
Groundwater Management Plan

Lucas Heights Resource Recovery Park

19 Little Forest Road, Lucas Heights NSW

**Prepared for Cleanaway Operations Pty
Ltd**

Project 85988.06

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The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

Signature

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Definition of Terms

ADWG	Australian Water Quality Guidelines
ANSTO	Australian Nuclear Science and Technology Organisation
ANZECC	Australian and New Zealand Environment and Conservation Council
ARRT Facility	Advance Resource Recovery Facility
AWQG	Australia Water Quality Guidelines
bgl	Below ground level
BH	Borehole
Douglas	Douglas Partners
DPI Water	Department of Primary Industries, Office of Water
EPL	Environmental Protection Licence
GALC	Gandangara Local Aboriginal Land Council
GDE	Groundwater dependant ecosystem
GHD	Gutteridge Haskins & Davey
GMP	Groundwater Management Plan
GMRRW	Guidelines for Managing Risk in Recreational Waters
GO Facility	Garden Organics Facility
GRAP	Groundwater Remediation Action Plan
HDPE	High density polyethylene
IWC	Industrial Waste Collection
LHRRP	Lucas Heights Resource Recovery Park
MB	Monitoring Bore
MC	Mills Creek
NHMRC	National Health and Medical Research Council

NSW EPA	New South Wales Environment Protection Authority
OEMP	Operation environmental management plan
SBR	Sequencing batch reactor
SCC	Sutherland Shire Council
SICTA	Sydney International Clay Target Association
SSD 6835	The Development Consent
SUEZ	SUEZ Australia Pty Ltd

Table of Contents

	Page No
1. Introduction.....	1
2. Site description.....	2
3. Background and proposed works.....	5
3.1 Background.....	5
3.2 Approved works.....	6
4. Geology and hydrogeology.....	8
4.1 Local geology and hydrogeology.....	8
4.2 Existing groundwater use in region.....	11
4.3 Leachate and groundwater extraction.....	17
4.4 Groundwater dependant ecosystems.....	22
5. Monitoring programme.....	24
6. Groundwater investigation trigger levels.....	34
7. Investigation, notification and mitigation procedure.....	38
7.1 Groundwater.....	39
7.2 Surface water.....	40
7.3 Water level triggers.....	41
7.4 GO facility trigger response plan.....	41
8. Remediation options.....	45
8.1 Groundwater contamination.....	46
9. Conclusions.....	46
10. References.....	47
11. Limitations.....	47

- Appendix A:** About This Report
- Appendix B:** Drawings
- Appendix C:** Monitoring Bore Status
- Appendix D:** EPL
- Appendix E:** Historic Test Bore Logs

Appendix F: DPI / DOI Correspondence

Appendix G: Groundwater Contour Plots and Cross Sections

Appendix H: Groundwater Well Installation Reports

Groundwater Management Plan Lucas Heights Resource Recovery Park

19 Little Forest Road, Lucas Heights NSW

1. Introduction

This report prepared by Douglas Partners Pty Ltd (Douglas) provides the groundwater management plan (GMP) prepared for the Lucas Heights Resource Recovery Park at 19 Little Forest Road, Lucas Heights NSW (the site). The management plan was commissioned by the Statement of Work dated 16 May 2024 from LC Chiang of Cleanaway Operations Pty Ltd and was undertaken in accordance with Douglas' proposal 85988.09.P.001.Rev1 dated 22 April 2024.

The report is a revision to the GMP prepared in 2018, Douglas report Groundwater Management Plan, Lucas Heights Resource Recovery Park, 19 Little Forest Road, Lucas Heights NSW, Report 85988.00.R.001.Rev2 dated 31 January 2018 (Douglas 2018). The primary purpose of the revision is to provide the details of the monitoring requirements and the trigger action plan specific to the GO Facility as well as other minor revisions.

The GMP has been prepared in accordance with Condition No. 35 of the Development Consent SSD 6835 which requires a plan that must:

- a) *Be prepared by a suitably qualified and experienced consultant, in consultation with the EPA and DPI water;*
- b) *Be submitted to the secretary, prior to the commencement of construction;*
- c) *Detail the groundwater monitoring network including location and frequency of monitoring, the parameters for testing, relevant criteria and trigger levels for action;*
- d) *Include a protocol for investigation, notification and mitigation of any exceedances of the identified trigger values; and*
- e) *Describe the measures that could be implemented to respond to identified groundwater contamination.*

This revision of the GMP has been prepared to address the following requirements:

- The monitoring requirements specifically related to the GO Facility as specified in Table 5.1 at locations LW510, MB057, MB056, MB510, MB511, MB512 and SP510; and
- Inclusion of the Trigger Action Plan related to the GO Facility into the GMP.

