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16 April 2015

AWJ Civil Pty Ltd
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ATTENTION: MATHEW MIKHAIL
By Email: Mathew@awj.com.au

Dear Mathew

**RE: QUARRYWEST, GREYSTANES
GROUNDWATER MANAGEMENT PLAN FOR SOUTHERN EMPLOYMENT
LANDS**

We are pleased to submit the revised Groundwater Management Plan (GMP) for the Southern Employment Lands (SEL), Greystanes. We have simplified the requirements whilst still maintaining the original elements to provide continuity with the previous version of the GMP.

Please do not hesitate to contact the undersigned should you have any queries.

For and on behalf of
PELLS SULLIVAN MEYNINK

DAVID PICCOLO

Distribution: 1 electronic copy to AWJ Civil Pty Ltd
Original held by PSM

Southern Employment Lands (SEL), Greystanes

GROUNDWATER MANAGEMENT PLAN (GMP)

PSM963-255R Rev1

APRIL 2015

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1 OBJECTIVE AND SCOPE

This Groundwater Management Plan (GMP) outlines a set of procedures to be followed to maintain the groundwater drainage system that has been constructed as part of the Southern Employment Lands (SEL) development in order to:

- Fulfil the commitments under the Part 3a development approval for the SEL Concept Plan;
- Fulfil the requirement of the Department of Water and Energy (DWE) dewatering license that is to be issued under Part V of the Water Act 1912 issued on 28 April 2008.

In particular, the GMP:

1. Defines the inspections and monitoring tasks that are to be carried out as part of the groundwater management program (Sections 4.2 and 4.3).
2. Specifies the reporting arrangements required (Section 4.4).
3. Provides guidance on recommended maintenance actions that may arise from the inspection and monitoring measures (Section 5).
4. Highlights the need for appropriate safe work methods and procedures to be developed and implemented as part of the inspection, monitoring and maintenance works (Section 6).

The GMP has been prepared on the basis that the groundwater collected from the site will be supplied under agreement to nearby Cumberland Country Golf Club (CCGC). CCGC will pump untreated groundwater drained from the SEL and pipe it along a 4 km pipeline to their golf course, where it will be used for the irrigation of course greens, tees and fairways.

This GMP shall be read in conjunction with the PSM Groundwater Report 2014 (Reference 1).

Table 1.1 provides definitions for three terms used extensively throughout this document.

**TABLE 1.1
DEFINITIONS**

TERM	ABBR	DEFINITION
Community Title Association	CTA	The administrative body responsible for the management and maintenance of the development.
Engineer/Scientist/Hydrogeologist	ESH	Suitably qualified civil/environmental engineer, environmental scientist or hydrogeologist appointed to undertake monitoring or engineering inspections, and to provide ongoing advice with respect to the drainage system.
Maintenance Staff	MS	Contractor personnel suitably qualified/experienced to undertake maintenance tasks

2 BACKGROUND

Background information regarding the setting, geology and hydrogeology of the SEL is provided in the PSM Groundwater Report 2014.

Groundwater quality monitoring was undertaken periodically (by others) at the site between 2001 and 2007. Summary statistics of the all the available groundwater water quality within targeted strata are presented in Appendix B.

3 GROUNDWATER DRAINAGE DESIGN

A passive groundwater drainage system has been designed and constructed to maintain the water table below the proposed finished ground surface. Groundwater is not actively extracted for the purpose of supplying water for potential uses.

Details of the groundwater drainage system are provided in the drawings in Appendix C. These include a single PSM drawing (PSM963-1001D) from 2015 and other GHD drawings (21-15443-GW-0700, 0710, 0720-0724) from work completed before 2011.

The groundwater drainage system comprises the following elements:

1. Source water management – Collection and removal of stormwater at the surface and near surface minimising infiltration to the water table.
2. Collection system comprising:
 - a. GW perimeter drain at the toe of the eastern batters north of the southern cut.
 - b. GW perimeter drain at the toe of the western batters:
 - i. At the southern cut.
 - ii. North of the slip zone.
 - c. GW drainage trench connecting components 2a and 2b above (March 2010 modification).

The perimeter drains are approximately 3 x 3 m in size, and backfilled with gravel of 100 mm diameter, sub-angular material.

3. Disposal system comprising:
 - a. Pipe system connecting the southern end of the 2b to Widemere East basin.
 - b. A 4 km pipeline to CCGC. As previously discussed the groundwater collected will be supplied under agreement to CCGC, who will pump and pipe the collected groundwater along a 4 km pipeline to their golf course.

The drainage system is based around a passive, gravity drain to the south, which has allowed for a minimal amount of ongoing maintenance. Maintenance shall be undertaken in response to observed undesirable changes to the groundwater system, evidenced through monitoring.

4 INSPECTION, MONITORING & REPORTING

4.1 Purpose

The purpose of the inspection, monitoring and reporting requirements in this GMP is to fulfil the monitoring requirements in the Licence and inform the CTA regarding the performance of the groundwater drainage system in order to assist in scheduling maintenance activities (see Section 5)..

The CTA shall be responsible for commissioning a suitably qualified ESH to undertake further maintenance assessments of the drainage system, when and if required.

4.2 Inspections

The required inspection types and frequencies are detailed in Table 4.1. Additional inspection tasks may arise during the life of the development. After 3 years the frequency can be revised by ESH to reflect the observations, if required.

TABLE 4.1
ITEMS FOR ROUTINE INSPECTIONS AND MONITORING

TYPE	ITEM	DESCRIPTION	FREQUENCY FIRST 3 YEARS	BY
Routine Inspection	Drainage Channels	Inspect the surface of the perimeter drainage channels for ponding of water, seepage, scour, blockages of water flow, and vegetation die-off.	Quarterly	MS or ESH
	Groundwater Manholes	Inspect groundwater manholes along Groundwater Line 1, 2 and 3 for signs of blockage or scaling.	6 monthly	MS or ESH
Monitoring	Level	The water level in the monitoring bores shall initially be measured using a dip meter. Should more than 300 mm of water be measured within the standpipe, continuous loggers such as a HOBO shall be installed in the monitoring bores, the HOBO's shall record level at a frequency of no less than 4 hourly.	6 monthly dipmeter initially and then downloading of HOBO data.	ESH
	Quantity	The water flow shall be measured using a flow metre with data logger installed at discharge point in manhole GW2/1.	6 monthly downloading of flow meter data.	ESH
	Quality	Sampling of groundwater from discharge point in manhole GW2/1 and laboratory testing for parameters in Table 4.2.	6 monthly sampling and testing.	ESH

4.3 Monitoring

4.3.1 General

It is proposed to monitor groundwater levels, quantity and quality.

The method and frequency of groundwater monitoring is presented in Table 4.1. After 3 years the frequency can be revised by an ESH to reflect the observations.

4.3.2 Groundwater levels

Groundwater levels are to be monitored at 7 locations as shown on Drawing PSM963-1001D. At these locations monitoring bores shall be installed. The locations of the monitoring bores have been selected to provide appropriate coverage of the SEL. It is noted that at locations 1, 2, 8 and 9 monitoring bores are already installed. Monitoring bore details are shown on Drawing 21-15443-GW-0724.

All monitoring bores shall be licensed, drilled and constructed by a licensed water bore driller, with copies of bore logs submitted to DWE. All wells shall be constructed in accordance with the ARMCANZ *Minimum Construction Requirements for Water Bores in Australia, Ed 2* (September 2003).

For security, bores shall be completed with a lockable, heavily-galvanised, steel bore shields or standpipes. The standpipe shall be clearly marked with the well ID and surveyed to AHD to within ± 0.005 m and MGA to within ± 0.1 m.

4.3.3 Groundwater quantity

The quantity of groundwater discharged by the drainage system shall be monitored by a flow meter located in manhole GW2/1 as shown on Drawing PSM963-1001D. .

4.3.4 Groundwater quality

Water quality monitoring shall be undertaken on water sampled from the drainage channel discharge point in the manhole GW2/1 as shown on Drawing PSM963-1001D.

All sampling shall be carried out in accordance with EPA accepted procedures, including the EPA publication *Approved Methods for the Sampling and Analysis of Water Pollutants in New South Wales*. Samples shall be collected and placed in laboratory-supplied sample bottles, with preservatives appropriate for the target analyte, in accordance with Australian and New Zealand Standard *AS/NZS 5667 Water Quality – Sampling* and shall include an appropriate Quality Assurance/Control Program in accordance with Section 8 of the Australia Standard AS 44821.1.

Analyses of samples shall be undertaken by an accredited National Association of Testing Authorities (NATA) laboratory.

Analytes to be monitored are shown in Table 4.2 below. The table also provides trigger levels for the analytes based on the 80th percentile calculated from background groundwater quality data collected between 2001 and 2007 from within the quarry. The 80th percentile site-specific criteria shall be used to help quantify 'measurable perturbations' in groundwater at the site.

