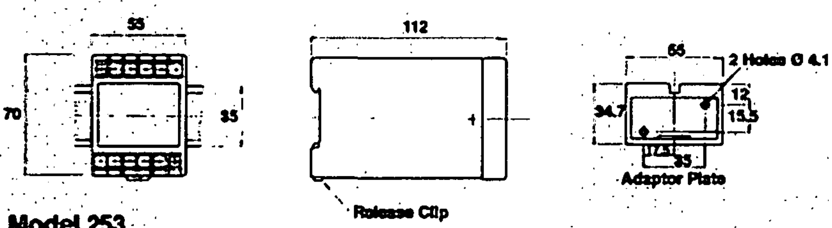
253-PH3



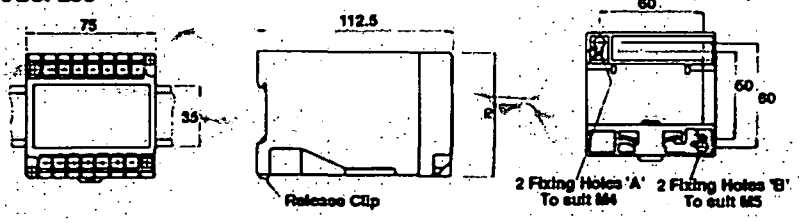
252-PSF
252-PSG



Model 252



Model 253



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APPENDIX M– SWITCBOARD – RTU POWER SUPPLY

SECURITY

PB251 Series

220-330 WATTS DC UPS

Features

- **Ultra-low noise output**
- **Independent battery charging output**
- **DC output OK & battery OK alarms & LEDs**
- **Battery-LVD and alarm**
- **Over-temperature protection**
- **Battery fuse fail LED**

Specifications

INPUT	
Voltage:	190 to 264 vac, or 190 to 400VDC
Line regulation:	0.2%typical
Current:	1.4A maximum
Inrush current:	10A maximum
Frequency:	45 to 65 Hz
OUTPUT	
Voltage	See table
Current	See table
Load regulation	0.5%typical
Current limit type - load cct	Constant current
Current limit type - batt. cct	Constant current
Short circuit protection	Indefi nite, auto-resetting
Over-voltage protection	17.5 to 20V latching (13.8Vdc output) 31.5 to 39V latching (27.6Vdc output)
Ripple & noise 100 MHz bandwidth	28mVp-p (13.8Vdc output) 55mVp-p (27.6Vdc output)
ENVIRONMENTAL	
Operating temperature	0 to 70°C ambient with derating, 5...90% relative humidity (non-condensing)
Over-temperature protection	Automatic & auto-resetting
Cooling requirement	Natural convection
Efficiency	80% minimum

STANDARDS & APPROVALS	
Safety	Complies with AS/NZS 60950, class 1, NSW Office of Fair Trading Approval N20602
EMC	Emissions comply with AS/NZS CISPR11, Group 1, Class B. Complies with ACA EMC Scheme, Safety & EMC Regulatory Compliance Marked
Isolation i/p-o/p i/p-ground o/p-ground	4242VDC for 1 minute 2121VDC for 1 minute 707VDC for 1 minute
ALARMS & BATTERY FUNCTIONS	
Converter ON/OK alarm	Indicated by voltage-free changeover relay contacts &
green LED	ON=PSU OK
Battery low (& fuse) alarm	10.2 to 12.6V for 12V battery, adjustable 20.4 to 25.2V for 24V battery, adjustable Indicated by voltage-free changeover relay contacts & green LED: ON=BATT OK
Low voltage disconnect	9.6 to 12V for 12V battery, adjustable 19.2 to 24V2 for 4V battery, adjustable
Charger over-load protection	Auto-resetting electronic circuit breaker
Reverse polarity protection	Internal battery fuse
Battery to load voltage drop	0.2 to. 0.25V typical
MECHANICAL	
Case size	264 L x 172 W x 67 H mm
Case size with heatsink	264 L x 186 W x 67 H mm
Rack size	232 D x 19" W x 2RU H
Weight	1.9 kg
Weight with heatsink	2.1 kg
Weight (rack mounted version)	5.5 kg

Selection Table

MODEL NUMBER	OUTPUT VDC	I_{LOAD}	I_{BATT}	OUTPUT POWER
PB251-12CM	13.8V	16A	2A	220W
PB251-12CM-H	13.8V	20A	2A	275W
PB251-24CM	27.6V	11A	2A	300W
PB251-24CM-H	27.6V	12A	2A	330W
PB251-12RML	13.8V	20A	4A	275W
PB251-12B	13.8V	20A	4A	275W
PB251-24RML	27.6V	12A	2A	330W

Note: Non standard battery charging current available on request. ie PB251-12CM-H-10 for 10A.

322

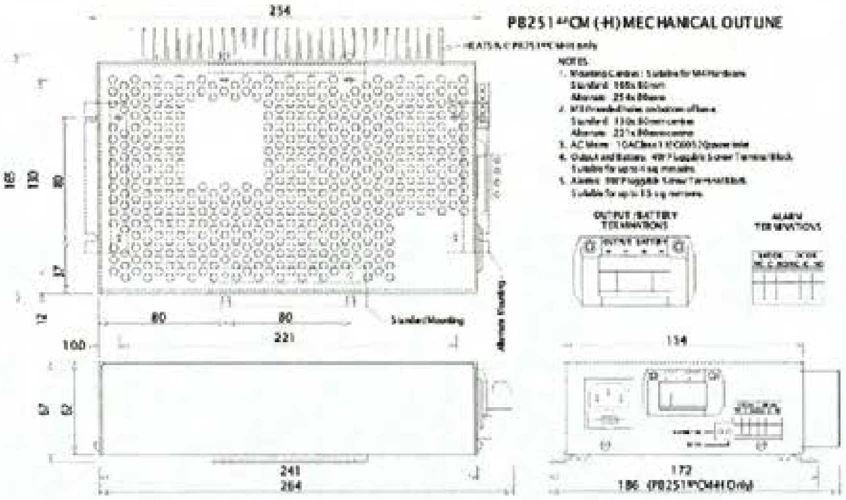
powerbox

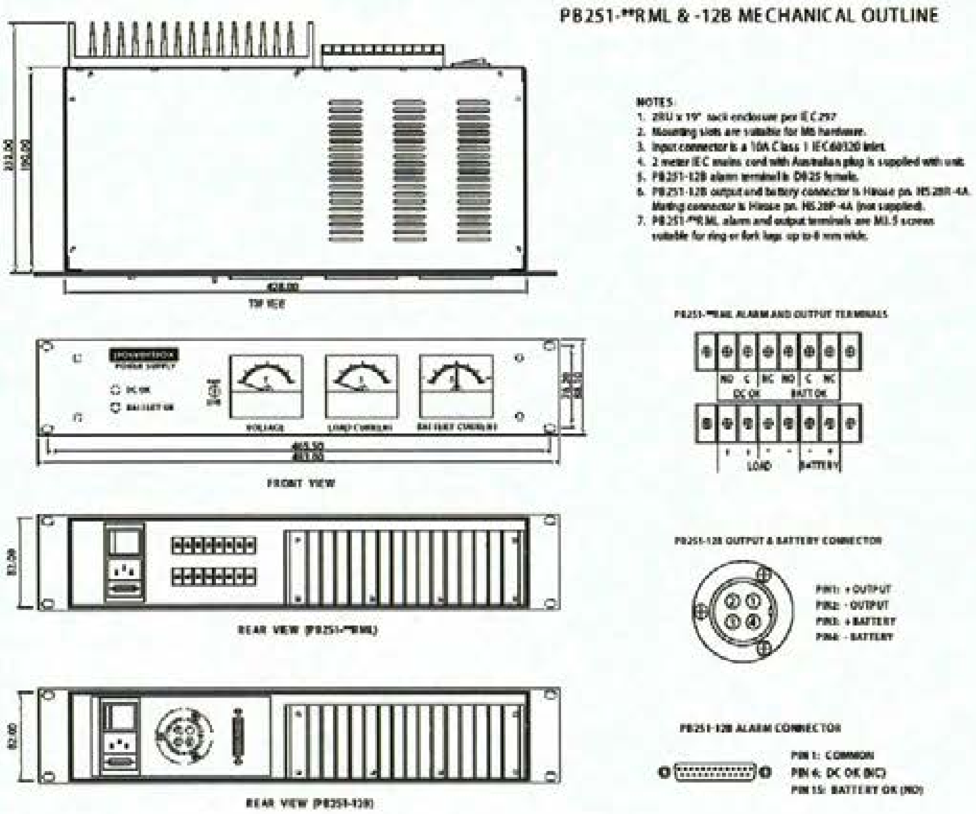
SECURITY

PB251 Series

275-330 WATTS DC UPS

Technical Illustrations





Your dependable power partner – www.powerbox.com.au

323

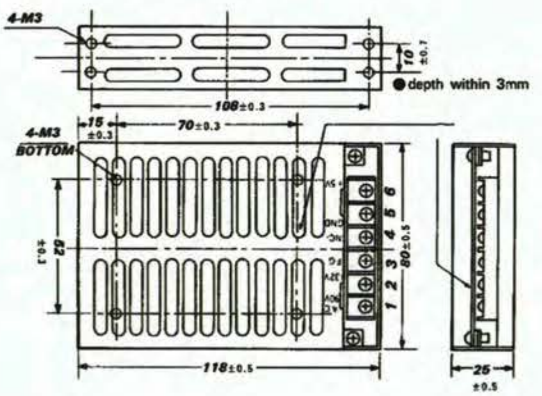
PBIH Series

15-150 WATTS DC/DC SINGLE OUTPUT

Selection Table

MODEL NUMBER	INPUT	OUTPUT		OUTPUT POWER
PBIH-1205F	9.2-16V	5V	3A	15W
PBIH-1212F	9.2-16V	12V	1.2A	15W
PBIH-1215F	9.2-16V	15V	1A	15W
PBIH-1224F	9.2-16V	24V	0.62A	15W
PBIH-2405F	19-32V	5V	3A	15W
PBIH-2412F	19-32V	12V	1.2A	15W
PBIH-2415F	19-32V	15V	1A	15W
PBIH-2424F	19-32V	24V	0.62A	15W
PBIH-4805F	38-63V	5V	3A	15W
PBIH-4812F	38-63V	12V	1.2A	15W
PBIH-4815F	38-63V	15V	1A	15W
PBIH-4824F	38-63V	24V	0.62A	15W
PBIH-11005F	85-140V	5V	3A	15W
PBIH-11012F	85-140V	12V	1.2A	15W
PBIH-11015F	85-140V	15V	1A	15W
PBIH-11024F	85-140V	24V	0.62A	15W
PBIH-1205G	9.2-16V	5V	5A	25W
PBIH-1212G	9.2-16V	12V	2.1A	25W
PBIH-1215G	9.2-16V	15V	1.7A	25W
PBIH-1224G	9.2-16V	24V	1.1A	25W
PBIH-1248G	9.2-16V	48V	0.5A	25W
PBIH-2405G	19-32V	5V	5A	25W
PBIH-2412G	19-32V	12V	2.1A	25W
PBIH-2415G	19-32V	15V	1.7A	25W
PBIH-2424G	19-32V	24V	1.1A	25W
PBIH-2448G	19-32V	48V	0.5A	25W
PBIH-4805G	38-63V	5V	5A	25W
PBIH-4812G	38-63V	12V	2.1A	25W
PBIH-4815G	38-63V	15V	1.7A	25W
PBIH-4824G	38-63V	24V	1.1A	25W
PBIH-4848G	38-63V	48V	0.5A	25W
PBIH-11005G	85-140V	5V	5A	25W
PBIH-11012G	85-140V	12V	2.1A	25W
PBIH-11015G	85-140V	15V	1.7A	25W
PBIH-11024G	85-140V	24V	1.1A	25W
PBIH-11048G	85-140V	48V	0.5A	25W
PBIH-1205J	9.2-16V	5V	8A	50W
PBIH-1212J	9.2-16V	12V	3.3A	50W
PBIH-1215J	9.2-16V	15V	2.7A	50W
PBIH-1224J	9.2-16V	24V	1.7A	50W
PBIH-1248J	9.2-16V	48V	0.8A	50W
PBIH-2405J	19-32V	5V	10A	50W
PBIH-2412J	19-32V	12V	4.3A	50W
PBIH-2415J	19-32V	15V	3.4A	50W
PBIH-2424J	19-32V	24V	2.5A	50W
PBIH-2448J	19-32V	48V	1A	50W
PBIH-4805J	38-63V	5V	10A	50W
PBIH-4812J	38-63V	12V	4.3A	50W
PBIH-4815J	38-63V	15V	3.4A	50W
PBIH-4824J	38-63V	24V	2.5A	50W
PBIH-4848J	38-63V	48V	1A	50W
PBIH-11005J	85-140V	5V	10A	50W
PBIH-11012J	85-140V	12V	4.3A	50W
PBIH-11015J	85-140V	15V	3.4A	50W
PBIH-11024J	85-140V	24V	2.5A	50W
PBIH-11048J	85-140V	48V	1A	50W
PBIH-1205M	9.2-16V	5V	18A	100W
PBIH-1212M	9.2-16V	12V	9A	100W
PBIH-1215M	9.2-16V	15V	7A	100W
PBIH-1224M	9.2-16V	24V	4.5A	100W
PBIH-1248M	9.2-16V	48V	2A	100W
PBIH-2405M	19-32V	5V	20A	100W
PBIH-2412M	19-32V	12V	9A	100W
PBIH-2415M	19-32V	15V	7A	100W
PBIH-2424M	19-32V	24V	5A	100W
PBIH-2448M	19-32V	48V	2A	100W
PBIH-4805M	38-63V	5V	20A	100W
PBIH-4812M	38-63V	12V	9A	100W
PBIH-4815M	38-63V	15V	7A	100W
PBIH-4824M	38-63V	24V	5A	100W
PBIH-4848M	38-63V	48V	2A	100W
PBIH-11005M	85-140V	5V	20A	100W
PBIH-11012M	85-140V	12V	9A	100W
PBIH-11015M	85-140V	15V	7A	100W
PBIH-11024M	85-140V	24V	5A	100W
PBIH-11048M	85-140V	48V	2A	100W
PBIH-1205R	9.2-16V	5V	27A	150W
PBIH-1212R	9.2-16V	12V	13A	150W
PBIH-1215R	9.2-16V	15V	10A	150W
PBIH-1224R	9.2-16V	24V	6.5A	150W
PBIH-1248R	9.2-16V	48V	3.3A	150W
PBIH-2405R	19-32V	5V	30A	150W
PBIH-2412R	19-32V	12V	14A	150W
PBIH-2415R	19-32V	15V	11A	150W
PBIH-2424R	19-32V	24V	7A	150W
PBIH-2448R	19-32V	48V	3.5A	150W
PBIH-4805R	38-63V	5V	30A	150W
PBIH-4812R	38-63V	12V	14A	150W
PBIH-4815R	38-63V	15V	11A	150W
PBIH-4824R	38-63V	24V	7A	150W
PBIH-4848R	38-63V	48V	3.5A	150W
PBIH-11005R	85-140V	5V	30A	150W
PBIH-11012R	85-140V	12V	14A	150W
PBIH-11015R	85-140V	15V	11A	150W
PBIH-11024R	85-140V	24V	7A	150W
PBIH-11048R	85-140V	48V	3.5A	150W

PBIH-F



· Dimensions in mm

terminal No.	
1	0 V (DC in)
2	+V (DC in)
3	FG
4	NO Connection
5	−V out
6	+V out

APPENDIX N– SWITCBOARD – RADIO

TRIO

DATACOM

TC-900DR

900 MHz
Full Duplex Data Transceiver

User Manual

Issue 13 : February 2001

TABLE OF CONTENTS

Modifications

Issue 1	February 1993 (Preliminary)
Issue 2	May 1993 Major Changes to Section 3
Issue 3	September 1993
	Minor Changes to sections, 3.1, 3.2.1, 3.2.2.1, 3.2.7, 3.4.3, 3.4.4, 4.4, 4.5, 4.7, 4.7.2, 4.7.3
	Major Changes; Inserted new section 3.2.6 KISS/SLIP Deleted section 4 Programming Deleted section 5.7.5, 5.7.6, 5.7.7 AFC Alignment
	Removed Filter Alignment Setup Diagram
	Inserted RSSI Level of Received Signal (typical)
Issue 4	February 1994
	Minor Changes to all sections
	Additions to Section 3 for Firmware V2.2 and Synchronous Operation
Issue 5	March 1994
	Addition of section 5.2.6.1 and 5.2.6.4
	Revised figure on page 75
Issue 6	September 1994
	Addition to Section 3.2.5, 4.7.1, 4.7.2, 4.7.3, 4.7.4
	Addition of Sections 3.3.11.1, 3.3.11.2, 4.5.1,
Issue 7	April 1995
	Addition to Sections 3.8.11.2 and 3.8.12.5 Rev D Sync LED
Issue 8	September 1995
	Insertion of new Section 3.2
Issue 9	June 1998
	Section 3.3.6 replaced
Issue 10	February 1999

Modifications (cont.)

Issue 11	February 1999 Minor changes to Sections 1.5, 3.3.1, Deleted Section 1.6, 4.5.1 Replaced Section 5
Issue 12	July 2000 Minor Change to Section 7
Issue 13	February 2001 Change of Company Name

SECTION 1

INTRODUCTION

1 INTRODUCTION

1.1 GENERAL

The TC-900DR is a Full Duplex 900 MHz Radio, featuring a fully integrated 4800 or 9600 bps data modem.

The entire unit is housed in a robust metal enclosure that provides a compact and transportable means for the transmission of data over radio.

The product has been fully designed and developed in Australia, by an Australian owned and managed company.

The TC-900DR meets the ACA SP4/89 specification which covers radio data transmissions over point-to-point and point-to-multipoint systems.

It is ideally suited for applications such as :

- Transaction Processing.
- Public Utility Telemetry Systems.
- Alarm Monitoring.
- Supervisory Control and Data Acquisition.
- Energy Distribution.
- Inventory Control
- Common Carrier Data Services.
- Temporary Installations

The modem provides byte oriented packet data communications over narrow band FM systems, using digital filtered binary FSK modulation.

The TC-900DR can be supplied for use with 12.5kHz, 15kHz, 25kHz or 30kHz channel spacings. Its operational parameters can be programmed with the TC-D Series installation programmer. This is a separate software package that runs on an IBM compatible PC under Windows 95/98/NT.

1.2 FACTORY QUALITY ASSURANCE

The TC-900DR has been designed and manufactured with particular emphasis placed on the following points :

- State of the art design techniques.
- Simple assembly/disassembly.
- Minimal alignment requirements.
- Manufactured using quality components.

All units have been manufactured using automated assembly procedures. This assures attention to detail and a high level of quality control.

All components used are of high quality, and conform to Trio DataCom's required specifications. The component suppliers provide batch, date and manufacturing criteria that are required to meet quality control standards.

Each unit is individually tested with an inbuilt self diagnostic program. It is then passed through a set of automatic test procedures with minimal human intervention. This ensures a consistently manufactured and performing product. Many of the alignments are factory set and should not require re-alignment in the field.

Trio DataCom's quality control does not finish here. Once each unit has passed its individual tests, it is placed in a cyclic heat/cooling chamber. This chamber is automatically cycled from -10ºC to +65ºC, twice, over a twenty hour period. During this time, the modem controller - using external precision calibrated test equipment - monitors and stores frequency stability versus temperature data. The TC-900DR uses this information to achieve its temperature compensated, frequency stability level of 1ppm.

Power output is measured during the temperature cycling. This is achieved by having the unit connected to a PC and various test equipment via a GPIB. Units that fail any of these tests are reported by the test program and corrective action taken before going through the complete cycle once again. Each unit shipped from the factory comes with a factory alignment printout which details:

- Configuration.
- Transmit frequency.
- Receive frequency.
- Receiver sensitivity.
- Transmitter power output.
- Transmitter modulation.

In most cases, the radio transmitter as shipped from the factory will require no re-alignment.

It is this care and quality control that ensures that the purchaser of a TC-900DR radio modem, obtains a consistently manufactured and performance specified product, which has been "burned in" to minimise any operational failures.

1.3 FEATURES

Advanced microwave and digital techniques were employed during the design phase of the TC-900DR, ensuring an innovative and state of the art product.

Features include :

- Fully integrated full duplex radio and modem
- Built in antenna diplexer
- Power output +30dBm (1 Watt nom) at antenna connector
- Radio meets ACA SP4/89 requirements 2/90
- In-built transparent remote diagnotics capability.
- Custom single chip modem - digital signal processing
- 4800 & 9600 bps transfer rates, full duplex
- Selectable 110..19k2 asynchronous RS-232 host interface
- Unique collision avoidance facilities
- Integrated supervisory signalling channel
- Software selectable configuration parameters
- Configurable bit error rate testing
- Excessive temperature power fold-back
- Auxiliary port for use with an optional supervisory audio handset

1.4 SPECIFICATIONS

1.4.1 RADIO SECTION

Rx frequency range	:	923MHz to 933MHz (see note 1)
Tx frequency range	:	847MHz to 857MHz (see note 2)
Channel spacing	:	Fully synthesized 12.5kHz / 25kHz, [opt 15/30] with programmable 1/2 channel raster offset
Frequency stability	:	1 ppm (-10°C to 65°C amb), [opt -30°C to 70°C], aging <= 1ppm/Annum
Power output at Antenna connector	:	+30 dBm ±1dBm (1W nom) switchable under software control 200mW/1W
Duty cycle	:	Continuous
Output impedance	:	50 Ohms
Timeout timer	:	Programmable from 1 sec. to 28 minutes (max)
Tx key up time		: <= to 1mS (output _ 1dB of power).
Rx sensitivity	:	0.5uV at antenna input for 12 dB SINAD at "delayed Rx signal" test point.
Rx intermodulation	:	>= 70 dB spurious free dynamic range.
Rx spurious responses	:	<= -65 dB.
Tx spurious emissions	:	<=-65 dBc (ref unmodulated carrier).

Full duplex with single antenna.

Note 1. The reciprocal frequency option for point-to-point operation or point to multi-point base repeaters is available as follows :
- *Rx frequency range 847MHz to 857 MHz.*
- *Tx frequency range 923MHz to 933 MHz.*

Note 2. The transmitter is normally supplied, with its frequency offset from the receiver by 76 MHz.

1.4.2 MODEM SECTION

User Ports	:	DB-9 connector, EIA RS232, DCE, serial asynchronous, 300..19k2 baud, 7/8 bit, no/odd/even parity.
Data Rate	:	4800/9600 bps Full Duplex.
BER	:	Less than 10E-6 @ -105dbm measured at antenna port
Data Format	:	Narrow band digital filtered binary FSK Modulation, using Trio DataCom's DFM4-9 digital modem chipset, including Trio's unique supervisory signalling channel C/DSMA collision avoidance scheme.
Synchronisation Delay	:	20 milliseconds.

1.4.3 RADIO AND MODEM SECTIONS COMBINED

Occupied bandwidth	:	Meets ACA SP4/89 guidelines for point-to-point and point-to-multipoint assignments.
Mean deviation	:	±1.5 kHz (4800bps), ±2.75 kHz (9600bps)
Power requirements	:	14 Volts AC 10VA or 13.8Volts DC (11 to 16V Max).
Transmit current	:	<= to 600 mA.
Receive current	:	175 mA.
Size	:	241mm x 161mm x 65mm.
Weight	:	1.3Kg.

1.4.4 CONNECTORS

User RS-232 Connection	:	DB9 female wired as DCE (modem). (AMP Part # 747844-5)
Mating connectors	:	DB9 male solder type. (AMP Part # 747983-3) Backshell to suit. (AMP Part # 205729-1). Optional supplied to order.
Antenna Connection	:	Gold plated SMA female bulkhead. (E.F.JOHNSON Part # 142-0701-501)
Mating connector	:	SMA male to RG223 crimp type. (E.F.JOHNSON Part # 142-0407-006) Optional supplied to order
AC/DC Power Connector	:	2 pin locking (9A rating). (PCB SOCKET MOLEX Part # M5569-2A2)
Mating connector	:	(RECEPTACLE MOLEX Part# M5557-2R) (RECEPT PINS MOLEX Part # M5556-TL). Supplied with standard unit.
Supervisory Audio Handset Connector	:	6 pin modular jack. (AMP Part # 520250-3)
Mating connector	:	6 pin modular jack plug. (AMP Part # 5-641337-3). Supplied with optional audio handset.

1.5 OPTIONAL ACCESSORIES

Trio stock a large range of ancillary devices including coax cables, RF connectors, antennas, lightning protection, power supplies, etc.

Please contact Sales for futher information.

SECTION 2

HARDWARE TECHNICAL DESCRIPTION

2 HARDWARE TECHNICAL DESCRIPTION

2.1 GENERAL

The TC-900DR is a 900 MHz full duplex radio complete with radio modem and antenna diplexer. In this and subsequent descriptions to follow, references have been made to block diagrams, circuit diagrams and component loading diagrams.

These can be found in appendix A, at the rear of this manual.

The unit can be divided into five major sub-blocks :

Radio section.

Antenna diplexer section.

Audio handset.

Modem section.

Unit housing assembly.

2.2 RADIO SECTION

The radio section is built on a single PCB with approximate dimensions of 193mm x 152mm x 1.6mm.

This section consists of the following main blocks :

- Receiver.
- Transmitter.
- Frequency control.
- Interfaces.

Each of these blocks can be further broken down as follows :

- Receiver.
  - Pre-amplifier.
  - Mixer.
  - 45 MHz I.F. filter.
  - FM I.F. & Demodulator
  - Audio processing.
    - Data.
    - Voice.
  - RSSI processing.
- Transmitter.
  - Audio processing.
    - Data.
    - Voice.
  - Modulator.
  - Multiplier.
  - Mixer.
  - Power amplifier.
  - Control.
    - PTT.
    - Power.
- Frequency control
  - Synthesiser.
  - Local oscillator.
  - AFC
- Interfaces
  - Modem section.
  - Antenna diplexer.
  - Audio handset.

2.2.1 RECEIVER

The general form of the receiver circuitry is shown in diagrams "DR9 Macro Block Diagram" (drawing number TC01-05-19 sheet 3/3), and "900 MHz Radio - Block Diagram" (drawing number TC01-05-19 sheet 2/3).

2.2.1.1 PRE-AMPLIFIER

The receiver pre-amplifier obtains signal direct from the antenna diplexer port - connector X2. It consists of two stages. The first stage is optimised to give a low noise figure, while the second is optimised to produce gain.

The central devices used are MRF5711 high frequency transistors. They provide the basis for a wide band amplifier that can receive from the lowest band frequency range of 852 to 854 MHz to the higher band frequency range of 928 to 930 MHz.

The RF selectivity is provided by the diplexer filter.

Strip line impedance matching networks are employed to ensure optimum performance of the amplifier.

The overall gain of the pre-amplifier is set to 20dB.

2.2.1.2 MIXER

The receiver mixer consists of a 180 "rat race hybrid ring" followed by a passive Schottky mixer diode.

The mixer injection frequency is set 45MHz from the required receive frequency, (high side injection for 930 MHz receive and low side for 850 MHz receive). This results in an I.F. frequency output of 45 MHz.

The level of the injection is set to 6 dBm by the amplifier stage Q3.

2.2.1.3 FIRST I.F. STRIP FILTER

The required receiver mixer product is filtered by the first I.F. filter. The filter is a bandpass crystal controlled device, centred on 45 MHz, and provides image rejection for the second IF Mixer.

The filter is aligned for optimum response by adjustment of inductors L4,L3 and L5.

2.2.1.4 FM IF and DEMODULATOR

The heart of the demodulator section is an NE615D high performance low power mixer FM IF system IC.

This device incorporates a mixer/oscillator, two limiting intermediate frequency amplifiers, a quadrature detector, muting circuitry, logarithmic RSSI, and a voltage regulator.

The input to the device is from the output of the 45 MHz first IF strip filter. This is applied at RF_{in} and RF_{bypass} pins (U2-p1,p2).

This signal is applied internally to a Gilbert cell mixer, which is set to convert the signal down to 455kHz.

The mixer injection is supplied by an internal oscillator, which is driven by an external oscillating signal applied at the XTAL OSC pins (U2-p3,p4).

The basic injection frequency is governed by the 44.545 MHz crystal XTAL1. This produces a mixer output product of 455 kHz.

The output of the mixer is available at MIXER OUT (U1-p20). This is applied to a 455kHz centred bandpass filter. This acts as the "front end" filter, CF1.

The bandwidth and rolloff characteristics of this filter are set, depending on the required baud rate of the data being used on the modem, and the required channel spacing. Refer to Circuit Diagram for filter types.

The filtered output is then applied to the input of the internal IF amplifier, IF AMPIN (U1-p18). The bandwidth of the amplifier is about 40 MHz, with a gain of about 39 dB(uv). C10 and C11 provide IF amplifier decoupling.

The output is available at IF AMP OUT (U1-p16). This is applied to a 455kHz centered bandpass filter. This acts as the "rear end" filter, CF2.

Again the filter selection depends on the required bandwidth. Refer to Circuit Diagram for filter types.

The filtered output is then applied to the input of the internal IF limiter, LIMITER IN (U1-p14). The bandwidth of the limiter is about 28 MHz, with a gain of about 62 dB(uv). C13 and C14 provide IF limiter decoupling.

The signal from the second limiting amplifier is passed to an internal Gilbert cell quadrature detector, as well as to LIMITER OUT (U1-p11).

One of the Gilbert cell ports is driven directly by the IF, the other by a tuned quadrature network, which is driven by the IF signal from LIMITER OUT. The tuned network is based around a ceramic resonator CF3. The Q of the network is varied depending on the required baud rate used by the modem. For 9600 baud the link LK3 is inserted, giving a higher damping factor than that required for 4800 baud, where the link is removed.

This gives the two input signals applied to the Gilbert cell a 90 degree phase relationship, the output of which is the demodulated audio/data signal.

The output signal is available at UNMUTED AUDIO OUT (U1-p9). A gated output is also available at MUTED AUDIO OUT (U1-p8).

2.2.1.5 AUDIO PROCESSING

2.2.1.5.1 DATA

The demodulated data signal output has been assigned to the UNMUTED AUDIO OUT pin (U1-p9). This ensures no interruption to the flow of data.

The signal is filtered by the C22, R20, R29 and C23 filter network. This is to remove any high frequency components produced at the output of the quadrature detector.

It is then amplified and DC level shifted by op-amp U1:C. The amount of DC bias applied to the signal can be varied by the potentiometer VR2. For correct processing by the modem, this level is set to 2V. The AC level of the signal is set to about 1 V_{p-p}

2.2.1.5.2 AUDIO

The demodulated audio signal output has been assigned to the MUTED AUDIO OUT pin (U1-p8). This allows switching control of the audio passed to the handset earpiece.

The signal is filtered by R23 and C17. This is to remove any high frequency components produced at the output of the quadrature detector.

It is then buffered, amplified and level shifted by op-amp U1:D, and presented to the handset via coupling capacitor C20 and connector X3-p2.

The mute control signal is applied to the NE615 (FM IF system IC) MUTE IN pin (U2-p5). When active, the audio output signal from the IC is attenuated by greater than 60dB.

2.2.1.6 RSSI

The RSSI output is presented by the NE615 at RSSI OUT (U2-p7). This signal is logarithmic with an output range greater than 90 dB. It is used for audio mute processing, and by the modem section as a data qualifier signal.

The signal is first passed through a unity gain buffer, op-amp U1:B, before it is split.

The RSSI level is compared with the setting of "audio mute adj" potentiometer VR1, by op-amp U1:A. The result is passed to the MUTE IN pin of the NE615.

This allows a suitable mute cutoff point to be set for the received audio sent to the handset earpiece.

The RSSI signal is also passed to the modem section for processing via R19 and connector X1-p21.

2.2.2 TRANSMITTER

The general form of the transmit circuitry is shown in diagrams "DR9 Macro Block Diagram" (drawing number TC01-05-19 sheet 3/3), and "900 MHz Radio - Block Diagram" (drawing number TC01-05-19 sheet 2/3).

2.2.2.1 AUDIO PROCESSING

2.2.2.1.1 DATA

The transmit data signal enters the radio section via connector J*3-p13, from the modem section. It is biased via R68 and R75 to a DC level of about 0.86V. The signal is then passed through a level setting potentiometer VR2, used to set the level of transmit deviation.

It is then presented to the input of the modulator circuit.

2.2.2.1.2 VOICE

The transmit voice signal enters the radio section via connector X3-p4, from the microphone in the handset. The pre-amp in the microphone circuit is given some bias via R76.

The signal is first passed through a clipping circuit. This consists of back to back clamping diode pair D2, AC-coupled via C154. This ensures that a maximum transmit deviation level is imposed.

The modulator circuitry is based around a low power FM transmitter system IC MC2833. Included in this device is a microphone amplifier and clipper. The audio is passed to the amplifier via R76 at the MIC AMP INPUT pin (U7-p5).

Feedback for gain is supplied by R76, and band limiting by C50. The amplifier output is presented at MIC AMP OUTPUT (U7-p4).

Further low pass filtering is provided by the network of R71, C49, R59.. and C42... C43 provides a rising response below 100Hz. This filtering is needed to shape the base band signal, so as the transmit frequency spectrum stays within channel boundaries.

The audio is coupled into the modulator circuit at the MODULATOR INPUT pin of the MC2833 (U7-p3).

2.2.2.2 MODULATOR

The heart of the modulator section is an MC2833 low power FM transmitter system IC. This device is a one chip FM transmitter subsystem designed for FM communication equipment. It includes a microphone amplifier, a variable reactance modulator, a voltage controlled oscillator, and two auxiliary transistors.

Data is fed directly to the input of the reactance modulator at the MODULATOR INPUT pin (U7-p3). The audio channel is fed via an inbuilt clipper amplifier in the MC2833. The output of this variable reactance circuit is used to modulate the FM carrier.

The carrier frequency of the modulator is provided by an internal oscillator, which is driven by an external oscillating signal applied at the RF OSC pins (U7-p15,p16).

This oscillating signal is governed by the 20.166 MHz crystal XTAL3. The actual applied frequency is set by the modulating signal, which slightly varies ("pulls") the crystal frequency. This is achieved by connection of the crystals circuit to the output of the variable reactance circuit VARIABLE REACTANCE OUTPUT (U7-p1). This output is coupled to the crystal via a frequency trimming coil L6.

The output FM signal is presented at the RF OUTPUT pin (U7-p14).

2.2.2.3 MULTIPLIER

The output of the modulator is passed to a frequency tripler stage employing auxiliary transistor TR2. This places the carrier frequency at 60.5 MHz.

It then passes to a frequency doubler stage employing auxiliary transistor TR1, where the carrier is moved up to 121 MHz.

The signal is amplified through these stages to a level of about -4 dBm at 121 MHz.

2.2.2.4 MIXER

The transmit FM signal at 121 MHz when mixed with the VCO frequency by U8 produces a transmitter signal 76 MHz from the receiver frequency.

The mixer employed is an MCL SBL-1X monolithic doubly balanced mixer (U8).

The transmit VCO signal is amplified to a level of about +6 dBm by Q2, and applied to the "L" input of the mixer. The 121 MHz signal is applied to the "I" input of the mixer.

To select the correct mixing product for the transmitter, a tunable filter using C78 and a coupled stripline circuit is used.

The output signal is then buffered by two MRF5711 transistors Q4 and Q5, to provide about +4 dBm of signal level, which is applied to the final amplifier section.

2.2.2.5 POWER AMPLIFIER

The power amplifier provides an overall gain of about 30dB. This is achieved by three stages of amplification.

The first stage uses an MRF5711 transistor (Q8). This device is primarily designed for high gain, low-noise, small signal amplifiers, and is ideal for a transmitter pre amplifier. This stage provides about 13 dB of gain. The power control circuit acts on this stage to provide constant power at the PA. output connector.

The second stage uses an MRF8372 transistor (Q9). This device is primarily designed for wideband, large signal predriver stages, in the 800MHz range. This provides a further 10 dB of gain.

The final stage uses two MRF8372 transistors (Q10, Q11) in a parallel configuration to provide the final output power. Each of these stages provides about 10 dB of gain. The output impedance is matched to 50 ohms via the use of balanced impedance strip lines.

The transmitted signal is presented at connector X4, at a level of about +32 dBm, where it is passed to the diplexer section.

2.2.2.6 CONTROL

2.2.2.6.1 PTT

PTT must be activated for the TC-900DR to transmit an RF signal. There are two sources of PTT, the audio handset, and the modem section.

PTT from the audio handset is referred to as "manual PTT". It enters the radio section via connector X3-p6. It is passed to the PTT control switch transistor Q12. PTT is active LOW, and turns on Q12 when applied.

PTT from the modem section enters the radio section via connector X1-p12, "/PTT". It is connected to the PTT control switch transistor Q12.

When PTT is not activated the transmitter is totally disabled. All stages of the transmit chain are turned off. This is to ensure that power consumption is kept to a minimum.

The PTT signal connects to the start of the transmit chain at the multiplier stage.

The internal transistors of the MC2833 IC, TR1 and TR2 have their bases effective grounded, turning off the devices. Similarly the mixer output buffer and amplifier transistors Q4 and Q5 are turned off as are the final amplifier stages employing Q8, Q9, Q11 and Q10.

When the PTT is activated, bias is applied to all these stages and transmission is possible.

Note : Tx enable must also be active to allow transmission.

2.2.2.6.2 TRANSMIT ENABLE

Transmit enable is a further control placed on the transmitter circuits. No transmission is possible unless the transmit enable signal is active. The signal enters the radio section via connector X1-p11, "/TX EN", from the modem section.

This signal basically enables the PTT switching transistor Q12, thus providing VCC for the 20.166 MHz oscillator section of the MC2833 modulator IC, and bias to the handset microphone.

2.2.2.6.3 POWER

The RF power output of the TC-900DR can be set to two levels. Low power level is 200mW, and high power is 1W.

This level is controlled by two dc levels. One signal is a control level from the modem section, the other from an RF detector located at the output of the transmitter itself. These two signals are used in conjunction to hold the output power constant.

The signal from the modem section enters the radio section via connector X1-p10, "TXPWR". The signal is fed to an op-amp comparison circuit U9:A, via level setting potentiometer VR4.

The level is compared to that actually detected at the output of the transmitter, by the circuit based around diode D3. The comparator output is then used to bias the first stage of the P.A. section (Q8) of the transmitter, hence varying the transistor gain performance and ultimately the output RF power. This basic feedback network is required to keep the power at a constant level, regardless of any external conditions.

The detected output power level is also fed back to the modem section for monitoring and analysis via connector X1-p9, "TXPWR SENSE".

2.2.2.6.4 TEMPERATURE SENSE

A temperature sensing device is included in the radio section. The device used is an LM335 precision temperature sensor, U6. It is operated as a two terminal zener diode, with a breakdown voltage directly proportional to absolute temperature, with an output of +10 mV per degree kelvin.

The temperature data output is passed to the modem section for analysis and processing via connector X1-p14, "TEMP SENSE".

During the "Burn In" cycle, that the TC-900DR is passed through during production, the unit calibrates the output of the sensor to the test temperature. In particular it stores the hottest temperature reached by the test cycle (about 65C).

If the unit reaches this maximum temperature setting while operating in the field, the modem section of the TC-900DR will automatically signal the power control circuit to place the transmitter into low power mode (200mW).

This low level of output power is retained until the temperature sensor signals the modem section, that the temperature has fallen back below the maximum temperature. When this occurs the transmitter is placed back to its previous power setting. A hysteresis is built into the microprocessor control circuitry to stop power jitter.

This scheme is referred to as "High Temperature Fold Back". It is used to protect the transmitter final power transistors from any damage that may be encountered under extreme temperature conditions.

2.2.3 FREQUENCY CONTROL

2.2.3.1 SYNTHESISER

The synthesiser section provides a local oscillator for use by the receiver and transmitter sections.

The synthesiser circuitry is based around a TBB206 PLL frequency synthesiser IC.

This device is a complex PLL circuit in CMOS technology for processor controlled frequency synthesis. The processor resides in the modem section, and three basic control lines are used to interface to the device. The enable "EN", data "DA" and clock "CL" control signals are passed to the TBB206 via connector X1-p16,p17,p18 respectively.

The reference frequency for the synthesiser is applied to the "RI" pin of the TBB206 (U3-p2). This reference is provided by a 12.000 MHz voltage adjustable temperature compensated crystal oscillator (VTCXO), XTAL2. This input has a sensitive preamplifier for a 16-bit (R)eference divider. C33 provides AC coupling for the input.

The VCO frequency is applied to the "FI" input pin of the TBB206 (U3-p8). This input has a highly sensitive preamplifier for a 12-bit N divider and a 7-bit A divider. C29 provides AC coupling for the input.

The actual signal applied to the "FI" input is from the output of a TBB202 dual modulus divider IC (U4-p4). This is to transform the actual VCO frequency of between 786 MHz and 996 MHz, down to a frequency acceptable for use by the "FI" input.

The divider ratio selected by the TBB202 is determined by the state of the "MOD" input pin (U4-p6). If the signal is HIGH, then a ratio of 1:128 is used. If the signal is LOW, a ratio of 1:129 is used. The state of this signal is controlled by the TBB206 synthesiser "MOD" output pin (U3-p7). The TBB206 drives this output LOW at the beginning of a cycle. When the A divider has reached its set value, the "MOD" output is set to HIGH. When the N divider reaches its set value, the output is set LOW again and the cycle is repeated.

The input to the TBB202 divider is from the VCO output via a strip line impedance matching network. The signal is applied to the "I1" pin (U44-p1).

The TBB202 can be placed into standby mode, when not in use. This is achieved by connection of the "STB" pin (U4-p7), to the multi function output port of the TBB206 synthesiser (U3-p6). This port is driven by the DFM4-9 modem IC located in the modem section.