In addition to the above considerations, the GMP takes into consideration comments from the Department of Primary Industries (DPI), Office of Water provided in a letter dated 19 April 2017 (refer to Appendix F), including a review of the existing water balance and a review of the groundwater monitoring network and further comments provided in correspondence from DPI Water dated 10 August 2017 (provided in Appendix F).

Furthermore, the NSW Department of Primary Industries (DPI), in a letter dated 10 October 2017 (provided in Appendix F) determined that the request to update the monitoring points and locations on the Licence is appropriate (the monitoring points included in this report) however recommended that the monitoring programme include additional analytes. Additional requirements from the Department of Industries (DOI) in a letter (reference no. OUT18/13125, provided in Appendix F) are also address in this revision.

Douglas note that DPI is how part of the Department of Planning and Environment (DPE) which is comprised of the NSW Department of Climate Change, Energy, the Environment and Water (DCCEEW) and the Department of Planning, Housing and Infrastructure (DPHI).

2. Site description

The site is identified as the Lucas Heights Resource Recovery Park (LHRRP). The site location is presented in Figure 1 (Figure 1.4 from GHD 2015) on Page 3 of this report.

The LHRRP is located within the Sutherland local government area, approximately 30 kilometres (km) south-west of the Sydney city centre.

Reprofiling of the landfill is proposed and would be located within the boundary of the existing LHRRP. The site is bounded to the west by Heathcote Road and New Illawarra Road to the south. Specifically, the proposed reprofiling would be located on:

- Lot 101 DP 1009354;
- Lot 3 DP 1032102; and
- Lot 2 DP 605077.

It is noted that the proposal directly affects only a portion of each of these lots. There is minimal encroachment into the Sydney International Clay Target Association (SICTA) leased land (part of Lot 3 DP 1032102).

The LHRRP site is currently accessed from Little Forest Road, off New Illawarra Road. Current facilities at the LHRRP include:

- Landfill;
- Resource recovery centre and waste collection point;
- GO facility for processing garden organics;
- Renewable energy production (operated by Energy Developments Ltd);
- Truck parking area;
- Community use areas (mini bike area at the southern extent of the site run by the Sutherland Police Citizens Youth Club and the SICTA leased land on the north western side of the site); and
- There are also several ancillary buildings and structures (e.g. weighbridge, machinery workshop, administration offices, stormwater and leachate dams).

The following land uses are located in the immediate vicinity of the LHRRP:

- Bushland areas that form part of ANSTO's exclusion zone (to the east and south);
- ANSTO's facilities (to the east on the opposite side of New Illawarra Road);
- Land uses in the surrounding area include:
 - o Holsworthy Military Reserve (to the west, northwest and southwest);
 - o The Ridge Sports Complex, a major regional sporting facility being developed on the site of the former Lucas Heights Waste and Recycling Centre (approximately 2.5 km to the north-east);
 - o Lucas Heights Conservation Area (immediately to the north of the LHRRP); and
 - o The suburbs of North Engadine (approximately 2 km to the east) and Barden Ridge (approximately 3 km to the north-east) Figure 1 shows these key areas.

The Gandangara Local Aboriginal Land Council (GALC) is proposing a development in the West Menai area. The West Menai State Significant Site contains 849 ha of mostly undeveloped land, covering parts of Menai, Barden Ridge and Lucas Heights.

The western boundary of the proposed development is Heathcote Road and the site extends east across Mill Creek to the edge of the existing Menai residential area close to New Illawarra Road.