TABLE 4.2
INDICATIVE TRIGGERS VALUES

PARAMETER	UNITS	TRIGGER VALUE ¹
pH	pH units	11
Electrical Conductivity	uS/cm	2,060
Calcium	mg/L	7
Magnesium	mg/L	1
Sodium	mg/L	436
Potassium	mg/L	10
Alkalinity as CaCO ₃	mg/L	363
Sulfate	mg/L	645
Chloride	mg/L	109
Ammonia as N	mg/L	40
Nitrite as N	mg/L	4
Nitrate as N	mg/L	3
Total Phosphorus as P	mg/L	0.25
Reactive Phosphorus as P	mg/L	0.05
Suspended Solids	mg/L	250 ²

Notes: 1. 80th percentile calculated from data collected from piezometers targeting picrite and fill geology (see GHD 2007c for the list of wells that target each geology)

2. Based on values collected from eight samples blended from groundwater taken from MW 18, MW 14, MW 20, MW 15, Artificial Aquifer, RepMW 10 and MW 22

4.4 Reporting

4.4.1 Following each task

Following completion of each round of inspections and monitoring:

1. The results shall be recorded on the *Proformas* included in Appendix A.
2. The following information shall be provided to the CTA:
 - a. The completed *Proformas*.
 - b. The downloaded data from the water level/flow data loggers.
 - c. Water quality test result sheets.

The CTA shall appropriately file this information and make it available to DWE, Blacktown City Council, Fairfield City Council and Holroyd City Council upon request.

The *Proformas* include a section where additional actions can be recommended by the MS or ESH. Possible actions are discussed in Section 5. The CTA shall act on these recommendations if required.

4.4.2 Annually

The DWE licence requires that an Annual Groundwater Management Report be prepared by an ESH contracted by the CTA and submitted to the DWE. After a period of five years the frequency of this reporting requirement shall be reviewed by an ESH. The Annual Groundwater Management Report shall include:

1. All water level, flow and quality data from monitoring.

2. A summary of all routine inspection and maintenance works or additional investigations undertaken throughout the year.
3. An interpretation of that data and a discussion of trends identified in the data and its implications including discussion of trigger levels for level, flow and quality data.
4. Comparison of the data with predictions of groundwater behaviour made in the PSM Groundwater Report 2014 and an assessment of drainage systems performance including the extent of aquifer depressurisation and salinity impacts.
5. Recommendations for further investigations or maintenance requirements related to the drainage system, if needed.

5 ACTIONS ARISING FROM INSPECTIONS AND MONITORING

5.1 Example of observations/measurements leading to actions

The following list presents some of the observations during inspections and monitoring that may lead to recommendation for further actions:

1. Observation of ponding of water, seepage, scour, blockages of water flow, and vegetation die-off in the swales.
2. Observation of signs of blockage or scaling in the pipe outlets in the manholes.
3. A significant increase in water levels is observed within the groundwater drainage channels.
4. Groundwater levels approaching the surface.
5. Significant changes in flow measurements.
6. Flow measurements exceeding licence allowance.
7. Quality measurements exceeding trigger levels. The 80th percentile site-specific criteria shall be used to help quantify 'measurable perturbations' in groundwater at the site. Exceedances of site-specific trigger values shall alert the need for further investigations to assess the impact of reduced recharge or stormwater leakage on shallow groundwater, and does not necessarily indicate a potential for negative environmental impact.

5.2 Routine Maintenance Scheduling

As a result of the routine inspections and monitoring a schedule of maintenance activities shall be drawn up and implemented by the CTA to address those issues identified during the inspection. Examples of possible maintenance activities may comprise, but not be limited to those listed in Table 5.1 below.

TABLE 5.1
TYPICAL ROUTINE MAINTENANCE

ITEM TYPICAL MAINTENANCE WORKS	LIKELY TO BE REQUIRED	MINIMUM FREQUENCY
Drainage Channels	a) Clear accumulated sedimentation b) Repair scours and seeps	Annually
Outlet pits and pipe from the drainage system	a) Rodding of pipes to remove large scaling/accumulation	Every 5 years

Records of any maintenance carried out as a result of the inspection shall be completed by the maintenance staff or contractor, commissioned by the CTA to undertake the maintenance, immediately after the works have been finalised, and submitted to the CTA for filing.

5.3 Corrective Actions or Additional Investigations

Routine maintenance and monitoring may indicate that further investigations or corrective action may be required to assess a non-compliance or abnormality.

Typical actions arising from inspections and monitoring may include recommendations for:

1. Scheduling of routine maintenance tasks.
2. Additional round of inspections/monitoring to confirm observations/measurements. For example if an exceedance of a quality trigger value is reported the ESH may recommend an additional sampling round within 7 days to confirm the exceedance.
3. Further investigation of observation/measurement. For example, if a quality exceedance is confirmed further investigations may be recommended by an ESH to assess the cause of the exceedance and assess the need for further corrective action.
4. Notification of relevant authorities. For example should the quantity exceed the licence requirements may be a recommendations that DWE be informed.

These investigations or corrective actions shall be undertaken by an MS or ESH commissioned by the CTA.

Prior to undertaking this work the ESH shall make themselves familiar with the design of the drainage system, construction records and also review all previous inspection reports. The CTA shall keep a copy of the design documents and construction records, along with the previous inspection records.

The contracted ESH shall identify and report on discrepancies between previous records and the current site conditions, identify any trends that may be of concern, and assess if these have implications for drainage efficiency, significant or otherwise. The ESH shall include in their report details of any corrective actions required, and other recommendations, including additional monitoring or testing.

The CTA shall be responsible for ensuring recommended maintenance works, corrective action, or investigations are undertaken either by MS or other suitably qualified individuals. Reports detailing any corrective actions or investigations carried out shall be prepared by the individual undertaking the works and submitted to the CTA for their records immediately after the works have been finalised.

5.4 Reactive Maintenance

Reactive maintenance works shall be implemented if an immediate and obvious hazard is observed during the inspections, monitoring or other investigations. The inspecting ESH shall notify the CTA without delay, both verbally and then in writing, and identify an appropriate course of action. The CTA is responsible for ensuring the appropriate course of action is undertaken based on this advice.

This action shall depend on the particular circumstances, and could range from arranging repair works to site evacuation. If the hazard can be mitigated by simple emergency repair works, these shall be implemented promptly. In a more serious situation, it may be necessary to commission a detailed investigation to establish the cause of the problem and to facilitate the design of rectification works. The CTA shall be responsible for commissioning an ESH or Contactor to undertake and report on these detailed investigations and design of rectification works. These individuals shall prepare records or reports of all reactive maintenance works or detailed investigations undertaken, which shall be submitted to and filed by the CTA.

The CTA shall notify the DWE in writing within six months of reactive maintenance works being undertaken. In the case of more serious situations, such as when site evacuation is required or major breakdowns in the groundwater drainage system are observed the CTA shall notify the DWE in writing and by telephone within five working days.

Where routine maintenance is repeatedly carried out in one location, the problem shall also be specifically targeted for further investigation by an ESH to be appointed by the CTA.

All records and reports related to maintenance or additional investigations shall be made available to DWE, Blacktown City Council, Fairfield City Council and Holroyd City Council upon request.

6 INSPECTION AND MONITORING SAFETY

OH&S documentation and implementation related to the ongoing management of the groundwater drainage system as described in this management plan is the responsibility of the CTA and the service provider.

All service providers must provide Safe Work Procedures (SWP) and Health Environmental Safety Plans (HESP) to address all the relevant safety issues associated with the site and tasks to be undertaken prior to commencement of any works at the site.

The CTA must ensure that all procedures outlined in the OH&S documentation are implemented and maintained throughout the works. We note that entry via manholes will require Confined Space Training certification and procedures including the associated PPE / equipment

REFERENCES

1. PSM Groundwater Report 2014. Quarrywest Greystanes, Groundwater Drainage System Analysis and Redesign, PSM963-222RRev1 dated 8 December 2014.
2. ANZECC/ARMCANZ 2000. Australian and New Zealand Guidelines for Fresh and Marine Water Quality.
3. ARMCANZ 2003. Minimum Construction Requirements for Water Bores in Australia, Ed 2.
4. Australian and New Zealand Standard ASNZS 5667 Water Quality – Sampling.
5. GHD 2007a. Greystanes Estate Southern Employment Lands- Groundwater Drainage Design Report.
6. GHD 2007b. Greystanes Estate SEL Subdivision- Groundwater Modelling Report.
7. GHD 2007c. Greystanes Estate SEL Subdivision- Department of Natural Resources Groundwater Extraction License Report.
8. NSW DoP, 2007. Major Project Assessment – Greystanes Southern Employment Lands (MP 06_0181).
9. Parson Brinckerhoff 2004. Preliminary Assessment of Hydrogeochemistry and Nutrients in Waters at Prospect Quarry.
10. Parsons Brinckerhoff 2006. Draft Greystanes Estate -Southern Employment Lands Groundwater Drainage Detailed Design Report, Revision A, 2113014A-RP-108-A.