The phase detector signal is provided on the "PD" pin of the TBB206 (U3-p12). This signal has especially short anti backlash pulses to avoid any "dead zones", and to neutralise any small phase deviations. This signal is passed to the loop filter of the VCO circuit.

A lock detect indication is given by the TBB206 synthesiser at the "LD" output pin (U3-p14). This signal is filtered and shaped by the network using R47 and C36, and presented to the modem section for monitoring and processing, via connector X1-p19.

2.2.3.2 VCO

The VCO used is an MQC309 series VCO. The exact device used depends on the required frequencies that the unit has to work with.

Two types are used :

A. MQC309 798 - Frequency range of 784 MHz to 816 MHz

Gives unit frequency ranges of :
- Transmit : 905 MHz to 937 MHz
- Receive : 829 MHz to 861 MHz

B. MQC309 978 - Frequency range of 962 MHz to 994 MHz

Gives unit frequency ranges of :
- Transmit : 841 MHz to 873 MHz
- Receive : 917 MHz to 949 MHz

The 798 type employs low side injection to the mixers, whereas the 978 type employs high side injection.

The loop filter consists of R44, C40, C41 and R43.

The output of the VCO is passed to the receiver mixer via RXMIX, and to the transmitter mixer via TXMIX signal lines. Each of these is impedance matched by strip line circuits for optimum performance.

The layout and selection of all these components has been done in such a way so as to minimise VCO noise being impressed onto either the transmitted or received RF signals.

2.2.3.3 VCO TEMPERATURE COMPENSATION

Frequency temperature compensation is provided for by an input to the reference oscillator circuit.

During the "Burn In" cycle, that the TC-900DR is passed through during production, the unit calibrates the output of the temperature sensor to the test temperature and to any frequency variations that occur, and stores the results.

When the unit is operating in the field, the temperature of the unit is constantly being analysed. Should a frequency offset be required based on the calibration measurements, the modem section signals to the 12.000 MHz reference oscillator to vary its frequency slightly. This signal is passed to the radio section via connector X1-p15, "TEMP COMP". The voltage on this line "pulls" the reference oscillator XTAL2 onto a new frequency, which corresponds to the correct offset required.

Note : Because the temperature compensation for the installed VTCXO is held in the NVRAM of the modem it is imperative that modems and radio boards are maintained as matched pairs. Should either the VCO or NVRAM require replacement it is highly recommended that the unit be returned to the manufacturer for re-calibration.

2.2.3.4 RECEIVER AFC

Automatic frequency control is provided for the received signal. The control signal is applied to the radio section from the modem section via connector X1-p22, "AFC CTL".

The basic injection frequency to the front end mixer of the NE615 FM demodulator IC (U2), is governed by the 44.545 MHz crystal XTAL1. The actual applied frequency can be set by the level of the AFC signal, which slightly varies ("pulls") the XTAL1 crystal frequency via the varactor diode DV1.

The modem section monitors the average DC level of the received signal (DATA signal X1-p13), which gives an indication of received frequency drift.

From this the modem section calculates the required compensation necessary and applies it to the "AFC CTL" signal line.

A reference signal is passed back to the modem section from the radio section via connector X1-p23, "AFC REF". This is processed by the modem section, and used to help determine the level of AFC signal level.

2.2.4 INTERFACES

2.2.4.1 MODEM SECTION

The radio section interfaces to the modem section via connector X1. Attached permanently to this connector is a 90mm length of 26 way ribbon cable, fitted with a female 26 way connector at the other end. This attaches to connector JX3 on the modem section PCB.

Refer to interface diagram "RADIO MODEM INTERFACE", drawing number TC01-05-18 sheet 1/3.

CONNECTOR X1/JX3 PIN NUMBERS	SIGNAL DESCRIPTION	
1	13V8 POWER SUPPLY RAIL	
2	13V8 POWER SUPPLY RAIL	
3	13V8 POWER SUPPLY RAIL	
4	GROUND	
5	GROUND	
6	GROUND	
7	8V POWER SUPPLY	
8	8V POWER SUPPLY	
9	TXPWR SENSE	(o/p- TRANSMIT POWER SENSE)
10	TXPWR	(i/p - TRANSMIT POWER LEVEL)
11	/TX EN	(i/p - TRANSMIT ENABLE)
12	/PTT	(i/p - PRESS TO TALK)
13	DATA	(i/p - TRANSMIT DATA)
14	TEMP SENSE	(o/p - TEMPERATURE SENSOR)
15	TEMPCOMP	(i/p-TEMPERATURE COMPENSATION)
16	EN	(i/p - ENABLE FOR SYNTH)
17	DA	(i/p - DATA FOR SYNTH)
18	CK	(i/p - CLOCK FOR SYNTH)
19	LD	(o/p - LOCK DETECT FROM SYNTH)
20	DATA OUT	(o/p - RECEIVED DATA)
21	RSSI	(o/p - RSSI SIGNAL)
22	AFC CTL	(i/p - AFC CONTROL)
23		(UNUSED)
24	SUPPLY/MIC	(UNUSED)
25	TEST1	(UNUSED)
26	TEST2	(UNUSED)

2.2.4.2 ANTENNA DIPLEXER

The interface between the radio section and the antenna diplexer section is via coaxial connectors X4 and X2, and low loss coaxial cables.

CONNECTOR	SIGNAL DESCRIPTION
X4	TRANSMITTER OUTPUT
X2	RECEIVER INPUT

2.2.4.3 AUDIO HANDSET

The interface between the radio section and the audio handset is via the modular-6 pin connector X3.

CONNECTOR X3 PIN NUMBERS	SIGNAL DESCRIPTION
1	8V POWER SUPPLY
2	AUDIO OUT (o/p - AUDIO TO EARPIECE)
3	GROUND
4	MIC (i/p - MICROPHONE AUDIO)
5	GROUND
6	MANUAL PTT (i/p - HANDSET PTT)

2.3 ANTENNA DIPLEXER SECTION

2.3.1 GENERAL

The antenna diplexer section of the TC-900DR is a separate plug in module, that "piggy backs" the radio section PCB.

The diplexer performs two major tasks. Firstly it couples both the transmit and receive RF paths to the antenna while providing high isolation between them, and secondly it provides image and spurious rejection for each of these paths, with high Q bandpass filters.

The isolation between the transmit side and the receive side is greater than 50 dB.

The diplexer consists of two teflon PCB's bonded together using a critical temperature and pressure process. The top and bottom outer layers are connected via brass eyelets, that are pressed through the PCB. This eliminates the need for through hole plating of Teflon, which requires the use of dangerous chemicals.

The design is essentially two continuous ground planes, filled in between, with laminate dielectric, and stripline filter tracks which are centrally located between these ground planes.

The etching of the filter tracks is closely monitored and controlled to ensure an accuracy of better than 0.001" in track width and spacing.

The diplexer has been factory tested to ensure bandpass and performance characteristics are met. The diplexer has approximately 3 dB of loss at 930 MHz and 2 dB of loss at 850 MHz.

This diplexer requires no alignment in the field.

2.3.2 INTERFACES

The antenna diplexer connects to the radio section via low loss coaxial cables and connectors, and to the units antenna via a SMA connector.

Two versions of the diplexer are available, depending on the transmit and receive frequencies used. The difference between the two is the loading of the SMA connector.

TYPE-A CONNECTIONS *(Transmit frequency = 930 MHz range)*

DIPLEXER CONNECTOR	SIGNAL DESCRIPTION AND DESTINATION
850 MHz port	RF RECEIVE - RADIO SECTION X2
930 MHz port	RF TRANSMIT - RADIO SECTION X4
ANT port	ANTENNA

TYPE-B CONNECTIONS *(Transmit frequency = 850 MHz range)*

DIPLEXER CONNECTOR	SIGNAL DESCRIPTION AND DESTINATION
850 MHz port	RF TRANSMIT - RADIO SECTION X4
930 MHz port	RF RECEIVE - RADIO SECTION X2
ANT port	ANTENNA

2.4 AUDIO HANDSET SECTION

2.4.1 GENERAL

Refer to diagram "MTCU HANDSET MAIN PCB & MIC PCB CIRCUIT DIAGRAM", drawing number 5015-A200-50.

The handset provides an audio link between units, to assist in link setup and commissioning. It is not intended for general use and the equipment is not licensed for voice operation only.

Caution : When the handset is inserted into the TC-900DR, reliable data transmission or reception is not possible. Unintentional voice traffic on a point to multi point system may cause data corruption to other units.

The data transmission section of the modem is totally disabled, if the handset is plugged in when the TC-900DR is turned on.

The handset contains two PCB's, a receive board and a microphone board, which are connected by a 10 way ribbon cable. Acoustic padding is also included in the handset for improved performance.

The microphone board contains an ECM30 electret microphone, along with a common emitter preamplifier stage (Q1), to provide transmit voice audio.

There are four indication LED's that are not used by the TC-900DR.

The receiver board contains a 78L05 5V voltage regulator (REG1). This is used to supply power to the LF353 receive amplifier (U2-p7), which drives a DH32-30 ohm earpiece.

The sidetone circuit provided by U2-p1 is disabled and not used by the TC-900DR. Similarly, the LED drivers are disabled.

The PTT switch places a ground connection onto its output signal line, for processing by the radio section.

2.4.2 INTERFACES

The audio handset connects directly to the radio section via the RJ11 connector, X3. Attached to the handset is an 8 way flexible curly cord.

PIN NUMBER	HANDSET CONNECTOR	X3 PIN NUMBER	RADIO SECTION CONNECTOR X3
1	LED CLK	-	UNUSED
2	LED DATA	-	UNUSED
3	13V2	1	8V POWER SUPPLY
4	DGND	3	GROUND
5	PTT	6	MANUAL PTT
6	MIC	4	MIC
7	MIC RET	5	GROUND
8	EAR PHONE	2	AUDIO OUT

2.5 MODEM SECTION

The modem section is built on a single PCB with approximate overall dimensions of 165mm x 152mm x 18mm.

It consists of the following main blocks :

Modem control

- DFM4-9 modem.
- Reset and watchdog.
- Memory.
  - External NVRAM.
  - External RAM.

Host interface.

Radio interface.

Transmit signal conditioning.

Receive signal conditioning.

- Data recovery.
- Clock recovery.

User indications.

Power supply

Interfaces.

- Radio section.
- Port A.
- Port B.
- Power.

2.5.1 MODEM CONTROL

2.5.1.1 DFM4-9 MODEM

The modem section is controlled by a DFM4-9 Trio DataCom modem IC, (U5).

This device is specifically designed to provide data communications from a host computer over a radio channel.

The DFM4-9 is capable of full duplex operation, at data rates of 4800 baud or 9600 baud over the radio channel. The transmitter and receiver data rates may be set independently. The host computer interface provides two RS232 asynchronous serial ports, configurable for a variety of baud rates, and data formats.

In the standard delivery format of the modem, only one asynchronous serial port is operational. (Port A).

Advanced data recovery techniques are employed to ensure excellent performance in both good and noisy signal environments.

The data transmission method used, employs advanced optimal waveform shaping techniques. This maximises the recovered signal at the destination receiver, while remaining within the allocated RF channel bandwidths. The method uses computer generated Finite Impulse Response (FIR) techniques, to derive the transmitted waveform data.

The modem features a unique supervisory signalling channel, which embeds low speed data in the primary bit-stream, and is transparent to the user of the primary channel.

To drive the DFM4-9 modem clocking circuits, an external resonator is required. A 19.6608 MHz crystal (XTAL1) is applied to the OSC pins (U5-p9,10) of the device to achieve this.

A 4 way DIP switch is supplied to set up some configuration parameters of the modem. These are only read by the DFM4-9 at device power up. They connect to the "ESx" pins of the device (U5-p3,p5,p6,p7). Switches 1 and 2 are presently unused, switches 3 and 4 are defined in section 4.5.1.

2.5.1.2 RESET AND WATCHDOG

A MAX690 reset and watchdog IC (U3), is used to perform a variety of ancillary functions. This device provides a fixed length reset pulse for the proper initialisation of the modem chip on power up and reinitialisation. The MAX690 monitors the level of the VCC power supply line. If the voltage moves out of specification, the reset output is activated. This ensures that the modem chip recovers correctly in the event of a power failure. The reset signal is applied to the "RESET" pin of the modem (U5-p8).

The MAX690 provides a power monitoring function, which gives advance warning of imminent power supply failure. The DFM4-9 modem checks this signal, applied to its "PF" pin (U5-p2), before performing any transactions with the non-volatile memory, thus preventing accidental corruption of the contents of this memory. This "advance warning", is the length of time that the power supply capacitors hold their charge, after loss of power, before the Vcc supply rail drops below its cutoff level, and a reset pulse is generated.

The MAX690 also includes a "watchdog" timer. This timer must be strobed at a minimum rate, to prevent a reset pulse being generated. The DFM4-9 provides this signal at its "WDO" pin (U5-p22). Should the DFM4-9 modem operation go astray for some reason, it is probable that it will no longer perform this strobing function correctly. This condition is treated as irrecoverable and the MAX690 will timeout on its watchdog function and re-initialise the modem.

2.5.1.3 MEMORY

2.5.1.3.1 EXTERNAL NVRAM

The DFM4-9 modem, has a wide variety of configurable operating parameters, all of which are stored in an ST24C04 NVRAM IC, (U4). These parameters are read at power up, and determine the operating characteristics of the modem.

The NVRAM has 4096 bits of memory. It is accessed using the standard I^2C, two wire, bus interface . A feature of this particular device, is a write protect function for one area of the memory.

This write protect feature prevents configuration data being inadvertently corrupted should some anomaly in modem operation occur. A hardware signal line is used to override this write protection feature, so that the configuration data may be changed by manual means. This signal can be accessed via the front panel connector, and is used when the TC-DFM9IP modem programmer is connected.

2.5.1.3.2 EXTERNAL RAM

External RAM is used to store data frames.

The RAM used may be either a 6264-8K or 62256-32K byte IC (U9). The standard TC-900DR is supplied with an 8K package. The DFM4-9 modem, tests the size of the attached RAM on power up.

All of the externally connected RAM is used to store packet data, and is allocated evenly between transmit and receive data. This memory is connected to the modem chip, by an 8 bit bus, and 3 control lines.

Two 8 bit 74HC573 latches (U8 and U10), are used to latch the memory address off the bus, before the data read or write cycle. The read/write control line to the RAM, is passed as the top address line in the MSB address latch.

The RAM read cycle operates as follows :

- The modem sets the two latch control lines, LADR_EN and HADR_EN, high.
- The high-address/R_select is then placed on the 8 bit bus.
- The HADR_EN line is set low to latch the data into U8.
- The lower eight address bits are placed on the bus.
- The LADR_EN line is set to low to latch the data into U10.
- The modem bus port is set to input mode.
- The RAM CE line is set low.
- The modem reads the data off the bus.

The RAM write cycle operates as follows :

- The modem sets the two latch control lines LADR_EN and HADR_EN, high.
- The high-address/W_select is then placed on the 8 bit bus.
- The HADR_EN line is set low to latch the data into U8.
- The lower eight address bits are placed on the bus.
- The LADR_EN line is set to low to latch the data into U10.
- The modem bus port is set to output mode.
- The modem writes the data to the bus.
- The RAM CE line is set low to write the data into the RAM.

Note: WARNING
A modem containing a 32K RAM package will not be compatible with a modem containing an 8K RAM package if end to end flow control is being used over the data link.

2.5.2 HOST INTERFACE

The host interface is provided by two RS232 ports, configured as DCE. These ports are presented to the user as 9 way female DMIN connectors, designated as PORT A and PORT B.

With the standard TC-900DR, only PORT A is operational.

The RS232 level translation is performed by two LT1081/MAX232 line transceivers (U1 and U2). These require a single five volt supply, and include internal charge pumps to generator the required +10V and -10V rails.

The four input and four output lines implement one full duplex serial port with RTS/CTS/DTR and DCD. This is PORT A. A second full duplex port with no handshake lines is provided on PORT B.

2.5.3 RADIO INTERFACE

The interface to the radio is via a 26 pin PCB header connector, X4.

The modem section has full control over the connected radio transceiver. It provides :

- Four lines for synthesiser control (used for RF channel selection).
- RSSI detection.
- Temperature sense input.
- Transmit power sense input.
- Temperature compensation for the synthesiser reference frequency.
- Receiver AFC.
- PTT control.
- Analogue lines for receive and transmit data signals.
- Regulated +13.8V and +8V power supplies.

Input to the receiver signal port, RXSIG, is offset by 2.0V DC, with a signal level of 1Vp-p AC.

The transmit signal output, TXSIG, has a signal level of 1Vp-p for 4800BPS, and 2Vp-p for 9600BPS, with a nominal DC offset of 2.0V. This offset may vary by ±1v according to the modulator temperature compensation requirements.

An ADC0834 four channel ADC (U6), is used to monitor various analogue quantities within the radio. The DFM4-9 modem communicates with the ADC by controlling 3 lines. An active high chip select, "ADCS" line (U5-p33), a data clock, "DCLK" line (U5-p35), and a serial data, "SD" line (U5-p36).

The state of the data line from the ADC is clocked into internal registers of the DFM4-9 on the rising edge of the clock line. The data stream consists of a four bit preamble, which includes the channel address. From the 5th clock pulse onward, the ADC drives the data line with the data of the conversion, MSB first. The transaction is terminated with the CS line being set to inactive low.

The first channel is used to monitor temperature, by measuring the voltage from an LM335 monolithic temperature sensor U6. The LM335 is situated in the radio section, adjacent to the 20.1666MHz XTAL and VCXO synthesiser reference oscillator, and is fed into the modem section via connector X4-p14, ADC0.

The second channel is used to monitor RSSI, by measuring the RSSI output of the NE615 IF circuit. This signal is fed to the modem section from the radio section via connector X4-p21, ADC1.

The third channel is used to monitor the power level output by the RF transmitter, by measuring a voltage derived in the power control section of the radio. This is used to determine the "health" of the radio transmitter. This signal is fed to the modem section from the radio section via connector X4-p9, ADC2.

The fourth channel of the ADC, is used to measure the voltage of the +13.8 volt supply rail and to sense the presence of the audio handset at power up. The handset derives microphone bias from the modulator stage, and the voltage at this point is measured and compared with a fixed nominal value, to determine if the handset is connected at the time of TC-900DR power up. This signal is fed to the modem section from the radio section via connector X4-p24, ADC3. This 4th ADC channel is also multiplexed to measure the AFC control voltage so that an indication of received signal frequency can be made. U14:D is used to perform this switching function.

An auxiliary latch (U11) is provided to supply some of the output control to the radio section.

The latch receives data from the same data buss as the RAM. The lower six bits are fed to an R/2R ladder network DAC (RN2), which is used to present an analogue voltage to the radio's local oscillator synthesiser frequency reference. This correction voltage provides for excellent temperature stability of the radio. This signal is fed to the radio section via connector X4-p15, TEMP COMP.

The two top bits of the latch, drive auxiliary functions within the radio section.

Bit 6 is used to control the power of the RF transmitter in the radio section. This can be set to a HIGH level of 1W, or to a LOW level of 200mW. This signal is fed to the radio section via connector X4-p10, TXPWR.

Bit 7 provides the RF transmitter enable signal to the radio section. No RF signal can be transmitted unless this signal is set to active. This signal is fed to the radio section via connector X4-p11, TX EN.

2.5.4 TRANSMIT SIGNAL CONDITIONING

The transmit section of the DFM4-9 modem, outputs a byte of data, four times per bit period, on the "TDx" pins (TD1..TD7, U5-p56..49).

The parallel data is presented to an eight bit R/2R ladder network (RN1). This is a simple DAC which produces the transmit waveform at its output.

This signal is fed into opamp (U13:C) for amplification and filtering. This stage is a single pole low pass filter, used to attenuate clocking noise in the waveform. Two more filter stages follow, U13:B and U13:D.

By using 4 samples per bit, and an 8 bit resolution, precise control of the waveform shape is possible.

The gain and pole frequency of amplifier stage U13:C is switched by the DFM4-9 modem, via a 74HC4066 CMOS FET switches (U14:A). This is to produce the required waveform for the two data rates currently available. The bit rate output signal, "BRO" is provided at U5-p44.

For 4800 baud, components C43 and R45, are "included" in the feedback loop of the amplifier stage. When 9600 baud is selected, switch U14:A is turned OFF, and the components are "excluded" from the circuit.

2.5.5 RECEIVE SIGNAL CONDITIONING

The data receiver, consists of several functional blocks. Some of these are implemented by internal functions of the modem IC, and the remainder by external circuitry.

The incoming analogue signal, is routed to two separate sections of circuitry. One to process the received clock, the other to process the received data.

2.5.5.1 DATA RECOVERY

The data recovery is based around an "Integrating Data Slicer" circuit.

This circuit consists of a non-inverting, resetable integrator (U16:A, U12:C and U15:D), a dual peak detector (U12:A,B) and a reference divider.

The received signal is passed into the modem section from the radio section via connector X4-p20, "RXSIG".

The signal is integrated by the non-inverting integrator formed by U16:A, and U12:C, and then forwarded on to a comparator (U7:B), where it is "squared up", ready to be read by the DFM4-9 modem.

An output signal is provided by the modem IC, to indicate the sampling point. In fact this signal, called "RxCLKOUT", is pulsed high immediately after the sampling operation has taken place.

The integrator is reset at the end of each bit period, by the 74HC4066 FET switch, U15:D, after the value of the bit has been read. The DFM4-9 provides this reset signal at the reset integrator "RxCLKOUT" pin (U5-p19).

The integrated receive signal, is then fed to the dual peak detector, where the positive and negative peaks of the integrated signal are detected, and stored on the capacitors C28 and C27.

The peak detector's attack time is determined by the output resistance of the opamps (U12:A,B) and the bulk resistance of the diodes (D7, D4). The decay time however is determined by the values of the hold capacitors (C28, C27) and the summing resistors (R24, R25).

Four diodes (D5, D6, D8, D9) are used to clamp the reference rail. If the incoming signal has a large DC shift, this clamping arrangement ensures that the data slicer reference level is quick to settle somewhere near its final operating point. This clamp however does impose a maximum allowable input signal level. Exceeding this level will cause the integrated signal to directly modulate the reference rail. The derived reference voltage level, is amplified and output back to the radio section, where it is used for AFC in the receiver.

2.5.5.2 CLOCK RECOVERY

The received clock signal is presented to the DFM4-9 modem at its "RXCLK" input (U5-p4).

Within the DFM4-9, a phase-locked-loop is used for data clock recovery, which relies on level transitions in the data signal.

This mechanism maintains the data sampling point in the center of the bit cells by comparing the signal's level transitions with an internal clock.

An error in the relative phase of the RXCLK signal and the internal clock, causes the internal clock to increase or decrease in speed, to bring the phase error to zero.

The phase-locked-loop clock recovery mechanism within the DFM4-9 modem, maintains the sampling point in the center of the bit cells; but the use of the integrator demands that this take place at the end of the bit cell. This means that the signal fed to the DFM4-9 modem RXCLK input must be delayed by half a bit period.

To obtain this, the received signal is passed through a half bit delay, low-pass filter (U16:D, U12:D, U7:A). The delay characteristics of this filter, are switchable between the available data rates of 4800 and 9600 baud operation, by five 74HC4066 FET switches. These switches are controlled by the "BRO" output of the DFM4-9.

2.5.6 USER INDICATIONS

There are four indication LED's supplied for user information. POWER, TXMIT, SYNC and RXSIG. The POWER LED is green, TXMIT LED is red and the other two are yellow.

The POWER LED (LED4), is driven from the 13V8 power supply line. When supply is present the LED is activated.

The TXMIT LED (LED3), is activated when PTT is present. It is driven when the switching transistor Q3 is turned ON by the DFM4-9 modem "PTT" output going active (UX3-p38).

The SYNC LED (LED2), is activated when a valid data stream has been detected. It is driven when the switching transistor Q2 is turned ON by the DFM4-9 modem "SYNC" output going active (U5-p43).

The RXSIG LED (LED1), is activated when the received signal level is at a usable level. It is driven when the switching transistor Q1 is turned ON by the DFM4-9 modem "RXSIG" output going active (U5-p43).

2.5.7 POWER SUPPLY

The power supply is based around the use of three voltage regulators that supply +13V8, +8V and +5V.

The incoming power is applied to a bridge rectifier (BR1). Normally two legs of this bridge are linked out, so it provides only reverse polarity protection shunt diodes. A special manufacturing option allows for AC input, where the links are removed. A 2200uF electrolytic capacitor (C2), provides filtering for AC inputs.

This is then applied to an LT1086 low dropout regulator (REG1). The output of this is set to 13V8 and feeds the RF final amplifier, and the following two regulators.

The 8V regulator (REG2) takes it's input directly from the 13V8 rail, its output is routed to the radio section, and provides supply for one of the amplifier devices.

The 5V regulator (REG3) provides the supply rail for the modem section logic circuits. It takes it's input from the 13V8 rail via diode D1. Extra filtering capacitance is provided by C7.

2.5.8 INTERFACES

2.5.8.1 RADIO SECTION

The modem section interfaces to the radio section via connector JX3. The physical link between the two sections is achieved via a 90mm length of 26 way ribbon cable.

Refer to interface diagram "RADIO MODEM INTERFACE", drawing number TC01-05-18 sheet 1/3.

CONNECTOR JX3 PIN NUMBER	SIGNAL DESCRIPTION	
1	13V8 POWER SUPPLY RAIL	
2	13V8 POWER SUPPLY RAIL	
3	13V8 POWER SUPPLY RAIL	
4	GROUND	
5	GROUND	
6	GROUND	
7	8V POWER SUPPLY	
8	8V POWER SUPPLY	
9	ADC2	(i/p - TRANSMIT POWER SENSE)
10	TXPWR	(o/p - TRANSMIT POWER LEVEL)
11	/TX EN	(o/p - TRANSMIT ENABLE)
12	/PTT OUT	(o/p - PRESS TO TALK)
13	TXSIG	(o/p - TRANSMIT DATA)
14	ADC0	(i/p - TEMPERATURE SENSOR)
15	TEMPCOMP	(o/p- TEMPERATURE COMPENSATION)
16	EN	(o/p - ENABLE FOR SYNTH)
17	DA	(o/p - DATA FOR SYNTH)
18	CK	(o/p - CLOCK FOR SYNTH)
19	LD	(i/p - LOCK DETECT FROM SYNTH)
20	RXSIG	(i/p - RECEIVED DATA)
21	ADC1	(i/p - RSSI SIGNAL)
22	AFC CTL	(o/p - AFC CONTROL)
23	SPARE	(UNUSED)
24	ADC3	(FOR SUPPLY/HANDSET)
25	TEST1	(UNUSED)
26	TEST2	(UNUSED)

2.5.8.2 PORT A

The modem section interfaces to the host user via the 9 way female DMIN type connector JX1.

CONNECTOR JX1 PIN NUMBER	SIGNAL DESCRIPTION	
1	DATA CARRIER DETECT	(DCD)
2	RECEIVE DATA OUTPUT	(RXD)
3	TRANSMIT DATA IN	(TXD)
4	DATA TERMINAL READY	(DTR)
5	COMMON	(COM)
6	DATA SET READY/prog mode	(DSR)
7	REQUEST TO SEND	(RTS)
8	CLEAR TO SEND	(CTS)
9	RING INDICATE/BER Test Mode	(RI)

Note: Pin 6 and pin 9 provide a dual function which depends on the mode that the TC-900DR is operating in.

2.5.8.3 PORT B

For the standard delivery version of the TC-900DR, port B is normally not enabled. This port provides no handshake lines except DCD (parallel connected with DCD on Port A) and DSR which is wired active.

CONNECTOR JX1 PIN NUMBER	SIGNAL DESCRIPTION	
1	DATA CARRIER DETECT	(DCD)
2	RECEIVE DATA OUTPUT	(RXD)
3	TRANSMIT DATA IN	(TXD)
4		
5	COMMON	(COM)
6	DATA SET READY/prog mode	(DSR)
7		
8		
9	RECEIVE SIGNAL STRENGTH INDICATOR	(RSSI)

Pin 9 is used to output the RSSI signal for external measurement.

The RSSI output ranges from 0 to 5 Volts, where 5 volts indicates the strongest signal. It is important to note that this port output has a high impedance of around 50K ohms and loading will decrease accuracy of the recorded measurement.

2.5.8.4 POWER

Power is supplied to the modem section via connector X1. Typically +13.8V DC is applied to the top pin, with the common connected to the bottom pin.

SECTION 3

OPERATIONAL DESCRIPTION

3 OPERATIONAL DESCRIPTION

3.1 GENERAL

The Trio DataCom TC-900DR radio modem, is a full duplex 4800/9600 bits per second device, which converts digital data into an analogue form suitable for transmission over a radio channel. It uses specially filtered direct binary frequency modulation techniques to achieve this. It conversely, converts the analogue signal derived from a radio channel into a digital data signal.

The heart of the unit is the DFM4-9 modem IC. This performs all waveform shaping, randomising and de-randomising, NRZ/NRZI conversion, clock recovery, and HDLC framing and CRC error generation and checking. These functions are performed simultaneously, allowing full duplex operation at up to 9600bps.

The modem is fully HDLC compatible. The user is provided with two RS232 compatible ports, which may each be configured with a standard PAD interface or SLIP/KISS protocol driver. The unit may also be configured for repeater operation.

It may be configured to use RS232 handshake lines, or XON/XOFF flow control on Port A.

The modem features a unique supervisory signalling channel, which embeds low speed data in the primary bit-stream, and is transparent to the user of the primary channel.

The supervisory signalling channel can be disabled if not required. It could be used to pass low speed data such as E and M status or C/DSMA control schemes.

The data rate of the supervisory signalling channel can be set independently for transmit and receive. It can range from about 40 to 533 bps with the primary channel rate at 4800 baud, and 80 to 1067 bps at a primary channel rate of 9600 baud.

NOTE: with the supervisory signalling channel active, the bit-stream is not compatible with standard HDLC interface devices (such as 8530).

The host user port may be configured for baud rates of 300 to 19K2, with 7 or 8 bit character size, 1 or 2 stop bits, and parity off/odd/even.

The DFM4-9 modem includes several data tables which are used to generate waveforms with different characteristics. This is primarily for optimum performance at differing baud rates. A custom data table can be placed into the NVRAM of the modem, for specialised applications.

Configuration of the modem is fully programmable, with parameters held in non-volatile memory. All configuration parameters are accessible with the TC-DFM9IP Installation Program.

Configuration parameters include but are not limited to:

Supervisory Signalling Channel rate.
XON/XOFF or RTS/CTS/DTR/DCD handshake mode.
Default transmitter lead in delay.
Constant specifying minimum RF RSSI for valid receive.
Constant specifying minimum Tx power level.
Asynchronous serial port parameters.
User interface operating mode :
- User port interface protocol
- PAD Parameters

3.2 TC-900DR MODEM FIRMWARE REVISION VA2.3.0

3.2.1 FUNCTIONAL CHANGES AND ADDITIONS

The Diagnostics "M" command (serial port Mode) completed. The implementation of this command was not finished in time for VA2.2 release. This command is used to configure either of the two user ports, for character length, number of stop bits, parity odd/even/off.

1. Bit 7 is used to address which port is being referenced (set to "0" for Port B, or set to "1" for Port A).
2. Bit 6 determines the character size. Set to "0" for 8 bit, or "1" for 7 bit character size.
3. Bit 5 is set to "1" to enable parity, "0" to disable parity.
4. Bit 4 determines Odd (set bit to "1"), or Even (set bit to "0") parity if Bit 5 is set.
5. Bit 3 determines the number of stop bits. Set to "0" for 1 stop bit, or set to "1" for 2 stop bits.
6. Bits 2, 1, and 0 are used to select the baud rate. The following table shows the available rates. The 19.2K baud selection should only be made for Port A if Port B is disabled. The last selection of 110 baud may be deleted from future firmware revisions.

Bit	Bit 1	Bit 0	Baud Rate
0	0	0	300
0	0	1	600
0	1	0	1,200
0	1	1	2,400
1	0	0	4,800
1	0	1	9,600
1	1	0	19,200
1	1	1	110

Channel Access Strategy 3 is now defined. This is selected by setting bits 1 and 0 (TxCtrl1 and TxCtrl0) in "Config1", both to "1". This mode forces a randomly generated delay **before** transmission begins, even if the channel is perceived to be clear. This delay mechanism is similar to that used in Channel Access Strategy 2 when the channel is perceived to be busy. This operating mode is useful in systems that include remote terminals that generate reports at regular fixed intervals. In such a system, slight differences in this interval between two remotes, would cause them to become synchronised for some time, and thus transmissions from them would consistently collide. Inserting a randomly generated delay before all transmissions will reduce the incidence of this effect.

The RS232 DCD handshake line now becomes active only during output of received data. Formerly, the DCD line indicated real time SYNC status of the modem data receiver. To facilitate the use of RS232 to RS422/RS485 converters, the DCD line is driven active a short time (approximately 0.5mS) before the received data is output to the user port, and lingers for approximately 2 to 3 character times (i.e. is proportional to baud rate of user port). The modem generates only one DCD function, which is available on pin 1 of both Port A and Port B. Thus the DCD pin of both user ports will be activated when either port is outputting received data.

3.2.2 OTHER ENHANCEMENTS

Improvements in handling of the RS232 RTS line (Port A), makes the modem more tolerant in the timing of rapid OFF transitions of this handshake line, immediately after the end of the last character of a message. It has been observed that communications drivers in many PLCs turn their RTS output line OFF very shortly after the end of a message, resulting in the loss of the last character of the message with previous modem firmware revisions. This revision does not suffer this problem.

The random number generator used for the Channel Access Timer, has been improved to make it more random.

3.3 FACILITIES AND CONFIGURATION INFORMATION FIRMWARE VERSION 2.2

3.3.1 GENERAL

The TC-900DR provides fully transparent remote diagnostics facilities, and expanded data stream switching, which supports advanced stream trunking applications.

The diagnostics core, supports the reporting of current analogue conditions, including temperature, RSSI (Received Signal Strength Indication), RF transmitter power, AFC (i.e. received signal frequency offset), and supply voltage. Also, an extensive range of operating parameters may be changed remotely, including remote (RF) channel change.

Configuration options, allow various system topology's, so that the location of the system's diagnostics controller is flexible.

The data stream switching mechanism has been upgraded to allow either MUX/DeMUXing or multi-stream routing functions, independently for each port.

A few other minor upgrades to previous revisions of firmware are:

* Two different "ticker clocks" implemented, one running at 1mS, and used for a) PAD Character Input Timers, and b) Channel Access Timer when running in Collision Avoidance mode. The other "ticker clock" runs at 10mS, and is used for the PTT timer, and a host of other internal functions, not accessible by configuration programming.
* When XON/XOFF flow control is enabled on PortA, the CTS output line continues to operate correctly, indicating the flow control state. XON/XOFF characters are generated in addition to, and reflect state changes on this line. As before, the DTR input line is ignored while XON/XOFF flow control is set, and the RTS line is not required to be true to validate transmit data.
* The modem stores data for transmission in buffer memory, which is limited. It also keeps track of frame boundaries of the stored data, and the number of frames it can manage is also limited by the amount of memory used to record the position of the frame boundaries. Thus it is possible that the modem can approach overflow before exhausting data buffer space, if frames are small. This flow control state is activated when the "frame boundary memory" approaches half full, for similar reasons used in data buffer management.
* If the Supervisory Signalling Channel is enabled in both transmit and receive directions, and PortA is configured in Repeater Mode, then the received Supervisory Signalling Channel data is also repeated, by being copied from the Supervisory Signalling Channel receiver to the Supervisory Signalling Channel transmitter.
* RSSI measurements are full eight bit conversion, so the "min_RSSI" configuration parameter lies in the range 0 - 255 (decimal). This is only important when setting this parameter without the aid of the DRPROG programmer.

3.3.2 INTERNAL DATA STREAM ROUTING

Essentially, all data streams travelling in both directions (transmit and receive), are examined and tested for a match with the diagnostics receive SID header code. If this match test is successful, then the data frame is copied into a buffer for the diagnostics core to process. The data frame also continues in the original direction as well. Thus diagnostics frames received from the radio channel (receive data), and from the stream switcher (transmit data, from one of the physical ports), are copied as they pass between the HDLC "device" and the data stream "switcher". Messages generated by the diagnostics core in response to received commands, are always sent back to the source of the command. That is, if a status request is received from the radio channel side of the modem, then the response is directed back out of the radio channel.

This dual access structure, allows the diagnostics controller to be located on either side of the modem, and thus supports any system topology.

3.3.3 DIAGNOSTICS REPEAT FUNCTION

Some applications will require that the "base" unit in a point to multi-point system repeats diagnostics frames. This will be the case where the system diagnostics controller is attached to a remote terminal in the system, and polls the system population from this point. The "base" unit must re-transmit diagnostics frames which are not addressed to itself. A "diagnostics repeat" configuration bit enables this function.

3.3.4 DIAGNOSTICS FRAME STRUCTURE

Diagnostics data frames, are structured according to a defined protocol. A frame consists 1st of the SID header code, which would normally (but not necessarily) be 00. Following this is a three byte address of the destination unit, followed by a three byte source address. An addressed unit responding to a diagnostics command, will swap these two address fields around, in the response frame. The destination address in a diagnostics frame to a TC-900DR unit, is in fact the unique (factory) serial number of the unit. By convention, the diagnostics controller (a DOS based PC), will use a unique address for itself, outside the range of permissible TC-900DR addresses (e.g. 000000). Following the two address fields, is a single character command/response code, which is in turn followed by any operands that may or may not be required for the command/response. Total frame size is limited to 17 bytes. After the SID header, address fields, and command/response mnemonic, this allows up to nine bytes of data to be transferred per diagnostics frame.

3.3.5 DIAGNOSTICS COMMAND SET

The following is a list of the command set recognised by the diagnostics core in the TC-900DR Firmware. Also is tabulated the response to each command. The following examples use address 123456 for the TC-900DR unit address, and 000000 for the address of the system diagnostics controller. For the purposes of clarity only, each byte in the example messages is separated by a comma. Mnemonics are represented in quoted form to indicate an ASCII character (e.g. "C" is actually binary byte h'43).

B Warm Boot Command.

This command forces the addressed unit to perform a "warm boot". Previous to this, the unit will have been halted (see "H" command), and one or more parameters changed with "P" and "W" commands.

Syntax:-

Command:- 12,34,56,00,00,00,"B"

Response:- 00,00,00,12,34,56,"b"

C Calibration Constant Poll.

This command requests the addressed unit to reply with it's internal Analogue To Digital Converter (ADC) calibration constants. These are necessary to accurately interpret the data sent in Status Poll ("S") replies. This command has no operands, and the response mnemonic is "c". The form of the command and reply is:

Syntax:-

Command:- 12,34,56,00,00,00,"C"

Response:- 00,00,00,12,34,56,"c",tt,rr,pp,ff,ss

Where:-

tt = Temperature calibration code

rr = RSSI calibration code

pp = Transmit Power calibration code

ff = Received Frequency Offset calibration code

ss = Power Supply calibration code

D Powered Up Response

This command is sent from the modem to the controller in response to a status poll ("S") immediately after the modem has been powered up. The modem will continue to send this command in response to a status poll until the controller acknowledges the command with a "d". The modem will then respond normally to a status poll.

This mechanism is used by the controller to determine whether it requires calibration data from the modem.

Syntax:-

Command:- 00,00,00,12,34,56"D"

Response:- 12,34,56,00,00,00"d"

F Set New RF Synthesiser Frequency.

This command forces the unit to set the RF synthesiser to a new frequency, thus selecting another radio channel. This command has one operand, which defines the source of the synthesiser data. A value of zero, indicates that the frequency data has already been set with a parameter set command. Values from one to four select one of the channels stored in the NVRAM of the modem configuration. The addressed unit responds with an "f" reply, before executing the channel change command (i.e. on the old channel).

Syntax:-

Command:- 12,34,56,00,00,00,"F",nn

Response:- 00,00,00,12,34,56,"f"

Where:-

nn = 00 to 04 to select data source.

H Halt Command.

This command forces the addressed unit to halt all internal operations, except diagnostics processing. This is necessary, when changing some parameters, before a warm boot command is issued to the re-configured unit.

Syntax:-

Command:- 12,34,56,00,00,00,"H"

Response:- 00,00,00,12,34,56,"h"

M Set Serial Port Mode.

This command forces the addressed unit to change the operating mode of one or both serial ports. Parameters such as character size, number of stop bits, parity etc. are changed with this command. It should be noted, that data may be lost while the operating mode of the serial ports is changed.

Syntax:-

Command:- 12,34,56,00,00,00,"M",xx

Response:- 00,00,00,12,34,56,"m"

Where:-

xx = Serial port address bit and mode data

P Parameter Set command.

This command stores the contents of the operand string to a storage buffer. No other action is taken. This command should be immediately followed by a "W" command. See "W" command below. The parameter may be either a bit quantity, a byte quantity, a word quantity, or a string quantity. The diagnostics core in the modem firmware determines this from the parameter indentifier, which indexes an internal lookup table. String quantities are of indefinite length, and determined by the length of the operand string in the received "P" command. The "P" command response ("p"), echoes the complete received string. This is unique to the "P" and "W" commands.

Syntax:-

Command:- 12,34,56,00,00,00,"P",nn,aa,bb,cc,...

Response:- 00,00,00,12,34,56,"p",nn,aa,bb,cc,...

Where:-

nn = parameter identifier

aa, bb, cc,... are data value(s) for selected parameter

R Parameter Readback command.

This command forces the addressed unit to read the state of the addressed parameter, and send this data back the the command originator (diagnostics controller) in a reply message. Again the size of the parameter (bit, byte, word, or string) is determined by the parameter identifier. String parameters are returned as a string of eight consecutive bytes.

Syntax:-

Command:- 12,34,56,00,00,00,"R",nn

Response:- 00,00,00,12,34,56,"r",nn,aa,bb,...hh

S Status Poll.