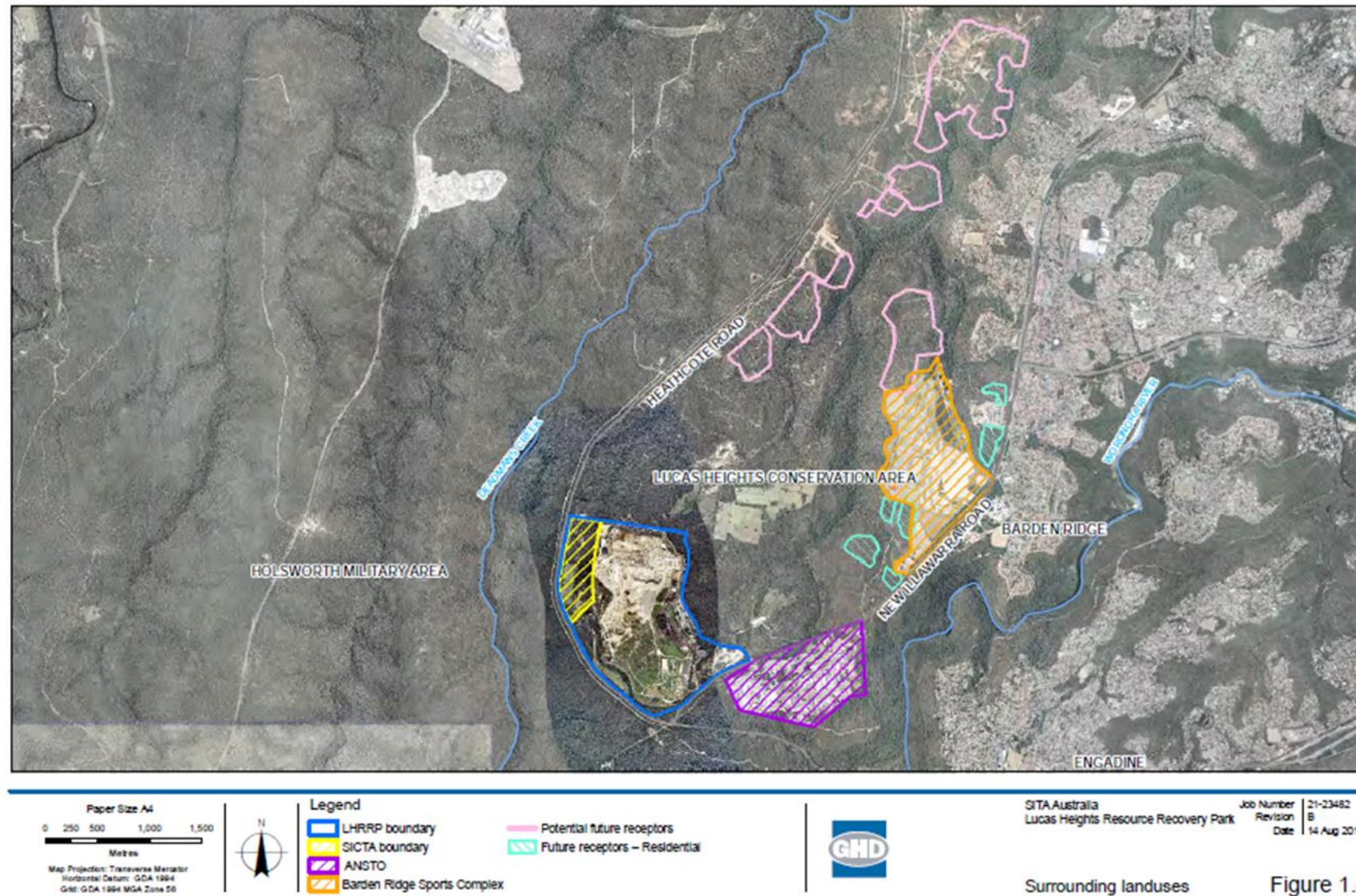


Figure 1: Site location and surrounding features (GHD 2015)

3. Background and proposed works

3.1 Background

The LHRRP is located within a forested area. The nearest residential areas are North Engadine (approximately 2 km to the east) and Menai and Lucas Heights located approximately 3 to 4 km to the north-east of the LHRRP. The area surrounding the LHRRP has had historical landfilling activities associated with municipal and industrial waste disposal. Previous landfill sites are listed below:

- Harrington's Quarry landfill which is understood to have briefly operated in 1987 and received municipal waste (NSW WAMC, 2012);
- Industrial Waste Collection (IWC) Landfill which operated between 1968 and 1976 and received liquid industrial wastes;
- Night Soil and Sludge Landfill which operated between 1965 and 1983 and received sludge and night soil from sewage treatment activities; and
- Little Forest Burial Ground, which operated between 1958 and 1963 and was filled with waste from ANSTO.