APPENDIX A

TYPICAL INSPECTION AND MONITORING FORMS

(From GHD GMP dated August 2011)

Record of Routine Inspection for Groundwater Maintenance

Other				
Other				

Routine Inspection Observations Cont'd (see Table 3.1 of SMP)

Cursory observations of the following items should form the basis, but not be limited to, all items included as part of this routine inspection. It is not the

	Satisfactory (Note 1)	Routine Maintenance Req'd (Note 2)	Engineering Inspection Required (Note 3)	Comments (Ref No.) Photo (Ref No.) (Note 4)
b. Drainage Channels				
No evidence of ponding of water				
No evidence of seepage				
No evidence of scour				
No evidence of vegetation die-off				
Other				
Other				

	Satisfactory (Note 1)	Routine Maintenance Req'd (Note 2)	Engineering Inspection Required (Note 3)	Comments (Ref No.) Photo (Ref No.) (Note 4)
d. Site Condition/General Safety				
Evidence of ponding on areas of landform				
Visible damage to apparatus				
Other				
Other				
Other				
Other				
Other				

Note 1	The item checked is in a functioning, safe condition, and no specific maintenance is required.
Note 2	The item checked requires routine maintenance, but does not require immediate engineering assessment to assess safety or design functionality
Note 3	
Note 4	The item requires an Engineering Inspection to assess design functionality or to prevent damage to other components Description/Comments regarding status and urgency of action required if columns 2 and 3 are checked, and Photographic Reference.

5. Comments

C1.

C2.

C3.

C4.

C5.

C6.

Record of Routine Inspection for Groundwater Maintenance

6. Actions to be taken

A1.

A2.

A3.

A4.

A5.

A6.

7. Report Distribution

	File	(tick)	File reference
Name	_____	☐	_____
Name	_____	☐	Date _____
		☐	Date _____

Additional Pages (e.g. sketches, notes):

SignatureDate

Date of Current Inspection: _____
 Date of Previous Inspection: _____

Groundwater Water Quality and Level Monitoring

1. Inspectors

Name: _____ Organisation: _____ Contact No.: _____
 Completed By: 1. _____
 2. _____
 3. _____
 4. _____

2. Sampling

water quality sampling to be completed by a NATA accredited laboratory

Date of Sample

Sample Reference Number

3. Weather

Condition

Fine ☐
 Overcast ☐

Rainfall (previous 12 hours)

None ☐
 Light/Intermittent ☐
 Moderate ☐
 Heavy ☐

Temperature

Overnight Frost ☐
 Cold <15°C ☐
 Mild 15-25°C ☐
 Hot 25-35°C ☐
 Extreme >35°C ☐

Wind

None/Light ☐
 Moderate ☐
 High ☐

Recent Weather

(describe general weather trends as per parameters above for previous 7 days)

4. Summary of Monitoring Results and Assessment Against Trigger values and/or Previous Results

Parameter	Units	80 th Percentile Trigger Value	Range (min-max)	Current Results	Notes
pH	pH units	11	9.2-11.8		
Electrical Conductivity	uS/cm	2,060	518-3140		
Calcium	mg/L	-	<1-25		
Magnesium	mg/L	-	<1-7.2		
Sodium	mg/L	-	27-640		
Potassium	mg/L	-	3.3-13		
Alkalinity as CaCO ₃	mg/L	-	90-557		
Sulfate	mg/L	-	6-1200		
Chloride	mg/L	-	32-284		
Ammonia as N	mg/L	40	0.03-116		
Nitrite as N	mg/L	4	<0.01-5.5		
Nitrate as N	mg/L	3	<0.01-18		
Total Phosphorus as P	mg/L	0.25	0.03-0.3		
Reactive Phosphorus as P	mg/L	0.05	<0.01-0.1		
Suspended Solids	mg/L	2503	-		

Note 80th Percentile Trigger Value and range based on groundwater quality in picinle and fill aquifers

APPENDIX B

GROUNDWATER QUALITY SUMMARY

(From GHD GMP dated August 2011)

&

RECENT GROUNDWATER LEVEL OBSERVATIONS

Table A: Groundwater Quality Summary Statistics

Parameter	Units	SHALE (MW04)	PICRITE (JK1, JK2, JK4, MW09, MW10/RepMW10 ^a , MW11, MW14, MW20)	DOLERITE (MW01, MW02, MW03, MW05, MW07, MW22)	FILL (MW13, MW15, AA1)
		Mean±Stdev (min – max)	Mean ±Stdev (min – max)	Mean±Stdev (min – max)	Mean±Stdev (min – max)
Temperature	°C	20.4	21.4±2.0 (18.5-26.2)	22.4±2.0 (17.9-24.4)	20.9±1.5 (18.8-22.0)
TDS	mg/L	9131	1084±460 (352.1-1806)	1012±550 (283-1987)	789±67 (723-856)
EC	uS/cm	10600	1622±661 (518-3140)	1285±710 (410-2681)	1139±89 (1018-1217)
pH	pH units	7.35	10.6±0.6 (9.3-11.8)	8.6±1.1 (7.3-10.9)	9.5±0.2 (9.2-9.8)
Dissolved Oxygen	mg/L		1.1±1.5 (0.1-4.3)	2.4±2.8 (0.4-4.4)	3.0

Parameter	Units	SHALE (MW04)	PICRITE (JK1, JK2, JK4, MW09, MW10/RepMW10 ^a , MW11, MW14, MW20)	DOLERITE (MW01, MW02, MW03, MW05, MW07, MW22)	FILL (MW13, MW15, AA1)
		Mean±Stdev (min – max)	Mean ±Stdev (min – max)	Mean±Stdev (min – max)	Mean±Stdev (min – max)
ORP	mV	62	-42±122 (-287-159)	1±79 (-115-168)	45±68 (-9-138)
Calcium	mg/L	292	5±6 (<1-25)	29±41 (1-147)	4±2 (2-7)
Magnesium	mg/L	445	1±2 (<1-7.2)	28±28 (<1-95)	1 (<1-3)
Sodium	mg/L	1520	325±154 (59-640)	224±145 (40-423)	185±108 (27-273)
Potassium	mg/L	47	8±3 (3.3-13)	8±3 (3-12)	7±2 (4-9)
Bicarbonate as CaCO ₃	mg/L		30±40 (0-109)	140±142 (0-337)	70

Parameter	Units	SHALE (MW04)	PICRITE (JK1, JK2, JK4, MW09, MW10/RepMW10 ^a , MW11, MW14, MW20)	DOLERITE (MW01, MW02, MW03, MW05, MW07, MW22)	FILL (MW13, MW15, AA1)
		Mean±Stdev (min – max)	Mean ±Stdev (min – max)	Mean±Stdev (min – max)	Mean±Stdev (min – max)
Carbonate as CaCO ₃	mg/L		139±70 (5-240)	103 (5-200)	100
Hydroxide as CaCO ₃	mg/L		95±141 (0-409)	48 (5-90)	0
Alkalinity as CaCO ₃	mg/L	669	249±145 (90-557)	255±148 (69-505)	189±16 (170-209)
Sulphate	mg/L	292	402±317 (6-1200)	287±345 (35-1070)	269±42 (216-320)
Chloride	mg/L	3430	85±56 (32-284)	103±102 (34-374)	65±16 (48-80)
Ammonia	mg/L		27.4±35.1 (0.03-116)	1.1±2.2 (<0.01-5.7)	1.8±0.5 (1-2.1)

Parameter	Units	SHALE (MW04)	PICRITE (JK1, JK2, JK4, MW09, MW10/RepMW10 ^a , MW11, MW14, MW20)	DOLERITE (MW01, MW02, MW03, MW05, MW07, MW22)	FILL (MW13, MW15, AA1)
		Mean±Stdev (min – max)	Mean ±Stdev (min – max)	Mean±Stdev (min – max)	Mean±Stdev (min – max)
Nitrite	mg/L		1.7±2.2 (<0.01-5.5)	0.04±0.05 (<0.01-0.1)	0.04
Nitrate	mg/L		2.0±4.5 (<0.01-18)	0.2±0.2 (<0.01-0.5)	4.1±3.1 (2-6.3)
Total P	mg/L		0.2±0.1 (0.03-0.3)	0.1±0.05 (0.04-0.1)	
PO ₄ ³⁺ -P	mg/L		0.04±0.02 (<0.01-0.1)	0.03±0.02 (<0.01-0.05)	<0.05
Dissolved Iron	mg/L		0.15±0.26 (0.01-0.5)	0.05±0.01 (0.04-0.05)	1.6
Dissolved Silica	mg/L		64.8±28.3 (27.6-95.6)	37.5±23.3 (21.0-53.9)	44.7

Notes:

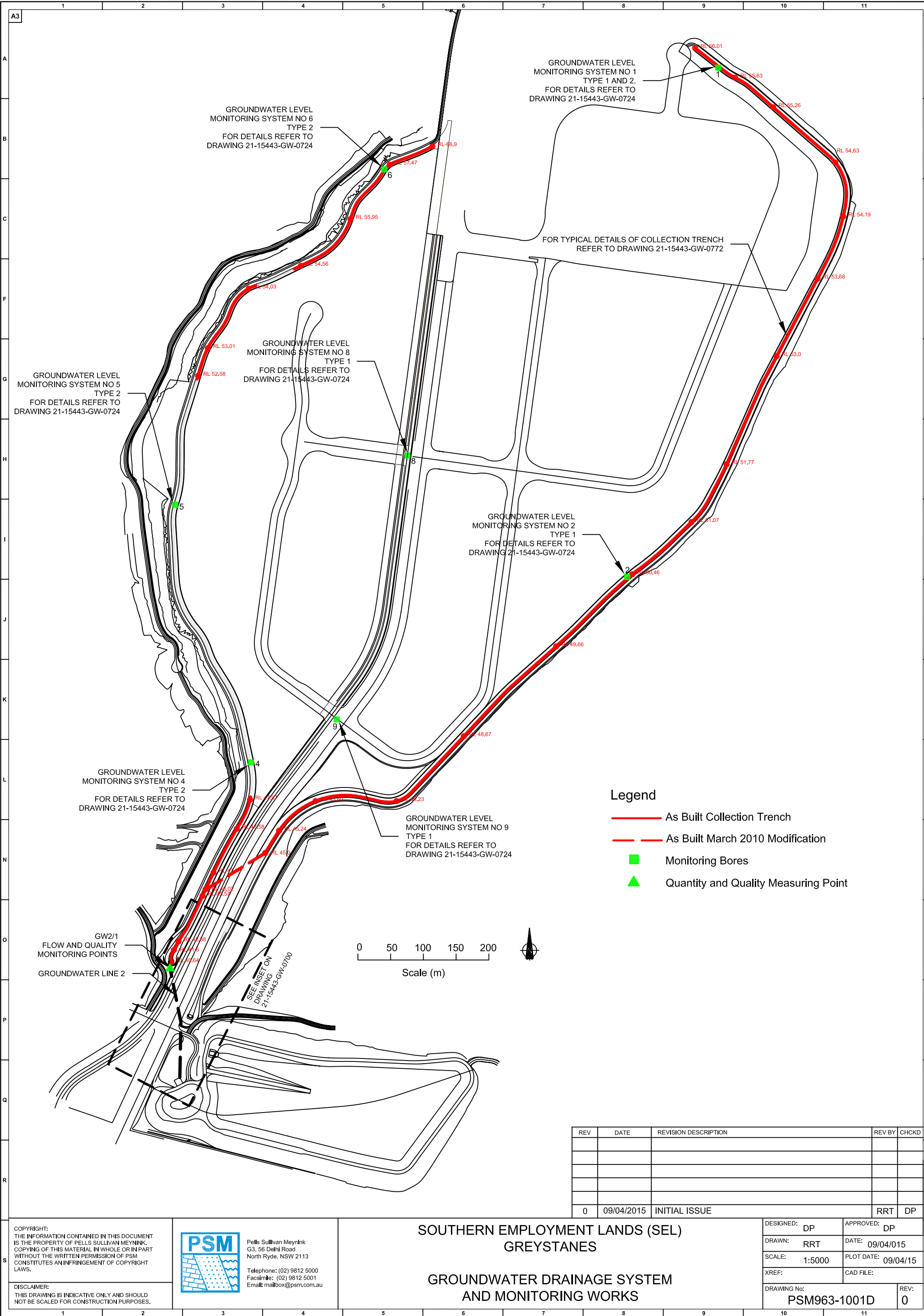
- a) MW10 destroyed prior to September 2005 monitoring round. RepMW10 is replacement, constructed in February 2006. Thus results recorded for MW10 prior to this date
- b) artificial aquifer bore/pump

SUMMARY OF GROUND WATER LEVELS (February 2014, September 2014 and January 2015)

PIEZOMETER	TYPE	DATE	MEASURED DEPTH FROM PIEZOMETER TOP (m)	COLLAR RL (m)	GROUND- WATER RL (m)	COMMENT
1	1	21/02/2014	No ground water recorded	61.03	Below 56	GW located below base of GW trench.
		25/09/2014				
	2	21/02/2014		60.99	Below 55.9	
		25/09/2014				
2	1	21/02/2014		55.67	Below 50.6	
		25/09/2014				
8	1	21/02/2014	61.23	Below 57.3		
		25/09/2014				
9	1	21/02/2014	2.55	56.97	N.A.	Inspection of piezometer indicated damaged casing and levels assessed as being due to surface inflow
9	1	16/01/2015	No ground water recorded	-	Below 53.37	Observations after the piezometer was repaired

APPENDIX C

DRAWINGS



- Legend**
- As Built Collection Trench
 - As Built March 2010 Modification
 - Monitoring Bores
 - Quantity and Quality Measuring Point

REV	DATE	REVISION DESCRIPTION	REV BY	CHKD
0	09/04/2015	INITIAL ISSUE	RRT	DP

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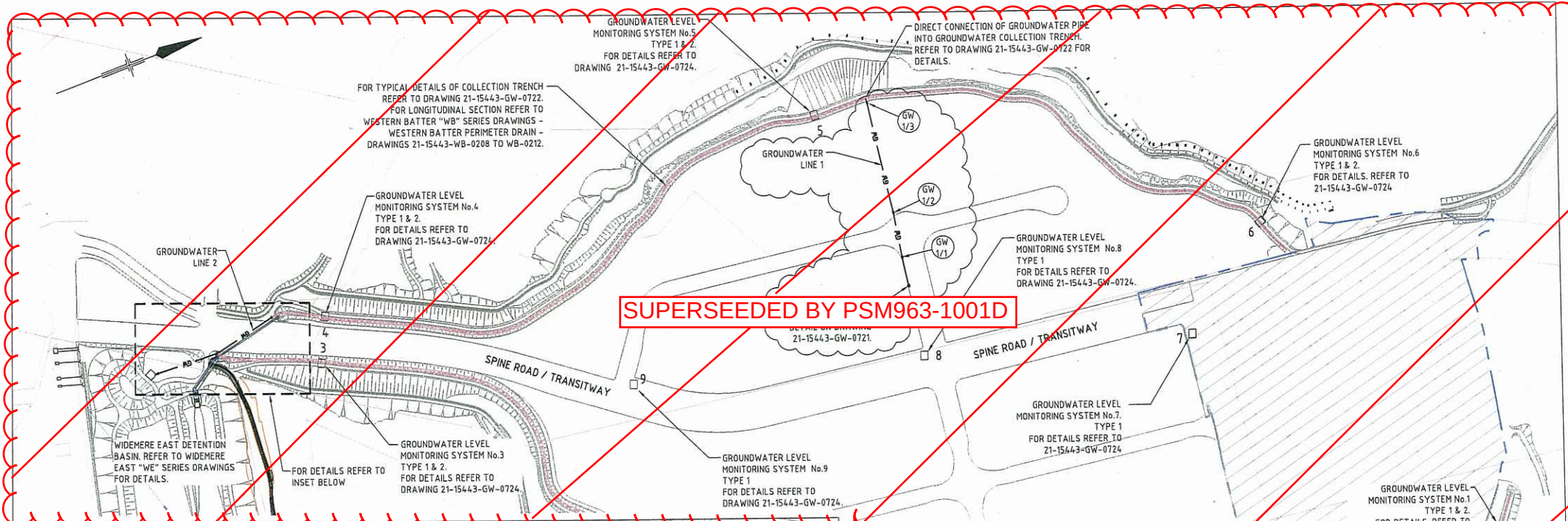
Pellis Sullivan Meynink
G3, 56 Delhi Road
North Ryde, NSW 2113

Telephone: (02) 9812 5000
Facsimile: (02) 9812 5001
Email: mailbox@psm.com.au

**SOUTHERN EMPLOYMENT LANDS (SEL)
GREYSTANES**

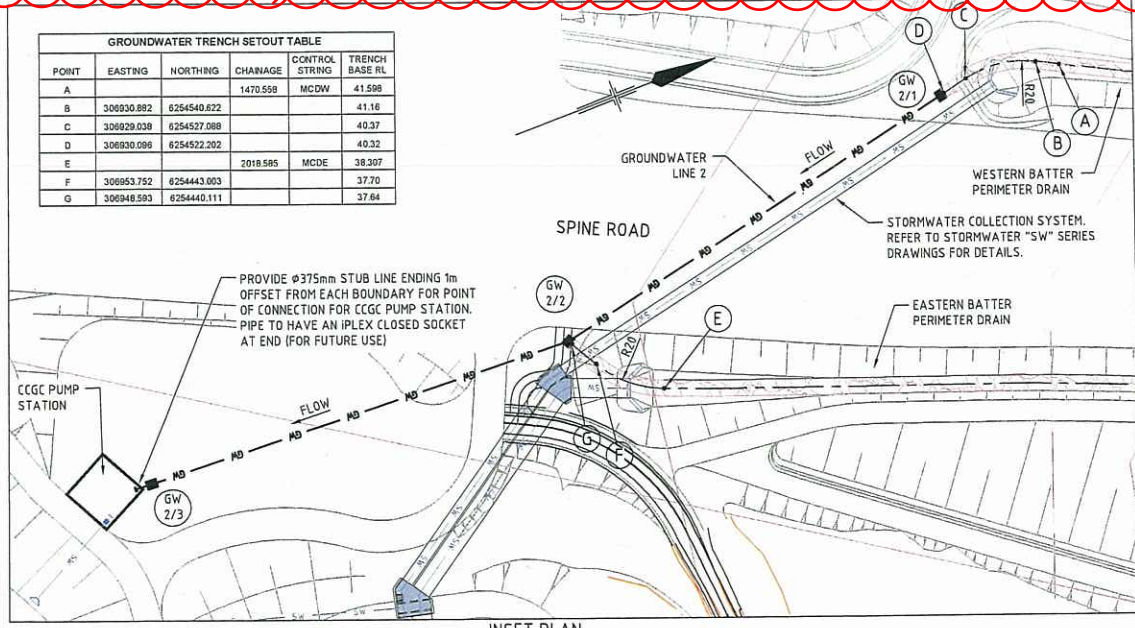
**GROUNDWATER DRAINAGE SYSTEM
AND MONITORING WORKS**