This command requests the addressed unit to reply with the current value of analogue quantities, present temperature, last/present received RSSI, transmit power of last transmission, received frequency offset of last/present received signal, and present supply voltage.

Syntax:-

Command:- 12,34,56,00,00,00,"S"

Response:- 00,00,00,12,34,56,"s",tt,rr,pp,ff,ss

Where:-

tt = Temperature conversion code

rr = RSSI conversion code

pp = Transmit Power conversion code

ff = Received Frequency Offset conversion code

ss = Power Supply conversion code

T Diagnostics Watchdog Timer command.

This command forces the addressed unit to (re)set a special watchdog timer. The operand value is a word (16_bit) quantity. A zero value will disable the timer. A non-zero value will initialise the timer. This timer, while non-zero, will be decremented periodically. If the timer is decremented to zero, then the TC-900DR will perform a cold boot, thus restoring operating parameters from the NVRAM configuration memory. This command should be used in conjunction with parameter set and write commands. If a parameter change renders the unit in-operable, then either it will not continue to receive further "T" commands to reset the timer, or the system diagnostics controller may cease to send the timer reset commands, thus will eventually cause the unit to cold boot.

Syntax:-

Command:- 12,34,56,00,00,00,"T",nnnn

Response:- 00,00,00,12,34,56,"t"

Where:-

nnnn = timer reset value (16 bit value)

V Request Firmware Version String command.

This command requests the addressed unit to reply with a string indicating it's firmware version number. Future firmware versions may provide further facilities that may then be used, by sending appropriate commands.

Syntax:-

Command:- 12,34,56,00,00,00,"V"

Response:- 00,00,00,12,34,56,"v","A2.2.0"

W Write Parameter command.

This command is used in conjunction with the "P" parameter set command. This parameter write command must be identical to the previous parameter set command. Providing they are identical (excepting the command mnemonic), then the operand is written to the selected modem operating parameter. Changing some parameters while normal operation continues could produce improper operation, possibly resulting in corrupted parameters, so the unit should be halted with a HALT command before such parameters are changed.

Syntax:-

Command:- 12,34,56,00,00,00,"W",nn,aa,bb,cc,...

Response:- 00,00,00,12,34,56,"w",nn,aa,bb,cc,...

Where:-

nn = parameter identifier

aa, bb, cc,... are data value(s) for selected parameter

3.3.6 PARAMETER SET

The following is a list of parameters which may be remotely set. Parameters marked with a "*", should only be changed while the unit is in a halted state, followed by a warm boot command. Parameters marked with a "#", may only be referenced in an "R" readback command. Attempts to change these with "P" and "W" commands may produce unpredictable results.

Parameter Identifier	Parameter Type(Size)	Parameter Name
00 (^@)	undefined	not defined, reserved to facilitate future expansion
01 (^A)	undefined	not defined, Trio DataCom test use only
02 (^B)	byte	Drift_Offset
03 (^C)	word	PTT_Time
04 (^D)	string	Synthesiser Data for channel change
05 (^E)	byte	min_RSSI
06 (^F)	byte	Tx_LID
07 (^G)	byte	Slot_Num
08 (^H)	byte	Slot_Time
09 (^I)	word	SIDA1 and SIDA2
0A (^J)	word	SIDB1 and SIDB2
0B (^K)	word	SIDD1 and SIDD2
0C (^L)	byte	KISS_adrA
0D (^M)	byte	KISS_adrB
0E (^N)	byte	EOMA_code
0F (^O)	byte	EOMB_code
10 (^P)	byte	input_timeA
11 (^Q)	byte	input_timeB
12 (^R)	byte	frame_sizeA
13 (^S)	byte	frame_sizeB
14 (^T)	bit *	SLIP/KISS_mode portA
15 (^U)	bit *	SLIP/KISS_mode portB
16 (^V)	bit	EOM_enable portA
17 (^W)	bit	EOM_enable portB
18 (^X)	bit *	KISS_mode portA
19 (^Y)	bit *	KISS_mode portB
1A (^Z)	bit	RTS/CTS_interlock portA
1B (^[)	bit *	PORTB_enable
1C (^\)	bit *	Repeat_Enable portA
1D (^])	bit *	Repeat_Enable portB

1E (^^)	bit *	(Not defined, reserved for Error Recovery Enable)
1F (^_)	bit *	(Not defined, reserved for Error Recovery Enable)
20 ( )	bit	LiveFrame portA
21 (!)	bit	LiveFrame portB
22 (")	bit	XonXoffMode portA
23 (#)	bit	XonXoffMode portB
24 ($)	byte	PORTA_Config
25 (%)	byte	PORTB_Config
26 (&)	bit	diags_repeat
27 (')	bit	TxPWR_HI/LOW
28 (()	bit	SID_Enable
29 ())	bit	RTS2PTT
2A (*)	bit	SYNC2PTT
2B (+)	bit	SCDO_Default
2C (,)	bit	SupChnFunc
2D (-)	bit	TxCtrl1
2E (.)	bit	TxCtrl0
2F (/)	byte	Config1
30 (0)	byte #	SMR1 (portA serial port mode)
31 (1)	byte #	SMR0 (portB serial port mode)
32 (2)	byte #	BRR1 (portA serial port baud rate)
33 (3)	byte #	BRR0 (portB serial port baud rate)
		Additions for version A2.3.0
34 (4)	byte	err_limit (Frame Error output for Base Station)
35 (5)	byte	err_flags
36 (6)	word	good_cnt
37 (7)	word	bad_cnt
38 (8)	word	lost_sync_cnt
39 (9)	word	lost_RSSI_cnt
		Additions for version A2.3.1
3A (:)	byte	DCD_timeA
3B (;)	byte	DCD_timeB
3C (<)	byte	Diags_Delay

3.3.7 ADVANCED STREAM ROUTING FUNCTIONS

The TC-900DR provides advanced stream routing functions. For each port, there is allocated two SID (Stream IDentifier) codes, and a configuration flag that determines how these two codes are used.

With the flag off, SIDx1 (where x is A or B for portA and portB respectively) defines the SID code of received frames that are de-multiplexed to the port, and SIDx2 defines the SID code that is inserted by the modem at the front of every frame it transmits. Thus only one data stream passes through the port, and the modem manages the insertion and extraction of SID header codes.

With the configuration flag on, SIDx1 and SIDx2 define a range of streams that will be passed from the received data to the port. SIDx1 defines the lowest stream, while SIDx2 defines the highest stream. The SID header codes remain on the received frames, and are passed to the port. For transmit data, the modem assumes that the SID header codes are already in place, being inserted by some external device, and no processing is performed on the transmit data. For this application, it is highly desirable that a SLIP (or KISS) driver be employed so that frame boundaries are defined.

These functions are independent for each port, so it is possible to construct (say), a multi-drop, multi-hop repeated data system, where one stream can be "peeled off" at each repeater site. There are many other possibilities, the TC-900DR product simply requiring suitable configuration to construct a vast range of network topologies.

3.4 FACILITIES AND CONFIGURATION INFORMATION VERSION 2

3.4.1 GENERAL

The TC-900DR, provides two independent user data streams, which are multiplexed onto the radio channel data stream. The stream switching protocol also provides for an embedded remote diagnostics facility.

The two (asynchronous) user ports can be configured for a variety of baud rates, character sizes, parity, and stop bits.

Flow control on user Port_A may be set to use RTS/CTS/DTR/DCD handshake lines, or XON/XOFF characters. Flow control for Port_B may be set to use XON/XOFF characters, or no flow control. Port_B is not supported by RTS/CTS/DTR handshake lines.

Data is transported in (HDLC) frames, protected by a 16 bit CRC error checking sequence, conforming to the CCITT standard. Received frames found to contain errors are discarded. The TC-900DR does not release received data frames to the user port, until completely received, and error checked.

Maximum frame size is configurable for each port independently, and may be set to any value between 4 and 255. Frame size limiting is disabled by setting this parameter to zero (0).

Each user port, is supported with PAD functions conforming to X3, or SLIP*[1] or KISS* protocol interface.

For Point To Multipoint applications, a unique collision avoidance mechanism is available, with configurable channel access parameters.

All configuration parameters are held in a non-volatile memory. Normally, this memory can only be written when the radio modem is connected to a programmer.

3.4.2 BRIEF OVERVIEW OF MODEM INTERNAL OPERATION.

3.4.2.1 DATA TRANSMITTER

Each physical user port, is supported by a "driver", in this case a PAD (Packet Assembler/Dis-assembler) or SLIP/KISS. This function transfers the data from the port, to a buffer memory. This buffer not only stores the raw user data, but also keeps track of frame boundaries. Another functional block, retrieves that stored data, and feeds it to a third mechanism, which generates the data waveform which is applied to the radio transmitter modulator.

1 * SLIP ®™ KISS ®™

3.4.2.2 DATA RECEIVER.

The receiver extracts data frames from the received signal, and stores the contents of the frames into buffer memory. It may also perform a steering function, if more than one port is enabled. A second function is to retrieve the stored data, and send it to the user port(s), consistent with some flow control regime.

3.4.3 SELECTING FRAME SIZE

The selection of maximum frame size is a compromise between channel through-put and data propagation time over the link.

The receiving modem collects and stores the incoming data frame, and on detecting the end of the frame, checks if an error has occurred. If not, then the stored data is released for transfer to the user data port. If an error has occurred, then the stored data is "flushed" from the data store. Thus a delay is introduced between the time the frame data begins to enter the destination radio modem, and the time this data begins to emanate from the user port. This delay is effectively the length of the data frame, which consists of the user's data, plus the framing overhead. This overhead will include at least 24 bits for the HDLC Flag and FCS (error checking data), plus another 8 bits if SID (Stream IDentifier) codes are enabled (refer to detailed description elsewhere in this document), plus the duration of the transmitter Lead-In-Delay, if the radio transmitter had to be started up to send the data. Thus larger frames reduce the proportional overhead, but increase the end to end propagation delay.

On the assumption that the radio transmitter was already on, and that the frames include the SID header, then every frame includes 32 bits of overhead.

Assuming that the user port is configured for 8 bit character size (8 bit data no parity, or 7 bit data and parity), and 1 stop bit, then each character is carried as a 10 bit sequence on the asynchronous user channel. On the radio channel data stream, user data is stripped of the start and stop bits used on the asynchronous user port, and transmitted as eight bit "octets", and so the character rate is 1/8th of the bit rate, while on the asynchronous user port, the character rate is 1/10th of the bit rate. For every 16 user characters 32 bits are stripped off, so if the maximum frame size parameter is set to 16, and the nominal baud rates are the same, then the effective character rates on the asynchronous user channel and the synchronous radio data channel will be the same. This also assumes that the supervisory signalling channel is not enabled, and does not allow for the overhead introduced by the HDLC "dummy zero" stuffing mechanism.

3.4.4 CONFIGURING PAD PARAMETERS

The Packet Assembler/Dis-assembler (PAD) can be configured with a variety of parameters. Each user port is supported by an identical but independent PAD.

The configuration parameters of the PAD, control how the user data (to be transmitted) is framed. There are three distinct mechanisms that can cause the frame that will carry the user data to be closed.

The first of these is the Maximum Frame Size parameter, already discussed above. As each character is input to the modem, a counter is incremented, and when this counter reaches the set maximum frame size, the data storage mechanism that operates within the modem, will close the frame. This function may be disabled, by setting the parameter to zero.

The second mechanism, is the use of a specified End Of Message (EOM) character. This function is enabled/disabled by a flag in a configuration byte for the port driver. The EOM character may be any 8 bit character. When the EOM function is enabled, all incoming user data is compared to the selected EOM character code, and in the event of a match, the current frame is closed. Note that this match only triggers the frame closure mechanism. The matching character is not deleted from the user data stream, and in fact becomes the last user character in the frame.

The third mechanism, is the implementation of a timer. If the timer is enabled, each character received from the user port re-starts the timer. If the time duration between successive user characters allows the timer to expire, then the frame closure mechanism is invoked. The timer counts in units of "ticker clocks", which is a time interval generated by the modem internally, and is approximately 2.5mS. The reload value for the timer can be set from 1 to 255 ticker clocks. The timer mechanism is disabled by setting the PAD timer parameter to zero.

There is a single bit configuration flag, that allows the radio modem to begin transmitting user data, even before the frame is deemed to be complete. In this case, as soon as there is any data in the storage buffer, the modem begins the transmission procedure. Providing that the input character rate is greater than or equal to the character rate on the synchronous radio channel, then there is no danger of an under-run condition, where the modem transmitter runs out of data before the PAD deems a frame end. However, should this occur, the modem data transmitter function simply closes the frame itself. Further data is carried in the next frame. This may or may not cause problems elsewhere in a system context. If higher protocol layers are employed (e.g. X.25, AX.25 etc.), where address and control fields normally occupy fixed positions in data frames, then the above scenario should not be allowed to occur.

The major advantage of allowing the radio modem to begin the transmission procedure before the frame is deemed to be complete, is that it avoids a (store and forward) delay in the modem transmitter, similar to that required in the receiver. For applications where a transparent point to point link is all that is required, this mode provides the most time efficient transport mechanism.

In fact with the immediate transmission function enabled, there is little necessity to enable the EOM or timer functions of the PAD.

3.4.5 SUPERVISORY SIGNALLING CHANNEL: APPLICATIONS & CONFIGURATION.

The reader is referred to drawing number TC01-05-18, which provides a diagramatic view of this section.

The Supervisory Signalling Channel (SSC) is implemented by the insertion of extra data bits in the primary bit-stream on the synchronous radio channel. These extra bits are inserted between primary data octets, at a rate which can be set to range from once every octet, to once every 15 octets. The SSC operates independently for transmit and receive directions, and can be disabled by setting the rate variable to zero.

The SSC, when enabled, can be configured either to provide end-to-end flow control for Port_A data, or implement the collision avoidance mechanism.

3.4.5.1 PORT_A END TO END FLOW CONTROL APPLICATION.

In this configuration, the SSC is used to carry flow control information for data on Port_A at each end of the link.

SSC data inserted into the transmitted bit-stream, relates to the flow of the primary data stream received. When handshake lines are employed, the DTR line locally controls the flow of receive data to the user port. The state of this line is also logically combined with the "fill" state of the receive buffer, and the result is then sent as SSC data in the transmit data stream. Thus the state of the transmitted SSC data bit is one ("1") if the DTR line is in a "false" state, OR the receive buffer is more than half (approximately) full. In the case where XON/XOFF flow control is used, the DTR line input is instead replaced with the state of the last received XON or XOFF control character.

SSC data extracted from the received bit-stream, is logically combined with the "fill" state of the transmit buffer, and the result is output to the CTS line of the modem. The CTS output line is set to "false" if the transmit buffer is more than half (approximately) full, OR the received SSC data bit is a one ("1"). Thus the CTS line is set to "false" if the local transmit buffer is more than half (approximately) full, OR the remote receive buffer is more than half full, OR the remote DTR input line is "false" (or equivalent XOFF received).

Data flow control is exercised only at the user port. No flow control is used on the radio channel, so once data is entered into the transmit buffer, it will be transmitted. This is the reason why the buffers are only allowed to become half full before the flow control mechanism engages. If the flow of receive data is stopped by deactivating the DTR line, the remaining data in the transmit buffer will not overflow the receive buffer. It should be noted that some hysteresis is used in the buffer occupancy tests, to prevent the CTS line from changing state too often, as some hosts (e.g. DOS machines) appear to get confused when this happens.

If the SSC is not configured for end to end flow control, or is disabled, then the flow control mechanisms still operate at a local level. That is, the CTS line (or equivalent XON/XOFF control regime) reflects the fill state of the local transmit buffer.

3.4.5.2 COLLISION AVOIDANCE APPLICATION.

When the SSC is allocated to transporting collision avoidance data, the transmitted SSC data reflects the state of the radio receiver. Other processes in the modem, measure the RSSI signal from the radio receiver, and compare this measurement to a preset threshold level. This threshold value is also held in the non-volatile configuration memory. The result of the comparison is copied to the modem pin that drives the RXSIG LED. The transition of the RXSIG signal from off to on, (re)starts an internal timer. This time is a fixed value of 35 ±5mS. The SSC data transmitted, is simply a copy of the RXSIG pin state, until the timer terminates, and there-after, the modem data receiver must be "SYNC'd" to maintain the "1" state of the SSC transmit data. Thus the SSC data transmitted by the modem will indicate that the radio channel receiver is busy, using only RSSI for the first 35 ±5mS, but after this time, data receiver SYNC is used to qualify this state. This prevents low level RF interference from effectively blocking the channel.

At the receiving end, the recovered SSC data is used by the radio modem to determine when the receiver of the destination station is free. This data can then be used to control it's channel access strategy. Channel access strategies are dealt with in more detail elsewhere in this document.

In such a data transport system, there is a single unit which performs the function of Master, and two or more stations which operate as Slaves. The SSC need only operate in one direction, that from Master to Slaves. In the reverse direction, the SSC can be disabled. That is the SSC in the Slaves is enabled in the data receiver only, while in the Master, it is enabled only in the data transmitter.

3.4.5.3 RECEIVED SSC DATA DEFAULT STATE

The received SSC data bit is stored in an internal latch. This latch is updated each time a SSC data bit is extracted from the incoming bit-stream. However, if the radio receiver looses signal, then a default state is forced into the latch. This default state is configurable.

For applications which use the SSC for collision avoidance, this configuration bit would normally be set to "1", so that the remote station would not attempt channel access while the signal from the base is lost.

For applications which use the SSC for end to end flow control, setting the default state of the SSC receive data latch to "0", would cause the CTS output line to indicate local flow control status only, until the destination unit enables it's transmitter, where-upon the received SSC data would reflect the state of the destination receive buffer and DTR input line. Alternatively, setting the default state to "1", would ensure that the CTS output line would be in a "FALSE" state, until the destination unit enables it's transmitter, where-upon the received SSC data would reflect the state of the destination receive buffer and DTR input line.

An associated configuration bit, is one that allows the automatic activation of the radio transmitter, whenever the data receiver attains SYNC. When this configuration bit is set to "1", the modem will automatically activate the radio transmitter's PTT control line when the data receiver is SYNC'd. This could be used at the base end of a small point to multipoint network, using the SSC for flow control, and would not require the host connected to base, to specifically activate the radio transmitter to establish the end to end link.

3.4.6 SLIP/KISS PROTOCOL DRIVERS

In addition to a generic PAD, two other host interface protocols are supported, "Serial Line Interface Protocol", SLIP, which hails from the world of UNIX(tm), and an extension of SLIP, KISS "Keep It Simple Stupid", (a rather unfortunate phrase in the present context, but a protocol standard proposed by Phil Kahn, USA, specifically for the control of radio connected data terminals) which includes a facility to send commands which are addressed to the DCE device itself. These commands set operating parameters of the radio-modem DCE, such as transmitter lead-in delay, or radio channel (RF frequency).

Neither of these protocol standards, specify anything about the construction of data packets on the radio channel. Allocation of address, control, and information fields is the user's responsibility.

As standard, the modem is equipped with an 8K (8192 bytes, 32K optional) data storage memory to hold transmit and receive data. This memory is divided equally between transmit and receive buffer space, and equally between the two user ports, so the largest frame size is 4095 bytes, if only PortA is enabled, (or 2047 bytes each if both user ports are enabled), before the frame check sequence (FCS)is appended.

Additionally, the modem can store up to sixty four separate frames for each direction, again split between the two user ports if both are enabled, though the total byte count is still limited to 8192 total.

3.4.6.1 SLIP Protocol Description/Definition

The SLIP protocol, is a data transport protocol, originated and used extensively in UNIX(tm) based systems, and thus also closely associated with TCP/IP networked systems. Although not truly a "standard" it is so widely used that it has become the defacto standard for serial interface in UNIX and many other networked systems. SLIP is a method of framing messages containing binary data, on asynchronous channels. The asynchronous serial channel is configured for eight bit character size, no parity, and one stop.

A specific binary code called FEND (Frame End, hexadecimal value=C0) is reserved to define a frame boundary. Should this same code occur in the data message to be transferred across the channel controlled under SLIP, then an escape sequence is used so that the message byte will not be confused for a FEND. This escape sequence, involves replacing the message hexadecimal C0 code with a two byte sequence FESC, TFEND. FESC (Frame Escape) is the binary code hexadecimal DB, and TFEND (Transposed FEND) is binary code hexadecimal DC. Likewise, if the FESC character ever appears in the user data, it is replaced with the two character sequence FESC, TFESC (Transposed FESC). The TFESC is the binary code hexadecimal DD. The following table clarifies this.

ABBREVIATION	DESCRIPTION	HEX VALUE
FEND	Frame end	C0 (192)
FESC	Frame escape	DB (219)
TFEND	Transposed frame end	DC (220)
TFESC	Transposed frame escape	DD (221)

As characters arrive at the SLIP receiver, they are appended to a buffer containing the current frame. Receiving a FEND marks the end of the frame, and consequently, succeeding bytes are considered part of the next frame.

Receipt of a FESC code puts the SLIP receiver into "escaped mode", causing it to translate a following TFESC or TFEND back to a FESC or FEND code, appending it to the buffer, and resuming it's normal state. Receipt of any byte other than TFESC or TFEND while in escaped mode, is an error. No translation occurs, and the SLIP receiver leaves escaped mode. A TFESC or TFEND received while not in escaped mode is treated as an ordinary character and stored accordingly. Reception of consecutive FEND characters, causes no action to be taken (i.e. is not interpreted as zero length frames).

An example of a typical SLIP frame is shown below. The message consists of the string DA,C4,C0,C5,DB,20,BD,DC,DD. The SLIP frame will be:-

<FEND>,DA,C4,<FESC>,<TFEND>,C5,<FESC>,<TFESC>,20,BD,DC,DD,<FEND>

==> C0,DA,C4,DB,DC,C5,DB,DD,20,BD,DC,DD,C0

3.4.6.2 KISS Protocol Description/Definition

The KISS protocol is an extension of SLIP. It uses the same method of framing packets, using FEND, FESC, TFEND, and TFESC codes. However, the first byte in each frame is reserved as a control code, that defines the function/content of the frame, and also contains an address.

This addressing scheme allows up to sixteen "Terminal node controllers" (TNC's), to share a multidrop buss. The top nibble of the control code carries the TNC address, and the lower nibble carries the command code. Normally the address is set at zero for installations containing only one TNC. Note that some extensions have been proposed for the KISS protocol, that properly support addressed multidrop line operation of multiple TNCs, that the present TC-900DR modem firmware does not implement. The following table shows the commands defined by KISS, and the comment column indicates how the TC-900DR modem interprets them.

COMMAND	FUNCTION	COMMENTS
0	**Data Frame**	The rest of the frame is data to be transmitted.
1	**TxDelay**	The next byte is the RF transmitter key-up delay in octets.
2	**Slotnum**	The next byte is the Slotnum parameter.
3	**Slot-Time**	The next byte is the "Slot" interval in "ticker clocks".
4	**TxTail**	The next byte is the time to hold up the RF transmitter after the closing FLAG has been sent. This command is obsolete, and not implemented in the TC-900DR.
5	**FullDuplex**	The next byte is zero for half duplex, non-zero for full duplex. This command is not implemented in the TC-900DR, as it always operates in full duplex mode.
6	**SetHardware**	Specific for each TNC. This parameter has values between 00 and 03, and commands the TC-900DR to set RF channels 0 to 3. Values above 3 are ignored by the present modem firmware, but may be used in future versions.
F	**ExitKISS**	Exit KISS and return control to higher level TNC control program. This command is not implemented in the TC-900DR.

3.4.7 RF TRANSMITTER CONTROL AND CHANNEL ACCESS STRATEGIES

There are three conditions which cause the modem to activate the radio transmitter. These are: a) receiver SYNC if enabled, as described above; b) RTS if enabled, as described below; and c) the existence of a data frame ready for transmission. The first two mechanisms are absolute, and if enabled, cause an immediate activation of the radio transmitter. There are two configuration bits that control how the availability of a data frame, will activate the radio transmitter, and thus gain access to the channel. For the purposes of this description, these are referred to as Modes A, B, and C.

In Mode A, channel access is immediate. The radio transmitter is activated, and the modem then proceeds to send a preamble sequence, followed by the data. The preamble sequence is necessary for receiver synchronisation, and the length is a configuration parameter. Further discussion of these aspects of the modem configuration are dealt with elsewhere in this document.

In Mode B, the modem will attempt channel access only if the radio receiver is NOT receiving a signal (i.e. the measured RSSI level is below the minimum RSSI threshold as described elsewhere in this document). This method could be used for small point to multipoint systems, where the base station would enable it's radio transmitter on receiving a transmission. Typically this would be done at the base unit by enabling the SYNC-PTT function, as described above. This implements a basic collision avoidance system, without the use of the Supervisory Signalling Channel, which then remains available for flow control applications.

In Mode C, the modem will attempt channel access only if the data receiver is SYNC'd, and the SSC data is "0" (i.e. base receiver free). This is the full Collision Avoidance system as described in detail above.

In the latter two cases, if another data frame is ready for transmission at the time the present one is ending, then it is automatically appended as another frame, and the transmission continues. Obviously since the radio transmitter is already enabled, no preamble is required or sent. The modem itself does not limit the number of consecutive frames it will transmit. If data continues to be input to the modem, once channel access is gained, it continues to be transmitted. It is the responsibility of the user to manage any maximum channel access time in overall system design. However, if the PTT timer is enabled (dealt with in detail elsewhere in this document), and the set time is reached, then the modem will disable the radio transmitter PTT line. User data will now be lost.

For the two latter strategies, if channel access fails (i.e. signal at radio receiver in the former case, or SSC=1 in latter case), then the modem uses a timed delay mechanism before testing for channel availability again.

3.4.7.1 SELECTING "SLOTIME" AND "SLOTNUM" VALUES

This delay time is necessary to prevent multiple remotes from attempting to gain access to the channel as soon as it is signalled to be clear after another transmission has finished, as this would result in the transmissions from all these remotes colliding. Instead, when a modem fails to gain channel access, it generates a randomly selected delay time, and when this time has expired, it again tests for channel availability.

There are two parameters which are used to generate the delay time. The "Slotime" parameter defines the size of the time increment used in selecting the delay. This value defines a time counted in "ticker clocks" (approximately 2.5mS), and has an allowable range of 0 to 255. The "SlotNum" parameter defines the upper limit of the random number generator. The random number generator selects an integer between one and the value of "SlotNum", and then multiplies this by the value of "Slotime" to derive the delay time. The "SlotNum" parameter has a maximum allowable range of 1 to 16.

These two parameters together provide a very flexible method of tuning the channel access characteristics of a system, and should be regarded as system tuning parameters. In the absence of any knowledge of a system configuration, Trio DataCom's set default values for these to parameters to 4 and 16 for "Slotime" and "SlotNum" respectively.

3.4.7.2 PTT CONTROL BY RTS LINE

Applications relying on establishing a point to point link before data is transferred, would normally require some "manual" method of activating the radio transmitter. A configuration bit enables the RTS input line to be used as a PTT control. The modem is always generating a data signal. During the time when no user data is available, the modem continually generates an "idle" bit-stream of HDLC FLAGs. This sequence produces no data output at the receiving radio modem.

3.4.8 SELECTING FLOW CONTROL REGIMES

The type of flow control to be used on the radio modem port(s), depends on the user's application and capabilities of the equipment which the user interfaces to the TC-900DR.

Port_A, which is always active, can be configured to use the standard RS232 handshake lines RTS/CTS/DTR, or use XON/XOFF protocol.

3.4.8.1 PORT_A, HARDWARE HANDSHAKE FLOW CONTROL

If hardware handshake lines are configured, then RTS must be active to validate characters input to the modem for transmission. As each character is received (i.e. at the end of each character bit sequence) the state of the RTS input line is tested to validate the character. If the RTS line is tested "true", then the character is stored ready for transmission. If "false", then the character is discarded. The modem provides flow control of transmit data with the CTS line. The CTS line is set "false" to indicate that no more transmit data should be input. Normally, most terminals or hosts will still send one or two more characters after the CTS line is set "false", and this is normal and allowed for in the CTS control logic. In fact the modem will continue to accept and store transmit data (providing the RTS line is still active) even though it has set the CTS line to "false", however the user then risks the occurrence of an overflow condition. If the transmit buffer becomes full, then further data is discarded.

A configuration bit, further controls the state of the CTS output line in relation to the RTS input line. If the bit is clear, then the CTS output will always indicate the flow control state, regardless of the state of the RTS input. If the bit is set, the CTS line is conditional on the state of the RTS input. If the RTS input is "false", then the CTS output is also "false". If the RTS input is "true", then the CTS output indicates the flow control state. This latter configuration is typical of a "wired" modem.

The modem's internal data store holds both the raw user data, and records the position of frame boundaries (as defined by PAD operation) in the data. A limited amount of memory is allocated to storing the frame boundary data. When this memory space is full, the modem sets the CTS output to false, even though the character storage space may not be full. The frame boundary storage space is sufficient to hold data for 64 frames. If the modem has both ports (Port_A and Port_B) enabled, then this space is evenly divided between the two, or if Port_B is disabled, then up to 64 frames can be stored for Port_A. If data continues to be input when the CTS line has been set to "false" because no more frame boundaries can be recorded, then the frame closure mechanism may abort. This has the effect that a frame will not be closed when defined by PAD configuration. An example of this, is where the PAD is configured to close the frame on receiving a <CR> (carriage return) EOM. If the frame boundary space is full, when a <CR> is input, then the subsequent characters will be appended to the same frame. Another attempt to create a new frame will not occur until the same or another frame close condition (as defined by PAD configuration) occurs, in this case another <CR>. This logic avoids the unnecessary loss of data.

Situations where the data storage space or frame boundary storage space become full, would be rare, and would only be likely to occur if the transmitter could not gain access to the channel, or the input data rate exceeds the channel transmission rate for some time.

Normally the TC-900DR is manufactured with an 8 kilobyte memory for data storage. This memory space is divided equally between transmit and receive data storage. If both user ports are enabled, then each half is equally divided between the ports (i.e. 2K/2K/2K/2K for Port_A transmit, Port_A receive, Port_B transmit, Port_B receive). If Port_B is disabled, then 4K is available for each of the transmit and receive data storage functions for Port_A.

The DTR line controls the flow of receive data to the user port. While the DTR input line is "true", available received data is output from the port. If the DTR input is "false", then receive data output ceases.

3.4.8.2 PORT_A XON/XOFF FLOW CONTROL PROTOCOL

When XON/XOFF flow control is configured for Port_A, the CTS line is set "true", the RTS input line is not required to validate input data, and receive data is not dependent on the state of the DTR line. Instead of controlling the CTS line, the modem sends XON/XOFF characters (embedded in the receive data stream), to the port. The flow of receive data is controlled by the receipt of XON/XOFF characters in the transmit data stream. These control characters are trapped out of the transmit data stream, and are not transmitted.

The underlying flow control logic is the same as RTS/CTS/DTR control. An XON is sent instead of a "false" to "true" transition of the CTS line, and an XOFF is sent instead of a "true" to "false" transition on the CTS line. A received XON is recorded by an internal flag that emulates a "true" state on the DTR line, and a received XOFF is recorded by the flag to emulate a "false" state on the DTR line.

This method of flow control would be considered to be less reliable, since a lost XON or XOFF control character could cause either an overflow condition, or data flow to stop altogether.

3.4.8.3 PORT_B FLOW CONTROL

User Port_B can be configured for no flow control, or XON/XOFF flow control. When XON/XOFF flow control is configured, it operates identically to Port_A, except that this port has no CTS line to set "true". Flow control on Port_B operates at a local level only, since end to end flow control via the SSC is available only for Port_A.

If XON/XOFF flow control is disabled, then no flow control is used on Port_B, as there are no RTS/CTS/DTR lines implemented on Port_B. Users should be careful to avoid overflow conditions, to avoid loss of data.

It will now be obvious that the RTS input line on Port_A can be used by more than one function in the modem. RTS can have no function, or be used in Port_A flow control, and/or provide a manual PTT facility.

3.4.9 SETTING MINIMUM RSSI LEVEL

The data receiver of the modem is continually running. It will be in one of two states. It is not SYNC'd, and thus looking for HDLC FLAGs in the radio receiver signal, or it is SYNC'd, and recovering frame data to be checked and stored. If the radio receiver is not receiving a signal, then the recovered signal applied to the data receiver of the modem, will consist only of noise. To prevent the modem from erroneously locking onto noise, a minimum RSSI level must be present to validate the recovered signal applied to the modem data decoder. This threshold level, is stored in the non-volatile configuration memory. It should be set by applying a signal to the radio receiver, which produces a desired SiNaD result, a desired bit error rate, or more crudely, a predetermined absolute signal level into the antenna connector of the TC-900DR. The modem (operating in Test/Program mode) is then commanded to measure the RSSI level, which produces a response of a message indicating the measured level, in hexadecimal. This process should be repeated several times, then an average taken. The analogue to digital conversion performed in this way, is an eight bit conversion. In normal operation, the modem performs a six bit conversion when measuring the RSSI level, so the average of the levels measured in the test mode should now be divided by four. The result should now be stored in the configuration memory, at the address reserved for it.

3.4.10 SETTING PTT TIMER

The modem implements a PTT timer. This timer can be disabled entirely by setting the PTT Timer configuration value to zero. The timer value is a 16 bit number, that counts in "ticker clocks". If the timer is enabled, whenever the modem activates the PTT control to the radio transmitter, it initialises the timer with the configured value. The timer is decremented while the PTT control remains active, and if it terminates, the PTT control is deactivated. No other action is taken, and all other functions within the modem are oblivious to this condition, so data frames continue to be output, and thus lost. The PTT timer is to be considered an emergency override mechanism only, in case an error occurs in the operation of the user's host equipment and/or software. To reset this time-out state, conditions must be met that would cause the modem to normally deactivate the PTT control. The PTT timer will then be re-initialised the next time the PTT control is activated. The time-out period may be set in "ticker clock" (2.5mS) increments to over 160 seconds.

3.4.11 DATA STREAM SWITCHING, SELECTING AND ENABLING SID CODES

The TC-900DR radio modem includes a feature that provides data stream switching. This is achieved by placing a Stream Identifier code (SID) at the beginning of every frame. This code functions as a simple addressing function. If both user ports of the TC-900DR are enabled, then SID codes should also be enabled, so that data frames carry a code which identifies the originating port (A or B), thus the port to which the frame data should be directed when the frame is received at the destination station.

However this stream switching mechanism is not only confined to this simple application. The SID codes for each user port, are contained in the configuration memory, and are thus "soft". It would be possible to engineer a small (up to 256 stations) network using an individual SID code for each remote station. Since the modem receiver will discard frames which are headed by an SID code which is not recognised, only frames specifically addressed would be stored and passed on to the attached host. The SID code is allocated to the port, so the modem uses the same SID code both for transmission and receipt of frames. Therefore in such a system, the master would be configured with SID codes disabled. The host attached to the master would preface each message with the eight bit address of the destination remote. The message from the remote emanating from the port will have the SID code removed. A message received from a remote, will have the SID code of the sending station at the beginning as the first byte. The remote modem itself places this code at the head of the frame.

Another application of the stream switching feature, is a remote diagnostics facility. This is a facility which is planned for release in the next firmware version. A reserved SID code will be used to address a diagnostics function within the modem. A command/addressing protocol is being developed that employs the units own unique serial number for addressing. "Stay tuned for further updates!".

The SID code is placed in the first octet of each frame. This provides up to 256 unique codes. However, to avoid possible future compatibility problems where higher level protocols are in use on the same channel (e.g. AX.25, etc.), it is suggested that the SID codes used have bit0 set to "1". Such higher level protocols normally use extended addressing where more than one octet is used to carry the destination/source address. A frame using an SID code with bit0 set, will fail an address test and be discarded by such systems. Conversely, if this modem receives a frame containing a higher level protocol, bit 0 of the first octet will normally be set to "0", so will not match any SID code stored in the configuration memory, and be discarded.

By default, Trio DataCom sets the SID codes to 03 and 05 for ports A and B respectively. We have also reserved SID code 00 for the diagnostics facilities.

3.4.11.1 Separate Tx And Rx SID Codes. (Firmware Revision V2.1 onwards)

Firmware revision V2.1.0 onwards allows the Transmit and Receive SID codes to be different. Normally the RxSID and TxSID parameters (separate for each port) would be programmed the same. By programming them to be different, means that a TC-900DR unit will receive frames carrying a SID code that matches the configured RxSID code, but transmit frames which carry a SID code that is specified by the TxSID code configuration parameter. Applications for this feature are in small point to multipoint systems, using a central "community" repeater.

3.4.11.2 Repeater Operation Mode. (Firmware Revision V2.1 onwards)

The TC-900DR radio modem may also be configured in a repeater mode. The repeater function is enabled as a protocol driver on a port. Thus each user port driver can individually be configured for repeater operation. Essentially, what this does is automatically routes the received data frames back to the transmitter. If SID codes are enabled, then the original SID codes are stored as part of the data frame, and thus the retransmitted frame is identical to that received. Note that only frames received error free will be repeated.

When a port driver is configured for repeater operation, the RxSID and TxSID codes stored in configuration data in the NVRAM are used to define a range of streams to be repeated. The RxSID code configuration parameter defines the lowest SID stream to be repeated, and the TxSID code configuration parameter defines the highest SID stream that will be repeated. Thus it is possible to configure a unit to perform a repeater function for two separate ranges of streams, by configuring both user ports with a repeater driver, or to configure one end of a data link to also be a repeater for a range of other streams.

3.4.12 SETTING TRANSMITTER LEAD_IN_DELAY

Whenever the radio transmitter is activated a timer is started. No data frames are transmitted until this timer terminates, so that the destination unit receiver has time to synchronise it's data receiver before frame data is begun. The radio transmitter is very fast, reaching final output power and frequency stability in a matter of a few hundred microseconds (other sections of this document deal with the receiver synchronising aspects). This timer counts in octets, not "ticker clocks" as most other timed functions do, so the actual time elapsed is a function of the radio channel bit rate. However, the synchronisation time is primarily a function of the number of bits to the receiver. Trio DataCom would suggest a value of 25 to 50 (decimal) for this parameter, but it's final value will depend on signal strength and quality at the receiving point, and should best be determined by test.

3.5 FACTORS AFFECTING MODEM SYNCHRONISATION TIME

3.5.1 (UN)SCRAMBLER AND HDLC STATE MACHINE

It can be shown, that the un-scrambler in the receiving unit will synchronise to the scrambler in the sending unit in 17 bits maximum.

The receiving unit must then detect an HDLC FLAG, which will take another 15 bits maximum. Thus the HDLC state machine and unscrambler should be synchronised in 32 bits maximum.

3.5.2 PHASE LOCKED LOOP

Before valid data can be read for the unscrambler, the phase locked loop (PLL) must lock. The time required for this to occur is affected by signal quality and content. The PLL relies on level transitions of the binary signal, on which to lock. It essentially compares the phase of an internal counter, with the phase of the incoming data bits. A detected phase error, will cause the internal counter to speed up or slow down, to reduce the phase error. The greater the error, then the greater the speed adjustment to the internal counter.

If the incoming data stream has few transitions, then the internal counter will "catch up" to it quicker, since it's speed is adjusted less often. The PLL will synchronise to within 90% of the correct phase (from 0%), in 16 to 36 bits time, depending on the number of transitions.

In practice, even though the PLL has not reached 90% lock, meaningful data will still be obtained as long as a good strength, clean signal is available.

3.5.3 ERROR CONTROL

Having recovered the raw data, the modem then applies the bit-stream to a de-ramdomiser, which is based on a recursive tapped shift register, described by the polynomial:

$$X^{17} + X^{12} + 1$$

The output of the de-randomiser is then fed through another conversion function, to convert the NRZI data to NRZ.

The data is now an HDLC data stream, conforming to ISO3309. It is then applied to a function which detects HDLC FLAGs, and extracts "dummy zeros", which were inserted by the transmitter. Frame boundaries are detected at this point.

The modem calculates and appends a 16 bit Cyclic Redundancy Checksum (CRC) word to the end of each frame. This calculation uses the polynomial:

$$X^{16} + X^{12} + X^{5} + 1$$

This is sometimes referred to as CRC-CCITT since it is a CCITT standard.

The 1's complement is taken of the calculation result and this FCS is appended to the end of the data frame and sent MSB first. (Refer to ISO 3309 for more information)

At the receiver, this calculation is repeated on the received data, and the result checked. A detected error, will cause the receiver to discard the entire frame. A higher protocol level (determined by the user) will detect the lost packet, and initiate a re-send of the packet.

In terms of the reliability of this FCS, it can be claimed that the following will be detected : [2]

All single bit errors.

All double bit errors.

Any odd number of errors.

Any burst error less than 16 bits long.

Most large burst errors.

From here emanates the original frame data, provided the FCS was correct. If not then the frame data is discarded. The data is stored in externally addressed memory, connected to the modem IC. Maximum data packet size is determined by the amount of available memory. Normally the modem is fitted with an 8K CMOS RAM, of which half (4096 bytes) is allocated to the receiver. The modem can be fitted with an external memory up to 32K with no other modifications. The receiver section of the modem can store up to 32 separate data packets.

How this data is handled from this point on, depends on the user protocol implemented by the modem on the user interface.

3.5.4 TRANSMISSION FORMAT AND TIMING

The data to be transmitted is input to the modem, via the user interface protocol implemented on the user interface. The modem stores the data packet(s) in externally addressed memory, connected to the DFM4-9 modem IC. Maximum data packet size is determined by the amount of available memory. Normally the modem is fitted with an 8K CMOS RAM, of which half (4096 bytes) is allocated to the transmitter. The modem can be fitted with an external memory up to 32K with no other modifications. The transmitter section of the modem can store up to 32 separate data packets.

Most of the transmitter functions are performed internally in the modem IC, with only a DAC (Digital to Analogue Converter) and final low pass filter implemented by external circuitry.