The LHRRP originally opened in 1987 (Mitchell McCotter & Associates Pty Ltd, 1991) based on a development consent received in 1985 permitting waste disposal operations. A development application was submitted and approved in 1999 which permitted the expansion of waste disposal operations and also the development of composting and other resource recovery operations at the site. The final land-use was approved to be parkland over the majority of the site with potential on-going composting and other resource recovery operations located on the eastern side of the site.

The site is currently licenced for the following activities under an environmental protection licence (EPL) under Section 55 Protection of the Environment Operations Act 1997, EPL No. 5065.

- Waste disposal (application to land);
- Waste storage (waste tyres and other types of waste; and
- Non thermal treatment of Liquid Waste.

The EPL is provided in Appendix D of this report. This EPL also includes the current licenced groundwater monitoring requirements. There are two additional EPL's for the site, EPL No. 12520 for non-thermal treatment of general waste and composting and EPL No. 13114 for waste storage (other types of waste).

On 23 January 2017 as part of SSD 6835, SUEZ received approval for various activities including increase in landfill capacity, relocate and expand the garden organics facility and construct and operate a new resource recovery facility. More detail regarding the approved works are described below in Section 3.2.

3.2 Approved works

This GMP has been prepared in response to the approved reprofiling of the existing landfill. The scope of the approved works has been extracted from the Environmental Impact Assessment (GHD 2015).

The proposed reprofiling of existing landfill areas will provide up to 8.3 million cubic metres of additional landfill airspace capacity. The process of reprofiling would include removal and replacement of existing capping material over previously landfilled waste and augmentation of gas and leachate collection systems. The environmental performance of the site will ultimately be improved by reducing the infiltration of stormwater into the landfill (resulting in reduced landfill leachate over the longer term) and would increase the overall amount of landfill gas recovered from the site.

As part of the proposal, SUEZ is seeking permission to increase the approved quantity of waste for landfilling at the site from 575,000 to 850,000 tonnes per year. This would enable the reprofiling of the site to be completed in 2037.

In addition to the reprofiling works the other future proposed development include the following:

- Relocation and expansion of the existing garden organics (GO) facility. The existing garden organics facility would be relocated to the western side of the site adjacent to Heathcote Road. Approval is being sought to increase the approved capacity from 55,000 to 80,000 tonnes of green waste and garden waste received per year at the facility. The new facility would include the partial enclosure, active aeration and covering of the first four weeks of the active composting process, which coincides with the period of highest potential for odour generation, to enable more effective control of odour. Relocation of the facility would result in increased separation distances from the current nearest occupied land at ANSTO, existing residential areas and the proposed new residential area at West Menai;
- Construction and operation of a fully enclosed advanced resource recovery technology (ARRT) facility. The ARRT facility would be located on the western side of the site adjacent to the GO facility and would process and recover valuable resources from up to 200,000 tonnes of general solid waste per year, reducing the amount of waste disposed to landfill to approximately 60,000 tonnes per year. This would divert up to 140,000 tonnes of waste per year from landfill. SSC and other councils would have the opportunity to have their municipal waste processed by the ARRT facility; and
- Community parkland. The landfill reprofiling would increase the area available for future passive recreation following site closure from 124 ha (existing approved parkland) to a total of 149 ha, an increase of approximately 25 ha. Landfilling would cease in 2037 after which time the site would be rehabilitated to form community parkland, with capping and landscaping to be completed and the site made available for community use in 2039.