DESIGNED: DP	APPROVED: DP
DRAWN: RRT	DATE: 09/04/015
SCALE: 1:5000	PLOT DATE: 09/04/15
XREF:	CAD FILE:
DRAWING No: PSM963-1001D	
REV: 0	

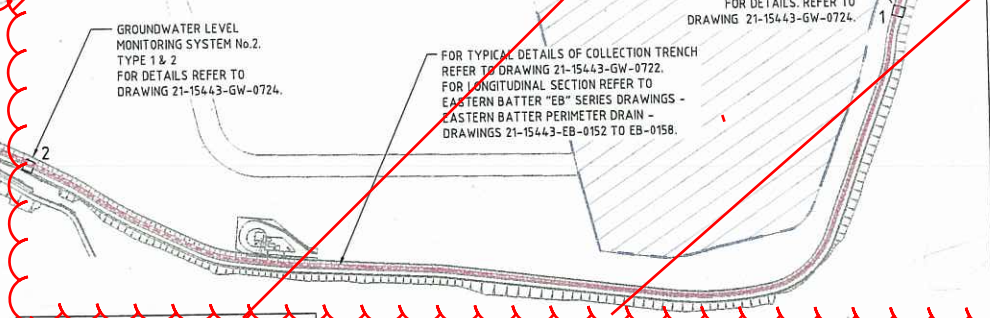


SUPERSEDED BY PSM963-1001D

POINT	EASTING	NORTHING	CHAINAGE	CONTROL STRING	TRENCH BASE RL
A			1470.558	MCDW	41.598
B	306930.882	6254540.622			41.16
C	306929.038	6254527.088			40.37
D	306930.096	6254522.202			40.32
E			2018.585	MCDE	38.307
F	306953.752	6254443.003			37.70
G	306948.593	6254440.111			37.64



INSET PLAN
SCALE 1:500



MANHOLE/ WELL	EASTING	NORTHING	CHAINAGE	CONTROL STRING
GW1/1	307155.022	6255310.014		
GW1/2	307097.812	6255320.314		
GW1/3	306954.206	6255339.812		
GW2/1	306930.254	6254521.469		
GW2/2	306947.839	6254438.744		
GW2/3	306944.770	6254357.255		
1			43.5	MCDE
2			1059	MCDE
3			1903	MCDE
4			1425	MCDW
5			688	MCDW
6			60	MCDW
7	307385.088	6255624.452		
8	307283.005	6255291.212		
9	307179.634	6254925.445		

LEGEND

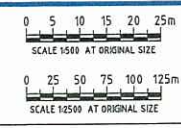
- COMPLETED SEPARABLE PORTION 1 WORKS
- GROUNDWATER MANHOLE
- EXISTING ARTIFICIAL AQUIFER
- GROUNDWATER COLLECTION PIPE
- GROUNDWATER COLLECTION TRENCH
- CADASTRAL BOUNDARY
- GROUNDWATER MONITORING WELL
- STORMWATER PIPE / CULVERT

NOTES

- THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE SPECIFICATIONS.
- FOR GENERAL NOTES REFER TO DRAWINGS 21-15443-GE-0003 TO GE-0005.
- FOR GROUNDWATER LONGITUDINAL SECTIONS REFER TO DRAWING 21-15443-GW-0710.
- FOR DETAILS REFER TO DRAWINGS 21-15443-GW-0720 TO GW-0724.
- MANHOLE SETOUT POINT TO BE CENTRE OF CHAMBER.
- MONITORING WELL SETOUT POINT TO BE CENTRE OF CASING.

FOR CONSTRUCTION

3	GROUNDWATER REDESIGN	JS	FC*	DW*	17.08.11
2	MW CO-ORDINATES AMENDED	MP	FC*	TD*	06.11.09
1	GROUNDWATER REDESIGN	SA	TD*	AH*	25.09.08
0	ISSUED FOR CONSTRUCTION	MP	TD*	AH*	25.01.08



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Drawn	V. THIAGARAJAH	Designer	J. PERTEL
Drafting	T. J. RGA*	Design	T. J. RGA*
Check		Check	
Approved	A. HORTON*	(Project Director)	
Date	29.01.08		

BORAL RECYCLING PTY. LTD.
GREYSTANES ESTATE SEL
GROUNDWATER COLLECTION LAYOUT PLAN

Client Project Title

Scale 1:2500

Drawing No: **21-15443-GW-0700**

Rev: 3

NOTE

FOR PIT DETAILS REFER TO
DRAWING 21-15443-GW-0723

★ SPECIFIED PIPE TYPES TO BE IPLEX UPVC
"BLACK MAX" OR APPROVED EQUIVALENT.

SUPERSEDED BY PSM963-1001D

FLOW DIAMETER GRADE	1L/s 300mm *	1L/s 300mm *	1L/s 300mm *	1L/s 300mm *
DATUM R.L. 28.000	1.50%	1.50%	1.50%	1.45%
INVERT LEVEL	56.22	55.65 55.61	54.73 54.69	52.52 52.48
DESIGN LEVEL	59.31	59.278	59.181	57.876 56.353
STATION	0+000	37+879	96+207	240+84.2 246+34.6

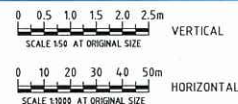
GROUNDWATER LINE 1
Scales Hor 1:1000 Ver 1:100

FLOW DIAMETER GRADE	1L/s 375mm *	1L/s 375mm *	1L/s 375mm *
DATUM R.L. 28.000	1.50%	1.00%	1.00%
INVERT LEVEL	40.32	39.07 37.64	36.81 35.77
DESIGN LEVEL	48.014	46.740	41.550 41.496
STATION	0+000	83+616	165+817 169+065

GROUNDWATER LINE 2
Scales Hor 1:1000 Ver 1:100

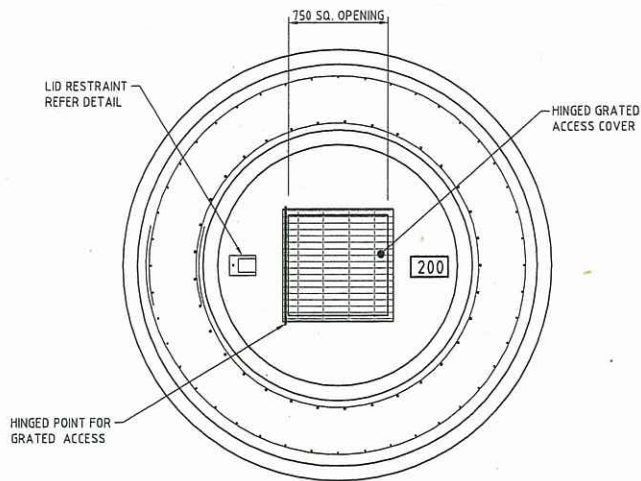
FOR CONSTRUCTION

No	Revision	Notes	Drawn	Job Manager	Project Director	Date
2	GROUNDWATER REDESIGN	LS	FC	DW	17.08.11	
1	GROUNDWATER REDESIGN	SA	TD	AH	25.08.08	
0	ISSUED FOR CONSTRUCTION	MP	TD	AH	25.01.08	