The data is placed into an HDLC frame (consistent with ISO3309), complete with dummy zeroes where required. During transmission, a CRC calculation (CRC-CCITT) is performed, and when the end of the data packet is reached, this FCS (Frame Check Sequence) is appended to the end of the frame, before the closing HDLC FLAG.

Where two or more consecutive frames are sent, only one FLAG octet is used to delimit the frames. All frames are composed of an integral number of octets.

[2] "Data and Computer Communications" William Stallings

Data from the HDLC formatting stage is fed through a function, to convert the NRZ data to NRZI format.

The NRZI encoded data stream is now fed to a data randomiser, to ensure that there is no DC component to the data stream. This is based on a recursive seventeen bit shift register with two taps.

3.5.5 COLLISION AVOIDANCE SCHEME

The unique supervisory signalling channel facility available in this product is ideally suited to the implementation of a highly effective collision avoidance mechanism. This is a highly desirable feature in a multipoint data network, in that it allows vastly increased usage of the available channel capacity.

For instance, take a point-to-multipoint network, with a central base station, and a large number of remote data terminals scattered around the central station.

This is a split frequency duplex channel, where the central station is able to transmit on frequency F1, and simultaneously receive on frequency F2. Remote stations transmit on frequency F2, and receive on frequency F1.

If a transmission by one remote station is "crashed" by a transmission by another remote station, then the base station may not get the message correctly, and thus not acknowledge it. If there is no control over when the remote stations transmit, then because the remote stations cannot "hear" each other, their transmissions will begin to collide more often as the data traffic increases. This type of system will suffer a total blockage as the total traffic requirement approaches about 50% of the channel capacity.

Now, if the base station could quickly inform all other remote terminals, when the base receiver is busy because one of the remote terminals is transmitting, then this message can be delivered to the base receiver without being "jumped on" by another terminal blindly "crashing in". The next terminal can then deliver it's message when the receiver is signaled to be free. Of course collisions are still possible, but the occurrence of these can be dramatically reduced by this type of scheme.

Now to implementation specifics. The supervisory signalling channel in the modem, can be set independently for transmit and receive directions. For the purposes of this collision avoidance scheme, the supervisory signalling channel is only required in the base transmit direction. In the reverse direction, the supervisory signalling channel is disabled. The base transmitter is active full time, sending only FLAGs when it has no real data to send. The base controller, then indicates to the whole population of remote terminals, the current status of the base receiver, in the value of the supervisory signalling channel data bits.

The remote data terminals are programmed so that they will not begin a transmission if the received supervisory signalling channel data indicates that the base receiver is currently busy. This would result in remote terminals queuing for access to the base receiver. To prevent all these remote terminals all beginning a transmission as soon as the base indicates a free receiver, a "windowed" timing mechanism would be implemented, with a random factor added in the terminal's selection of a "window".

There are many factors that would determine the quantification of system variables, but this short description serves to illustrate a basic approach.

3.6 TEMPERATURE COMPENSATION

Periodically, the modem controller reads the voltage on the temperature transducer mounted on the radio section. This value is then used in a table look-up procedure, to derive correction data to be applied to the modulator circuitry via a transmit waveform offset voltage. This is provided by the output of the six bit DAC (UX8/RN2), which is fed to the correction voltage input of the 12MHz reference oscillator.

The offset table is constructed in the temperature calibration cycle performed during the factory testing procedure. The radio-modem is temperature cycled twice from -10C to +65C. During this time, the necessary data is determined to correct the temperature induced frequency errors. At the end of the cycle, the final database is constructed and written to the non-volatile memory.

3.7 USER INDICATIONS

The TC-900DR provides three LED's that show status information to the user - RXSIG, SYNC, and TXMIT indications.

In all operation modes of the modem except "Programmer mode" (see the section below on special modes of operation), the RXSIG LED indicates the level of the RSSI signal from the radio IF strip, compared to a threshold set in the configuration data read from the non-volatile memory. If the signal is above the threshold, then the LED indicator is turned on. There is no hysteresis applied in this process.

In normal operation, the SYNC LED indicates when the modem has detected a valid data stream. The SYNC LED is activated, when the modem detects a valid HDLC flag sequence, and remains active until an invalid sequence of seven or more consecutive "1" bits is detected. The SYNC LED will not be turned on if the RSSI signal strength (as indicated by the RXSIG LED) is below the minimum threshold. This prevents false SYNC detection from noise. While the modem is SYNC'd, it does not continue to measure RSSI levels.

The TXMIT LED indicator is connected directly to the modem's PTT output transistor. It is active whenever the PTT line to the radio section is active low.

3.8 SPECIAL MODES OF OPERATION

3.8.1 GENERAL

Part of the power-up/reset initialisation phase of the TC-900DR modem, is a set of tests to determine whether the modem should enter a special operation mode.

There are three of these "special" modes. *Whilst in these modes the TC-900DR will not operate in its standard run mode.*

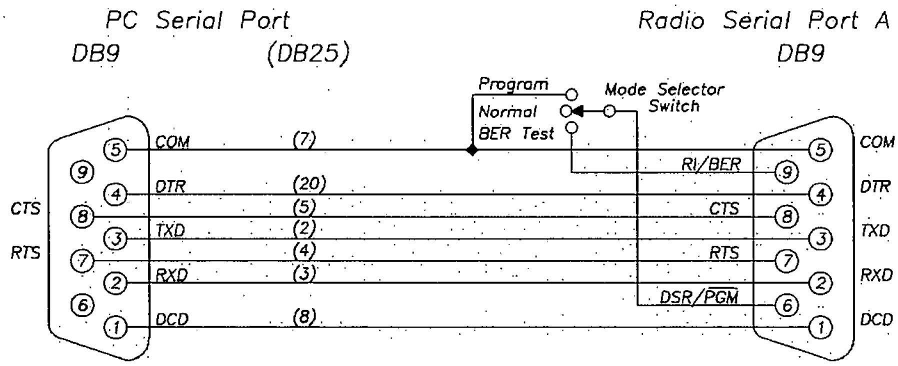
- Programmer mode.
- Bit error rate test mode.
- Handset mode.

These modes are only entered if the required setup conditions are present at power up of the TC-900DR. An error mode of operation can also be entered into, if during normal operation of the TC-900DR modem, an error condition occurs.

3.8.2 PROGRAMMER MODE

Pin 6 on the DB9 connector of Port A, is normally the DSR line. This pin is pulled high by a resistor to +13.8v, so that to a connected DTE the DSR signal implies that this DCE is ready.

However, if this pin is connected to pin 5 when the modem is powered up, the controller senses this, and attempts to enter "Programmer mode". The modem sends out of the serial port, an ASCII "?" (question mark) character, and waits for the programmer to reply with a password. The SYNC LED toggles on and off with every output of the "?" prompt until the correct password is entered. This mode is sustained for approximately 30 seconds. Failure to supply the correct password in time, will cause the modem to abandon the "Programmer mode" attempt, and go on with it's normal power-up procedure. This password protection scheme provides some defense against unauthorised tampering with the TC-900DR modems configuration data.



3.8.3 BIT ERROR RATE TEST MODE

Pin 9 of the DB9 connector of Port A, is normally the Ring Indicate output line. The modem includes a resistive pulldown to ground to show a negative condition on this line. However, if this pin is driven positive (typically by connecting it to pin 6), then the modem's data transmitter and receiver will enter the BER test mode.

It will activate the RF transmitter and generate a scrambled bit pattern which should be decoded at a receiver as a constant logic "1" level in the unscrambled data.

A test point on the modem section PCB, is available to monitor this point with a frequency counter. (In fact this test point is always active, and may be used to monitor the received data decoded by the DFM4-9 modem IC at any time). Any errors in the decoded bitstream, will be "0", and the receiver portion of the modem in this mode, will activate the SYNC LED every time it sees a "0" bit.

An internal timer is used to generate a time equivalent to 1000 bits. Every error bit detected, will activate the SYNC LED, and restart the timer. If and when the timer expires, the SYNC LED is deactivated. Thus, for error rates of 1 in 103 and above, the SYNC LED will be ON most of the time. A 1 in 104 error rate will show the SYNC LED active for approximately 10% of the time. This function provides a crude indication of Bit Error Rate for installation purposes.

Other functions performed in this state include RXSIG indication, and temperature compensation. The state of pin 9 is constantly monitored in this mode. If the pin ceases to be driven positive, then the BER Test mode is terminated, and the modem restarts it's initialisation phase.

3.8.4 HANDSET MODE

The DFM4-9 modem tests for the presence of a handset plugged into the handset audio port at power up.

This is done by measuring the voltage on channel 4 of the analogue to digital converter (UX10-p6). This signal is passed into the modem section from the radio section via connector X4-p24, "ADC3".

If a handset is plugged in, then the measured voltage will be about 2V, but if it isn't installed, then the voltage will be about 4V. The measured voltage is compared to 3V to determine whether the handset is plugged in. If this test succeeds, then the modem will not generate a data stream. However, it will continue to indicate received RF signal strength, and perform temperature compensation. The handset has a PTT button, and this signal is connected across the modem's PTT output. Thus the handset PTT switch will activate the TXMIT LED.

3.8.5 ERROR INDICATION MODES

3.8.5.1 GENERAL

There are three error conditions that will cause the RXSIG and SYNC LEDs to be used for error indications and not their normal purpose. Two of these are fatal conditions, that cause the modem to restart after the duration of the error indication phase.

3.8.5.2 TRANSMIT POWER LOW

While the modem activates the radio transmitter, it periodically checks the transmit power. If the power measurement is less than a threshold set in the non-volatile memory, then the RXSIG and SYNC LEDs are made to alternate, approximately four times per second. The TXMIT LED will also be on during this process. This indication condition will persist for the duration of the transmission. As soon as the transmission is discontinued, the error indication will cease, and the two LEDs revert to their normal function.

3.8.5.3 NVRAM READ ERROR

The DFM4-9DR modem accesses the non-volatile memory as part of it's initialisation phase, to get configuration data. If the communication protocol with the device is violated, or the non-volatile memory CRC checksum is found to be incorrect, then the modem indicates this by flashing the RXSIG and SYNC LEDs twice alternately. That is, one LED operates ON and OFF twice, then the other. A total of five cycles of this occurs, then the modem restarts it's initialisation from scratch.

3.8.5.4 SYNTHESISER LOCK DETECT ERROR

If at any time during normal operation, BER mode, or handset mode, the TBB206 frequency synthesiser indicates an out of lock condition, the modem enters an error indication mode for a short time before restarting. One LED is turned ON (☼), the LEDs are swapped, then both turned OFF (●). Then the latter LED ON again, swap LEDS, and then OFF. This will give the appearance of a sweeping motion between the LEDs.

The following table shows all error condition displays for comparison.

Tx PWR Error		NVRAM Error		TBB206 Error Synthesiser	
RXSIG	SYNC	RXSIG	SYNC	RXSIG	SYNC
☼	●	☼	●	☼	●
●	☼	●	●	●	☼
☼	●	☼	●	●	●
●	☼	●	●	●	☼
☼	●	●	☼	☼	●
●	☼	●	●	●	●
☼	●	●	☼		repeat
●	☼	●	●		
continue			repeat		

3.9 SYNCHRONOUS OPERATION MODE FIRMWARE REVISION: V2.1

3.9.1 GENERAL

The TC-900DR when operating in Synchronous mode, implements a V:24 like interface. The unit uses a special wiring harness that converts the two 9 pin "D" connectors on the end panel of the TC-900DR to a standard 25 pin "D" connector for user interface.

Synchronous Mode implements a bit level interface. Data is carried on a bit by bit basis. No framing or error detection is performed. Modem operation is full duplex.

Current implementations of SYNC mode, do not provide a DCD signal in the 25 pin RS232 interface.

3.9.2 DATA RECEIVER

While sufficient RF signal is present into the radio receiver, the data decoder is continually extracting data bits from the received signal, and outputting these to the user interface connector. If the received RF signal into the radio receiver falls below the minimum threshold, then the data decoder stops.

3.9.3 SETTING MINIMUM RSSI LEVEL

The data decoder of the modem is continually running while sufficient RF signal is present into the radio receiver. If the radio receiver is not receiving a signal, then the recovered signal applied to the data decoder of the modem, will consist only of noise. To prevent the modem from erroneously locking onto noise and producing "garbage" at the RxD pin, a minimum RSSI level must be present to validate the recovered signal applied to the modem data decoder. This threshold level, is stored in the non-volatile configuration memory. It should be set by applying a signal to the radio receiver, which produces a desired bit error rate, a desired SiNaD result, or more crudely, a predetermined absolute signal level * into the antenna connector of the TC-900DR. The modem (operating in Test/Program mode) is then commanded to measure the RSSI level, which produces a response of a message indicating the measured level, in hexadecimal. This process should be repeated several times, then an average taken. The analogue to digital conversion performed in this way, is an eight bit conversion. In normal operation, the modem performs a six bit conversion when measuring the RSSI level, so the average of the levels measured in the test mode should now be divided by four. The result should now be stored in the configuration memory, at the address reserved for it. The DR9_PRGM programmer available from Trio DataCom Pty Ltd facilitates this process.

*Use a signal generator modulated with a sine wave frequency of half the nominal bit rate of the unit (e.g. for a 4800BPS unit, use 2400Hz modulation).

3.9.4 DATA RECEIVER CLOCK OUTPUT

The receive section of the modem, includes a clock line driven by the modem. This signal is used to synchronise the transfer of receive data to the user system. The RCO (Rx_Clock_Output, pin17 in the DB25 connector) line changes from ON (TRUE) to OFF (FALSE) as the RxD (Receive_Data, pin3 in the DB25 connector) line outputs the next bit, and from OFF (FALSE) to ON (TRUE) in the nominal centre of the bit cell. This conforms to the V.24 specification.

3.9.5 OTHER RS232 RECEIVER CONTROL LINES

The DSR (Data_Set_Ready) line is driven true by the modem. This line is in fact merely tied to the internal +13.8volt rail via a 4K7 resistor. The DTR (Data_Terminal_Ready) input is unused in Synchronous mode.

3.9.6 DATA TRANSMITTER

The transmit data input is continually sampled and coded for transmission. This process consists of sampling the data input, randomising the bit pattern so that the DC component of the transmitted stream is zero, and generating a waveform suitable for application to the modulator of the FM radio transmitter.

3.9.7 DATA TRANSMITTER CLOCKS

The modem transmit data interface, includes two clock lines. One clock line, TCO (Transmit_Clock_Out, pin15 in DB25 connector) is driven by the modem, the other, TCI (Transmit_Clock_In, pin24 in the DB25 connector) can be enabled to allow the external user to supply a transmit data clock. This is implemented by synchronising the internal clock generator to the user's clock (within a small frequency range). This function is essentially a Phase Locked Loop, and effectively adjusts the phase of the internal clock to match that of the input clock. If the user clock source stops, then the modem will continue to generate the internal clock at it's nominal rate. In accordance with specification V.24, the state of the transmit data line (TxD, pin2 in the DB25 connector) is sampled on the ON to OFF transition of the clock, the bit cell boundary occurs with the OFF to ON transition of the clock.

3.9.8 TRANSMITTER RTS/CTS LINES

Two other control lines are included in the transmitter interface. The RTS (Ready_To_Send) input line, is used to control the radio RF transmitter. The CTS (Clear_To_Send) output line is driven by the modem, to indicate that the modem transmitter is ready to accept transmit data. The RTS to CTS time is determined by an internal timer. A configuration parameter is used to load the internal timer when the RTS line is activated, which must expire before the modem activates the CTS line. This time is necessary to allow the remote receiver to settle and synchronise to the data stream, before the user at the transmitting end begins sending data. However it should be noted, that the CTS signal does not perform any flow control function within the modem.

3.9.9 PHASE SYNCHRONISM WITH GLOBAL CLOCKS

When data is transferred over more than short distances, and synchronism must be maintained to some external global master clock (e.g. Telecom DDN network), then the propagation delay, and thus phase shift of the data becomes significant. A facility is provided, to introduce a phase delay in the transmitted data stream, of up to 3/4 of a bit, in 1/4 bit steps. This delay is adjusted so that minimum phase offset results at the receiver of the destination station.

3.9.10 TRANSMIT TIMER

The modem implements a transmit (PTT) timer. This timer can be disabled entirely by setting the PTT Timer configuration value to zero. The timer value is a 16 bit number, that counts in increments of 2.5 milliseconds. If the timer is enabled, whenever the modem activates the PTT control to the radio transmitter, it initialises the timer with the configured value. The timer is decremented while the RTS line remains active, and if it terminates, the PTT control is deactivated. No other action is taken, and all other functions within the modem are oblivious to this condition, including the CTS line, so data continues to be "carried", and thus lost. The PTT timer is to be considered an emergency override mechanism only, in case an error occurs in the operation of the user's host equipment and/or software. To reset this timeout state, the RTS line must be taken from ON to OFF. The PTT timer will then be re-initialised the next time the RTS line is activated. The timeout period may be set in 2.5mS increments to over 160 seconds.

3.9.11 LED INDICATORS

3.9.11.1 Received Signal Strength Indication. RXSIG LED

In all operation modes of the modem except "Programmer Mode" (see section below on special modes of operation), the RXSIG LED indicates the level of the RSSI signal from the radio IF strip, compared to a threshold set in the configuration data read from the non-volatile memory. If the signal is above the threshold, then the LED indicator is turned on. There is no hysteresis applied in this process.

3.9.11.2 Data Carrier Detect Indication. SYNC LED

In "Synchronous" operation mode (V2.1.x), prior to modem hardware revision "D", and firmware revision "V2.1.4", the SYNC LED is superfluous and not driven.

Note that firmware revision V2.1.5 onwards should only be used in SYNC mode.

From modem hardware Revision D onwards, the SYNC LED drive is used to generate a DCD function in the user interface connector, and requires firmware revision V2.1.4 onwards (i.e. firmware revision V2.1.4 onwards drives the SYNC LED ON 20mS after the "leading edge" of the RxSig LED).

This means that the SYNC LED drive should always show this function and not be allowed to show low Tx Power (see Error indication modes section 3.8.5.2). To facilitate this the Min Tx Pwr parameter in the TC-900DR modem should be set to zero, when the modem is built for synchronous operation.

3.9.11.3 Radio Transmitter Active Indication. TXMIT LED

This LED indicator is connected directly to the modem's PTT output drive. It is illuminated whenever the PTT line to the radio board is active.

3.9.12 SPECIAL MODES OF OPERATION

3.9.12.1 Programmer Mode

Part of the power-up/reset initialisation phase of the modem, are tests to determine whether the modem should enter a special operation mode. The first, is a test for "Programmer Mode". Pin6 on the DB9 connector of Port A, is normally the DSR line. To this end, this pin is pulled high by a resistor to +13.8v, so that to a connected DTE this signal says that this DCE is ready. However, if this pin is connected to pin5 (Com) when the modem is powered up, the modem senses this, and attempts to enter "Programmer Mode". The modem sends out of PORTA, an ASCII "?" (question mark) character, and waits for the programmer to reply with a password. Failure to supply the correct password in time, will cause the modem to abandon the "Programmer Mode" attempt, and go on with it's normal power-up procedure. This password protection scheme provides some defence against unauthorised tampering with the radio/modem's configuration data.

3.9.12.2 Bit Error Rate Test Mode

The next test, is one for "Bit Error Rate Test Mode". Pin9 of the DB9 connector of Port A, is normally the Ring Indicate output line. The modem includes a resistive pulldown to Gnd to show a negative condition on this line. However, if this pin is driven positive (typically by connecting it to pin6), then the modem's data transmitter and receiver will enter the BER test mode. It will activate the RF transmitter and generate a scrambled bit pattern which should be decoded at a receiver as a constant logic "1" level in the unscrambled data. A test point on the modem PCB, is available to monitor this point with a frequency/event counter. (In fact this test point is always active, and may be used to monitor the received data decoded by the modem IC). Each error bit in the decoded bitstream, will be "0", and the receiver portion of the modem in this mode, will activate the SYNC LED every time it sees a "0" bit. An internal timer is used to generate a time equivalent to 1000 bits. Every error bit detected, will activate the SYNC LED, and restart the timer. If and when the timer expires, the SYNC LED is deactivated. Thus, for error rates of 1 in 10^3 and above, the SYNC LED will be ON most of the time. A 1 in 10^4 error rate will show the SYNC LED active for approximately 10% of the time. This function provides a crude indication of Bit Error Rate for installation purposes. Other functions performed in this state include RXSIG indication, and temperature compensation. The state of pin9 is constantly monitored in this mode. If the pin ceases to be driven positive, then the BER Test mode is terminated, and the modem restarts it's initialisation phase.

3.9.12.3 Order_Wire/Handset Mode

Failure of the BERT Mode test, brings the modem to test for the presence of a handset plugged into the handset audio port. This is done by measuring the voltage on channel 4 of the analogue to digital converter. If a handset is plugged in, then the measured voltage will be about 2 volt, but if it isn't installed, then the voltage will be about 4 volt. The measured voltage is compared to 3 volt to determine whether the handset is plugged in. If this test succeeds, then the modem will not generate a data waveform to the radio transmitter. However, it will continue to indicate received RF signal strength, and perform temperature compensation. The handset has a PTT button, and this signal is connected across the modem's PTT output. Thus the handset PTT switch will activate the TXMIT LED.

3.9.12.4 Error Indication Modes

There are three error conditions that will cause the RXSIG and SYNC LEDs to be used for error indications and not their normal purpose. Two of these are "fatal" conditions, that cause the modem to restart after the duration of the error indication phase.

3.9.12.5 Transmit Power Low

While the modem activates the radio transmitter, it periodically checks the level of the radio transmitter output power. If the power measurement is less than a threshold set in the non-volatile memory, then the RXSIG and SYNC LEDs are made to alternate, approximately four times per second. Of course, the TXMIT LED will also be on in this case. This indication condition will persist for the duration of the transmission. As soon as the transmission is discontinued, the error indication will cease, and the two LEDs revert to their normal function. The user should be aware that from Revision D of the modem PCB, this state will cause incorrect operation of the DCD output line. As stated above, the Min Tx Pwr parameter should be set to zero.

3.9.12.6 NVRAM Read Error

The modem accesses the non-volatile memory as part of it's initialisation phase, to get configuration data. If the communication protocol with the memory device is violated, or the non-volatile memory CRC checksum is found to be incorrect, then the modem indicates this by flashing the RXSIG and SYNC LEDs twice alternately. That is, one LED winks on and off twice, then the other. A total of five cycles of this occurs, then the modem restarts it's initialisation from scratch.

3.9.12.7 Radio Frequency Synthesiser, Lock Detect Error

If at any time during normal operation, BERT mode, or handset mode, the frequency synthesiser indicates an out of lock condition, the modem enters an error indication mode for a short time before restarting. One LED is turned ON, the LEDs are swapped, then both off. Then the latter LED ON again, swap LEDS, and OFF. This will give the appearance of a sweeping motion between the LEDs. The following table shows all three modes for comparison.

Tx PWR Error		NVRAM Error		TBB206 Error Synthesiser	
RXSIG	SYNC	RXSIG	SYNC	RXSIG	SYNC
○	●	○	●	○	●
●	○	●	●	●	○
○	●	○	●	●	●
●	○	●	●	●	○
○	●	●	○	○	●
●	○	●	●	●	●
○	●	●	○		repeat
●	○	●	●		
continue			repeat		

3.9.13 WIRING ADAPTOR HARNESS FOR TC-900DR SYNCHRONOUS MODEL

PORT A	1 (DCD)	(RCO)	17	DB25F
	2 (RxD)	(RxD)	3	
	3 (TxD)	(TxD)	2	
	4 (DTR)	(DTR)	20	
	5 (Com)	(Com)	7	
	6 (DSR)	(DSR)	6	
	7 (RTS)	(RTS)	4	
	8 (CTS)	(CTS)	5	
	9 (RI)			
PORT B	1 (DCD)	(DCD)	8	
	2 (RxD)	(TCO)	15	
	3 (TxD)	(TCI)	24	
	4			
	5 (Com)			
	6 (DSR)			
	7			
	8			
	9 (RSSI)			

SECTION 4

ALIGNMENT PROCEDURE

4 ALIGNMENT PROCEDURE

4.1 GENERAL

This section details operational performance and alignment procedures that may be required for the TC-900DR. During servicing it may also be necessary to measure specific performance parameters as a means of verifying the presence of a fault condition.

4.2 TEST EQUIPMENT REQUIRED

The following list of test equipment is required to carry out all of the procedures detailed below.

- Frequency counter accurate to better than 100 Hz at 1 GHz
- FM Signal generator. 455 kHz to 1 GHz. -120 dBm to +10dbm. Synthesised in 100 Hz steps.
- Spectrum analyser 10 MHz to 1GHz. Dispersion down to 2kHz/cm. 80+ dB dynamic range. IF b/w down to 1 kHz.
- RF Power meter to 1GHz. -20 to +30 dbm. Accuracy ± 0.25 dB.
- Digital volt meter.
- HP3406 RF Millivoltmeter or similar.
- RF Test leads, MCX male and SMA male.
- Audio noise and distortion test set.
- Audio oscillator.
- Surface mount repair tools.

4.3 TEST POINT LOCATIONS

Both the radio section PCB and the modem section PCB contain numerous test points. They are easily located on the PCB's, and are detailed below.

4.3.1 MODEM SECTION PCB

TEST POINT	SIGNAL	DESCRIPTION
TP1	TxCLK	Transmit clock
TP2	BER TST	BER test output
TP3	SYNC	Synchronised output
TP4	RxCLKOUT	Integrator reset
TP5	RxCLK	Receive clock
TP6	RxDATA	Receive data
TP7	DATA OUT	Transmit data
TP8	INTEGRATOR	Rx integrator reset

4.3.2 RADIO SECTION PCB

TEST POINT	SIGNAL	DESCRIPTION
FINAL PA SECTION		
TP31	TXPWR-2	Bias to Q8
TP25	TXPWR-3	Bias to Q8
TP27	TXPWR-4	Bias to Q9
TP14	+8v	Power Supply
TP15	TXEN	Transmit enable
TP20	RxMIXOUT	Rx mixer bias
TP28	TXPA-1	Bias to Q10
TP29	TXPA-2	Bias to Q11
TP26	+13V8	Power supply
TP33	PWR CONT	Power control supply
TP30	PTT+8V	Press to talk
121 MHz SECTION		
TP13	DATA	Tx data input
TP17	60.5 MHz	Modulated 60.5MHz
TP16	121 MHz	Output of doubler
TP18	121 MHz	Modulated 121 MHz
TP32	MIC	Tx Mic audio input
NE615 IF SECTION		
TP6	415kHz I/P	455 filter input/second mixer output
TP9	QUAD	Quad detector
TP8	DATA	Rx data out
TP10	AUDIO	Rx audio out
TP7	RSSI	RSSI output
TP4	MUTE	Mute control output
TP1	2nd L.O	Second Xtal oscillator
TP2	2nd L.O	Second Xtal oscillator
TP3	IF Input	45 MHz IF filter input
TP5	IF Output	45 MHz IF filter output
TP19	VCO	VCO oscillator injection
SYNTHESISER/VCO SECTION		
TP12	LOCK DET	Synthesiser lock detect
TP11	+5V	Synthesiser +5v supply
AUXILIARY HANDSET INTERFACE SECTION		
TP21	MIC	Tx mic audio input
TP22	PTT	Manual press to talk
TP23	+8V	Handset +8V supply
TP24	AUDIO OUT	Rx audio output

4.4 ADJUSTMENT POINTS

All adjustment points are located on the radio section PCB. The following is a list of these adjustable components.

COMPONENT	ADJUSTMENT
XTAL2	VCO reference frequency
VR3	Deviation level set
L10	Tripler filter
L9	Doubler filter
L7	121 MHz filter
L8	121 MHz final filter
L6	Tx frequency set (121MHz Osc)
VR4	Tx power control adjust
C78	Tx mixer tunable filter
VR1	Rx audio mute adjust
VR2	Rx data DC BIAS offset adjust
L3	45 MHz filter alignment
L1	44.545 oscillator adjust
L4	45 MHz filter alignment
L5	45 MHz filter alignment

4.5 LINK OPTIONS

Several options are set in the TC-900DR modem by the setting of links on the radio section PCB. Listed below is an option table for the various combinations.

LINK NUMBER	SETTING	DESCRIPTION	
LK2	IN	AFC option disabled	
	OUT	AFC option enabled	(factory standard)
LK4	IN	PWR control disable	
	OUT	PWR control enabled	

4.6 HOUSING

The TC-900DR has been designed with the serviceability of the unit in mind. Construction of the unit is robust yet easily dismantled. The unit is primarily assembled in an aluminium extrusion with a central chassis that is fixed to the front panel.

4.6.1 DISASSEMBLY PROCEDURE

To disassemble the unit, simply remove the two silver screws on the underside of the unit and the six black screws located on the front panel (the front panel of the unit has the two DB9 connectors protruding from it). Ensure you do not loose the attached nylon washers, as these prevent the Lexan front panel label being damaged upon replacing and tightening the six screws. Simply slide the unit out of the extrusion clasping front panel and the complete unit is exposed to you.

Caution : When re-assembling be careful not to foul the ribbon cable against the case when sliding the unit into its case as this may inadvertently damage the cable.

4.6.2 MODEM AND POWER SUPPLY PCB

All components and connections to the modem section PCB are accessible without removing the PCB from the chassis. If access to the rear of the PCB is required, firstly remove two nuts that clamp the C TO-220 power supply regulator to the front panel. Once this is removed, simply remove the four screws securing the PCB to the chassis.

The PCB is now free to work on, and can be folded out so as to service the unit in an open accessible condition whilst still connected to the radio section PCB. If required, the modem section PCB can be separated from the radio section PCB by simply unplugging the ribbon cable.

NOTE: Regulators will need to have heat-sinks fitted if unit is to be operated in this condition for excessive time periods.

4.6.3 ANTENNA DIPLEXER

The antenna diplexer is mounted on top of the radio section PCB. It is easily removed by firstly disconnecting the two miniature RF connectors (MCX type) from the PCB.

Care should be taken when unplugging these connectors so as not to damage them, it is important to remove and insert connectors in a vertical direction.

Secondly, remove the nut securing the antenna output connector from the central mounting chassis. The last two remaining screws must be removed which secure the diplexer to two metal PCB standoffs on the radio section PCB. The diplexer can now be removed.

Testing of the radio section PCB can be continued without the antenna diplexer, by connecting to the receiver and transmitter ports separately.

Miniature MCX RF Connectors are available from Trio DataCom if required.

4.6.4 RADIO SECTION PCB

The radio section consists of a two sided PCB which has surface mount components on one side and conventional components on the other. Several critical test points are accessible on the component side of the PCB which minimises removal of the PCB from the chassis.

To remove the PCB from the chassis, fifteen screws must be removed. Upon removal of these screws, the PCB can be manoeuvred from the chassis and once again can fold out so as to be serviceable as a complete unit.

NOTE : It is essential that all RF Deck mounting bolts are fitted and secure upon reassembly as many of these bolts provide inter-stage isolation and secure grounding ensuring the product meets all specifications.

Once service of the unit is complete, reassembly is simply the reversal of the above procedures.

Care should be taken when sliding the complete chassis assembly back into the extrusion. Ensure that the ribbon cable connecting the modem and radio section PCB's is carefully "tucked" away within its designated slot so as not to damage the cable.

4.7 ALIGNMENT DESCRIPTION

CAUTION - As the TC-900DR is capable of full duplex operation, care should be taken to avoid damage to sensitive test equipment such as signal generators or spectrum analysers. It is recommended that a 30db 2 Watt pad be connected between the unit and any test equipment prior to testing.

This section is for alignment/adjustment of the RF Deck and should be read in conjunction with Section 2 (Hardware Technical Description) and Section 7 (Fault Finding) if faults or difficulties are experienced.

For initial alignment, proceed in the following order :

Reference oscillator & synthesiser.

121 MHz Tx modulated injection oscillator.

Tx final stage/Power control.

Receiver and audio mute

4.7.1 REFERENCE OSCILLATOR AND SYNTHESIZER

1 Check VCXO (XTAL2) for reference frequency o/p at a level of 550 mV rms with an RF Millivoltmeter, and the VCO o/p for an RF level of around 150 mV rms.

2 Check that the TBB202 dual modulus prescaler (U4) is producing an output of approximately 7 MHz and a level of 550 mV rms at the "IF" i/p to the TBB206 synthesiser I.C.(U3-p8)

3 Ensure that the synthesiser has been programmed to a frequency within the range of the VCO, and check that the VCO is locked by observing a high (5V) level on Lock detect output of the synthesiser I.C.(U3-p14). Note that very short duration pulses to ground is normal.

4 Program the synthesiser with the following VCO frequencies according to VCO type and ensure lock occurs at both ends of the frequency range. These frequencies are 2 MHz beyond the published specification.
VCO TYPE: MQC-798
Maximum 786MHz VCO = 907MHz Tx or 831MHz Rx
Minimum 814MHz VCO = 935MHz Tx or 859MHz Rx
VCO TYPE: MQC-978
Maximum 996MHz VCO = 875MHz Tx or 951MHz Rx
Minimum 960MHz VCO = 839MHz Tx or 915MHz Rx

5 Program the VCO to a given frequency within the range as specified above and measuring the VCO o/p frequency, adjust the 12 MHz (VCXO) reference trimmer to bring the frequency within 250 Hz of the VCO frequency.
Note: Unit is temperature compensated at factory and no field adjustment of Ref. Oscillator is possible. If VCO frequency is not correct (±1500Hz), consult factory for service advice.
Note ensure that the VCXO control input is within its active range (1-4 Volts).

6 Check the VCO power o/p by monitoring the Rx mixer bias at TP20, where approximately 200 mVDC should be measured.

7 With a spectrum analyser set to the VCO frequency and a dispersion of about 5 or 10 kHz per cm, check that the reference sidebands are less than -60dBc in the adjacent channel.

8 Check VTCXO Reference frequency is F(tx) +121 MHz for 853 remote units or F(tx) -121 MHz for master units. If Reference is out by more than ±1.5kHz, drift offset should be applied via the programmer or unit should be returned for factory service. attempting to alter Reference trimmer will void temperature compensation process and should only be done in an emergency and as a temporary measure.

4.7.2 121 MHZ MODULATOR

Note - make sure the transmitter is loaded with a suitable attenuator on the antenna or Tx o/p socket before energising

1. For Initial alignment set all coil cores to their nominal positions as per the table below :

Miller coils

L9	5 turns from top of coil can
L10	2 turns
L7	4 turns
L8	5 turns
L6	0 turns

To prevent the final transmitter stages from producing excessive power whilst low level stages are being aligned, it is suggested that the Tx post mixer tunable filter be de-tuned. Energise the transmitter via manual PTT from the auxiliary handset.

2. Tune L7 through L10 for peak o/p. For initial alignment this can be done by monitoring the 121 MHz level at TP18 initially and then at the input to the SBL-1X transmit mixer (U8), where a level of about 75mV should be measured by an RF millivoltmeter (e.g HP11960).

Typical RF millivoltmeter readings for each stage are :

TP17	125 mV RF = 0.25 VDC on HP11960 probe.
TP16	40 mV RF = 0.06 VDC on HP11960 probe.
TP18	550 mV RF = 1.0 VDC on HP11960 probe.
121 MHz i/p to mixer	75 mV RF = 0.13 VDC on HP11960 probe.

Note: The signal at TP17 is present as long as "Tx En" is active. The subsequent test points require PTT to also be active.

If the complete transmit chain is known to be operative then the 121 MHz o/p can be peaked by first de-tuning C78 on the tunable Tx filter until the Tx power o/p is less than 100 mW and then tuning Inductors L7 to L10 for maximum output at the Tx frequency.

3. With the radio section links set for the desired data rate (see link table above),set the peak deviation as per the chart below with VR3, and center frequency to 121.000 MHz with L6.
   NOTE : THESE ADJUSTMENTS ARE INTERACTIVE. ENSURE ALL COILS ARE SECURE

BAUD RATE	DEVIATION LEVEL
4800 bps	± 1.5 kHz peak
9600 bps	± 2.75 kHz peak

4. Note that temperature compensation is applied to the 121MHz oscillator so attempting to adjust either VR3 or L6 will upset compensation and should only be done as a temporary measure. Return unit to factory for repair if errors >±500Hz are detected.

4.7.3 TX FINAL

NOTE: It is essential that all RF Deck mounting bolts are fitted and secure upon reassembly as many of these bolts provide inter-stage isolation and secure grounding ensuring the product meets all specifications.

1 Ensure the 121 MHz Tx injection is operating correctly.

2 Check Q2,4,5,8, are all biased correctly as per the voltage chart.
Temporarily disable the Tx power control circuitry by shorting LK4 located on the top side of the board near the ribbon cable.
Energise the transmitter via the manual PTT on the auxiliary handset.

3 Tune the Tx filter tuning capacitor C78 for a peak output power measured at Antenna port or X4.

4 With full drive, Q9 driver collector current as seen across TP26//TP27 should be approximately 45 mA (100mVDC), and NOT MORE THAN 55mA (120mVDC).

5 With full drive at Q9 each final transistor should be drawing around 175 mA(385mVDC) as seen across TP26/TP29 or TP28. The output power measured directly at the final connector should be between +32 and +34 dbm without power control.

6 Re-enable the power control circuitry and with the 'Txpwr' control line set at +5VDC, set VR4 for +32 dbm+/- 0.25 dB at the tx o/p socket X4. Check that the current in EACH final collector does NOT EXCEED 225 mA.

7 Check with the spectrum analyser that the Tx o/p is free from spurious signals.

Note 1 . Prior to the diplexer the VCO level is nominally about -20 dbc.

Note 2 . Close in mixing products (less than +/- 30 MHz) must be greater than 65db below the carrier, as they are not attenuated by the diplexer filters.

D.C. Voltages of Radio Section

RF Output Power set to +32 dbm at X4 (diplexer input) with 13.8 VDC supply

Transistor	Base	Emitter	Collector
Q2	1.66 VDC	0.92 VDC	6.96 VDC
Q4	1.79 VDC	1.06 VDC	6.46 VDC
Q5	1.80 VDC	1.08 VDC	7.51 VDC
Q8	1.05 VDC	0.31 VDC	4.02 VDC
Q9	0.47 VDC	0 VDC	13.35 VDC
Q10	0.28 VDC	0 VDC	13.05 VDC
Q11	0.29 VDC	0 VDC	13.16 VDC
Q12	7.17 VDC	7.97 VDC	7.88 VDC
Q1	7.29 VDC	7.97 VDC	7.91 VDC
Q13	4.56 VDC	3.84 VDC	7.97 VDC
Q7	1.14 VDC	0.41 VDC	6.68 VDC
Q6	1.13 VDC	0.40 VDC	7.52 VDC
Q3	1.06 VDC	0.33 VDC	7.59 VDC

4.7.4 RECEIVER

The receiver section requires little or no alignment once factory aligned.

4.7.4.1 No AFC Models (Xtal 1 = 45.455MHz)

1. Adjust L1 for 45.455 MHz measured with pickup loop near L1.
2. In emergency adjust coils L3, L4 and L5 for best SINAD at TP8.
3. Adjust audio mute VR1 to mute handset audio at 10dB SINAD
4. Adjust VR2 for 2.0 VDC at TP8 whilst receiving data off-air.

4.7.4.2 AFC Models

Monitor 44.545 MHz with pickup at L1. Test for 44.545 ±1.5KHz

Consult factory for alignment or service information.

SECTION 5

INSTALLATION AND COMMISSIONING

5 INSTALLATION OVERVIEW

All Data Radio Modem devices needs to be properly installed and commissioned in order to function reliably. It is important that installers are familiar with RF products / installations and are geared up with appropriate tools necessary to confirm the ongoing reliability of a communications system.

This chapter is intended as a short form checklist to ensure such radio devices are installed correctly and that important tests are made and recorded at each site for future reference should a problem eventuate.

Installers should check that each data radio has been programmed to suit their specific requirements before installation.

5.1 GENERAL

Installations play a critical role in network performance. Although this is a known fact, installations are often performed poorly or given little regard. It is essential that the installation is performed in a professional manner with careful attention and consideration to the following items :

1. Adequate primary power cable - relative to the length of cable to minimise voltage drop.
2. Shielded data cable between the unit and any external data equipment.
3. Low loss coax used for antenna feed line.
4. Careful termination of RF connectors.
5. A suitable antenna for the requirement.
6. Suitable placement of the antenna.
7. Adequate signal strength from the base station / other radio communications device.

5.2 INSTALLATION

The following information should assist when installing and commissioning data radio systems.

5.2.1 DATA CONNECTION

In industrial environments connection to any external device should be by shielded data cable with the shield connected to the connector shell to minimise data corruption, and/or radio interference.

5.2.2 MOUNTING

The radio modem should be mounted in a cool, dry, and vibration free environment. Mounting of the unit should be in a location providing easy access to screws and all connections.

5.2.3 POWER CONNECTIONS

The power required for 5 Watt (Tx) at 13.8VDC, is typically 2.0 Amps. As the Tx key up current is significant, the gauge of primary power wiring should be considered. It is suggested that a minimum of 18 gauge stranded copper wire be used for distances of up to two metres and a minimum of 14 gauge for longer distances up to 5 metres.

Ensure correct polarity to avoid costly repairs.

5.2.4 COAX CABLE CONNECTION

It is important to select the correct cable and connectors for each application as a poor selection can seriously degrade the performance of the unit.

As an example, for each 3dB of cable and connector loss, half the transmitter power is lost and twice the receiver signal power is required to produce the same bit error rate.

In some installations where strong signals are present, a compromise of cable and connector cost may be acceptable.
It is essential that all connector terminations are performed as per the manufacturers specifications (especially at 900MHz and above) and if connectors are to be used outside, it is essential that a sealant such as amalgamating tape be used to seal connectors. DO NOT use acetic cure silicon to seal the connectors.