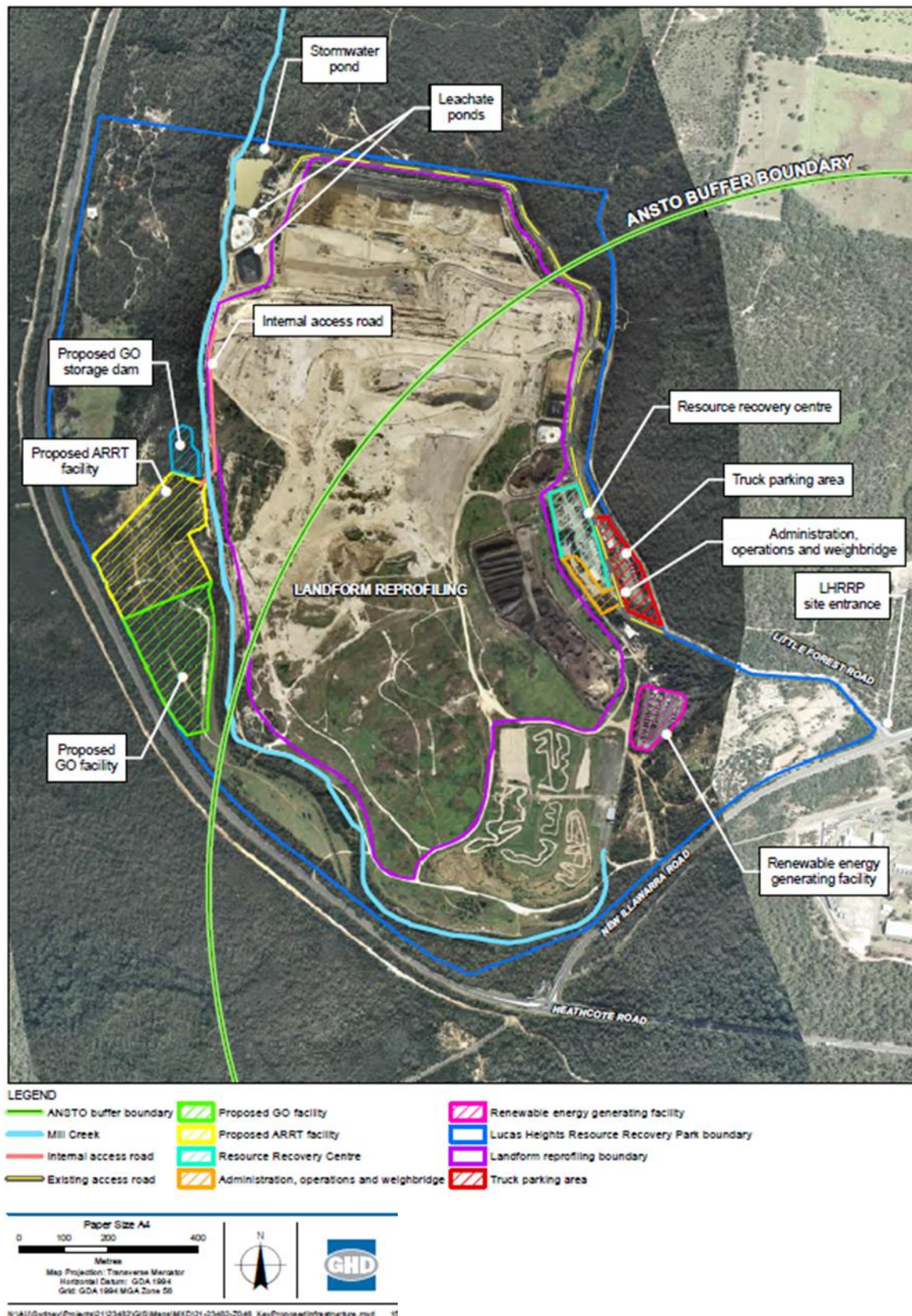


Figure 2: Approved works (from GHD 2015)

4. Geology and hydrogeology

4.1 Local geology and hydrogeology

Detailed geological characterisation has been completed at the LHRRP as part of previous investigations. This included, review of regional geological data, site (drilling) investigations, seismic surveys and geological mapping of jointing on exposed surfaces. The findings of these investigations are summarised below. Test bore logs from the previous investigations are provided in Appendix E and Appendix H.

The LHRRP site is located on the Woronora Plateau which is primarily comprised of Triassic aged Hawkesbury Sandstone of thicknesses approximating 200 m. The Hawkesbury Sandstone is comprised of cross bedded massive sandstones, laminates and occasional black shale and claystone lenses. The sandstone matrix is often well cemented.

During investigations in 1994, 2000 and 2003 (Douglas 1994, Douglas 2000 and Douglas 2003)¹ the following profile was typically encountered:

- Surficial Clayey SAND / Sandy CLAY ranged in depth from 0 to 2.8 m bgl;
- Very low strength weathered SANDSTONE extending from ground surface or beneath unconsolidated sediments to depths of up to 6.1 m bgl; and
- Medium to high strength slightly fractured to unbroken SANDSTONE extending from the base of the low strength sandstone to depths of 60 m bgl). Laminate and siltstone layers were noted in some bores.

Douglas (1994) found that sandstone lithology dominates the area although minor horizons of shale and laminite were recorded. A persistent argillaceous band was identified at the site but it is not necessarily continuous, these horizons appear to be washed out in some areas.