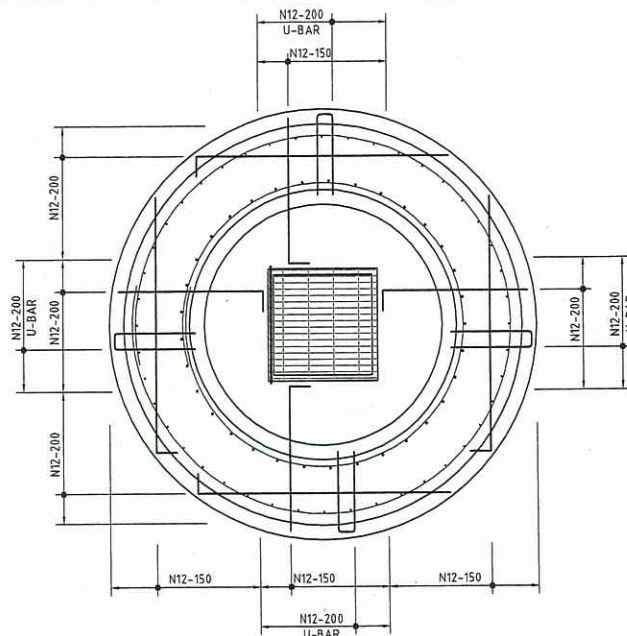


DO NOT SCALE	Drawn V. THIAGARAJAH	Designer F. CARROZZA
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	Approved A. HORTON* (Project Director)	
	Date 29.01.08	
Scale AS SHOWN		This Drawing must not be used for Construction unless signed as Approved

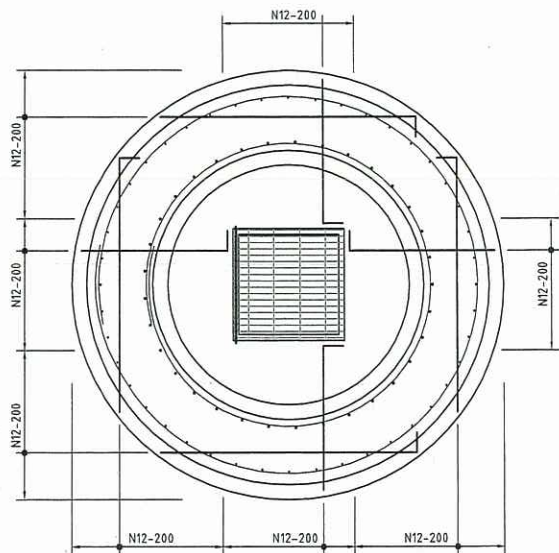
Project	Title	Revision	Drawing No	Rev
A1	21-15443-GW-0710	Rev. 2		



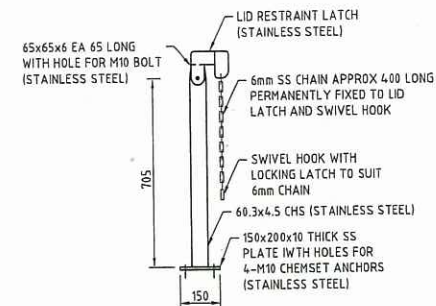
LANDING SLAB PLAN
REINFORCEMENT - BOTTOM
SCALE 1:20



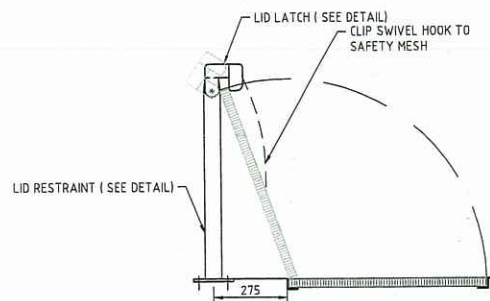
LANDING SLAB TOP
REINFORCEMENT - BOTTOM
SCALE 1:20



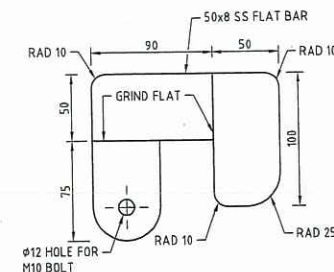
LANDING SLAB PLAN
REINFORCEMENT - BOTTOM
SCALE 1:20



LID RESTRAINT
SCALE 1:10



GEOMETRY FOR LID RESTRAINT
SCALE 1:10



LID RESTRAINT LATCH
SCALE 1:2

GRATED COVER (STAINLESS STEEL)
INSTALLED TO MANUFACTURERS
SPECIFICATIONS

N12 FISHTAIL AT 200 CTS. CFW TO
ANGLE/COVER (STAINLESS STEEL)
FRAME SPECIFIED IN MANUFACTURER'S
SPECIFICATION (40x40x5 EA)

1 DETAIL
SCALE 1:10

FOR CONSTRUCTION

No	Revision	Date	By	Check	Appr	Desc
1	REVISION CLOUD REMOVED	25.09.08	SA	TDM	AH	
0	ISSUED FOR CONSTRUCTION	25.01.08	MP	TDM	AH	

0 100 200 300 400 500mm
SCALE 1:10 AT ORIGINAL SIZE

0 200 400 600 800 1000mm
SCALE 1:20 AT ORIGINAL SIZE



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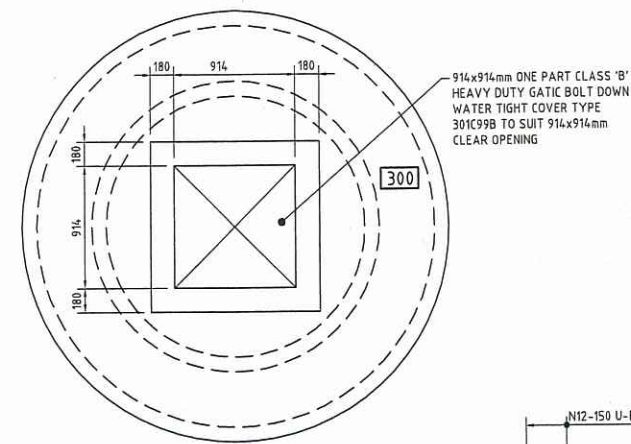
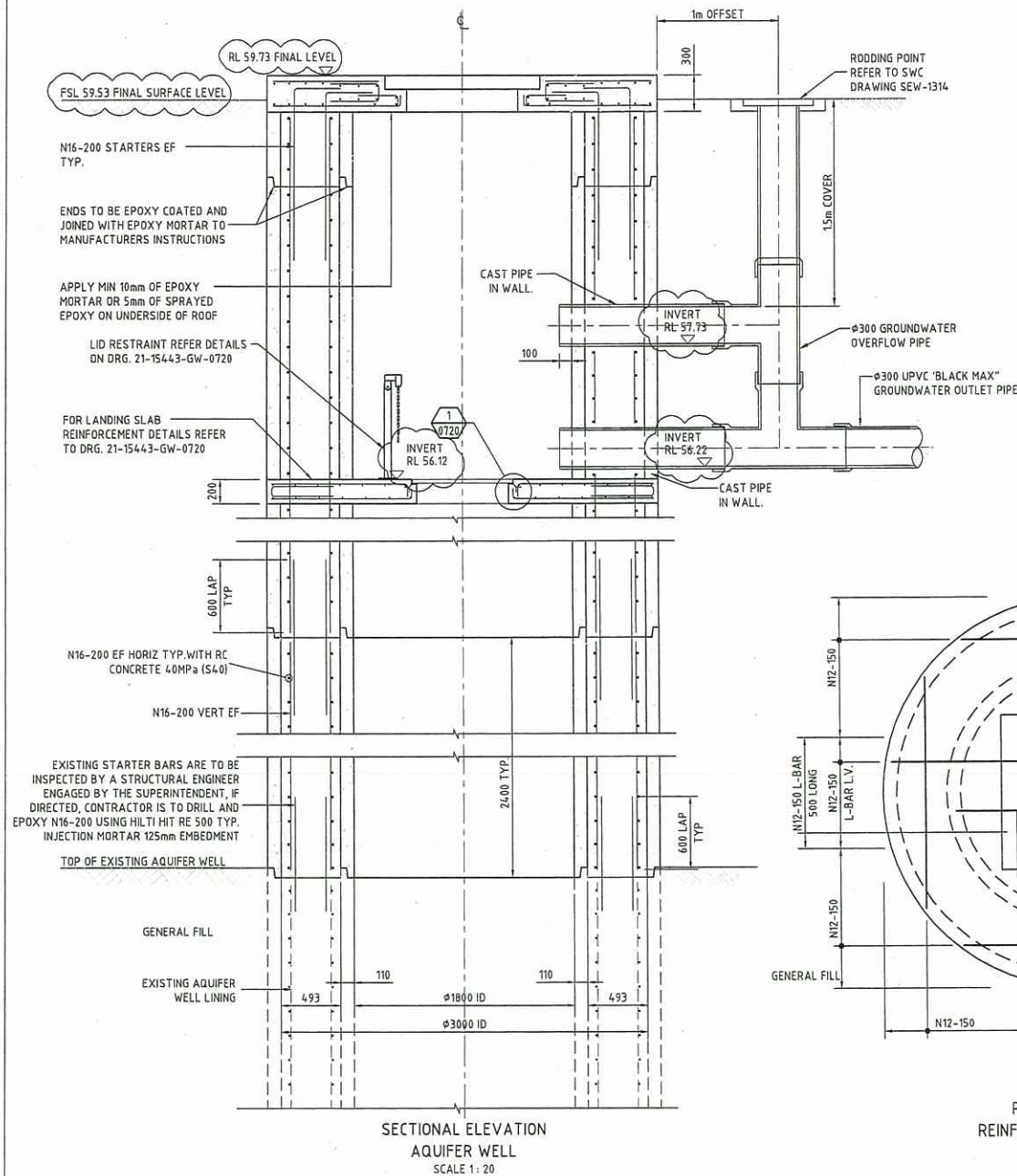
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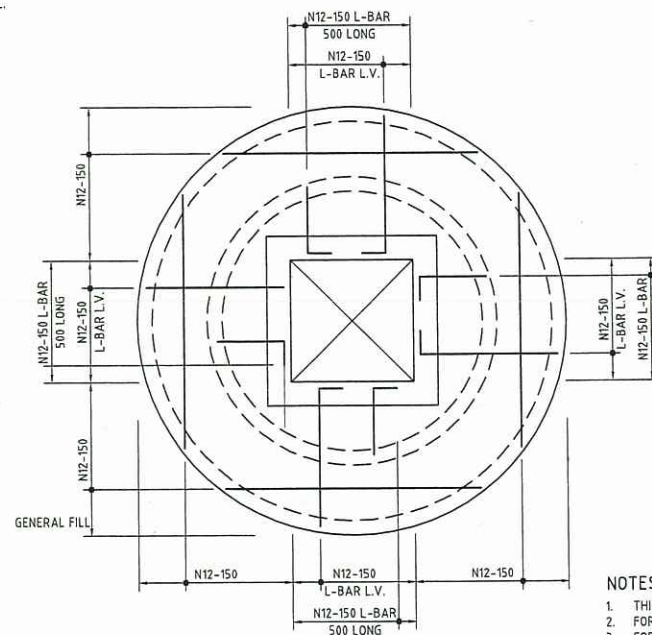
Drawn	V.THAGARAJAH	Designer	F.CARROZZA
Checked	T.IRGA*	Design	T.IRGA*
Approved	A.HORTON*	Date	29.01.08
Scale	AS SHOWN		