It is also important that coax cables are not stressed by tight bends, kinking or excessive flexing. Ensure that coax cables have sufficient strain relief and are secure. If large diameter rigid or semi rigid cable is used, it is recommended to use a short length of high quality RG58 or RG223 cable between the unit and main cable feed.

The following chart is a guide to losses in various types of coaxes at 400MHz and 900MHz over distance, please consider this when installing the unit.

CABLE TYPE	***LOSS RELATIVE TO DISTANCE***							
	1 dB		***3 dB***		***6 dB***		***9 dB***	
	450MHz	900MHz	450MHz	900MHz	450MHz	900MHz	450MHz	900MHz
RG58C/U	2.3m	1.6m	7m	5m	14m	10m	20m	15m
RG223/U	3.1m	2.3m	9m	7m	18m	14m	28m	21m
RG213/U	6.1m	4m	18m	12m	37m	24m	55m	37m
HELIAX LDF4-50A	19m	14m	57m	43m	114m	87m	171m	130m
HELIAX LDF5-50A	38m	25m	114m	75m	229m	150m	343m	225m

5.3 ANTENNA INSTALLATION

The selection of antennas and their placement is one of the most important factors when installing a radio based network. People often use a simile, it is like putting square wheels on a Mercedes Benz..... very true comparison.

Antennas are generally mounted to a vertical pole with either vertical or horizontal polarisation as per the licence requirement.

Antennas should be mounted as high as practical and away from metal surfaces which can cause reflections.

Determining the type of antenna is very important and as a typical generic example, Point to Multipoint (PTMP) systems generally employ high gain (3, 6, or 9dB gain) omni directional antennas at the base station sites and either omni directional whips (unity gain) or preferably high gain directional yagi antennas (9 or 14dB gain) at the remote sites.

5.3.1 YAGI ANTENNAS

Yagi antennas not only provide signal gain and directivity, but also provides protection from interfering signals which are outside the beam width of the antenna. Yagi antennas are essential when communicating over very long distances.

Yagi antennas are polarised and must be mounted either vertically (elements pointing from the ground to the sky) or horizontally (elements in parallel with the horizon).

As a general rule, Point to Multipoint remote units are vertically polarised, while Point to Point links are horizontally polarised.

When mounting yagi antennas with vertical polarisation, it should be noted that the dipole (loop section of antenna) has a drain hole. The small drain hole on one end of the dipole must be pointed towards the ground so that water will drain out of the antenna.

5.3.2 OMNI DIRECTIONAL ANTENNAS

Omni directional antennas provide a radiation pattern of equal strength through 360^0 in the horizontal plane. This makes them ideal for base antennas in point to multipoint systems because they can reach the remote antennas.

Omni directional antennas are also used at remote sites (although yagi antennas are preferred) and are typically ground independent "whip" type antennas. The main reason for using whips at remote sites is for aesthetics as they are far less obtrusive than a yagi.

Regardless of the type, antennas need to be mounted properly and in a suitable location as covered below.

5.3.3 ANTENNA PLACEMENT

Antenna placement is of paramount importance and plays a big part of the antennas and in turn systems performance.

When choosing antenna locations the aim is to find the largest path of unobstructed space and locate the antennas within that space. It is important to locate antennas as high as possible and definitely clear of any moving obstructions.

Where possible it is important to avoid mounting antennas:

1. Against or adjacent to steel structures.
2. In an area which will have constant intermittent obstructions - people walking past, vehicles driving past etc. That is, mount antennas well above such moving obstructions.
3. Near any electrical equipment.
4. Near metal beams, structures etc.
5. Inside any metal enclosures, tin sheds / warehouses etc. - note meshed wire fences act like a "brick wall" to RF transmissions.
6. Away from guard rails or support beams.

Note: Sometimes installations in such environments are unavoidable and where this is the case, certain care can be taken to still ensure a reliable installation. Please consult Trio for assistance on a case by case basis.

If tests indicate poor signal strength then the antennas at one or both ends of the link should be raised, and/or moved clear of obstructing objects, or if directional antennas are employed they should be checked for correct directional orientation and polarisation (horizontal or vertical signal orientation).

5.3.4 REFLECTIONS AND OUTPUT POWER

Ideally, the propagation path should be clear Line of Site (LOS).

The biggest problem with UHF radio when used within "steel" buildings or obstructed paths is the large presence of signals randomly reflected from the surrounding obstructions or "steel" walls. These signals cannot be eliminated, but by maintaining a 10 to 20dB margin between the wanted and unwanted signals, problems should not be experienced. The simplest way to do this is to use directional gain antennas.

These antennas will provide attenuation to all signals arriving from a direction other than the direct path. Where steel walls or structure exist immediately behind the antenna location, the high front to back ratio of such antennas will negate such high level reflections. Power output should be set at the minimum level required to achieve a 25dB fade margin, in order to minimise the amount of RF being reflected, and to avoid saturating the receiver front end and therefore reducing the margin between wanted and unwanted signals.

5.4 COMMISSIONING - RSSI LEVEL

When commissioning a data radio network, it is important to ensure that the incoming received signal strength (RSSI) is adequate to provide reliable communications.

Note: A good signal path should allow for approximately 30dB fade margin.

Received signal strength (RSSI) of the incoming signal is available as an analogue output on Trio data radio modems. This RSSI output ranges from 0 to approx 4 Volts, where 4 Volts indicates the strongest signal. The actual values of received signal strength can be determined by comparing the output voltage against the calibrated graph supplied in the handbook.

By referring to the RSSI chart alignment of aerials can be optimised to achieve the greatest signal strength (highest output voltage).

Note: Be sure to stand clear of aerials when measuring this output voltage, touching or standing in close proximity to aerials will give inaccurate readings.

5.4.1 CHECKING DATA COMMUNICATIONS

If the host computer and remote equipment are capable of performing data integrity tests then connect the host and terminal data equipment to the radio modems.

Remove and re-apply power to each radio modem to ensure they are both in data comms mode, and run data tests on the link.

5.4.2 BIT ERROR RATE (BER) TESTING

If the connected data equipment is NOT capable of running data integrity tests then the TC-450DS modems can be put into a BER test mode, whereby the data channel can be tested in each direction to a reasonable level without external test equipment. To run a link test with the radio modems themselves, they must BOTH be put into BER test mode.

To place the unit in BER mode connect pin 6 and pin 9 of port A together and apply power..

The transmitter can be activated by driving the RTS pin (7) of port A positive. The unit will then send a predefined pseudo random sequence which is tested for accuracy by the receiving unit and any errors displayed on the front panel 'SYNC' lamp.

Each error bit will illuminate the lamp for approximately 1000 bits duration, therefore error rates above 1 in 1000 will show an almost constant error indication.

To return the unit to normal data transmission mode simply power it up without pin 9 connected to pin 6.

For further information on radio path problems please contact Trio DataCom for detailed advice.

Note : BER testing is not viable in an operational point to multi-point environment as the BER test will interfere with other operative units.

5.4.3 OUTPUT POWER - VSWR

Upon installation of equipment an output power measurement should be done using a suitable power meter. Forward and reflected power should be measured at the antenna port and recorded for future reference. The reflected power measurement should be as a minimum 3 : 1 of the forward power. If this is not the case, investigate possible causes such as poor terminations, faulty antenna etc.

5.4.4 DATA CONNECTION

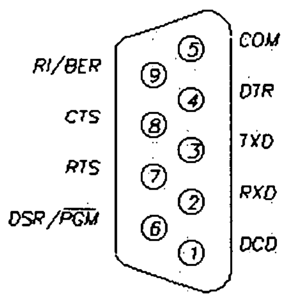
The data connection is via a DB9 connector labelled 'Port A', which is wired as a DCE as shown below. The port labelled 'Port B' is not used for the standard configuration but can be enabled by the programmer for use as a totally independent second data channel. In industrial environments connection to the modem should be by shielded data cable with the shield connected to the connector shell to minimise data corruption, and radio interference.

- User Serial "Port A" Pin Assignment

PIN NO. & FUNCTION

1. DATA CARRIER DETECT (DCD)
2. RECEIVE DATA OUTPUT (RXD)
3. TRANSMIT DATA IN (TXD)
4. DATA TERMINAL READY (DTR)
5. COMMON (COM) ___
6. PROGRAM PIN (PGM)
7. REQUEST TO SEND (RTS)
8. CLEAR TO SEND (CTS)
9. BIT ERROR RATE PIN (BER)

EXTERNAL VIEW OF 'PORT A'



NOTE: Pin 6 and pin 9 provide a dual function which depends on the mode that the TC-450DR is operating in.

- User Serial "Port B" Pin Assignment

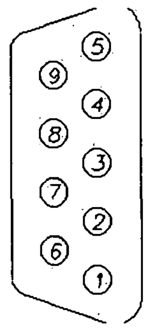
Port B of the TC450DR is essentially unused in its standard configuration but can be enabled by the Programmer for use as a totally independent second data channel. This port is essentially used for specific applications and only has one connection that may be of use for installation purposes. This connection (Pin 9) is Receive Signal Strength Indicator (RSSI) output.

This RSSI output ranges from 0 to 5 Volts, where 5 Volts indicates the strongest signal. It is important to note that this Port output has a high impedance of around 10K ohms and loading will decrease accuracy of the recorded measurement.

PIN NO. & FUNCTION

1. DATA CARRIER DETECT
2. RECEIVE DATA O/P (RxD)
3. TRANSMIT DATA O/P (TxD)
4. DATA TERMINAL READY (DTR)
5. COMMON
6. DATA SET READY (DSR)
7. REQUEST TO SEND (RTS)
8. CLEAR TO SEND (CTS)
9. RECEIVE SIGNAL STRENGTH

EXTERNAL VIEW OF `PORT B'



5.5 GENERAL CHECKLIST

The following is a simple commissioning checklist which should be used at every site not only to ensure correct installation, but also as a reference list for problems which may eventuate.

TRIO SITE COMMISSIONING CHECK LIST / RECORD			
Company:		Operator:	
Site Location:		Date:	
Link to:		Serial #:	
Radio Type:		Config File Name:	
Antenna Type / Gain		Path Distance	
Tx Power at Radio		Measured RSSI Volts	
Reflected Power		Fade Margin	
VSWR		Line of Site to Base	
Tx Power at Antenna		DC volts at Radio (Tx)	
Site QA Inspection:			
Notes:			
Signed		Date	

SECTION 6

FAULT FINDING

6 FAULT FINDING

This section is to assist with difficulties that may be experienced when installing or working on the TC-900DR.

6.1 MODEM/GENERAL

The following is a list of possible problem areas, and suggested checks that can be made to isolate any general problem that may have occurred.

1. POWER SUPPLY

   a) Check for +13.8 Volts at supply input.
   b) Check fuse on Modem P\S PCB (1 Amp SLO-BLOW).
   c) Check supply volts:

Modem P\S	i) 13.8 Volts ii) 8 Volts iii) 5 Volts
RF Deck	i) 13.8 Volts ii) 8 Volts iii) 5 Volts

2. ANTENNA

   a) Check antenna, cable and connectors for damage or water
   b) Check forward and reflected power at antenna connector of unit.
   VSWR should be <= 1.5:1

3. PROGRAMMING

   Check programming information. e.g.
   i)Transmit and receive frequencies are within the operating band of the unit
   ii) User interface configuration.

4. INTERFACE

a) Check connections to Port A (DB9 Connector).
b) Check cable to host communications.
c) Interface commands to unit are incorrect or communications are not established correctly.

5. POOR TRANSMITTER PERFORMANCE

a) Check correct transmit frequency programmed.
b) Check transmitter carrier frequency.
c) Check transmitter deviation.
d) Check RF output power level.

6. POOR RECEIVER PERFORMANCE

a) Check correct receive frequency programmed.
b) Check receive sensitivity.
c) Check audio output level and DC bias to modem.
d) Check mute threshold.

6.2 RECEIVER

The following is a list of problem areas, and suggested checks that can be made to isolate any receiver specific problems that may have occurred.

6.2.1 RECEIVE SENSITIVITY LOW

1. Check mixer drive level by measuring DC bias developed across R27.
2. Check for correct DC bias conditions and supply volts on RF Amp, Local Osc buffer, and IF Strip, compared to voltage charts.
3. Ensure 44.545 MHz oscillator (part of NE615 IF IC) is within ± 250 Hz. This is best carried out by using a communications test set such as an IFR1200 or similar in receiver mode with frequency error displayed.
4. Ensure that the local oscillator is netted to frequency by monitoring the Tx mixer injection with a pick up loop connected to a sensitive frequency counter of high stability. Adjust the VCXO frequency reference until correct L.O. frequency is observed. Note that the VCO and synthesiser use the VCXO as the frequency standard. Measure the Synthesiser LOCK signal to ensure the VCO is in phase lock.
5. With a 50 ohm signal generator tuned to 455 kHz, apply signal via a 1nF capacitor to the inputs of the 1st and second IF Amp sections of the 615 IF IC and compare the level required to produce the correct RSSI level.
6. With a 50 OHM signal generator tuned to 45.000 MHz, apply signal to the points defined on the IF test chart and compare RF level required to produce the reference RSSI level as specified at TP4.
7. Apply signal frequency to the RF input connector at X2 and compare the level required to produce RSSI reference level at TP4 with that shown in the IF Level Chart.
8. Reconnect the Antenna Diplexer and apply the signal generator to the Antenna terminal of the diplexer. Adjust the generator level to provide the same Rx mixer bias from applied RF signal as was noted in 7) above. The level required should be no more than 3 dB (Rx diplexer path loss) greater.

Note that the RSSI signal provided by the IF IC is a fairly accurate logarithmic scale between 0.5 and 4VDC, providing about 0.5 VDC for each 10 dB of signal applied to the input of the IF Strip, and can be used as a reasonable measure of signal providing it is unmodulated and on center frequency at 455 kHz.

6.2.2 RECEIVER LEVEL CHART

The following chart lists the level (terminated) of a 50 OHM signal generator to produce 2.0VDC of RSSI at TP4 when applied as specified to the point shown and at the frequency indicated.

FREQUENCY	CONNECTION POINT AND APPLICATION	NOM LEVEL
455 kHz	Pin 20 of IC U2 NE615 via 1nF	-72 dBm
455 kHz	Pin 18 of IC U2 NE615 via 1nF	-74 dBm
455 kHz	Pin 1(i/p) of IF Filter CF2 via 1nF	-58 dBm
455 kHz	Pin 14 of IC U2 NE615 via 1nF	-43 dBm
45 MHz	Rx i/p at X2 via coax direct	-49 dBm
45 MHz	Mixer i/p following R.F. Amp	-62 dBm
45 MHz	Mixer diode (D1) o/p across C100	-61 dBm
45 MHz	Junction of 1st & 2nd 45 MHz crystal filter	-77 dBm

6.3 TRANSMITTER

The following is a list of problem areas, and suggested checks that can be made to isolate any transmitter specific problems that may have occurred.

1. NO TRANSMIT

   1. Check PTT circuit.
   2. Check unit is programmed within its operational range.
   3. Check if manual PTT (Rear Aux connector) keys transmitter.
   4. Check if any transmitter output is present. Tuning required?

2. TRANSMITTER SPURIOUS EXCESSIVE

The probable cause is dependent upon the nature of the spurious as follows:

Carrier ± 910kHz. - IF detector signal (2x455) modulating or mixing with carrier. - Check 1n bypass on reference i/p to power control op-amp. Check bypasses on collectors and supply lines of low level transmitter stages, and L.O. buffer.

Carrier ± 20.166 and/or 40.333. - Excessive harmonics of 20.166 crystal oscillator in 121 MHz FM driver IC (U7). Check all pins of IC (U7) for correct DC conditions. Check all tuning inductors for 'normal Q', as 'soft' tuning will almost surely indicate an incorrect or faulty capacitor, or inductor.

Carrier ± VCXO reference frequency (approximately 7 MHz). - Reference signal modulating VCO, or mixing with carrier in L.O.buffers. - Check Synthesiser supply bypasses, check for defective joints or components in and around the resistive divider at output of VCO.

Note that it is imperative that low frequency divider products be attenuated before they can reach the base/emitter junctions of the L.O. buffer transistors where they can mix with the VCO frequency.

Note also that poor SMD solder joints will provide nonlinear conductance and give rise to frequency mixing in this area. Check for faulty components or poor joints around the Synthesiser to VCO frequency control area, or VCO supply line bypassing.

Excessive Transmitter power radiated or conducted to the area of the VCO can also cause spurious effects and may enhance the levels of otherwise acceptable levels of spurious. If this is suspected, check that ALL chassis securing bolts are fitted and tight on the RF deck, and that ALL bypass capacitors and chokes are fitted and correct in and around the final Tx stages.

3. TRANSMITTER POWER LOW OR UNSTABLE :

1 *Firstly - Ensure that ALL RF Deck mounting bolts are fitted and secure.*

2 Check that the feed resistors used for current indication on all stages of the final are of correct value and firmly in circuit.

3 Check that the Tx L.O. buffer and post mixer buffers are correctly biased as per the voltage charts.

4 If necessary disconnect the final stages from the Tx post mixer buffers by removing the solder bridge between Q5 and Q8, and with an appropriate instrument measure the RF power available from the Tx buffers to the final pre-driver.
Note that the o/p impedance of the buffer is 50 OHM and must be measured by a 50 OHM instrument. It is highly recommended that a measuring spectrum analyser be used here as this instrument will also display the relationship between the wanted signal and other spurious or unwanted mixing products.
The nominal display seen at this point by a spectrum analyser is shown on the spectrum charts attached.

5 To test the final stages separate from the buffers - inject a signal from a 50 OHM generator at Tx frequency into pre-driver (Q8) via C122. The level required to drive the final to full output is shown on the Tx level chart.

6 Check that the current drawn by the driver transistor as measured across the feed resistor (TP28 to TP27) is within spec, and if not check and or replace the driver transistor or associated components as necessary.

7 Check that the current drawn by each final transistor as indicated by the voltage across the 2.2 OHM (2x4.7 ohm in parallel) collector feed resistors (TP26 to TP28 and TP29) is within the range stated in the voltage charts, and that both are within 10% of each other. If in error check components around final pair and replace final transistors as necessary.

NOTE it is possible for power transistors to be partly defective due to current or thermal abuse, and the fact that the devices are actually drawing current does not always indicate that they are producing full power at the collector.

TX LEVEL CHART :

Frequency	Connection Point & Application	Level Remarks
Base band	Data from modem section TP13 (4800 baud)	2 VD.C
Base band	Applied data signal to modulator U7 pin 3 (4800 baud level from modem)	1 V_{p-p}
Base band	Audio signal to modulator TP32	0.84 VD.C 60 mV_{p-p} for VR3 set for maximum value 400 mV_{p-p} for VR3 set for minimum value
Base band	Audio signal to modulator U7- pin 4	1.3 VD.C 0.5 V_{p-p}
121 MHz	Signal level at TP18:A	-5 dBm
Final Tx frequency	Output to diplexer connector X1	3W at maximum power setting

SECTION 7

APPENDIX A

DRAWINGS

7 APPENDIX A DRAWINGS

TC01-08-12	Data Radio Mounting Details
TC01-08-11	Data Radio Assembly Details
TC01-04-05	Data Radio Basic Modem 9K6/4K8 Component Loading Details
TC01-00-05	450DR / 900DR Packet Modem (2 sheets)
TC01-08-10	PWB Manufacturing Details 900DR Data Radio - Radio Board (2 sheets)
TC01-00-10	Data Radio Project Sheet
TC01-00-10	Data Radio Final PA (AFC Fitted)
TC01-00-10	Data Radio 121 MHz OSC (AFC Fitted)
TC01-00-10	Data Radio - Synthesiser - VCO (AFC Fitted)
TC01-00-10	Data Radio - NE6154K8/9K6 (AFC Fitted)
TC01-04-15	850-930 MHz Antenna Diplexer Component Side Assembly
TC01-05-10	Radio Board Top Side (C/S) Test Point & Adjustment Location Details
TC01-05-10	Radio Board Bottom Side (S/S) Test Point & Adjustment Location Details
TC01-05-16	Duplex Radio BER/S+N/N vs Sig
TC01-05-17	AFC Alignment Setup - Block Diagram
TC01-05-12	4800/9600 BPS Modem Functional Diagram
TC01-05-23	Asynchronous Modem Functional Diagram
TC01-05-19	Macro Block Diagram
TC01-05-18	Radio Section - Modem Section Interface
DR9-BLOK	900MHz Radio Block Diagram
	RSSI Level cf Received Signal (typical)

SECTION 8

APPENDIX B

GLOSSARY of TERMS and ABBREVIATIONS

8 APPENDIX B GLOSSARY

ADC:	Analogue to digital converter.
AFC:	Automatic frequency control.
BER:	Bit error rate.
bps:	Bits per second.
C/DSMA:	Carrier or data sense, multiple access scheme.
COM:	Common.
CRC:	Cyclic redundancy checksum.
CTS:	Clear to send.
DAC:	Digital to analogue converter.
DCD:	Data carrier detect.
DCE:	Data communications equipment.
DFM4-9:	Trio DataCom digital modem chipset.
DIP:	Dual in line package.
DOTAC:	Department of Transport and Communications.
DSR:	Data set ready.
DTR:	Data terminal ready.
FCS:	Frame check sequence.
FEND:	Frame end.
FESC:	Frame escape.
FIFO:	First in first out.
FIR:	Finite impulse response.

FM :	Frequency modulation.
FSK:	Frequency shift keying.
GPIB:	General purpose interface bus.
HADR_EN:	High address enable signal.
IC :	Integrated circuit.
I.F.:	Intermediate frequency.
i/p:	Input.
KISS:	Keep it simple stupid.
LADR_EN:	Low address enable signal.
MSB:	Most significant bit.
NVRAM:	Non volatile RAM.
NRZ:	Non return to zero.
NRZI:	Non return to zero - inverted.
o/p:	Output.
PCB:	Printed circuit board.
PLL:	Phase locked loop.
PMP:	Point-to-multipoint.
ppm:	Parts per million.
PTP:	Point-to-point.
PTT:	Press to talk.
RF :	Radio frequency.
RI :	Ring indicate.
R_select:	RAM read select signal.
SIO:	Serial input/output.
RSSI:	Receive signal strength indication.
RTS:	Request to send.
Rx :	Receive.
RXD:	Receive data output.
SCADA:	Supervisory control and data acquisition.
SLIP:	Serial line interface protocol.

TC-900DR: Trio DataCom 900MHz full duplex data transceiver.

TC-DFM9IP: Trio DataCom TC-900DR parameter programming software suite.

TFEND: Transposed Frame End.

TFESC: Transposed Frame Escape.

TNC: Terminal node controller.

Tx : Transmit.

TXD: Transmit data in.

VCO: Voltage controlled oscillator.

W_select: RAM write select signal

TRIO DATACOM

TC-900DR USER GUIDE

41 Aster Avenue Carrum Downs 3201 Australia Tel: 61 3 9775 0505 Fax: 61 3 9775 0606

GENERAL

The Trio DataCom TC-900DR is a full duplex 900 MHz Radio featuring a fully integrated 4800/9600 bps data radio modem and antenna diplexer. Configuration of the unit is fully programmable, with parameters held in non volatile memory (NVRAM). All configuration parameters are accessible using the TC-DRPROG installation package, consisting of a programming lead, manual and software which will run on a PC under Windows 95/98/NT. It is essential that each unit is programmed to suit individual requirements prior to operation. *For detailed information refer to the TC-900DR Handbook*

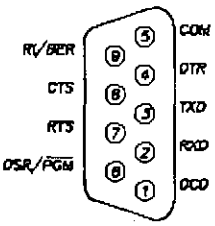
DATA CONNECTION

The data connection is via a DB9 connector labeled 'Port A' (shown below), which is wired as a DCE.

User Serial "Port A" Pin Assignment.

EXTERNAL VIEW OF 'PORT A

NOTE: Pin 6 and pin 9 provide a dual function which depends on the mode that the TC-900DR is operating in.

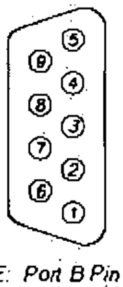


PIN NO. & FUNCTION
1. *DATA CARRIER DETECT (DCD)*
2. *RECEIVE DATA OUTPUT (RXD)*
3. *TRANSMIT DATA IN (TXD)*
4. *DATA TERMINAL READY (DTR)*
5. *COMMON (COM)*
6. *PROGRAM PIN (PGM)*
7. *REQUEST TO SEND (RTS)*
8. *CLEAR TO SEND (CTS)*
9. *BIT ERROR RATE PIN (BER)*

User Serial "Port B" Pin Assignment.

Port B can be used as a secondary data steam (independent of Port A) once configured by the programmer. Port B also has one connection that may be of use for installation. This connection (Pin 9) is Receive Signal Strength Indicator (RSSI) output. 0-5V where 1.5V typically indicates -110dBm and every 0.5V increase indicates an improvement of » 10dBm.

EXTERNAL VIEW OF 'PORT B'



PIN NO. & FUNCTION
1. *DATA CARRIER DETECT (DCD)*
2. *RECEIVE DATA O/P (RxD)*
3. *TRANSMIT DATA O/P (TxD)*
4. *UNUSED*
5. *COMMON*
6. *DATA SET RECEIVE (DSR)*
7. *UNUSED*
8. *UNUSED*
9. *RECEIVE SIGNAL STRENGTH*

NOTE: Port B Pin 9 output has a high impedance of around 50K OHMS and loading will decrease accuracy of the RSSI measurement.

POWER CONNECTIONS

The power required is 13.8VDC nominal, at 600mA (Tx) nominal. If the POWER LED indicator is not illuminated once power is applied, check the internal 1Amp fuse fitted within the unit.

POWER CONNECTOR	PIN ASSIGNMENT
TOP PIN	*+VE SUPPLY (13.8vdc)*
BOTTOM PIN	*GROUND*

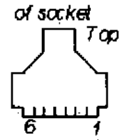
Ext. view of socket

AUXILIARY CONNECTOR

The auxiliary connector is primarily for use with the optional audio handset. The connections to this auxiliary 6 pin RJ11 connector are as follows:

PIN NUMBER	FUNCTION
1	*8 VOLTS*
2	*AUDIO OUT*
3	*GROUND*
4	*MIC INPUT/SENSE*
5	*GROUND*
6	*MANUAL PTT*

External view of socket



The optional audio handset is recommended as an aid in checking installations for radio path viability. This audio handset will only function when fitted prior to applying power to the unit.

The modem upon power up will check the presence of the handset and will inhibit data being transmitted so that voice communications can be established.

Once the path tests have been conducted the audio handsets **MUST be REMOVED** and the unit powered up with the handset removed before data communication can commence.

USER INDICATIONS

The TC-900DR provides 4 LED's that show status information to the user - POWER, RXSIG, SYNC, and TXMIT indications.

The POWER is indicated by a green LED and simply signifies that power has been applied to the unit.

The RXSIG LED (yellow) indicates the level of RSSI signal from the radio IF strip, compared to a threshold level set in the configuration data programmed by the user. If the signal is above the threshold, then the LED indicator is turned on.

In all operation modes except "Programmer mode", the SYNC LED (yellow) indicates when the modem has detected a valid data stream. The SYNC LED is activated, when the modem detects a valid HDLC flag sequence, and remains active until an invalid sequence of seven or more consecutive "1" bits is detected.

The SYNC LED will not be turned on if the RSSI signal strength (as indicated by the RXSIG LED) is below the minimum threshold. This prevents false SYNC detection from noise.

The TXMIT LED (red) indicator is connected directly to the modem's PTT output transistor. Whenever the radio is transmitting, this TXMIT LED indicator will be on.

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SPECIAL MODES OF OPERATION

Part of the power-up/reset initialisation phase of the TC-900DR are tests to determine if the modem should enter one of 3 "special operation" modes. *In these modes the TC-900DR won't operate in its standard run mode.*

- Programmer mode.
- Bit error rate test mode.
- Handset mode.

These modes are only entered if the required setup conditions are present at power up. An error mode of operation can also be entered into, if during normal operation, an error condition occurs.

PROGRAMMER MODE

CABLE - Pins 2, 3, 4, 5 straight through with Pin 6 on the DB9 connector of Port A, connected to pin 5. When the modem is powered up with this fitted, the controller senses this and attempts to enter "Programmer mode" and the "SYNC" LED will flash approx. once per second. (Note, the TC-DRPROG programming software and lead has the required connections). Failure to supply the correct password in time, will cause the modem to abandon the "Programmer mode" attempt, and go on with it's normal power-up procedure.

BIT ERROR RATE TEST MODE

Pin 9 of the DB9 connector of Port A, is normally the Ring Indicate output line. However, if this pin is driven positive (connecting it to pin 6 [DSR] and pin 7 [RTS]), then the modem's data transmitter and receiver will enter the BER test mode. This will activate the RF transmitter, and generate a scrambled bit pattern which should be decoded at a receiver as a constant logic "1" level in the unscrambled data. Any errors in the decoded bitstream, will be "0", and the receiver portion of the modem in this mode, will activate the SYNC LED every time it sees a "0" bit.

Note: As the TC-900DR is full duplex this test can operate in both directions simultaneously.

Every error bit detected, will activate the SYNC LED. For error rates of 1 in 10^3 and above, the SYNC LED will be ON most of the time. A 1 in 10^4 error rate will show the SYNC LED active for approximately 10% of the time. This function provides a crude indication of Bit Error Rate for installation purposes. Note: Error count messages (ET:XXXX) for every 10,000 bits are presented to Port A for the user. If pin 9 ceases to be driven positive, then the BER Test mode is terminated, and the modem restarts it's initialisation phase.

HANDSET MODE

The DFM4-9 modem tests for the presence of a handset plugged into the handset auxiliary port at power up. If a handset is plugged in, the modem will not generate a data stream. However, it will continue to indicate received RF signal strength. The handset has a PTT button, and this signal is connected across the modem's PTT output. Thus the handset PTT switch will activate the TXMIT LED. It is essential to remove the handset from the unit and reapply power to the unit in order to return to normal operation.

ERROR INDICATION MODES

There are 3 error conditions that cause the RXSIG & SYNC LEDs to be used for error indications and not their normal purpose. Two are fatal conditions, that cause the modem to restart after the duration of the error indication phase.

TRANSMIT POWER LOW

While the modem activates the radio transmitter, it periodically checks the transmit power. If the power measurement is less than a threshold set in the non-volatile memory, then the RXSIG and SYNC LEDs are made to alternate, approximately 4 times per second. The TXMIT LED will also be on during this process. This indication condition will persist for the duration of the transmission. As soon as the transmission is discontinued, the error indication will cease, and the two LEDs revert to their normal function. Factory set to 100 milliWatts.

NVRAM READ ERROR

The DFM4-9DR modem accesses the non-volatile memory as part of it's initialisation phase, to read programming configuration data. If the communication protocol with the device is violated, or the non-volatile memory CRC checksum is found to be incorrect, then the modem indicates this by flashing the RXSIG and SYNC LEDs twice alternately. That is, one LED operates ON and OFF twice, then the other. A total of five cycles of this occurs, then the modem restarts initialisation.

SYNTHESISER LOCK DETECT ERROR

If at any time during normal operation, BER mode, or handset mode, the TBB206 frequency synthesiser indicates an out of lock condition, the modem enters an error indication mode for a short time before restarting.

One LED is turned ON (○), the LEDs are swapped, then both turned OFF (●). Then the latter LED ON again, swap LEDS, and then OFF. This will give the appearance of a sweeping motion between the LEDs. The following table shows all error condition displays.

Tx PWR Err		NVRAM Err		SYNTH Err	
RXSIG	SYNC	RXSIG	SYNC	RXSIG	SYNC
○	●	○	●	○	●
●	○	●	●	●	○
○	●	○	●	●	●
●	○	●	●	●	○
○	●	●	○	○	●
●	○	●	●	●	●
○	●	●	○		repeat
●	○	●	●		
continue			repeat		

MOUNTING AND ANTENNA CONNECTION

The TC-900DR should be mounted in a cool, dry, vibration free environment, whilst providing easy access to screws and connections. There are 4 mounting holes on the unit. The antenna should be an external yagi antenna but can be a ground independent dipole mounted via a feeder to the antenna connector (SMA type) for short range applications. However the whole radio modem should be clear of the associated data equipment to prevent mutual interference.

ASSEMBLY OF POWER LEAD

A small plastic bag containing a molex connector (M5557-2R) and two pins (M5556-TL) is provided in the packing box.

The pins are designed to take 18-24 (AWG) wire size with insulation range 1.3 - 3.10mm.

Please take care when crimping the pins. 04/01

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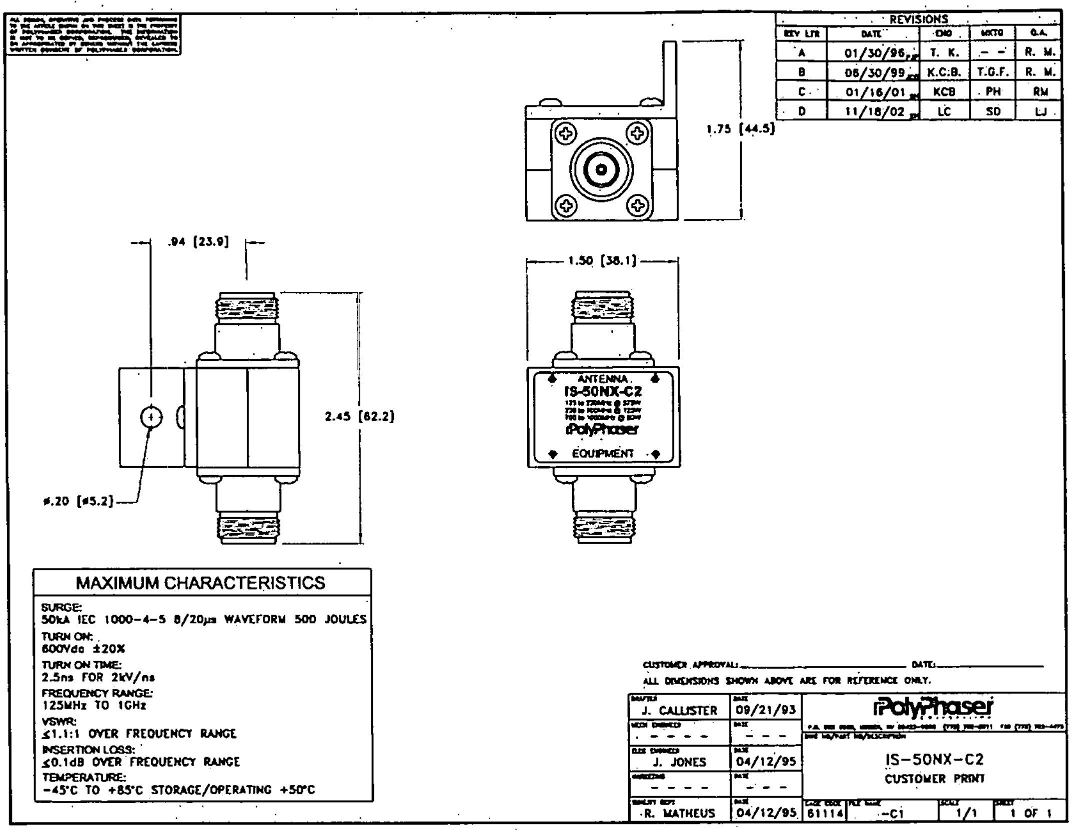
REVISIONS
A 01/30/96 T. K. R. M.
B 06/30/99 K.C.B. T.G.F. R. M.
C 01/16/01 KCB PH RM
D 11/18/02 LC SD LJ
1.75 [44.5]
.94 [23.9]
1.50 [38.1]
2.45 [62.2]
ø.20 [ø5.2]
ANTENNA
IS-50NX-C2
PolyPhaser
EQUIPMENT
MAXIMUM CHARACTERISTICS
SURGE:
50kA IEC 1000-4-5 8/20μs WAVEFORM 500 JOULES
TURN ON:
600Vdc ±20%
TURN ON TIME:
2.5ns FOR 2kV/ns
FREQUENCY RANGE:
125MHz TO 1GHz
VSWR:
≤1.1:1 OVER FREQUENCY RANGE
INSERTION LOSS:
≤0.1dB OVER FREQUENCY RANGE
TEMPERATURE:
-45°C TO +85°C STORAGE/OPERATING +50°C
CUSTOMER APPROVAL: DATE:
ALL DIMENSIONS SHOWN ABOVE ARE FOR REFERENCE ONLY.
J. CALLISTER 09/21/93
J. JONES 04/12/95
R. MATHEUS 04/12/95
PolyPhaser
IS-50NX-C2
CUSTOMER PRINT
61114 -C1 1/1 1 OF 1

Process Level 1	Level 2	Level 3	Level 4	Level 5	Comments
Inlet Works					
	C43 Flowsplitter No1				
		Ultrasonic level detector			
		Local Control Panel			
		450 mm Pipe CPSTP			
			Waterman Valve		
			450 mm Valve		
		300 mm Pipe Flowsplitter			
			Waterman Valve		
		375 mm Pipe			
			Waterman Valve		
			Pneumatic Actuator		
	C44 Vortex Grit Trap No1				
		Mixer			
		Grit Removal Pipework			
		Local control panel			
	C42 Inlet Works No2				
		Building			
		Lifting Beam			
		Bypass Waterman Valve			
		Inlet Waterman Valve			
		Outlet Waterman Valve			
		Stairs Handrails and Walkways			
		Grit Dewatering Screen			
		Rag Screw Conveyor No1			
			Geared Drive Unit		
		CPSTP Inlet No2 Screens			
			Trommel		
				Geared Drive Unit	
				Conveyor	
				Drive Mechanism No1	
				Water Spray Assembly	
			Lighting		
			Manually Raked Bar Screen		
			Ferric Chloride Dosing System		
				Dosing Pump	
				Holding Tank	
				Bunding	

Process Level 1	Level 2	Level 3	Level 4	Level 5	Comments
	C01 Inlet Structure No1				
		Knife Edge Valve			
		Stairs from Pri Sed Tank No1			
		Handrails			
		450 mm Pipe to No3 Pri Sed Tank			
		300 mm Pipe to No1 Pri Sed Tank			
	C45 No2 Odour Control				
		Odour Control Unit No1			
			Isolation Valve		
		Odour Control Unit No2			
			Isolation Valve		
		Odour Control Unit No3			
			Isolation Valve		
		Odour Control Unit No4			
			Isolation Valve		
		Fan			
		Odour Control Switchboard			
		Pipework Supports			
		Heating Coil			
	Pipework and MH				
		225 mm Pipe			
		100 mm Pipe			
Primary Treatment					
	C64 Raw Sludge PS				
		Handrails			
		Raw Sludge Pumpset No1			
			Pump		
			Isolation Valve		
			NonReturn Valve		
		Raw Sludge Pumpset No2			
			Pump		
			Isolation Valve		
			NonReturn Valve		
		Raw Sludge Valve Pit			
		Odour Control Unit			
			Isolation Valve		
		100 mm RM			
			Isolation Valve No1		
			Isolation Valve No2		

Process Level 1	Level 2	Level 3	Level 4	Level 5	Comments
	C03 Pri Sed Tank No1				Zone 1
		Sludge DrawOff Pit			
			Actuator Sludge		
			Draw Off Valve Sludge		
		Handrails			
		Stationery Bridge			
			Handrails		
			Worm Reduction Gearbox		
			Geared Drive Unit		
Pri Sed Tank No 2		Vee Cut Weir Scum Baffle Box			+ old inlet works
		Centre Column Assembly			
		Scraper Assembly			
		150 mm Pipe			
	C05 Pri Sed Tank No3				
		Handrails			
		Sludge DrawOff Pit			
			Actuator Sludge		check/confirm isolation of all three tanks + associated motors/valve actuators?
			Draw Off Valve Sludge		
		Stairs			
		Centre Column Assembly			
			Slip Ring Assembly		
		Bridge			
			Geared Drive Unit		
		Vee Cut Weir Scum Baffle Box			
		Scraper Assembly			
		450 mm Pipe to Aeration Tanks			
		150 mm Pipe			
	Pipework and MH				
		375 mm Pipe			
Biological Reactors					
	C02 Aeration Tank No1				
		Inlet Penstock			
		Outlet Weir			
		Handrails and Stairs			
		DO Probe			
		~~Anoxic Mixer No1~~			
		Surface Aerator No1			
			Reduction Gearbox		
			Motor		
			Impeller		
			VFD		
		Anoxic Aerator No1			
			Reduction Gearbox		
			Motor		
			Impeller		
		450 mm Pipe to Flow Distribution Box			

Process Level 1	Level 2	Level 3	Level 4	Level 5	Comments
	C07 Aeration Tank No2				
		Inlet Penstock			
		Outlet Weir			
		Handrails			
		DO Probe			
		Surface Aerator No2			
			Reduction Gearbox		
			Motor		
			Impeller		
			VFD		
		Anoxic Aerator No2			
			Reduction Gearbox		
			Motor		
			Impeller		
		~~Anoxic Mixer No2~~			
	Anoxic Tank No1 C47				
		Mixer No5			
		Mixer No4			
		Mixer No3			
		Mixer No2			
		Mixer No1			
		Stairs Walkways and Handrails			
	Aerobic Tank No1 C48				
		Air pressure gauge			
		Air Temp Gauge			
		Air Flow Meter			
		Diffuser Bank No1			
			Isolation Valve		
		Diffuser Bank No2			
			Isolation Valve		
		Diffuser Bank No3			
			Isolation Valve		
		Diffuser Bank No4			
			Isolation Valve		
		Diffuser Bank No5			
			Isolation Valve		
		Diffuser Bank No6			
			Isolation Valve		
		No1 Drain to MH 29			
		No1 Drain Valve			
		No1 Scum WAS Drain			
		DO Probe No1			
		DO Probe No2			
		Air Main			
		Pressure Transducer			
		AnoxicAerobic Recycle Pumpset No1			
			Pump		
			Isolation Valve		
			NonReturn Valve		
			VFD		