Client	BORAL RECYCLING PTY. LTD.
Project	GREYSTANES ESTATE SEL
Title	GROUNDWATER COLLECTION
	AQUIFER WELL DETAILS - SHEET 1 OF 2
Sheet No	A1
Drawing No	21-15443-GW-0720

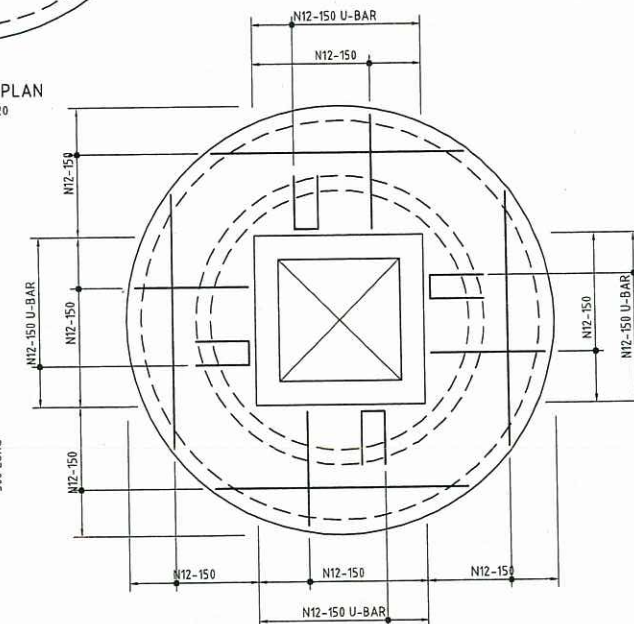
Rev: 1



ROOF SLAB PLAN
SCALE 1:20



ROOF SLAB PLAN
REINFORCEMENT - BOTTOM
SCALE 1:20



ROOF SLAB PLAN
REINFORCEMENT - TOP
SCALE 1:20

NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE SPECIFICATIONS.
2. FOR GENERAL NOTES REFER DRAWINGS 21-15443-GE-0003 TO 0005.
3. FOR LOCATION OF AQUIFER WELL REFER DRAWING 21-15443-GE-0700
4. CONCRETE COVER = 40mm FOR ROOF
5. CONCRETE COVER = 50mm FOR WALLS
6. CONCRETE $f'c$ 40 MPa
7. IT IS ASSUMED THAT EXISTING PUMP AND ELECTRICAL APPARATUS IS MAINTAINED FOR CONSTRUCTOR USE FOR SITE EARTHWORKS OPERATION. ONCE WORKS ON SITE ARE COMPLETE THE PUMP AND ELECTRICAL APPARATUS ARE TO BE DISASSEMBLED AND REMOVED FROM SITE.

FOR CONSTRUCTION

No	Revision	Note	Drawn	Job Manager	Project Director	Date
1		AQUIFER WELL LEVELS AMENDED	JS	FC*	DW*	10.08.11
2		AQUIFER WELL LEVELS AMENDED	SA	TDH*	AH*	25.09.08
0		ISSUED FOR CONSTRUCTION	MP	TDH*	AH*	25.01.06

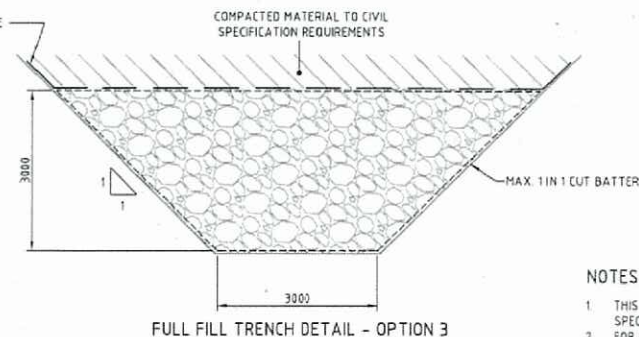
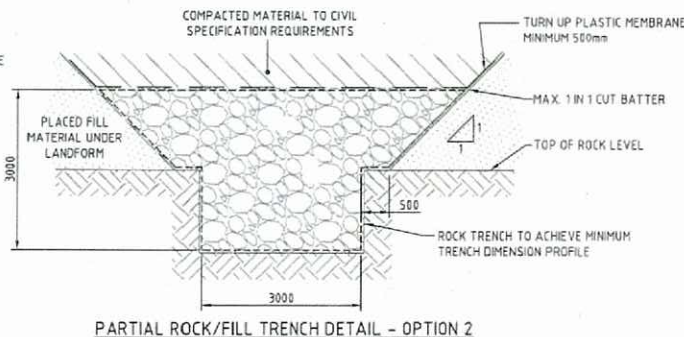
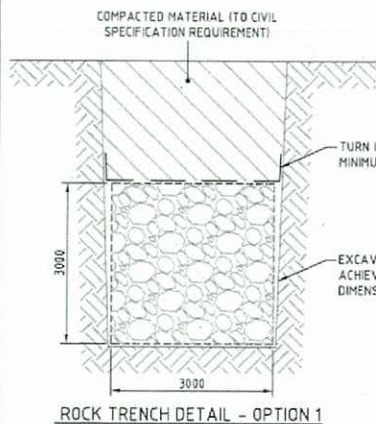
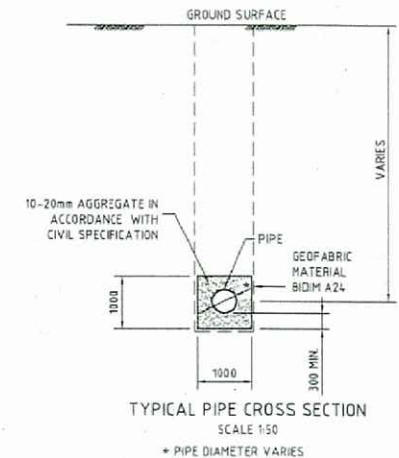
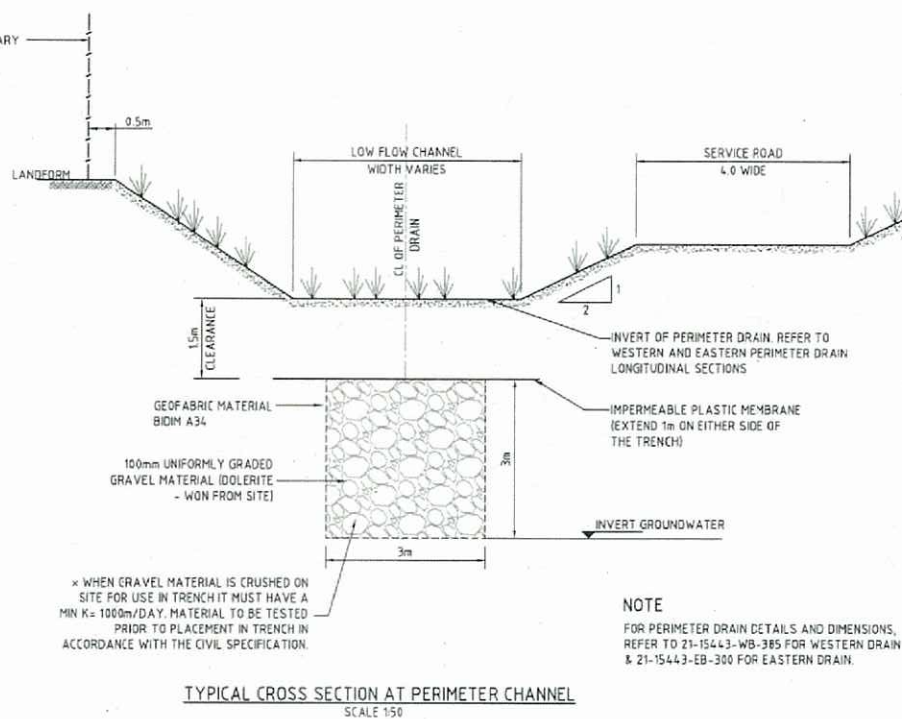
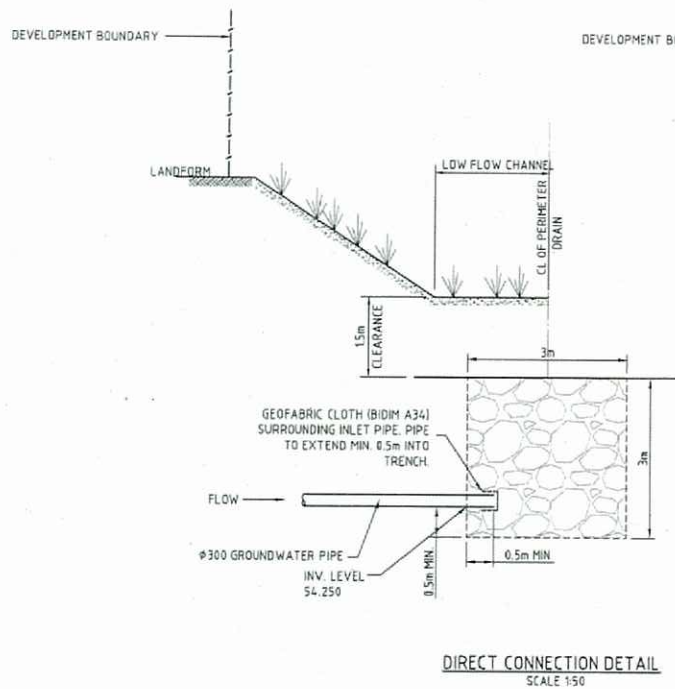


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	Approved A.HORTON* (Project Director)	Date 29.01.08
	Scale AS SHOWN	This Drawing must not be used for Construction unless signed as Approved

Client **BORAL RECYCLING PTY. LTD. GREYSTANES ESTATE SEL**
Project **GROUNDWATER COLLECTION AQUIFER WELL DETAILS - SHEET 2 OF 2**
Title
Drawing No: **21-15443-GW-0721**

Rev: 2



GROUNDWATER TRENCH CONNECTION METHODS
SCALE 1:50

GROUND WATER TRENCHING OPTIONS PROVIDED ARE ONLY A GUIDE FOR THE CONTRACTOR. ANY OTHER OPTION PROPOSED BY THE CONTRACTOR SHALL ENSURE A MINIMUM BASE WIDTH OF 3m

NOTES

- THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE SPECIFICATIONS.
- FOR GENERAL NOTES REFER DRAWINGS 21-15443-GE-0003 TO 0005.
- GROUNDWATER PIPE TO BE UPVC IPLEX "BLACK MAX" PIPE OR EQUIVALENT.

FOR CONSTRUCTION

0	ISSUED FOR CONSTRUCTION	MP	25.01.08
Rev	Revision	Drawn	Checked
1	Issued for construction	MP	25.01.08

0 0.5 1.0 1.5 2.0 2.5m
SCALE 1:50 AT ORIGINAL SIZE



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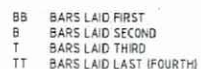
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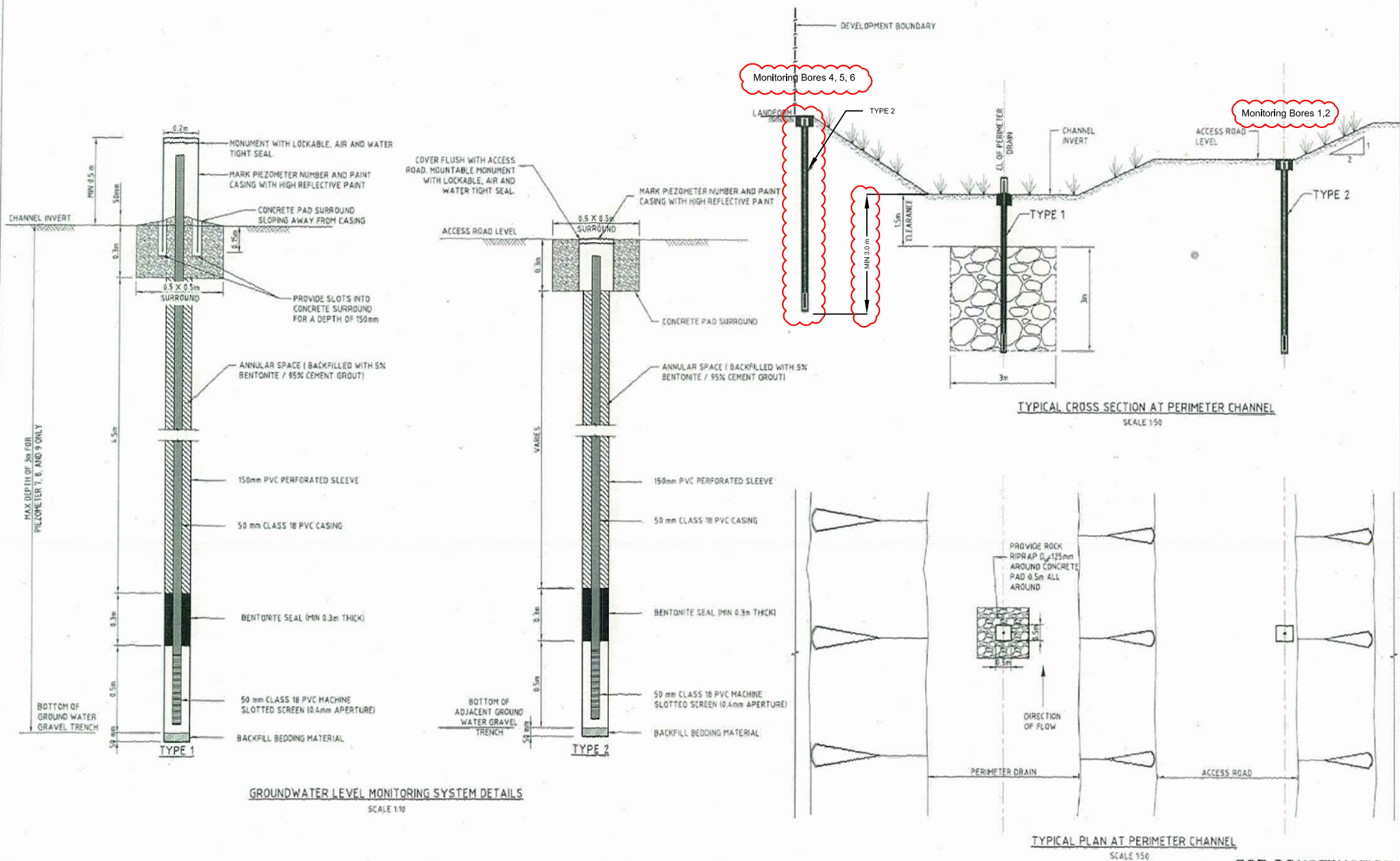
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Drawn	V. THAGARAJAN	Designed	F. CARROZZA
Checked	[Signature]	Design Check	[Signature]
Approved	[Signature]	Scale	AS SHOWN

Client	BORAL RECYCLING PTY. LTD.
Project	GREYSTANES ESTATE SEL
Title	GROUNDWATER COLLECTION
Sheet No	TYPICAL DETAILS - SHEET 1 OF 3
Drawing No	21-15443-GW-0722
Rev	0

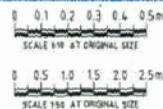


Case File No. G 2115443-CAD/CFO/sereno/21-15443-W 2025 Aug



FOR CONSTRUCTION

0	ISSUED FOR CONSTRUCTION	MP	AM	25.01.08
1	Revised	Notes	1. Indicate any changes to original design or drawings of the project or drawing.	Drawn: [Signature] Approved: [Signature] Date: [Date]



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Checked: [Signature]	Design Check: [Signature]	Project: GREYSTANES ESTATE SEL
Approved: [Signature]	Date: 29/1/08	Title: GROUNDWATER COLLECTION
Scale: AS SHOWN		Sheet: A1

BORAL RECYCLING PTY. LTD.
GREYSTANES ESTATE SEL
GROUNDWATER COLLECTION
TYPICAL DETAILS - SHEET 3 OF 3

Drawing No: 21-15443-GW-0724

Rev: 0