Process Level 1	Level 2	Level 3	Level 4	Level 5	Comments
		AnoxicAerobic Recycle Pumpset No2			
			Pump		
			Isolation Valve		
			NonReturn Valve		
			VFD		
		Recycle Pumps 1 2 Control Panel			
		AerobicAnoxic Recycle Flow Meter			
		Recycle pipework includes fittings			
		Skimmer Pump			
		Stairs Walkways and Handrails			
		Delivery Line to WAS			
			Scum Outlet Valve		
			Draw Off Valve		
			Air Operated Knife Edge Valve		
			Solenoid Valve		
			Pneumatic Controls		
		Compressor			
			Pressure Vessel		
	Anoxic Tank No2 C49				
		Mixer No6			
		Mixer No7			
		Mixer No8			
		Mixer No9			
		Mixer No10			
		Stairs Walkways and Handrails			
	Aerobic Tank No2 C50				
		Diffuser Bank No7			
			Isolation Valve		
		Diffuser Bank No8			
			Isolation Valve		
		Diffuser Bank No9			
			Isolation Valve		
		Diffuser Bank No10			
			Isolation Valve		
		Diffuser Bank No11			
			Isolation Valve		
		Diffuser Bank No12			
			Isolation Valve		
		No2 Drain to MH 29			
		No2 Drain Valve			
		No2 Scum WAS drain			
		DO Probe No1			
		DO Probe No2			
		AnoxicAerobic Recycle Pumpset No3			
			Pump		
			Isolation Valve		
			NonReturn Valve		
			VFD		

Process Level 1	Level 2	Level 3	Level 4	Level 5	Comments
		AnoxicAerobic Recycle Pumpset No4			
			Pump		
			Isolation Valve		
			NonReturn Valve		
			VFD		
		Recycle Pump 3 4 Control Panel			
		AerobicAnoxic Recycle Flow Meter			
		Recycle Pipework includes fittings			
		Skimmer Pump			
		Stairs Walkways and Handrails			
		Delivery Line to WAS			
			Scum Outlet Valve		
			Draw Off Valve		
	Diam 525 Pipe				
	C46 Flowsplitter No2				
		Dropboards No3			
		Dropboard to Anoxic Tank No2			
		Dropboard to Anoxic Tank No1			
		Pneumatic Actuator			
		Ultrasonic Level Detector			
		Local Control Panel			
		250 mm Pipe Bypass Pipe			
		450 mm Pipe to Anoxic Tank No1			
	C55 WAS PS No1				
		WAS Pumpset No1			
			VFD		
			Pump		
			Delivery Valve		
			NonReturn Valve		
		WAS Pumpset No2			
			VFD		
			Pump		
			Delivery Valve		
			NonReturn Valve		
		Control Panel			
		Handrails			
		Flow Meter			
		100 mm RM			
		150 mm Pipe Overflow to MH 29			
	Pipework and MH				
		MH No29			
		225 mm Pipe MH 29 to 28			
		MH No28			
		225 mm Pipe MH 28 to 27			
		MH No27			
		225 mm Pipe MH 27 to 26			
		MH No26			
		225 mm Pipe MH 26 to 4			

Process Level 1	Level 2	Level 3	Level 4	Level 5	Comments
Secondary Clarification					
	C09 Sec Sed Tank No1				
		Telescopic Valve Pit			
			Telescopic Valve		
		Centre Column Assembly			
			Slip Ring Assembly		
		Bridge			
			Geared Drive Unit		
		Vee Cut Weir Scum Baffle Box			
		Scraper Assembly			
		150 mm Pipe to MH 18			
			Gate Valve		
	C10 Sec Sed Tank No2				
		Gate Valve to Drain Tank			
		Telescopic Valve Pit			
			Telescopic Valve		
		150 mm Pipe to MH 17			
		Centre Column Assembly	Slip Ring Assembly		
		Bridge			
			Geared Drive Unit		
		Vee Cut Weir Scum Baffle Box			
		Scraper Assembly			
		300 mm Pipe to MH No5			
	C11 Sec Sed Tank No3				
		Telescopic Valve Pit			
			Telescopic Valve		
		150 mm Pipe to MH 15			
		Gate Valve to Drain Tank			
		Centre Column Assembly			
			Slip Ring Assembly		
		Bridge			
			Geared Drive Unit		
		Vee Cut Weir Scum Baffle Box			
		Scraper Assembly			
		450 mm pipe to MH No1			
	C52 Sec Sed Tank No4				
		Sludge Draw off Pipe to No2 RAS PS			
		Diam 160 Scum Pipe			
		Tank Drain Pipe to MH 28			
		Drain Pipe Valve			
		Handrails			
		Bridge			
			Geared Drive Unit		
		Centre Column Assembly			
			Slip Ring Assembly		
		Air powered Scum Pump			
		Vee Cut Weir Scum Baffle Boxes			
		Local Control Panel			
		Scraper Assembly			

Process Level 1	Level 2	Level 3	Level 4	Level 5	Comments
	C53 Sec Sed Tank No5				
		Sludge Drawoff Pipe to No2 RAS PS			
		Diam160 Scum Pipe			
		Tank Drain Pipe to MH 27			
		Drain Pipe Valve			
		Handrails			
		Stairs			
		Bridge			
			Geared Drive Unit		
		Centre Column Assembly			
			Slip Ring Assembly		
		Vee Cut Weir Scum Baffle Boxes			
		Local Control Panel			
		Scraper Assembly			
	C08 RAS PS No1				
		RAS Pumpset No1			
			Pump		
			Isolation Valve		
			NonReturn Valve		
		RAS Pumpset No2			
			Pump		
			Isolation Valve		
			NonReturn Valve		
		RAS Pumpset No3			
			Pump		
			Isolation Valve		
			NonReturn Valve		
		Disc Valve			
		Handrails			
		Valve Pit			
		RM			
			Isolation Valve		
			Isolation Valve		
			Isolation Valve		
				Isolation Valve	
				Isolation Valve	
			Rising Main Isolation Valve		
				Isolation Valve	
				Isolation Valve	

Process Level 1	Level 2	Level 3	Level 4	Level 5	Comments
	C54 RAS PS No2				
		Control Panel			
		Handrails			
		RAS Pumpset No5			
			Pump		
			Isolation Valve		
			NonReturn Valve		
		RAS Pumpset No4			
			Pump		
			Isolation Valve		
			NonReturn Valve		
		RAS Metering Pit			
			Control Panel		
			Handrails		
			Sec Sed Tank No4 Inlet Line		
				Actuated Plug Valve	
				Actuator	
				Flow Meter	
				Isolation Valve	
			Sec Sed Tank No5 Inlet Line		
				Actuated Plug Valve	
				Actuator	
				Flow Meter	
				Isolation Valve	
		200 mm RM			
		100 mm Pipe			
	C51 Flowsplitter No3				
		Handrails			
		Stairs			
		Walkway			
		Dropboard No2			
		Dropboard No1			
		375 mm Pipe			
		375 mm Pipe			
	C12 Flow Distribution Box				
		450 mm Pipe			
		300 mm Inlet			
		300 mm Pipe			

Process Level 1	Level 2	Level 3	Level 4	Level 5	Comments
	Pipework and MH				
		MH No14			
			150 mm Pipe		
		MH No15			
			Gate Valve		
			150 mm Pipe		
		MH No17			
			Gate Valve		
		150 mm Pipe MH 17 to16			
		150 mm Pipe			
		Pipe			
			Isolation Valve		
		MH No5			
			375 mm Pipe		
		MH No1			
			675 mm Pipe		
		MH No2			
			Isolation Valve		
			450 mm Pipe		
			Isolation Valve		
			450 mm Pipe		
		MH No16			
			150 mm Pipe		
		MH No18			
			150 mm Pipe		
		Pipe			
		MH No30			
			300 mm Pipe		
Disinfection					
	Chlorine Dosing				
		Chlorination Pumps			
			Chlorination Pumpset No2		
				Pump	
				Motor	
				Inline Filter	
			Chlorination Pumpset No1		
				Pump	
				Motor	
				Inline Filter	
			Fittings		
			Flow Switch		
		Exhaust Fan			
		Lifting Beam			
		Hoist			
		Audible Visual Alarm			
		Chlorination Valves Pipework			
		Chlorination Unit			
		Drum Scale			
		Drum Lifting Beam			
		Change Over Valve No1			
		Change Over Valve No2			
		Chlorinator Ejector No1			
		Chlorinator Ejector No2			

Process Level 1	Level 2	Level 3	Level 4	Level 5	Comments
		Leak Detection Unit			
	C20 Chlorine Detent Tank No1				
		Isolation Valve			
		Drain Gate Valve			
		Stationary Bridge			
	C21 Chlorine Detent Tank No2				
		Isolation Valve			
		Drain Gate Valve			
		Stationary Bridge			
	Pipework and MH				
		150 mm Drain			
		MH No13			
Digestion					
	Compressors and Blowers				
		Compressor No1 F7A			
		Compressor No2 CSA7			
		Blower No3			
			Motor		
			Air Delivery Valve		
			NonReturn valve		
			Blower		
			Inlet Silencer		
			Pressure Monitor		
		Blower No2			
			Motor		
			Air Delivery Valve		
			NonReturn valve		
			Blower		
			Inlet Silencer		
			Pressure Monitor		
		Blower No1			
			Motor		
			Air Delivery Valve		
			NonReturn valve		
			Blower		
			Inlet Silencer		
			Pressure Monitor		
		Lifting Beam			
		Block and Tackle			
		Air Manifold			
		CI Pipework			
		Pressure Transducer			
		Exhaust Fan			
		Air Dryer No1			

Process Level 1	Level 2	Level 3	Level 4	Level 5	Comments
	C06 Digested Sludge Sump				
		Overflow pipe			
	C17 Boiler Room				
		Lifting Beam			
		Heater Pumpset No1			
			Suction Valve		
				Air Operated Actuator	
			Delivery Valve		
				Air Operated Actuator	
			Pump		
			Motor		
		Heater Pumpset No2			
			Pump		
			Motor		
			Suction Valve		
				Air Operated Actuator	
			Delivery Valve		
				Air Operated Actuator	
		Recycle Pump No1			
		Recycle Pump No2			
	C22 Sludge Trans Pumping Station				
		Valve Pit			
		Sludge Transfer Pumpset No1			
			Pump		
			Isolation Valve		
			NonReturn Valve		
		Sludge Transfer Pumpset No2			
			Pump		
			Isolation Valve		
			NonReturn Valve		
	C23 Digester No2				
		Gate Valves 1			
		Gate Valves 2			
		Gate Valves 3			
		150mm dia AC Pipework to Sludge Thickener			
		150mm dia AC Pipework to Transfer PS			
		Handrails			
		Floating Dome			
	C18 Digester No1				
		Pipework			
		Gate Valves			
		Handrails			
		Floating Dome			

Process Level 1	Level 2	Level 3	Level 4	Level 5	Comments
	Pipework and MH				
		MH No9			
			Air Driven Actuator		
			Gate Valve		
		MH No19			
			Gate Valve		
			Three Way Valve		
		MH No20			
			Air Driven Actuator		
			Gate Valve		
		80 mm Pipe MH 20 to 9			
		MH No21			
			Gate Valve		
			Automatic Valve		
		80 mm Pipe			
		525 mm Pipe			
Sludge Dewatering					
	C13 Sludge Thickener No1				
		NonReturn Valve			
		Gate Valve			
		150mm dia AC Pipework to Sludge Thickener No2			
		Stairs			
		Handrails		499721	
		Valve Pit			
			Valves Valve Pit		
		Sludge Recirculation Pumpset			
			Pump Sludge		
			Motor Sludge		
			Suction Valve		
			Delivery Valve		
	C24 Sludge Thickener No2				
		WAS Inlet Gate Valve			
		WAS Inlet NonReturn Valve			
		Digester Inlet NonReturn Valve			
		Digester Inlet Gate Valve			
		150mm dia AC Pipework to MH 25			
		150mm dia AC Pipework to Transfer PS			
		150mm dia AC Pipework to MH 22			
		Stairs			
		Handrails			
		Valve Pit			
			Isolation Valve		
			Isolation Valve		
			Actuated Knife Gate Valve		
		Stationery Bridge			
			Geared Drive Unit		
			Paddle Stationery		
		Vee Cut Weir			

Process Level 1	Level 2	Level 3	Level 4	Level 5	Comments
	C56 Sludge Drying Beds				
		80 mm Pipe			
		80 mm Pipe			
		150 mm Pipe			
	C19 Sludge Dewatering Facility				
		Belt Presses Gravity Decks			
			Gravity Deck No1		
				Geared Drive Unit	
				Inlet Air Op Isolation Valve	
			Belt Press No1		
				Geared Drive Unit	
				Bund	
				Inlet Knife Edge Valve	
				Flocculator Mixer	
			100mm dia VC Drain		
			Stairs		
			Building Lighting		
			Handrails Kickboards		
			Flow Meter		
		Poly Batching Plant			
			Level Detection Devices		
			Auto Flush System		
			Spirac Screw Conveyor		
			Poly Mixer No1		
			Poly Mixer No2		
			Holding Tanks For Poly		
		Poly Dosing			
			Poly Pumpset No1		
				Pump	
				Motor	
			Poly Pumpset No2		
				Pump	
				Motor	
		Sludge Feed			
			Sludge Digester Pumpset No1		
				Pump	
				Motor	
			Sludge Digester Pumpset No2		
				Motor	
				Pump	
			RM		
				Isolation Valve	
				Actuated Isolation Valve	
				Flow Meter	
			150mm Pipe		
		Compressor			
			Pressure Vessel		

Process Level 1	Level 2	Level 3	Level 4	Level 5	Comments
		Sludge Dewatering			
			MH No8		
			150 mm Pipe MH 8 to 3		
			MH No7		
			150 mm Pipe MH 7 to 6		
			MH No6		
			225mm PIPE		
			MH No3		
			225 mm Pipe MH 3 to 4		
			MH No22		
			150mm dia		
			MH No23		
			225 mm Pipe MH 23 to 24		
			MH No24		
			225mm PIPE		
			MH No25		
			225mm PIPE		
Tertiary Treatment					
Chemical Treatment					
Effluent Outfall					
	C25 Effluent Pumping Station				
		Lifting Beam			
		Block and Tackle			
		Walkway Handrails and Steps			
		Effluent Pumpset No1			
			Motor		
			Suction Valve		
			Delivery Valve		
			NonReturn Valve		
			Pump		
		Effluent Pumpset No2			
			Pump		
			Motor		
			Suction Valve		
			Delivery Valve		
			NonReturn Valve		
		Chlorine pH Analyser			
		Inline Turbidity Analyser			
	Effluent Reuse				
		CPSTP C33 Recycled Water Reticulation			
		CPSTP C39 Recycled Water PS			
			Recycle Water Pumpset No1		
				Pump	
				Isolation Valve	
				NonReturn Valve	
				Foot Valve	
				Motor	
			Recycle Water Well		

Process Level 1	Level 2	Level 3	Level 4	Level 5	Comments
Control Systems					
	Logic Control				
	C75 SCADA System				
	Telemetry				
Power Supply					
	Generator Set				
		Alternator			
		Diesel Engine			
		Control Panel			
		Steel Frame			
		Generator Cables			
	C73 Electrical Pits Conduit				
		Electrical Pits			
		Conduit Runs			
	Switchboards cabling				
		PLC Main Switchboard			
		VFD Circuit Breaker Switchboard			
		Aeration SubSwitchboard			
		Inlet Works Sub Switchboard			
		Mains Distribution Switchboard			
			Aeration Building SubMains		
			Raw Sewerage SubMains		
			Boiler Room SubMains		
			Sludge Dewatering SubMains		
		Surface Aerators Switchboard			
		Old Plant Switchboard			
		Sludge Dewatering Switchboard			
		Boiler Room Switchboard			
General Site					
	C57 Blower Building				
		Lighting			
	Security				
		Boundary Fene CPSTP Security			
	C41 C25 C27 Building				
		Lighting			
	C17 Boiler Room				
		Stairs			
		Handrails			
		Lighting			
	C32 Potable Water Supply				
		Backflow prevention valve			
		100 mm Main Line			
		50 mm Main Line Stage 3			

Process Level 1	Level 2	Level 3	Level 4	Level 5	Comments
	C28 Control Building				
		Lighting			
		Air Conditioner Lab			
		Air Conditioner Office			
		Air Conditioner Switchboard Room			
		Audible Evacuation Alarm			
		100 mm Drain to MH 11			
	C72 Storage Shed				
	C74 External Lighting				
	C31 Roadworks Kerbing				
		Roads			
		Kerb Channel			
	C31 Drainage				
		Catchpits			
		Stormwater Drains			
		Stormwater Manholes			
	Air Supply Pipework				
		Diam 25 Branch to RAS Valves			
		Diam 63 from Blower Building to Scum Pump			
		Diam 40 from Scum Pump to Inlet Works No2			
		Diam 40 Brand to WAS Valve			
		Diam 32 Brand to Flowsplitter No2			
	Grounds				

St Achs

Client : Brisbane City · Brisbane Water

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SEWER PUMP STATION UPGRADE AND GRAVITY SEWER

Drawing Index :

DWG NO.	DRAWINGS TITLE
486/5/6-0024-001	COVER PAGE
486/5/6-0024-002	GENERAL NOTES
486/5/6-0024-003	PLAN OF LINE 1 (SHEET 1 OF 3)
486/5/6-0024-004	PLAN OF LINE 1 (SHEET 2 OF 3)
486/5/6-0024-005	PLAN OF LINE 1 (SHEET 3 OF 3)
486/5/6-0024-006	LONGITUDINAL SECTION OF LINE 1 (SHEET 1 OF 5)
486/5/6-0024-007	LONGITUDINAL SECTION OF LINE 1 (SHEET 2 OF 5)
486/5/6-0024-008	LONGITUDINAL SECTION OF LINE 1 (SHEET 3 OF 5)
486/5/6-0024-009	LONGITUDINAL SECTION OF LINE 1 (SHEET 4 OF 5)
486/5/6-0024-010	LONGITUDINAL SECTION OF LINE 1 (SHEET 5 OF 5)
486/5/7-0024-031	PUMPSTATION PIPEWORK
486/5/7-0024-032	MISCELLANEOUS DETAILS AND SETOUT DATA AND LIVE SEWER TABLES

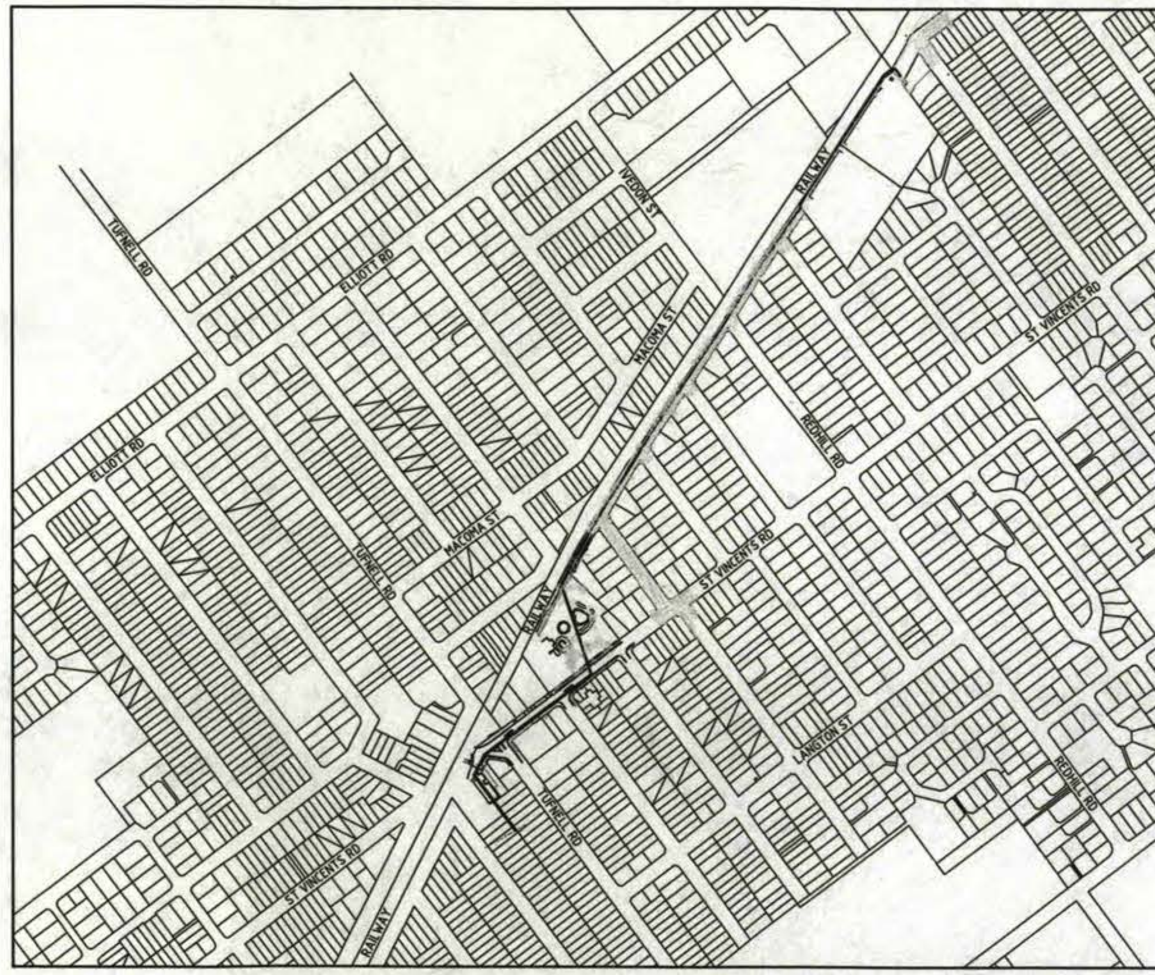
Standard Drawings :

DWG NO.	DRAWINGS TITLES
SEW -1201	EMBEDMENT AND TRENCHFILL TYPICAL ARRANGEMENT
SEW -1308	STANDARD EMBEDMENT RIGID AND FLEXIBLE PIPES
SEW -1305	MAINTENANCE HOLES TYPICAL CHANNEL DETAILS
SEW -1308	MAINTENANCE HOLES TYPICAL MH COVER ARRANGEMENTS
SEW -1402	BURIED CROSSINGS MAJOR ROADWAYS
486/5/25-SC003/1	"F" TYPE MAINTENANCE HOLE GENERAL ARRANGEMENT
486/5/25-SC003/2	"F" TYPE MAINTENANCE HOLE TOP SLAB DETAIL
486/5/25-SC001	SEWER MAINTENANCE HOLE COPING AND ANCHOR BRACKET DETAILS
486/5/25-SC004/1	"X" TYPE STANDARD DEEP MAINTENANCE HOLE GENERAL ARRANGEMENT
486/5/25-SC004/6	"X" TYPE STANDARD DEEP MAINTENANCE HOLE TOP SLAB DETAILS
486/5/25-SP001/3	PE NUSEWERS MH CONNECTIONS
486/5/25-0003-311	CHAIN SUSPENDED SUBMERSIBLE PUMP, TYPICAL INSTALLATION
486/5/25-0003-312	CHAIN SUSPENDED SUBMERSIBLE PUMP, DN150 HOSE CONNECTION BEND ASSEMBLIES
486/5/25-SB006	STANDARD SEWERAGE AIRVALVE DETAIL FOR Ø100 TO Ø300 RISING MAIN
486/5/25-SC006/3	900DIA RISING MAIN DISCHARGE MAINTENANCE HOLE TOP SLAB AND VENT DETAILS
486/5/25-SE001/1	STANDARD OVERFLOW FLAP VALEV TYPE 1 CHAMBER DETAILS
486/5/25-SE001/2	STANDARD OVERFLOW FLAP VALEV TYPE 1 TOP SLAB AND FLAP DETAILS
486/5/25-SP001/3	PE NUSEWERS MH CONNECTION DETAIL

Project No : A1139600

Contract No : 7103-01

Locality Plan :



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AS CONSTRUCTED

A	09/09/09	AS CONSTRUCTED	RS	JWG	DESIGN W.O. No.		DRAFTED	R. CRAWFORD	J. VAN HEREL 21.11.08		K. VAHEESAN	25.11.08
0	13/11/08	FOR CONSTRUCTION	TK	JVH	CONSTRUCTION W.O. No.		DRAFTING CHECK	R. CRAWFORD	DESIGN	R.P.E.Q. No. DATE	PRINCIPAL DESIGN MANAGER	DATE
No.	DATE	AMENDMENT	DRAFTED	APPROVED	FUNDED BY B.C.C. ( ) EXTERNAL ( )	FUNDING	CAD FILE		J. GREEN	2624 21.11.08	J. KARYDAS	25.11.08
							B.C.C. FILE No.		DESIGN CHECK	R.P.E.Q. No. DATE	PRODUCTION / NETWORK DELEGATE	DATE

AS CONSTRUCTED
SIGNED [signature] DATE 19-5-10
NAME John W Green RPEQ No. 2624

DESIGNED:		DATE:	
DRAWN:		DRAWING No. 7103-P-DWG-6101	REV.
CHECKED:			
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PROJECT
ST ACHS
SEWER PUMP STATION UPGRADE AND GRAVITY MAIN

TITLE
COVER PAGE

SHEET No. OF
BRISBANE WATER DRAWING No. 486/5/6-0024-001
AMEND. A

GENERAL:

G 1 READ THESE DRAWINGS IN CONJUNCTION WITH OTHER ENGINEERING DRAWINGS, SPECIFICATIONS AND WITH SUCH OTHER WRITTEN INSTRUCTIONS AS MAY BE ISSUED. THE CONSTRUCTION NOTES SHALL APPLY UNLESS OTHERWISE VARIED BY THE DRAWINGS OR SPECIFICATIONS.

G 2 NOMINATION OF PROPRIETARY ITEMS DOES NOT INDICATE EXCLUSIVE PREFERENCE BUT INDICATES THE REQUIRED PROPERTIES OF THE ITEM. SIMILAR ALTERNATIVES HAVING THE REQUIRED PROPERTIES MAY BE OFFERED FOR APPROVAL.

G 3 REFER ANY DISCREPANCY TO THE SUPERINTENDENT BEFORE PROCEEDING WITH THE WORK.

G 4 DO NOT OBTAIN DIMENSIONS BY SCALING FROM THE DRAWINGS. ALL DIMENSIONS ARE IN MILLIMETRES AND ALL LEVELS AND CO-ORDINATES IN METRES, UNLESS NOTED OTHERWISE. (UNO)

G 5 VERIFY SETTING OUT DIMENSIONS SHOWN ON THE DRAWINGS BEFORE CONSTRUCTION AND FABRICATION IS COMMENCED.

G 6 MAINTAIN STRUCTURES AND EXISTING SERVICES IN STABLE CONDITION DURING CONSTRUCTION. NO PART SHALL BE OVERSTRESSED. PROVIDE TEMPORARY BRACING AS REQUIRED.

G 7 THE CONTRACTOR SHALL BE RESPONSIBLE FOR ENSURING K & C AND ANY DRAINAGE STRUCTURES ARE NOT DAMAGED DURING CONSTRUCTION. ANY DAMAGE SHALL BE MADE GOOD BY RE-CONSTRUCTION OR REPAIR AS DIRECTED BY AND TO THE SATISFACTION OF THE SUPERINTENDENT.

G 8 ALL WORKMANSHIP AND MATERIALS SHALL BE IN ACCORDANCE WITH THE REQUIREMENTS OF RELEVANT SAA CODES, BCA AND THE LOCAL LAWS AND ORDINANCES OF THE RELEVANT GOVERNMENT AUTHORITY.

G 9 SUPPORT ALL TRENCHES IN ACCORDANCE WITH THE REQUIREMENTS OF WH&S ACT. ALL TRENCHES OVER 1.5m DEEP SHALL BE SUPPORTED UNLESS CERTIFIED SAFE BY A COMPETENT PERSON WITHIN THE MEANING OF THE ACT.

G 10 NOTWITHSTANDING THAT THE PRESENT AND/OR PROPOSED POSITIONS OF UNDERGROUND SERVICES MAY BE INDICATED ON THE DRAWINGS, THEIR POSITION AND DEPTH IS APPROXIMATE ONLY. PRIOR TO ANY EXCAVATION THE CONTRACTOR SHALL CONTACT ALL RELEVANT AUTHORITIES AND SHALL POT-HOLE ALL SERVICES TO OBTAIN DETAILED LOCATIONS. THE CONTRACTOR SHALL NOTIFY THE SUPERINTENDENT OF ANY CONFLICTS BETWEEN THE PROPOSED MAIN AND EXISTING SERVICES. THE SUPERINTENDENT WILL ADVISE DETAILS OF ANY REQUIRED CHANGES TO ALIGNMENT OR LEVEL, OR ARRANGE FOR CHANGES TO SERVICES.

G 11 ROADS SHALL NOT BE CLOSED FOR THEIR FULL WIDTH EXCEPT FOR TIMES WHEN MOVEMENT OF MATERIALS ARE NECESSARY. TRAFFIC SHALL BE CONTROLLED BY ACCREDITED TRAFFIC CONTROLLERS ONLY.

ENVIRONMENTAL:

E 1 THE EXTENT OF CLEARING OF VEGETATION SHALL BE KEPT TO THE ABSOLUTE MINIMUM NECESSARY TO UNDERTAKE THE WORKS.

E 2 SILTATION CONTROLS, SITE REVEGETATION AND ENVIRONMENTAL REQUIREMENTS SHALL ALL BE CARRIED OUT TO THE SATISFACTION OF THE SUPERINTENDENT.

E 3. CONSTRUCTION SHALL COMPLY WITH ALL ENVIRONMENTAL AND LEGISLATIVE REQUIREMENTS SET OUT IN THE PROJECT ENVIRONMENTAL MANAGEMENT PLAN.

E 4 TREES THAT ARE TO REMAIN AND THAT ARE AFFECTED BY TRENCHING ARE TO BE IDENTIFIED AND MARKED. ROOTS ARE TO BE EXPOSED BY HAND AND SAW-CUT IN ACCORDANCE WITH RE-VEGETATION PLANS. ANY INADVERTENT DAMAGE TO ROOTS CAUSED BY EXCAVATION IS TO BE REPORTED TO THE SUPERINTENDENT.

SURVEY DATUM:

S1 HORIZONTAL DATUM IS BASED ON SURVEY CONTROL SUPPLIED BY TENIX IN AUTOCAD DWG FILE 060135. SURVEY STATIONS USED, BOLT IN BITUMEN LOCATED N.W CORNER RAILWAY Tce & EAMES St. CCS NAME 9004 & SCREW IN CONC. LOCATED WEST SIDE TUFNELL Rd AT INTERSECTION OF LANGTON St CCS NAME 9000.

FOUNDATIONS

F1. THE REQUIRED BEARING CAPACITY IS 60KPa. PRIOR TO THE COMMENCEMENT OF CONSTRUCTION, THE FOUNDATION MATERIAL SHALL BE INSPECTED AND TESTED BY A GEOTECHNICAL ENGINEER TO ENSURE THE DESIGN REQUIREMENTS ARE MET.

F2. IN THE EVENT OF THAT THE FOUNDING STRATA FOR THE SLAB IS FOUND TO BE UNSUITABLE, THE MATERIAL SHALL BE REMOVED AND REPLACED TO A MINIMUM DEPTH OF 1m, SUBJECT TO THE ADVICE OF THE GEOTECHNICAL ENGINEER. THE REPLACEMENT FILL SHALL:-
- HAVE A MINIMUM SOAKED CBR = 15%
- HAVE A PARTICLE SIZE OF NOT GREATER THAN 75mm
- HAVE 80% MINIMUM PASSING 19mm SIEVE
- HAVE 30% MINIMUM PASSING 0.075mm SIEVE
- HAVE A PLASTICITY INDEX OF 30% MAXIMUM
- HAVE A SHRINK/SWELL INDEX OF 1.0% MAXIMUM
- COMPLY WITH SECTION 4 OF AS3798
- BE APPROVED BY THE GTA PRIOR TO PLACEMENT
- NOT BE LOOSE RUBBLE FROM BUILDING DEMOLITION WORKS

PLACE FILL IN 250mm LOOSE THICKNESS LAYERS AND COMPACT TO THE DENSITIES SPECIFIED BELOW.
FILL UNDER ANY FOOTING AND SLABS FOR ANY STRUCTURE:
- FINE CRUSHED ROCK 95% MOD.
- OTHER FILL 98% STD.

F3. ALL CONCRETE TO BE GRADE N32/20.

F4. ALL COVER TO GROUND BEAMS TO BE 50mm UNO.

F5. ALL COVER TO SLABS TO BE 30mm UNO.

ELECTRICAL

EL1. ALL CABLES AND CONDUITS SHALL COMPLY WITH AS/NZS3000 AND AUSTEL REQUIREMENTS.

EL2. UNDERGROUND CONDUITS SHALL BE HEAVY DUTY RIGID PVC WITH 600mm MINIMUM COVER AND 1 IN 200 MINIMUM GRADE.

EL3. ALL UNDERGROUND CONDUITS SHALL BE COVERED WITH 150mm WIDE ORANGE MARKER TAPE BEARING THE WORDS: "WARNING – ELECTRICAL CABLE BURIED BELOW" LAID IN THE TRENCH APPROXIMATELY 150mm BELOW FSL FOR THE ENTIRE LENGTH.

EL4. ALL EXTERNAL ABOVE GROUND ELECTRICAL CONDUITS SHALL BE GALVANISED STEEL UNO.

EL5. ALL CONDUITS SHALL HAVE LONG RADIUS BENDS.

PIPES AND MANHOLES

P1. PIPE MATERIALS TO BE AS FOLLOWS:
- WHERE PIPELINE IS CONSTRUCTED BY OPEN TRENCH METHOD – DN450mm PE100 PN12.5 SDR(13.6) WITH BUTT WELDED OR ELECTROFUSION COUPLING JOINTS.
- WHERE PIPELINE IS CONSTRUCTED BY PIPE JACKING METHOD – DN400mm GLAZED VITRIFIED CLAY WITH STAINLESS STEEL COUPLINGS.

P2. MINIMUM CLEARANCE BELOW PIPE BARREL:
- WHERE TRENCH BASE IS IN SOIL – 100mm MINIMUM
- WHERE TRENCH BASE IS IN ROCK – 150mm MINIMUM

P3. INSTALLATION OF PE PIPELINES SHALL BE IN ACCORDANCE WITH AS/NZS 2566.2.

P4. ONLY TRAINED AND CERTIFIED WELDERS SHALL PERFORM WELD JOINTING OF PIPELINES. BEFORE FACTORY AND FIELD WELDING, PRE-QUALIFICATION OF THE WELDING PROCEDURE SHALL BE OBTAINED. THE INFORMATION REQUIREMENTS SET OUT IN CL2.12.1 AND CL2.12.2 OF WSA01-2004 SHALL BE SUBMITTED TO BW FOR APPROVAL.

P5. FOR POLYETHYLENE PIPE, EMBEDMENT MATERIAL SHALL BE 5-7mm ANGULAR SINGLE GRADED CRUSHED ROCK CONFORMING TO TABLE 11.1 GRADING OF BEDDING MATERIAL IN REFERENCE SPECIFICATION S140 EARTHWORKS. PIPE BEDDING SHALL BE COMPACTED BEFORE PLACEMENT OF THE PIPE. EMBEDMENT MATERIAL IN THE PIPE SIDE SUPPORT ZONE SHALL BE PLACED IN TWO LAYERS. THE FIRST LAYER PLACED TO THE SPRING LINE OF THE PIPE AND THE SECOND LAYER TO THE OBVERT LEVEL OF THE PIPE. EACH LAYER SHALL BE RODDED IN PLACE AND EVENLY COMPACTED TO ENSURE THE PIPE BARREL IS FULLY SUPPORTED WITH NO CAVITIES. CARE MUST BE TAKEN NOT TO MOVE THE PIPE FROM ITS ALIGNMENT DURING COMPACTION. THEN PIPE OVERLAY MATERIAL CAN THEN BE PLACED AND COMPACTED.

P6. ALL PIPES SHALL BE INSTALLED WITH THE METHOD OF TRENCHING AS DETAILED IN THE PROJECT DRAWINGS. AN ADDITIONAL ALLOWANCE OF 200mm EACH SIDE OF TRENCH FOR SHORING IS TO BE ALLOWED OVER THE STANDARD TRENCH WIDTHS.

P7. GRAVITY MAIN CLEARANCES SHALL BE 300mm VERTICALLY (BARREL TO BARREL) FROM EXISTING SERVICES.

P8. ALL CONNECTIONS TO LIVE SEWER RETICULATION TO BE UNDERTAKEN UNDER SUPERVISION OF BRISBANE WATER OPERATIONAL STAFF.

P9. NON-PRESSURE PE PIPELINES SHALL BE TESTED FOR LEAKAGE USING LOW PRESSURE AIR TESTING OR HYDROSTATIC TESTING IN ACCORDANCE WITH THE PROCEDURES OUTLINED IN AS/NZS 2566.2

P10. WHERE CONNECTING TO EXISTING PIPEWORK, THE LEVEL AND DIAMETER OF THE EXISTING PIPEWORK SHALL BE CONFIRMED BY THE CONTRACTOR PRIOR TO ORDERING FITTINGS AND COMMENCING CONNECTION WORKS.

P11. FLANGES SHALL BE IN ACCORDANCE WITH AS4087 CLASS 16 FOR STEEL AND DUCTILE IRON UNO.

P12. ALL SPIGOT AND SOCKET SHALL BE CEMENT LINED CALCIUM ALUMINATE CLASS PN35. ALL FLANGED DI PIPEWORK SHALL BE CEMENT LINED FLANGE CLASS PIPE. ALL DICL FITTINGS SHALL BE COATED INTERNALLY AND EXTERNALLY WITH FUSION BONDED NYLON (FBN) OR FUSION BONDED EPOXY (FBE).

P13. ALL DICL PIPEWORK, INCLUDING FITTINGS AND MECHANICAL COUPLINGS SHALL BE WRAPPED IN POLYETHYLENE SLEAVING. SLEAVING SHALL COMPLY WITH AS3681.

P14. ALL BURIED FASTENERS SHALL BE STAINLESS STEEL GRADE 316.

P15. ALL CUT ENDS OF DICL PIPES SHALL BE PREPARED AND EPOXY COATED IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS FOR A MINIMUM LENGTH OF 200mm.

P16. ALL MANHOLES SHALL BE CAST INSITU AND SHALL BE CONSTRUCTED IN ACCORDANCE WITH BW STANDARD DRAWING 486/5/25-SC003/1 REV C "F" TYPE MAINTENANCE HOLE GENERAL ARRANGEMENT.

P17. MANHOLE TOP SLABS SHALL BE CONSTRUCTED IN ACCORDANCE WITH BW STANDARD DRAWING 486/5/25-SC003/2 REV A "F" TYPE MAINTENANCE HOLE TOP SLAB REINFORCEMENT AND CONSTRUCTION DETAILS.

P18. IN NON-TRAFFICABLE AREAS MANHOLE COVERS SHALL BE AS PER BW STANDARD DRAWING 486/5/25-SF003/1&2&3 MAINTENANCE HOLE COVER SEWER-CLASS B-BOLT DOWN COVER DETAILS.

P19. IN TRAFFICABLE LOCATIONS MANHOLE COVERS SHALL BE AS PER 486/5/25-SF004/1&2&3&4 MAINTENANCE HOLE COVER SEWER-CLASS D.

P20. REINSTATEMENT OF ROAD PAVEMENT SHALL BE IN ACCORDANCE WITH 10.5.6 FLEXIBLE (ASPHALT) PAVEMENT OF REFERENCE SPECIFICATION s140 EARTHWORKS.

P21. REINSTATEMENT OF ROAD VERGES, FOOTPATHS AND PARKS SHALL BE TO THE CONDITION BEFORE THE WORKS COMMENCED.

P22. CONNECTION OF POLETHYLENE PIPE TO MAINTENANCE HOLES TO BE CONSTRUCTED IN ACCORDANCE WITH 486/5/25-SP001/3 PE NUSSEWERS MH CONNECTION DETAIL.

CONCRETE:

C1. ALL WORKMANSHIP AND MATERIALS SHALL BE IN ACCORDANCE WITH AS3600 AND AS3785 CURRENT EDITION WITH AMENDMENTS, EXCEPT WHERE VARIED BY THE CONTRACT DOCUMENTS.

C2. UNLESS NOTED OTHERWISE, QUALITY OF ALL CONCRETE ELEMENTS SHALL BE CLASS N32.

C3. ADDITIVES SHALL NOT BE USED WITHOUT THE SUPERINTENDENTS PRIOR APPROVAL.

C4. CONCRETE IS TO BE COMPACTED USING VIBRATORS.

C5. SIZES OF CONCRETE ELEMENTS DO NOT INCLUDE THICKNESS OF APPLIED FINISHES.

C6. PROVIDE ALL EXPOSED EDGES AND CORNERS WITH 20 CHAMFERS OR FILLETS.

C7. FORM ALL CONSTRUCTION JOINTS AND USE ONLY WHERE SHOWN OR APPROVED BY THE SUPERINTENDENT.

C8. NO HOLES, CHASES OR EMBEDMENT OF PIPES, OTHER THAN THOSE SHOWN ON THE DRAWINGS SHALL BE MADE WITHOUT THE APPROVAL OF THE SUPERINTENDENT.

C9. CURING OF CONCRETE SHALL BE COMMENCED AS SOON AS POSSIBLE AFTER PLACING OR STRIPPING, REFER 'CURING' IN AS3600 & THE SPECIFICATION.
ACCEPTABLE CURING METHODS ARE AS FOLLOWS:
-WATER IMMERSION
-WATER SPRAY BENEATH APPROVED PLASTIC SHEETING
-APPROVED WAX EMULSION CURING COMPOUND
-APPROVED CHLORINATED RUBBER CURING COMPOUND

C10. FORMWORK AND ITS REMOVAL TO BE IN ACCORDANCE WITH AS3610.

C11. CONSTRUCTION TOLERANCES TO BE IN ACCORDANCE WITH AS3610.

C12. FORMED SURFACE FINISHES TO BE IN ACCORDANCE WITH AS 3610.

C13. FINISHED FORMED SLAB SURFACES:
CLASS 1 TOLERANCE - TRUE PLANES WITHIN 3 IN 3000
SURFACE FINISH - POWER TROWEL AND STEEL FLOAT FINISH.

C14. WHERE REINFORCEMENT NOT CENTRALLY PLACED - MINIMUM COVER 50mm

LEGEND

NEW SERVICE MAIN	
OVERHEAD ELECTRICITY	V
UNDERGROUND ELECTRICITY	E
GRAVITY SEWER	S
SEWER RISING MAIN	SRM
TELSTRA (OPTICAL FIBRE)	OF
TELSTRA (LOCAL CABLE)	T
WATER	W
STORMWATER DRAIN	SW
SURFACE DRAINAGE	D
GAS	GAS
FENCE LINE	—/—/—
BOUNDARY LINE	
EXISTING KERB AND CHANNEL	
EDGE OF BITUMEN	
ELECTRICAL POWER POLE	PP
EXISTING POLE WITH LIGHT	
FIRE HYDRANT	FH
SLUICE VALVE	SV
ISOLATION VALVE	
TELSTRA PIT	
PERMANENT SURVEY MARK	
SITE REFERENCE MARK	STN

ABBREVIATIONS

ABBREVIATIONS SHALL BE IN ACCORDANCE WITH STANDARDS AUSTRALIA PUBLICATION "SYMBOLS AND ABBREVIATIONS FOR BUILDING AND CONSTRUCTION" EXCEPT AS FOLLOWS:

AL	ALARM LEVEL
BWL	BOTTOM WATER LEVEL (PUMP STOP LEVEL)
FL	FLANGE
FSL	FINISHED SURFACE LEVEL
GJ	GIBAULT JOINT
NSL	NATURAL SURFACE LEVEL
RRJ	RUBBER RING JOINT
SP	SPIGOT
SO	SOCKET
SS	STAINLESS STEEL
STD DRG	STANDARD DRAWING
TWL	TOP WATER LEVEL (PUMP START LEVEL)
UNO	UNLESS NOTED OTHERWISE

MWH
ABN: 53 085 776 601
LEVEL 1, 601 CORONATION DRIVE
TOOWONG, QLD 4066
Telephone: (07) 3510 7300
Facsimile: (07) 3510 7350

AS CONSTRUCTED

AS CONSTRUCTED
SIGNED [signature] DATE 19-5-6
NAME Sean W Cross RPEQ No 2624

DESIGNED:		DATE:	
DRAWN:		DRAWING No. 7103-P-DWG-6103	REV.
CHECKED:			
No.	DATE	REVISION	CHK. APPR.

Tenix
TENIX ALLIANCE PTY LTD
BRISBANE . MELBOURNE . PERTH . SYDNEY

PROJ. MANG. RPEQ No: | APPROVED: RPEQ No:

No.	DATE	AMENDMENT	DRAFTED	APPROVED
B	09/09/09	AS CONSTRUCTED	RS	JWG
A	08/01/09	GENERAL AMENDMENTS	N.D.B	J.V.H
0	13/11/08	FOR CONSTRUCTION	TK	JVH

FUNDING			
DESIGN W.O. No.			
CONSTRUCTION W.O. No.			
FUNDED BY B.C.C. ( )	EXTERNAL ( )		

DRAFTED	R. CRAWFORD	J. VAN HEREL	21.11.08	K. VAHEESAN	25.11.08
DRAFTING CHECK	R. CRAWFORD	DESIGN J. VAN HEREL	R.P.E.Q. No. DATE	PRINCIPAL DESIGN MANAGER	DATE
CAD FILE		J. GREEN	2624 21.11.08	J. KARYDAS	25.11.08
B.C.C. FILE No.		DESIGN CHECK J. GREEN	R.P.E.Q. No. DATE	PRODUCTION / NETWORK DELEGATE	DATE

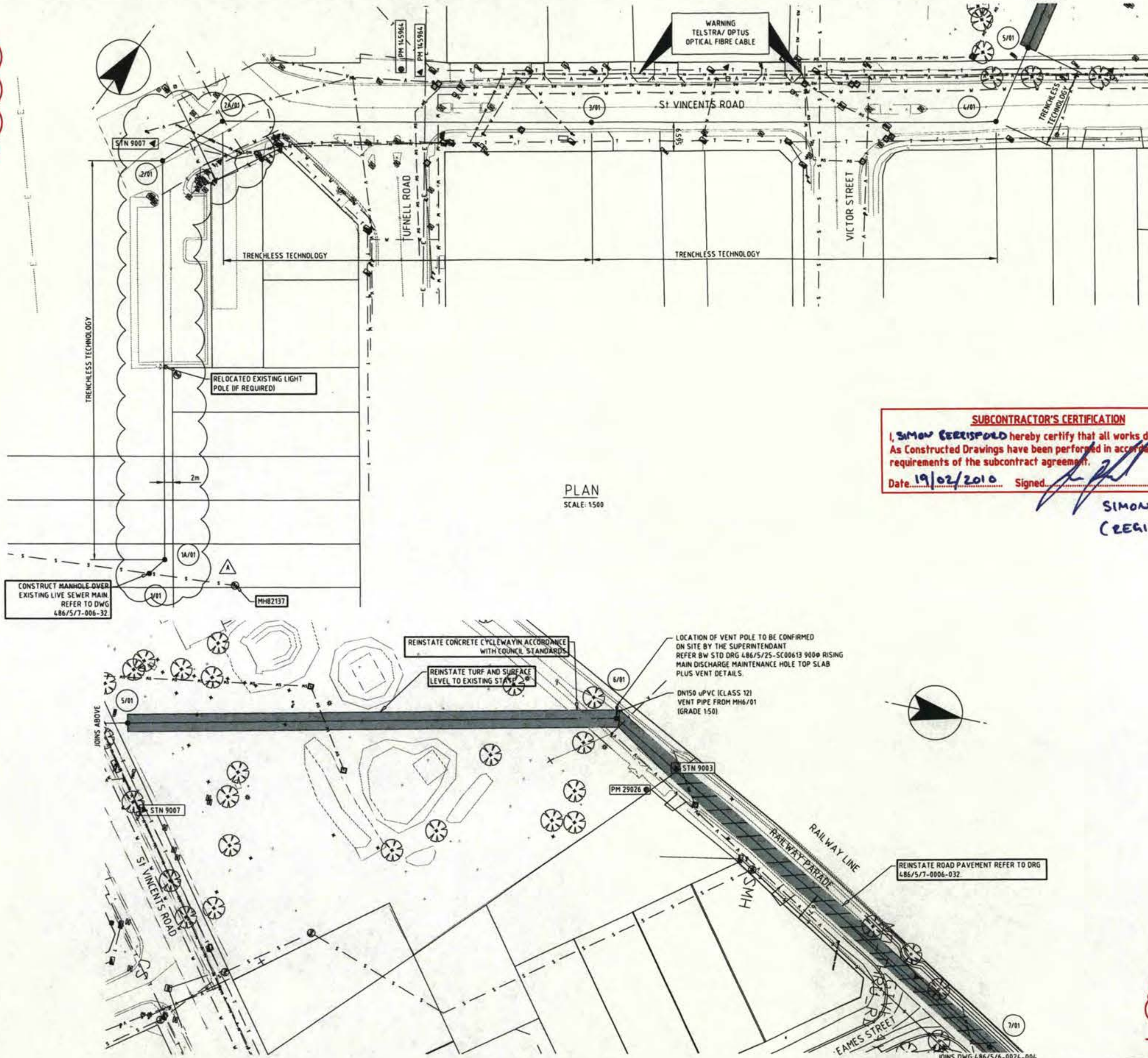
BRISBANE WATER

PROJECT
ST ACHS
SEWER PUMP STATION UPGRADE AND GRAVITY MAIN

TITLE
GENERAL NOTES

SHEET No. OF
BRISBANE WATER DRAWING No. 486/5/6-0024-002
AMEND. B

SETOUT CO-ORDINATES		
POINT	EASTING	NORTHING
1/01	57678.215	169115.940
1A/01	57678.128	169121.442
2/01	57623.159	169194.907
2A/01	57628.643	169207.935



SUBCONTRACTOR'S CERTIFICATION

I, SIMON BERRISFORD hereby certify that all works detailed on the As Constructed Drawings have been performed in accordance with the requirements of the subcontract agreement.

Date 19/02/2010 Signed

SIMON BERRISFORD
(REGISTERED SURVEYOR)

MWH

ABN: 53 085 776 601
LEVEL 1, 601 CORONATION DRIVE
TOOWONG, QLD 4066
Telephone: (07) 3510 7300
Facsimile: (07) 3510 7350

LEGEND

- PROPOSED TRUNK SEWER MAIN
- EXISTING WATER
- EXISTING TELECOMMUNICATIONS
- EXISTING SEWER
- EXISTING OVERHEAD ELECTRICAL
- EXISTING ELECTRICAL
- EXISTING STORM WATER
- EXISTING OPTIC FIBRE
- TURF REINSTATEMENT
- 50mm THICK BCC ASPHALT TYPE 2
- GRAVEL REINSTATEMENT
- CONCRETE

-5 0 10 20 30 40
SCALE 1:500 ON A1.

Telstra AUSTRALIA

NOTE : TELSTRA LOCATIONS ARE APPROXIMATE ONLY FROM TELSTRA PLANS. LOCATIONS ARE TO BE CONFIRMED PRIOR TO START OF CONSTRUCTION. CONTACT DIAL BEFORE YOU DIG 1100 FOR DETAILS.

OPTIC FIBRE!

NOTE : OPTIC FIBRE LOCATIONS ARE APPROXIMATE ONLY. LOCATIONS ARE TO BE CONFIRMED PRIOR TO START OF CONSTRUCTION. CONTACT DIAL BEFORE YOU DIG 1100 FOR DETAILS.

ENERGEX

NOTE : ENERGEX LOCATIONS ARE APPROXIMATE ONLY FROM ENERGEX PLANS. LOCATIONS ARE TO BE CONFIRMED PRIOR TO START OF CONSTRUCTION. CONTACT DIAL BEFORE YOU DIG 1100 FOR DETAILS.

PROTECT YOUR PERSONAL INTERESTS
HEAD
EARS
EYES
HANDS
BODY
FEET

AS CONSTRUCTED

~~FOR CONSTRUCTION~~

AS CONSTRUCTED
SIGNED DATE 14-5-10
NAME John W Green RPEQ No 2624

DESIGNED:		DATE:		
DRAWN:		DRAWING No. 7103-P-DWG-6103		REV.
CHECKED:				
No.	DATE	REVISION	CHK.	APPR.

Tenix
TENIX ALLIANCE PTY LTD
BRISBANE . MELBOURNE . PERTH . SYDNEY
7 BAROONA ROAD MILTON 4064
PH:(07) 3510 7100 FAX:(07) 3876 4022
Email : WWW.TENIX.COM

PROJ. MANG. RPEQ No :
APPROVED: RPEQ No :

No.	DATE	AMENDMENT	DRAFTED	APPROVED
B	00.09.09	AS CONSTRUCTED	L.L.	S.B.
A	26.05.09	ALIGNMENT UPDATED	T.K	
0	13.11.08	CONSTRUCTION ISSUE	R.C	

FUNDING	
DESIGN W.O. No.	
CONSTRUCTION W.O. No.	
FUNDED BY B.C.C. ( )	EXTERNAL ( )

DRAFTED	R. CRAWFORD
DRAFTING CHECK	R. CRAWFORD
CAD FILE	
B.C.C. FILE No.	

J. VAN HEREL		21.11.08
DESIGN J. VAN HEREL	R.P.E.Q. No.	DATE
J. GREEN	2624	21.11.08
DESIGN CHECK J. GREEN	R.P.E.Q. No.	DATE

K. VAHEESAN	25.11.08
PRINCIPAL DESIGN MANAGER	DATE
J. KARYDAS	25.11.08
PRODUCTION / NETWORK DELEGATE	DATE

BRISBANE WATER

PROJECT
ST ACHS
SEWER PUMP STATION UPGRADE AND GRAVITY MAIN

TITLE
PLAN OF LINE 1
SHEET 1 OF 3

SHEET No. 2 OF 11

BRISBANE WATER DRAWING No 486/5/6-0024-003

AMEND B

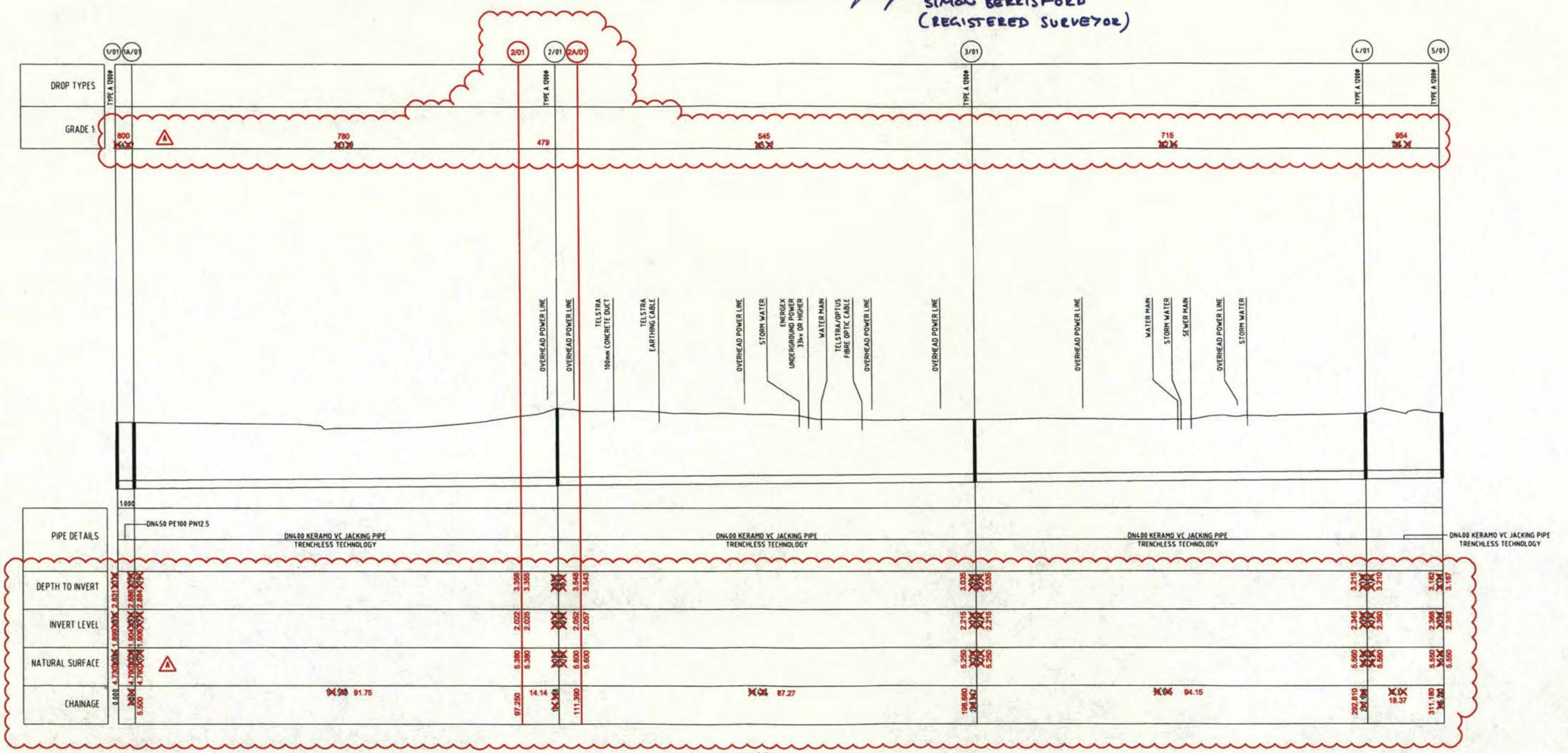
SUBCONTRACTOR'S CERTIFICATION

I, SIMON BERRISFORD hereby certify that all works detailed on the As Constructed Drawings have been performed in accordance with the requirements of the subcontract agreement.

Date 19/02/2010 Signed

SIMON BERRISFORD (REGISTERED SURVEYOR)

MWH
ABN: 53 085 776 601
LEVEL 1, 601 CORONATION DRIVE
TOOWONG, QLD 4066
Telephone: (07) 3510 7300
Facsimile: (07) 3510 7350



LONGITUDINAL SECTION OF LINE 1

SCALE: 1:500 (HOR.)
1:100 (VERT.)

AS CONSTRUCTED

~~FOR CONSTRUCTION~~

NOTES:

1. THE POSITION OF SERVICES SHOWN IN THE SECTION ARE APPROXIMATE ONLY. THE CONTRACTOR SHALL CONFIRM THE LOCATION OF SERVICES PRIOR TO COMMENCING PIPELINE EXCAVATION AND SHALL NOTIFY THE SUPERINTENDENT OF ANY CONFLICTS BETWEEN THE PROPOSED MAIN AND THE EXISTING SERVICES.

No.	DATE	AMENDMENT	DRAFTED	APPROVED
A	5/09/09	AS CONSTRUCTED	LL	S.B.
0	13/11/08	FOR CONSTRUCTION	TK	

FUNDING	
DESIGN W.O. No.	
CONSTRUCTION W.O. No.	
FUNDED BY B.C.C. ( )	EXTERNAL ( )

DRAFTED	R. CRAWFORD	J. VAN HEREL		21.11.08
DRAFTING CHECK	R. CRAWFORD	DESIGN J. VAN HEREL	R.P.E.Q. No.	DATE
CAD FILE		J. GREEN	2624	21.11.08
B.C.C. FILE No.		DESIGN CHECK J. GREEN	R.P.E.Q. No.	DATE

K. VAHEESAN	25.11.08
PRINCIPAL DESIGN MANAGER	DATE
J. KARYDAS	25.11.08
PRODUCTION / NETWORK DELEGATE	DATE

AS CONSTRUCTED
SIGNED DATE 19-5-10
NAME John W Green RPEQ No. 2624

DESIGNED:		DATE:	
DRAWN:		DRAWING No. 7103-P-DWG-6106	REV.
CHECKED:			

No.	DATE	REVISION	CHK.	APPR.

Tenix
TENIX ALLIANCE PTY LTD
BRISBANE . MELBOURNE . PERTH . SYDNEY
7 BARCOONA ROAD MILTON 4064 PH:(07) 3510 7100 FAX:(07) 3876 4022 Email: WWW.TENIX.COM

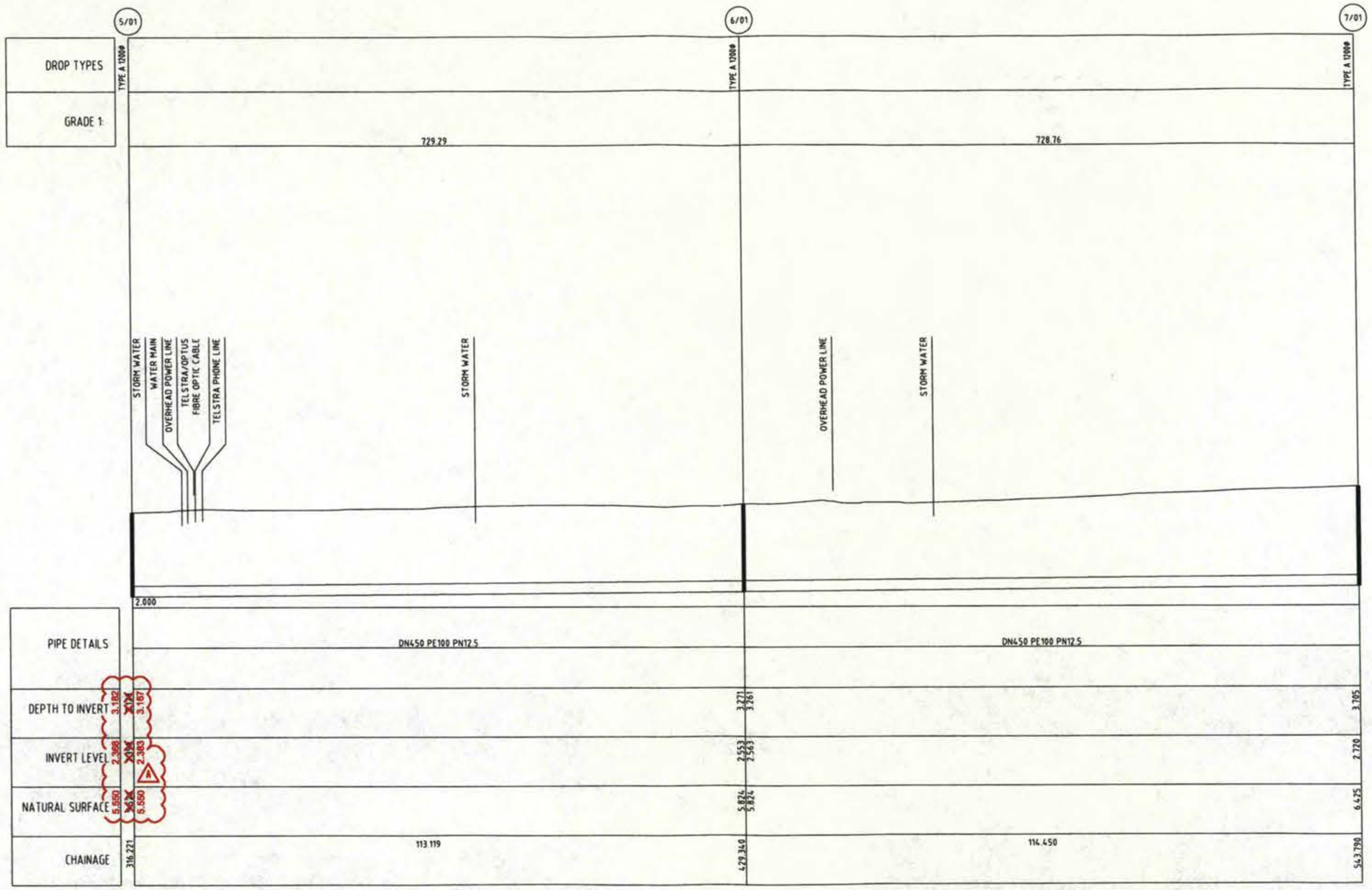
PROJ. MANG. RPEQ No:
APPROVED: RPEQ No:

PROJECT
ST ACHS
SEWER PUMP STATION UPGRADE AND GRAVITY MAIN

TITLE
LONGITUDINAL SECTION OF LINE 1
SHEET 1 OF 5

SHEET No. OF
BRISBANE WATER DRAWING No. 486/5/6-0024-006
AMEND. A

MWH
ABN: 53 085 776 601
LEVEL 1, 601 CORONATION DRIVE
TOOWONG, QLD 4066
Telephone: (07) 3510 7300
Facsimile: (07) 3510 7350



LONGITUDINAL SECTION OF LINE 1

SCALE: 1:500 (HOR.)
1:100 (VERT.)

SUBCONTRACTOR'S CERTIFICATION

I, SIMON BERRISFORD hereby certify that all works detailed on the As Constructed Drawings have been performed in accordance with the requirements of the subcontract agreement.

Date 19/02/2010 Signed

SIMON BERRISFORD
(REGISTERED SURVEYOR)

AS CONSTRUCTED

~~FOR CONSTRUCTION~~

NOTES:

1. THE POSITION OF SERVICES SHOWN IN THE SECTION ARE APPROXIMATE ONLY. THE CONTRACTOR SHALL CONFIRM THE LOCATION OF SERVICES PRIOR TO COMMENCING PIPELINE EXCAVATION AND SHALL NOTIFY THE SUPERINTENDENT OF ANY CONFLICTS BETWEEN THE PROPOSED MAIN AND THE EXISTING SERVICES.

AS CONSTRUCTED
SIGNED DATE 19-5-10
NAME John W Green RPEQ No. 2624

No.	DATE	AMENDMENT	DRAFTED	APPROVED
A	9/09/09	AS CONSTRUCTED	LL	S.B.
0	13/11/08	FOR CONSTRUCTION	TK	

FUNDING	
DESIGN W.O. No.	
CONSTRUCTION W.O. No.	
FUNDED BY B.C.C. ( )	EXTERNAL ( )

DRAFTED	R. CRAWFORD	J. VAN HEREL		21.11.08	
DRAFTING CHECK	R. CRAWFORD	DESIGN J. VAN HEREL	R.P.E.Q. No.	DATE	
CAD FILE		J. GREEN	2624	21.11.08	
B.C.C. FILE No.		DESIGN CHECK J. GREEN	R.P.E.Q. No.	DATE	

K. VAHEESAN	25.11.08
PRINCIPAL DESIGN MANAGER	DATE
J. KARYDAS	25.11.08
PRODUCTION / NETWORK DELEGATE	DATE

BRISBANE WATER

PROJECT
ST ACHS
SEWER PUMP STATION UPGRADE AND GRAVITY MAIN

DESIGNED: DATE:
DRAWN: DRAWING No. 7103-P-DWG-6107 REV.
CHECKED:
No. DATE REVISION CHK. APPR.

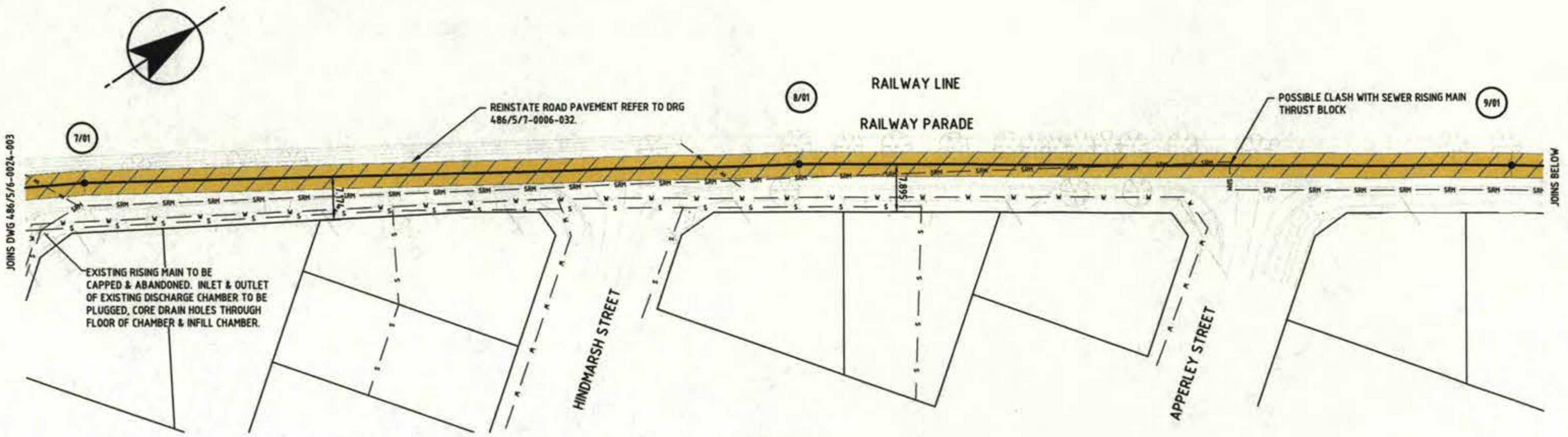
TITLE
LONGITUDINAL SECTION OF LINE 1
SHEET 2 OF 5

Tenix
TENIX ALLIANCE PTY LTD
BRISBANE . MELBOURNE . PERTH . SYDNEY

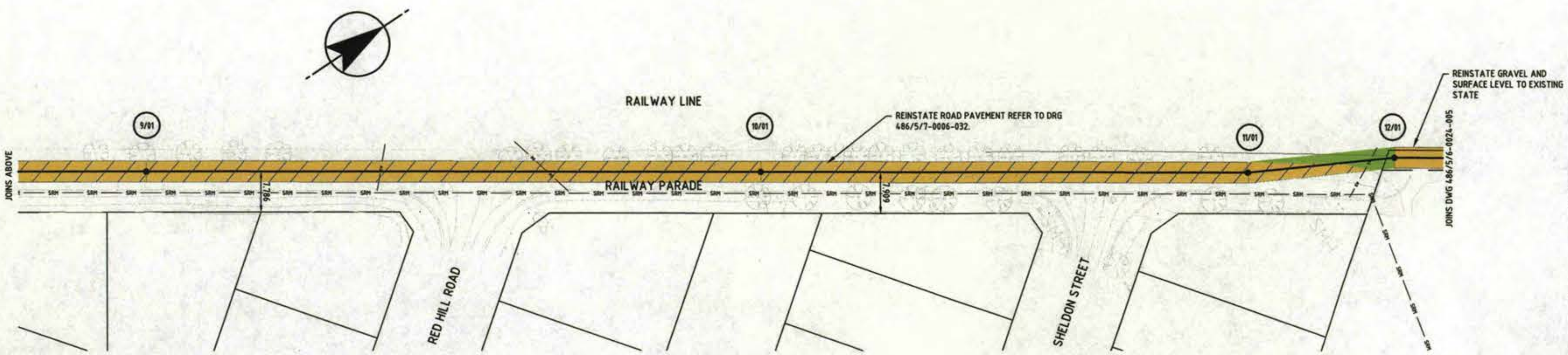
PROJ. MANG. RPEQ No: APPROVED: RPEQ No:

SHEET No. OF
BRISBANE WATER DRAWING No. 486/5/6-0024-007
AMEND A

MWH
ABN: 53 085 778 601
LEVEL 1, 601 CORONATION DRIVE
TOOWONG, QLD 4066
Telephone: (07) 3510 7300
Facsimile: (07) 3510 7350



PLAN
SCALE: 1:500



PLAN
SCALE: 1:500

LEGEND

- PROPOSED TRUNK SEWER MAIN
- EXISTING WATER
- EXISTING TELECOMMUNICATIONS
- EXISTING SEWER
- EXISTING OVERHEAD ELECTRICAL
- EXISTING ELECTRICAL
- EXISTING STORM WATER
- EXISTING OPTIC FIBRE
- TURF REINSTATEMENT
- 50mm THICK BCC ASPHALT TYPE 2.
- GRAVEL REINSTATEMENT
- CONCRETE

NOTES

1. REFER TO A1139600-M-010 FOR PUMP STATION LAYOUT DEALS

SCALE 1:500 ON A1.
SCALE 1:50 ON A1.

Telstra AUSTRALIA
NOTE : TELSTRA LOCATIONS ARE APPROXIMATE ONLY FROM TELSTRA PLANS. LOCATIONS ARE TO BE CONFIRMED PRIOR TO START OF CONSTRUCTION. CONTACT DIAL BEFORE YOU DIG 1100 FOR DETAILS.

OPTIC FIBRE!
NOTE : OPTIC FIBRE LOCATIONS ARE APPROXIMATE ONLY. LOCATIONS ARE TO BE CONFIRMED PRIOR TO START OF CONSTRUCTION. CONTACT DIAL BEFORE YOU DIG 1100 FOR DETAILS.

ENERGEX
NOTE : ENERGEX LOCATIONS ARE APPROXIMATE ONLY FROM ENERGEX PLANS. LOCATIONS ARE TO BE CONFIRMED PRIOR TO START OF CONSTRUCTION. CONTACT DIAL BEFORE YOU DIG 1100 FOR DETAILS.

AS CONSTRUCTED

AS CONSTRUCTED
SIGNED [signature] DATE 19-5-10
NAME John W Green RPEQ No. 2624

No.	DATE	AMENDMENT	DRAFTED	APPROVED
A	09/09/09	AS CONSTRUCTED	RS	JWG
0	13.11.08	CONSTRUCTION ISSUE	RC	

FUNDING	
DESIGN W.O. No.	
CONSTRUCTION W.O. No.	
FUNDED BY B.C.C. ( )	EXTERNAL ( )

DRAFTED	R. CRAWFORD
DRAFTING CHECK	R. CRAWFORD
CAD FILE	
B.C.C. FILE No.	

J. VAN HEREL		21.11.08
DESIGN J. VAN HEREL	R.P.E.Q. No.	DATE
J. GREEN	2624	21.11.08
DESIGN CHECK J. GREEN	R.P.E.Q. No.	DATE

K. VAHEESAN	25.11.08
PRINCIPAL DESIGN MANAGER	DATE
J. KARYDAS	25.11.08
PRODUCTION / NETWORK DELEGATE	DATE

BRISBANE WATER

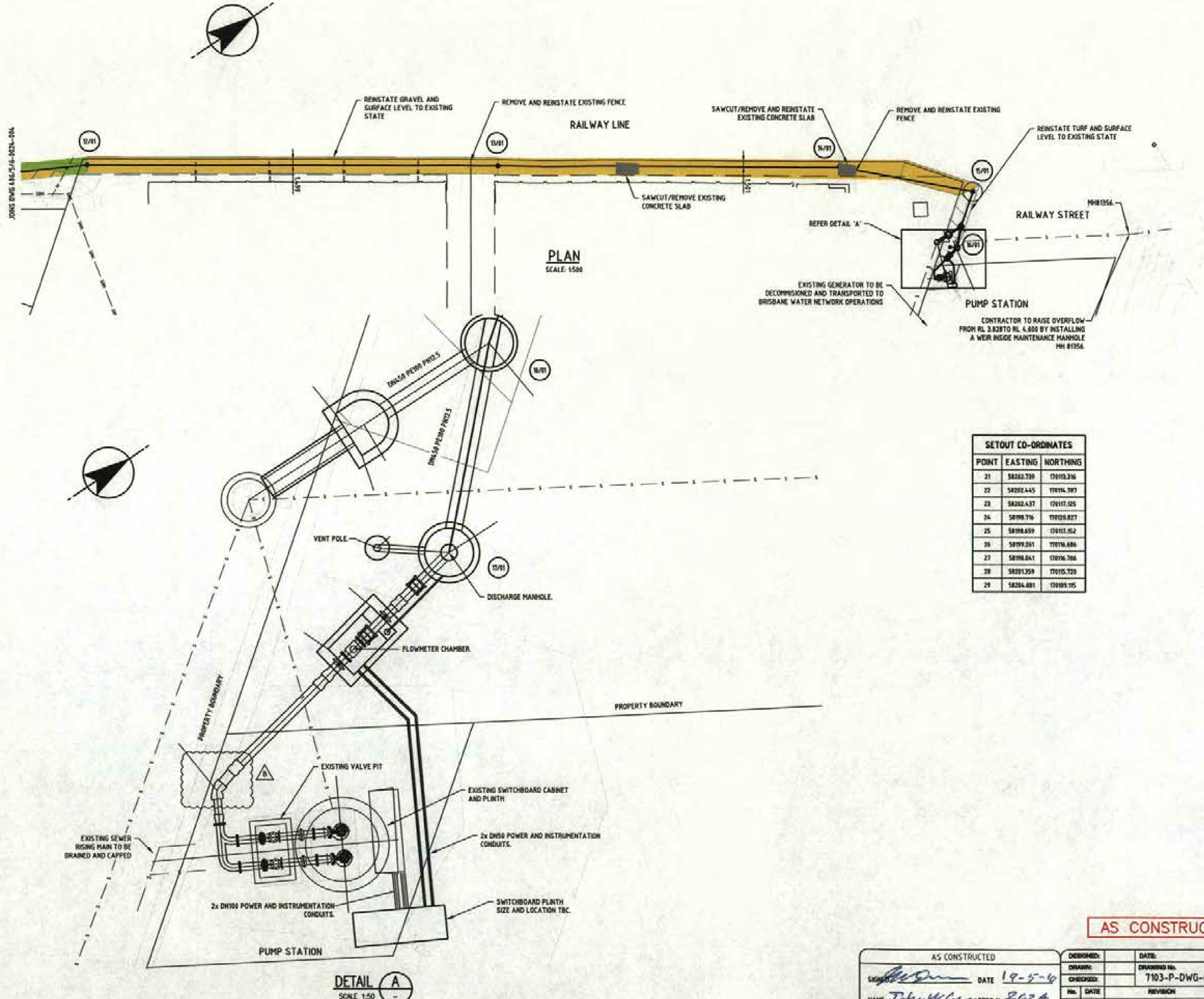
PROJECT
ST ACHS
SEWER PUMP STATION UPGRADE AND GRAVITY MAIN

DESIGNED: | DATE:
DRAWN: | DRAWING No. 7103-P-DWG-6104 | REV.
CHECKED:
No. | DATE | REVISION | CHK. | APPR.

TITLE
PLAN OF LINE 1
SHEET 2 OF 3

Tenix
TENIX ALLIANCE PTY LTD
BRISBANE . MELBOURNE . PERTH . SYDNEY
PROJ. MANG. RPEQ No: | APPROVED: RPEQ No:

SHEET No. 3 OF 11
BRISBANE WATER DRAWING No. 486/5/6-0024-004
AMEND. A



SETOUT CO-ORDINATES		
POINT	EASTING	NORTHING
21	58202.739	170113.316
22	58202.445	170114.787
23	58202.437	170117.125
24	58198.776	170120.827
25	58198.659	170117.152
26	58199.261	170116.686
27	58198.041	170116.766
28	58201.359	170115.720
29	58204.881	170109.115

MWH

ABN: 53 085 776 601
LEVEL 1, 601 CORONATION DRIVE
TOOWONG, QLD 4066
Telephone: (07) 3510 7300
Facsimile: (07) 3510 7350

LEGEND

- PROPOSED TRUNK SEWER MAIN
- EXISTING WATER
- EXISTING TELECOMMUNICATIONS
- EXISTING SEWER
- EXISTING OVERHEAD ELECTRICAL
- EXISTING ELECTRICAL
- EXISTING STORM WATER
- EXISTING OPTIC FIBRE
- TURF REINSTATEMENT
- 50mm THICK BCC ASPHALT TYPE 2.
- GRAVEL REINSTATEMENT
- CONCRETE

NOTES

1. REFER TO A1139600-M-010 FOR PUMP STATION LAYOUT DEAILS

SCALE 1:500 ON A1.
SCALE 1:50 ON A1.

Telstra AUSTRALIA
NOTE : TELSTRA LOCATIONS ARE APPROXIMATE ONLY FROM TELSTRA PLANS. LOCATIONS ARE TO BE CONFIRMED PRIOR TO START OF CONSTRUCTION. CONTACT DIAL BEFORE YOU DIG 1100 FOR DETAILS.

OPTIC FIBRE!
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ENERGEX
NOTE : ENERGEX LOCATIONS ARE APPROXIMATE ONLY FROM ENERGEX PLANS. LOCATIONS ARE TO BE CONFIRMED PRIOR TO START OF CONSTRUCTION. CONTACT DIAL BEFORE YOU DIG 1100 FOR DETAILS.

AS CONSTRUCTED

No.	DATE	AMENDMENT	DRAFTED	APPROVED
C	09/09/09	AS CONSTRUCTED	RS	JWG
B	30.01.09	AIR VALVE REMOVED	N.D.B	J.V.H
A	21.11.08	PUMP STATION SITE LAYOUT REVISED	R.C	J.V.H

FUNDING
DESIGN W.O. No.
CONSTRUCTION W.O. No.
FUNDED BY B.C.C. ( ) EXTERNAL ( )

DRAFTED R. CRAWFORD
DRAFTING CHECK R. CRAWFORD
CAD FILE
B.C.C. FILE No.

J. VAN HEREL 21.11.08
DESIGN J. VAN HEREL R.P.E.Q. No. DATE
J. GREEN 2624 21.11.08
DESIGN CHECK J. GREEN R.P.E.Q. No. DATE

K. VAHEESAN 25.11.08
PRINCIPAL DESIGN MANAGER DATE
J. KARYDAS 25.11.08
PRODUCTION / NETWORK DELEGATE DATE

AS CONSTRUCTED
SIGNED [signature] DATE 19-5-10
NAME John W Green RPEQ No. 2624

DESIGNED: DATE:
DRAWN: DRAWING No. 7103-P-DWG-6105 REV.
CHECKED:
No. DATE REVISION CHK. APPR.

Tenix
TENIX ALLIANCE PTY LTD
BRISBANE . MELBOURNE . PERTH . SYDNEY
PROJ. MANG. RPEQ No :
APPROVED: RPEQ No :

PROJECT
ST ACHS
SEWER PUMP STATION UPGRADE AND GRAVITY MAIN

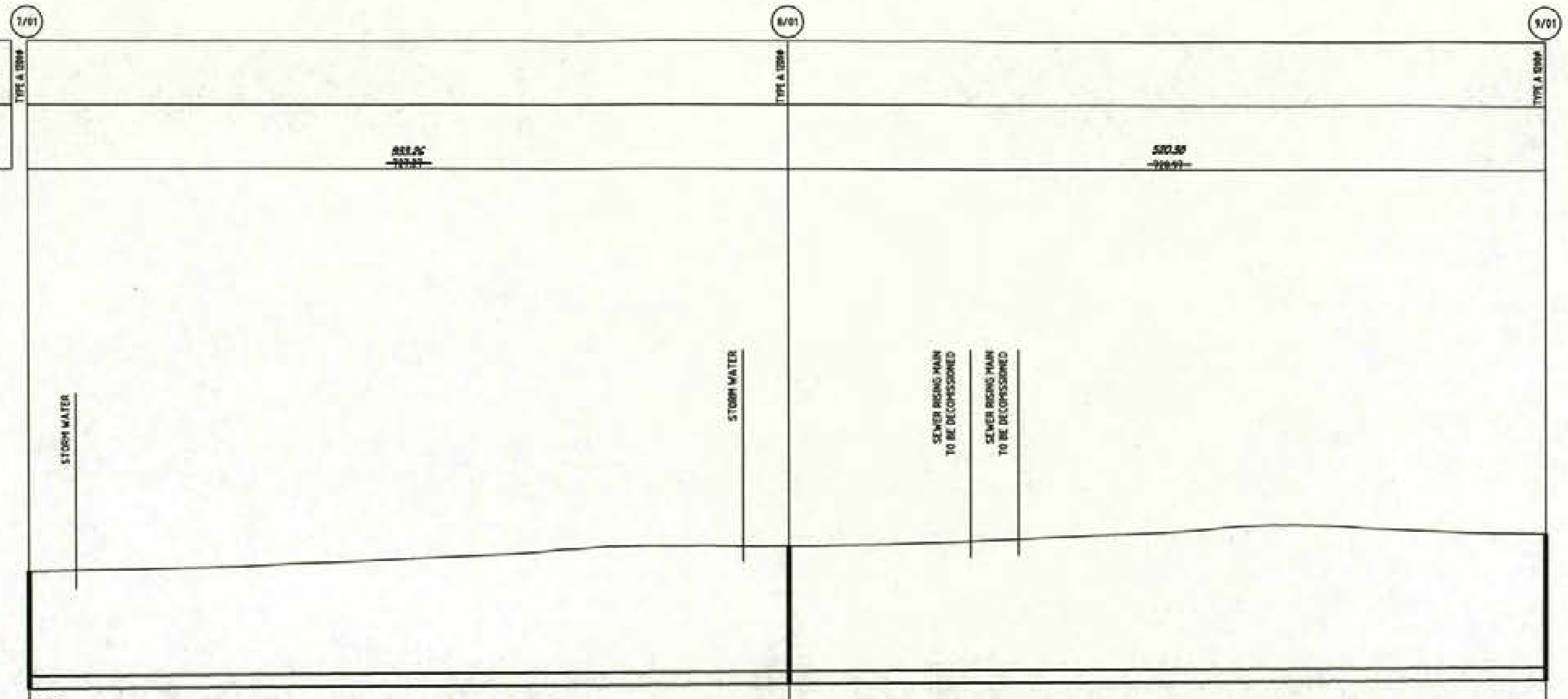
TITLE
PLAN OF LINE 1
SHEET 3 OF 3

SHEET No. OF
BRISBANE WATER DRAWING No. 4865/6-0024-005
AMEND. C

MWH

ABN: 53 085 776 601
LEVEL 1, 601 CORONATION DRIVE
TOOWONG, QLD 4066
Telephone: (07) 3510 7300
Facsimile: (07) 3510 7350

DROP TYPES		
GRADE 1	933.26	520.38



PIPE DETAILS		DN450 PE100 PN12.5		DN450 PE100 PN12.5	
DEPTH TO INVERT	3.785		4.362 / 4.362		4.620
INVERT LEVEL	2.670		2.805 / 2.805		3.040
NATURAL SURFACE	6.425		7.167 / 7.167		7.660
CHAINAGE	563.790	~~120.000~~ 121.324	663.790	~~120.000~~ 119.600	783.790

LONGITUDINAL SECTION OF LINE 1

SCALE: 1:500 (HOR.)
1:100 (VERT.)

AS CONSTRUCTED

NOTES:

1. THE POSITION OF SERVICES SHOWN IN THE SECTION ARE APPROXIMATE ONLY. THE CONTRACTOR SHALL CONFIRM THE LOCATION OF SERVICES PRIOR TO COMMENCING PIPELINE EXCAVATION AND SHALL NOTIFY THE SUPERINTENDENT OF ANY CONFLICTS BETWEEN THE PROPOSED MAIN AND THE EXISTING SERVICES.

No.	DATE	AMENDMENT	DRAFTED	APPROVED
A	05/05/09	AS CONSTRUCTED	RS	JWG
B	15/11/08	FOR CONSTRUCTION	TK	

FUNDING
DESIGN W.O. No.
CONSTRUCTION W.O. No.
FUNDED BY B.C.C. ( ) EXTERNAL ( )

DRAFTED	R. CRAWFORD
DRAFTING CHECK	R. CRAWFORD
CAD FILE	
B.C.C. FILE No.	

J. VAN HEREL		21.11.08
DESIGN J. VAN HEREL	R.P.E.Q. No.	DATE
J. GREEN	2624	21.11.08
DESIGN CHECK J. GREEN	R.P.E.Q. No.	DATE

K. VAHEESAN	25.11.08
PRINCIPAL DESIGN MANAGER	DATE
J. KARYDAS	25.11.08
PRODUCTION / NETWORK DELEGATE	DATE

AS CONSTRUCTED
SIGNED DATE 14-5-10
NAME John W Green RPEQ No. 2624

DESIGNED:		DATE:		
DRAWN:		DRAWING No. 7103-P-DWG-6108		REV.
CHECKED:				
No.	DATE	REVISION	CHK.	APPR.
A		AS CONSTRUCTED		

Tenix
TENIX ALLIANCE PTY LTD
BRISBANE . MELBOURNE . PERTH . SYDNEY

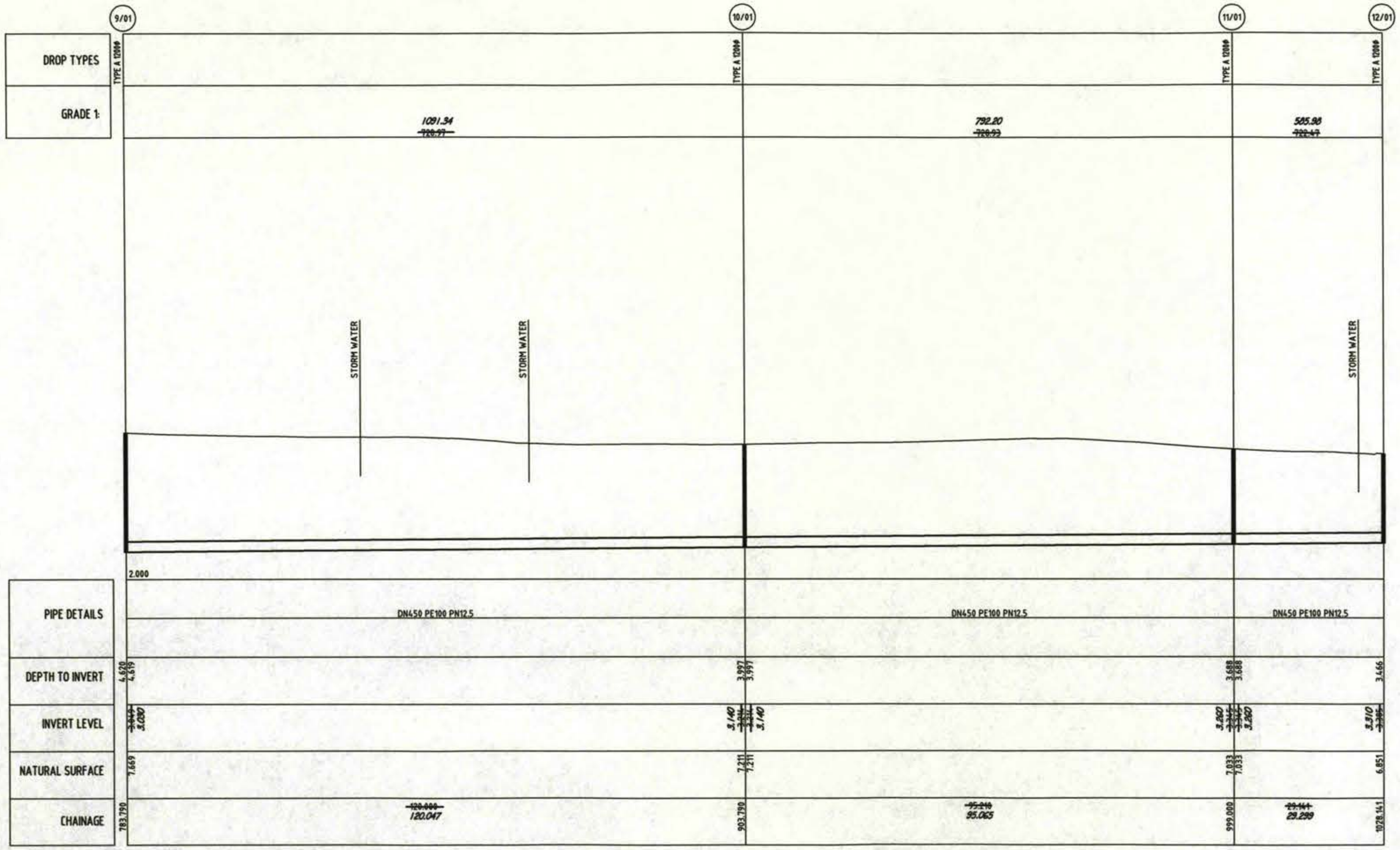
PROJ. MANG. RPEQ No :
APPROVED: RPEQ No :

PROJECT
ST ACHS
SEWER PUMP STATION UPGRADE AND GRAVITY MAIN

TITLE
LONGITUDINAL SECTION OF LINE 1
SHEET 3 OF 5

SHEET No. OF
BRISBANE WATER DRAWING No. 486/5/6-0021-008
AMEND. A

MWH
ABN: 53 085 776 601
LEVEL 1, 601 CORONATION DRIVE
TOOWONG, QLD 4066
Telephone: (07) 3510 7300
Facsimile: (07) 3510 7350



LONGITUDINAL SECTION OF LINE 1

SCALE: 1:500 (HOR.)
1:100 (VERT.)

AS CONSTRUCTED

NOTES:

1. THE POSITION OF SERVICES SHOWN IN THE SECTION ARE APPROXIMATE ONLY. THE CONTRACTOR SHALL CONFIRM THE LOCATION OF SERVICES PRIOR TO COMMENCING PIPELINE EXCAVATION AND SHALL NOTIFY THE SUPERINTENDENT OF ANY CONFLICTS BETWEEN THE PROPOSED MAIN AND THE EXISTING SERVICES.

No.	DATE	AMENDMENT	DRAFTED	APPROVED
A	09/09/09	AS CONSTRUCTED	RS	JWG
0	13/11/08	FOR CONSTRUCTION	TK	

FUNDING
DESIGN W.O. No.
CONSTRUCTION W.O. No.
FUNDED BY B.C.C. ( ) EXTERNAL ( )

DRAFTED	R. CRAWFORD
DRAFTING CHECK	R. CRAWFORD
CAD FILE	
B.C.C. FILE No.	

J. VAN HEREL		21.11.08
DESIGN J. VAN HEREL	R.P.E.Q. No.	DATE
J. GREEN	2624	21.11.08
DESIGN CHECK J. GREEN	R.P.E.Q. No.	DATE

K. VAHEESAN	25.11.08
PRINCIPAL DESIGN MANAGER	DATE
J. KARYDAS	25.11.08
PRODUCTION / NETWORK DELEGATE	DATE

AS CONSTRUCTED
SIGNED [signature] DATE 19-5-10
NAME John W Green RPEQ No. 2624

DESIGNED: DATE:
DRAWN: DRAWING No. 7103-P-DWG-6109 REV.
CHECKED:

No.	DATE	REVISION	CHK.	APPR.
A		AS CONSTRUCTED		

PROJECT
ST ACHS
SEWER PUMP STATION UPGRADE AND GRAVITY MAIN

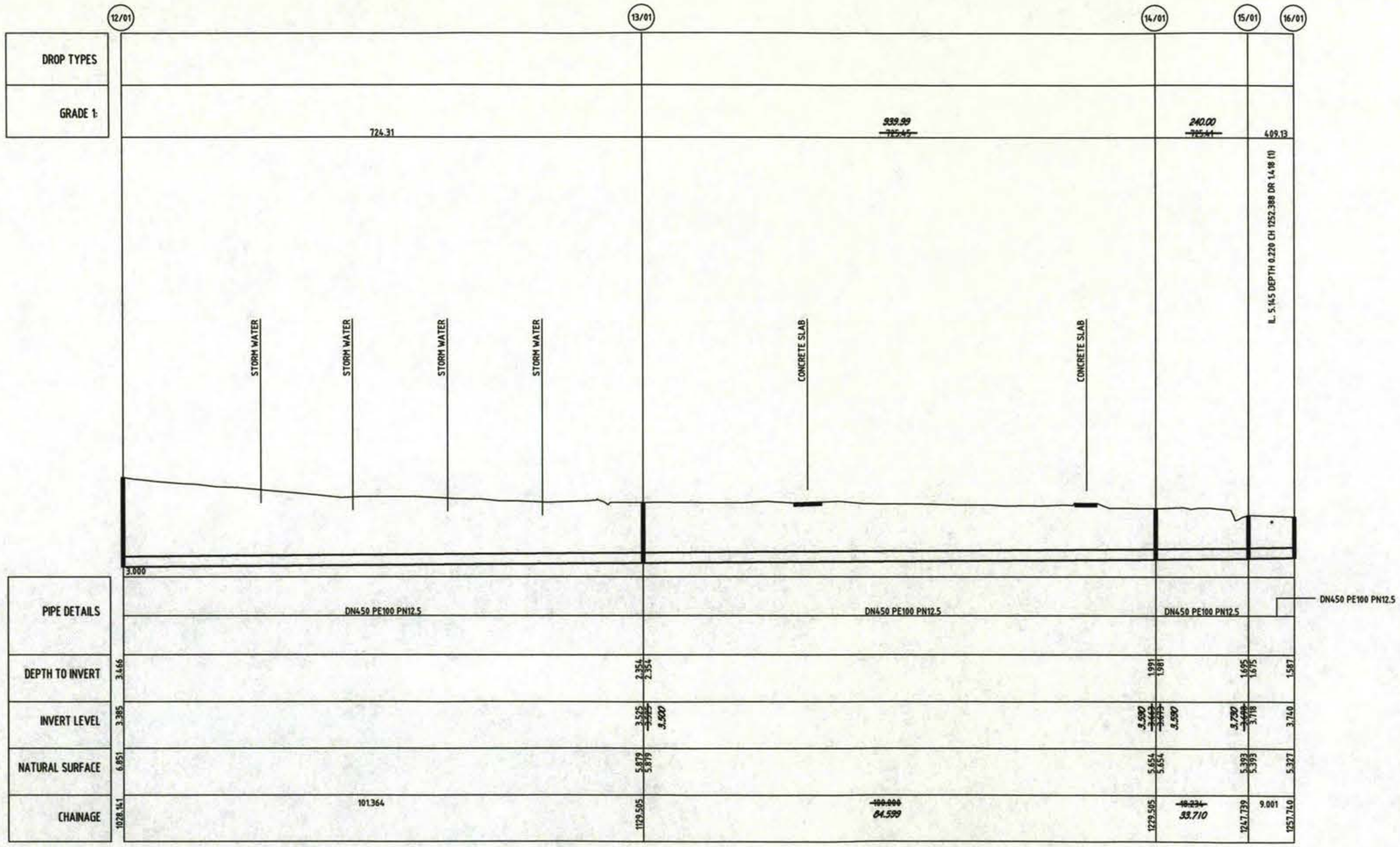
TITLE
LONGITUDINAL SECTION OF LINE 1
SHEET 4 OF 5

Tenix
TENIX ALLIANCE PTY LTD
BRISBANE . MELBOURNE . PERTH . SYDNEY
7 BARDONA ROAD MILTON 4064
PH:(07) 3510 7100 FAX:(07) 3878 4022
Email : WWW.TENIX.COM

PROJ. MANG. RPEQ No :
APPROVED: RPEQ No :

SHEET No. OF
BRISBANE WATER DRAWING No. 486/5/6-0024-009
AMEND. A

MWH
ABN: 53 085 776 601
LEVEL 1, 601 CORONATION DRIVE
TOOWONG, QLD 4066
Telephone: (07) 3510 7300
Facsimile: (07) 3510 7350



LONGITUDINAL SECTION OF LINE 1

SCALE: 1:500 (HOR.)
1:100 (VERT.)

AS CONSTRUCTED

NOTES:

1. THE POSITION OF SERVICES SHOWN IN THE SECTION ARE APPROXIMATE ONLY. THE CONTRACTOR SHALL CONFIRM THE LOCATION OF SERVICES PRIOR TO COMMENCING PIPELINE EXCAVATION AND SHALL NOTIFY THE SUPERINTENDENT OF ANY CONFLICTS BETWEEN THE PROPOSED MAIN AND THE EXISTING SERVICES.

No.	DATE	AMENDMENT	DRAFTED	APPROVED
B	09/09/09	AS CONSTRUCTED	RS	JWG
A	21/11/08	LONGITUDINAL SECTION REVISED	R.C.	J.V.H.
0	13/11/08	FOR CONSTRUCTION	TK	

FUNDING	
DESIGN W.O. No.	
CONSTRUCTION W.O. No.	
FUNDED BY B.C.C. ( )	EXTERNAL ( )

DRAFTED	R. CRAWFORD
DRAFTING CHECK	R. CRAWFORD
CAD FILE	
B.C.C. FILE No.	

J. VAN HEREL		21.11.08
DESIGN J. VAN HEREL	R.P.E.Q. No.	DATE
J. GREEN	2624	21.11.08
DESIGN CHECK J. GREEN	R.P.E.Q. No.	DATE

K. VAHEESAN	25.11.08
PRINCIPAL DESIGN MANAGER	DATE
J. KARYDAS	25.11.08
PRODUCTION / NETWORK DELEGATE	DATE

BRISBANE WATER

AS CONSTRUCTED
SIGNED [signature] DATE 19-5-10
NAME John W Green RPEQ No. 2624

DESIGNED:		DATE:	
DRAWN:		DRAWING No. 7103-P-DWG-6110	REV.
CHECKED:			

No.	DATE	REVISION	CHK.	APPR.
B		AS CONSTRUCTED		

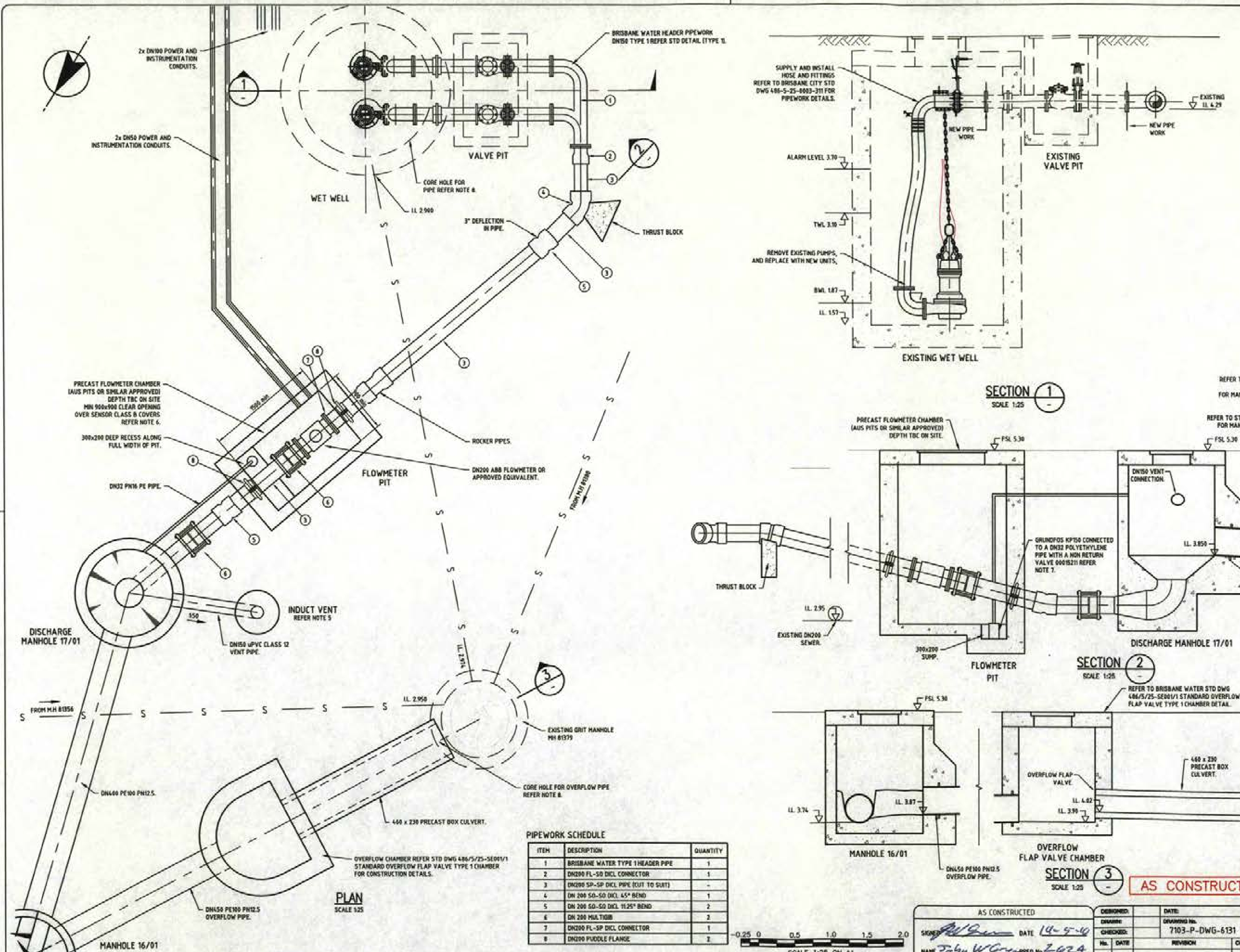
Tenix
TENIX ALLIANCE PTY LTD
BRISBANE . MELBOURNE . PERTH . SYDNEY
7 BAROONA ROAD MILTON 4064
PH(07) 3510 7100 FAX(07) 3876 4022
Email : WWW.TENIX.COM

PROJ. MANG. RPEQ No :
APPROVED: RPEQ No :

PROJECT
ST ACHS
SEWER PUMP STATION UPGRADE AND GRAVITY MAIN

TITLE
LONGITUDINAL SECTION OF LINE 1
SHEET 5 OF 5

SHEET No. OF
BRISBANE WATER DRAWING No. 486/5/6-0024-010
AMEND. B



NOTES:

1. CONTRACTOR TO CONFIRM ALL LEVELS AND DIMENSIONS PRIOR TO COMMENCING PUMPSTATION MODIFICATION WORKS.
2. PUMP OPERATING LEVELS TO BE CONFIRMED AT THE TIME OF PUMP PROCUREMENT.
3. THRUST BLOCKS FOR HORIZONTAL AND VERTICAL DOWNTHRUST SHALL BE CAST AGAINST UNDISTURBED STABLE MATERIAL. REFER TO WSAA STD DWG #WAT-1205 AND WAT-1207 FOR THRUST BLOCK SIZING.
4. MODIFICATION TO PUMP STATION ELECTRICAL SWITCHBOARD TO BE CONFIRMED.
5. REFER TO BRISBANE WATER STD DRG 486/5/25-SC00613 9008 RISING MAIN DISCHARGE MH TOP SLAB AND VENT DETAILS VENT POLE TO BE 3.5m HIGH. V79 VENT CONE TO BE REPLACED WITH DN 100 MICA FLAP VENT (OR SIMILAR APPROVED).
6. REFER TO DWG 486/4/25005-002D GENERAL ARRANGEMENT FLOW METER FACILITY FOR EARTHING DETAIL, SUMP PUMP DISCHARGE ARRANGEMENT AND TOP SLAB REQUIREMENTS.
7. SUMP PUMP SHALL BE A GRUNDFOS KP150 NIRO 240VAC DRAINAGE PUMP WITH INTEGRAL LEVEL CONTROL. THE FLOWMETER PIT SHALL BE PROVIDED WITH A SINGLE LEVEL ELECTRODE AND AN MTRA ELECTRODE ALARM RELAY TO ALERT THE CONTROL ROOM VIA TELEMETRY THAT THERE IS WATER IN THE PIT.
8. HOLE TO BE CORED PERPENDICULAR TO WALL OF MANHOLE. JOINT TO BE SEALED WITH APPROVED HYDROPHILLIC SEAL AROUND PIPE AND BETWEEN EXISTING CONCRETE AND NON SHRINK GROUT.

PIPEWORK SCHEDULE

ITEM	DESCRIPTION	QUANTITY
1	BRISBANE WATER TYPE 1 HEADER PIPE	1
2	DN200 FL-SO DICL CONNECTOR	1
3	DN200 SP-SP DICL PIPE (CUT TO SUIT)	-
4	DN 200 SO-SO DICL 45° BEND	1
5	DN 200 SO-SO DICL 11.25° BEND	2
6	DN 200 MULTIGRI	2
7	DN200 FL-SP DICL CONNECTOR	1
8	DN200 PUDDLE FLANGE	2

-0.25 0 0.5 1.0 1.5 2.0
SCALE 1:25 ON A1.

AS CONSTRUCTED

No.	DATE	AMENDMENT	DRAFTED	APPROVED
E	05/05/09	AS CONSTRUCTED	RS	JWG
D	30.01.09	AIR VALVE REMOVED	N.O.B	J.V.H.
C	20.01.09	DISCHARGE MANHOLE 17/01 MOVED TO NEW POSITION	N.O.B	J.V.H.

FUNDING
DESIGN W.O. No.
CONSTRUCTION W.O. No.
FUNDED BY B.C.C. ( ) EXTERNAL ( )

DRAFTED R. CRAWFORD
DRAFTING CHECK R. CRAWFORD
CAD FILE
B.C.C. FILE No.

J. VAN HEREL 21.11.08
DESIGN J. VAN HEREL R.P.E.Q. No. DATE
J. GREEN 2624 21.11.08
DESIGN CHECK J. GREEN R.P.E.Q. No. DATE

K. VAHEESAN 25.11.08
PRINCIPAL DESIGN MANAGER DATE
J. KARYDAS 25.11.08
PRODUCTION / NETWORK DELEGATE DATE

AS CONSTRUCTED
SIGNED [signature] DATE 14-5-09
NAME John W Green RPEQ No. 2624

DESIGNED: DATE:
DRAWN: DRAWING No. 7103-P-DWG-6131 REV.
CHECKED:
No. DATE REVISION CHK. APPR.

Tenix
TENIX ALLIANCE PTY LTD
BRISBANE . MELBOURNE . PERTH . SYDNEY
PROJ. MANG. RPEQ No: APPROVED: RPEQ No:

PROJECT
ST ACHS
SEWER PUMP STATION UPGRADE AND GRAVITY MAIN

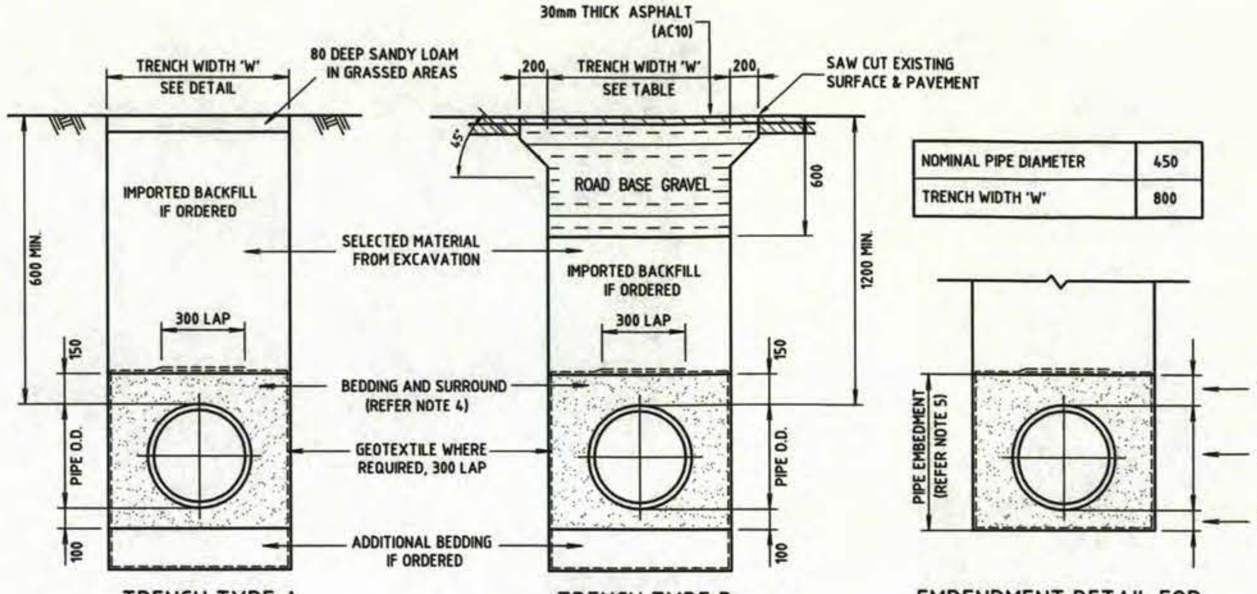
TITLE
PUMPSTATION PIPEWORK AND RISING MAIN

SHEET No. OF
BRISBANE WATER DRAWING No. 486/5/7-0024-031
AMEND. E

TRENCH AND PIPE EMBEDMENT DETAILS

NOTES:

1. MINIMUM CLEARANCE BELOW PIPE BARREL;
   WHERE TRENCH BASE IS IN SOIL - 100mm MINIMUM
   WHERE TRENCH BASE IS IN ROCK - 150mm MINIMUM
2. ALL PIPES SHALL BE INSTALLED WITH METHOD OF TRENCHING AS DETAILED IN THE PROJECT DRAWINGS . AN ADDITIONAL ALLOWANCE OF 200mm EACH SIDE OF TRENCH FOR SHORING IS TO BE ALLOWED OVER THE STANDARD TRENCH WIDTHS. BEDDING AND BACKFILL MATERIALS AND COMPACTION SHALL BE IN ACCORDANCE WITH THE PROJECT SPECIFICATIONS
3. BACKFILL MATERIAL SELECTION AND PLACEMENTSHALL BE IN ACCORDANCE WITH SECTION 10.4 BACKFILLING REFERENCE SPECIFICATION S140 EARTHWORKS.
4. THE EMBEDMENT SOIL MUST BE EVENLY COMPACTED BETWEEN THE PIPE AND THE SURROUNDING NATIVE SOIL. CARE MUST BE TAKEN NOT TO MOVE THE PIPE FROM ITS ALIGNMENT DURING COMPACTION. ATTENTION TO THE QUALITY AND DEGREE OF COMPACTION OF EMBEDMENT MATERIAL PLACED EACH SIDE OF A 'SEWER MAX' PIPELINE IS NECESSARY TO PREVENT UNDUE OVALISATION.
5. FOR POLYETHYLENE PIPE EMBEDMENT MATERIAL SHALL BE ANGULAR SINGLE GRADED CRUSHED ROCK CONFORMING TO TABLE 11.1 GRADING OF BEDDING MATERIALSIN REFERENCE SPECIFICATION S140 EARTHWORKS. PIPE BEDDING SHALL BE COMPACTED BEFORE PLACEMENT OF THE PIPE. EMBEDMENT MATERIAL IN THE PIPE SIDE SUPPORT ZONE SHALL BE PLACED IN TWO LAYERS. THE FIRST LAYER PLACED TO THE SPRING LINE OF THE PIPE AND THE SECOND LAYER TO THE OBVERT LEVEL OF THE PIPE. EACH LAYER SHALL BE RODDED IN PLACE AND EVENLY COMPACTED TO ENSURE THE PIPE BARREL IS FULLY SUPPORTED WITH NO CAVITIES. CARE MUST BE TAKEN NOT TO MOVE THE PIPE FROM ITS ALIGNMENT DURING COMPACTION. THEN PIPE OVERLAY MATERIAL CAN THEN BE PLACED AND COMPACTED.

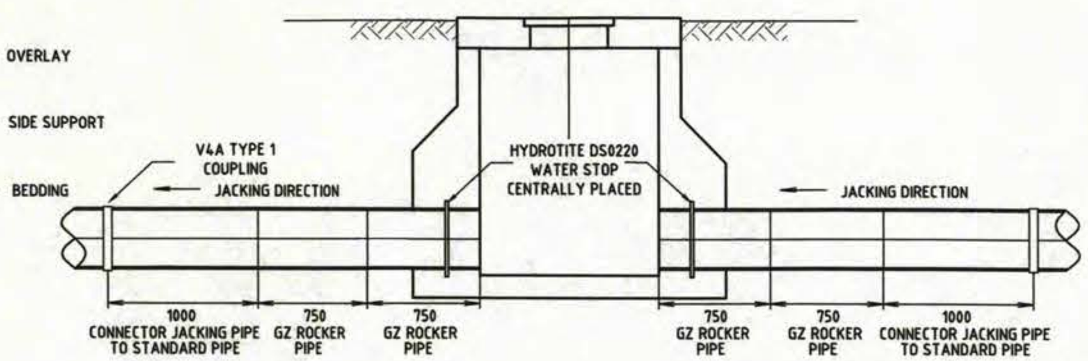


TRENCH TYPE A
ELSEWHERE

TRENCH TYPE B
EXISTING ROAD PAVEMENTS

NOMINAL PIPE DIAMETER	450
TRENCH WIDTH 'W'	800

EMBENDMENT DETAIL FOR POLYETHYLENE PIPE (REFER NOTE 5)



JACKING PIPE DETAIL
SCALE 1:25

LIVE SEWER WORKS

No.	DESCRIPTION	DIA. SEWER	MH NO.	MH TYPE	COVER TYPE	LOT NO.	F.S.L.	E.S.L.	I.L.	DEPTH
1 (A)	CONTRACTOR TO CONSTRUCT NEW MAINTENANCE HOLE MH1/01OVER EXISTING DN300 LIVE SEWER. CONTRACTOR TO BENCH AND RENDER UP TO PIPE BUT NOT REMOVE CROWN OF PIPE.	DN 300	MH1/01	F	B		4.730		1.899	2.831
1 (B)	COUNCIL TO REMOVE CROWN OF SEWER PIPE INSIDE NEW MAINTENANCE HOLE MH1/01 AND COMPLETE BENCHING.									
2 (A)	COUNCIL TO BREAK INTO EXISTING MAINTENANCE HOLE MH81379 AND CONSTRUCT 460x230 CONCRETE CULVERT FOR NEW OVERFLOW.	460x230	MH81379	G			5.530	5.530	3.940	1.590
2 (B)	COUNCIL TO CORE INTO EXISTING MAINTENANCE HOLE MH81379 AND INSTALL DN150 STUB FOR VENT PIPE CONNECTION.	DN150	MH81379				5.530	5.530	4.830	0.700
3 (A)	COUNCIL TO TEMPORARILY PLUG OUTLET OF MH81379 TO ENABLE ISOLATION OF SP087 FOR UPGRADE.									
3 (B)	FOLLOWING COMPLETION OF LINE 1 GRAVITY MAIN CONTRACTOR TO INSTALL BY-PASS PUMPING ARRANGEMENT. FLOW TO BE DIVERTED FROM MH81379 TO MH1/16.									
3 (C)	CONTRACTOR TO DRAIN, CAP AND ABANDON EXISTING RISING MAIN.									
3 (D)	CONTRACTOR TO COMPLETE UPGRADE OF SP087.									
3 (E)	COUNCIL TO REMOVE TEMPORARY PLUGS IN OUTLET OF MH81379 AFTER SUCCESSFUL "ON MAINTENANCE" INSPECTION.									
4 (A)	CONTRACTOR TO PLUG THE INLET AND OUTLET OF THE DISCHARGE CHAMBER ON THE EXISTING MAIN AT THE CORNER OF RAILWAY PDE AND EAMES ST. CONTRACTOR TO CORE DRAIN HOLES THROUGH FLOOR OF THE CHAMBER AND INFILL ABANDONED CHAMBER.									
5 (A)	CONTRACTOR TO INSTALL WEIR PLATE INSIDE EXISTING MAINTENANCE HOLE MH81356 TO RAISE EXISTING OVERFLOW LEVEL RL4.60m (CURRENT OVERFLOW INVERT = 3.828m).		MH81356	G	D		5.600	5.600	4.600	1.200

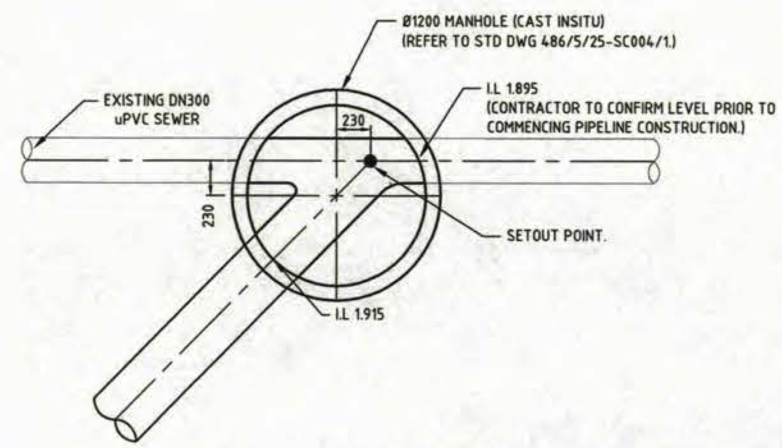
CONTRACTOR TO REQUEST LIVE WORKS PRIOR TO COMMENCEMENT OF CONSTRUCTION IF REQUIRED.	LIVE WORKS: BRISBANE WATER PH: 3407 8308, 3407 8346
CONTRACTOR TO CONFIRM SEWER WORK START DATE AND BOOK INSPECTION TIMES (MIN. TWO (2) WORKING DAYS NOTICE REQUIRED.)	INSPECTION: MINOR SEWER WORKS INSPECTION. PH: 040403438
CONTRACTOR TO CONSTRUCT SEWER WORKS AND ARRANGE INSPECTIONS AS REQUIRED. A FIELD INSPECTION REPORT WILL BE ISSUED UPON SUCCESSFUL "ON MAINTENANCE" INSPECTION AND COLLECTION OF "AS CONSTRUCTED" INFORMATION BY THE MINOR SEWER WORKS INSPECTION UNIT.	INSPECTION: MINOR SEWER WORKS INSPECTION. PH: 040403438
CONTRACTOR IS REQUIRED TO FORWARD A COPY OF THE FIELD INSPECTION REPORT TO BRISBANE WATER TO CONFIRM THE SEWER WORKS ARE ACCEPTABLE AND REQUEST LIVE WORKS TO COMPLETE SEWER WORKS.	LIVE WORKS: BRISBANE WATER PH: 3407 8308, 3407 8346

SETOUT DATA

MANHOLE	EASTING	NORTHING	MH COVER CLASS
1/01	57678.215	169115.940	B
1A/01	57678.128	169121.442	B
2/01	57623.159	169194.907	D
3/01	57698.396	169260.386	D
4/01	57773.663	169316.938	D
5/01	57769.789	169334.897	B
6/01	57744.421	169445.067	B
7/01	57801.536	169546.977	D
8/01	57865.164	169645.264	D
9/01	57930.861	169744.211	D
10/01	57999.201	169846.346	D
11/01	58053.465	169924.308	D
12/01	58067.011	169950.650	B
13/01	58122.965	170034.752	B
14/01	58179.937	170116.994	B
15/01	58193.288	170128.008	D
16/01	58208.635	170120.759	D
17/01	58194.121	170094.596	D

SURVEY CONTROL DATA

POINT #	EASTING	NORTHING	ELEVATION	DESCRIPTION
9000	57812.804	169023.771	5.098	SCREW IN SLAB
9001	57660.103	169246.230	5.439	NAIL IN FENCE POST
9002	57788.463	169342.776	5.822	SCREW IN FENCE POST
9003	57753.255	169461.322	5.876	NAIL IN PAVEMENT
9004	57788.350	169525.331	6.147	BOLT IN BITUMEN
9005	57729.950	169363.698	5.743	NAIL IN BITUMEN
9006	57716.266	169289.743	5.464	SCREW IN FENCE POST
9007	57620.314	169195.818	5.472	NAIL IN ROAD



MH1/01 JUNCTION DETAIL
SCALE 1:25

AS CONSTRUCTED

MWH
ABN: 53 085 776 601
LEVEL 1, 601 CORONATION DRIVE
TOOWONG, QLD 4066
Telephone: (07) 3510 7300
Facsimile: (07) 3510 7350

AS CONSTRUCTED
SIGNED [signature] DATE 19-5-10
NAME Schu W Green RPEQ No. 2624.

No.	DATE	AMENDMENT	DRAFTED	APPROVED
C	09/09/09	AS CONSTRUCTED	RS	JWG
B	20/01/09	MANHOLE 17/01 & FLOWMETER REPOSITIONED	N.D.B	J.V.H
A	08/01/09	JACKING PIPE DETAIL ADDED	N.D.B	J.V.H

FUNDING
DESIGN W.O. No.
CONSTRUCTION W.O. No.
FUNDED BY B.C.C. ( ) EXTERNAL ( )

DRAFTED: R. CRAWFORD
DRAFTING CHECK: R. CRAWFORD
CAD FILE
B.C.C. FILE No.

DESIGN: J. VAN HEREL — J. VAN HEREL 21.11.08 (R.P.E.Q. No. / DATE)
J. GREEN 2624 21.11.08
DESIGN CHECK: J. GREEN (R.P.E.Q. No. / DATE)

K. VAHEESAN 25.11.08
PRINCIPAL DESIGN MANAGER — DATE
J. KARYDAS 25.11.08
PRODUCTION / NETWORK DELEGATE — DATE

BRISBANE WATER

PROJECT: ST ACHS
SEWER PUMP STATION UPGRADE AND GRAVITY MAIN

DESIGNED: / DRAWN: / CHECKED: / DATE:
DRAWING No. 7103-P-DWG-6132 REV.
No. DATE REVISION CHK. APPR.

TITLE: GENERAL DETAILS PLAN AND SETOUT DATA

Tenix
TENIX ALLIANCE PTY LTD
BRISBANE . MELBOURNE . PERTH . SYDNEY
PROJ. MANG. / RPEQ No: / APPROVED: / RPEQ No:

SHEET No. OF
BRISBANE WATER DRAWING No. 486/5/7-0024-032
AMEND. C