Geological mapping undertaken in Douglas (1994) indicates that shale outcrops are present at the site, predominately in the north-east. The shale layers tended to dip to the north at between 2 and 5 degrees, however, the regional dip of the geology is considered to be to the north at an overall slope of 1.5 to 2 degrees. Regional jointing systems have also affected this environment with surface drainage developing along well developed and relatively continuous jointing systems at spacings of 300 to 400 m (Douglas 1994).

¹ D. J. Douglas & Partners 1994. Report on Hydrogeology and Groundwater Monitoring, Waste Depot, Lucas Heights. Report 14780 dated 11 May 1994 (Douglas 1994).

Douglas Partners 2000. Report on Geotechnical Assessment, Assessment of Fractured Rock, Lucas Heights Waste Management Depot, Lucas Heights, Douglas Project 14780 X, dated May 2000

Douglas Partners 2003. Summary Report of Groundwater Investigations – Assessment of Fractured Rock, Lucas Heights, prepared for Lucas Heights Waste Management Centre, Project 14780X May 2003 (Douglas 2003).

It is inferred that these jointing systems have resulted in the development of the primary surface water features including Mill Creek and Deadmans Creek and Woronora River. On a more local scale jointing spacing of between 1 and 3 m common and can be laterally extensive (up to 100 m being common), however, vertical continuity is generally limited to less than 20 m (Douglas 1994). Geological mapping undertaken in Douglas (1994) suggest that local jointing is orientated in NNE and ESE directions.

Surface weathering of the bedrock in the vicinity of LHRRP is generally considered to be less than 2 m (Douglas 1994). DP (1992) reported that the Hawkesbury Sandstone had been subject to lateritic weathering and that the extent and depth of the weathering is variable across the site. This was confirmed with seismic surveys which also suggested the presence of two to four distinct layers that reflected variation in the type and depth of weathering. Generally, the weathered layers were deeper on the ridges and shallower in the valleys.

Geological mapping undertaken in 2000 (Douglas 2000) indicated that a fractured zone approximately 15 m wide was present in the northern face of the landfill excavation (NE corner of landfill site, refer to Figure 3 for approximate location) which may have been induced by blasting. The permeability in the fracture zone would be expected to be higher than the surrounding lithology. It is noted that since 2000 the landfill batter has been excavated further, effectively removing the fracture zone (or the majority of it). This area was subsequently lined with a geo-synthetic liner and landfilled.

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Figure 3: Approximate location of former fracture zone

Groundwater levels measured in Douglas (1994) indicate that the groundwater gradient is to the north to north-west. Subsequent monitoring undertaken at the site since then has generally confirmed this assessment, although the local gradient is strongly influenced by structural and topographic features. It should be noted that water levels in fractured sandstone reflect the groundwater pressures in the fracture systems that are intersected in those boreholes. Where several fracture systems with different pressures are intersected, the measured water level will be the intermediate level and reflect the hydraulic conductivity as well as relative pressure in each of the joint systems.

While the groundwater regime of the Mill Creek catchment is complex the results of Douglas (1994) indicates that intergranular permeability of the local sandstone is very low, although significant secondary permeability exists in the form of fissures which probably arise from stress relief fracturing. These fissures are typically at a depth of 30 to 50 m in the Mill Creek Valley.

A variety of techniques were used to assess the hydraulic characteristics of the sandstone formation that dominates the lithology at the site including packer tests, slug tests, and pumping tests (Douglas 1994). The measured hydraulic conductivity and transmissivity was found to be strongly related to structural features. High hydraulic conductivities were found to be localised over discrete and relatively narrow depth intervals associated with fracturing.

The measured hydraulic conductivity at the site showed considerable variability, however a pattern was noted (Douglas 1994). The results of hydraulic conductivity tests in the fracture zone in the north-west of the site indicated a transmissivity of 3 to 5 m²/day. Elsewhere along Mill Creek fracture zone north-west of the site the measured transmissivity ranged from 1 to 6 m²/day in packer tests and 19 to 25 m²/day from pumping tests. Outside the Mill Creek fracture zone the transmissivities were lower in the range of 0.1 to 3 m²/day. Therefore, the transmissivities of the sandstone formation in the vicinity of the landfill site is typically much lower than that near Mill Creek. It was noted that during a site inspection on 11 May 2017 that only minor seepage was observed in the sandstone walls of the cells on the northern boundary of the site.

Douglas (1994) concluded that there was a potential for contaminant transport through the deep fracture systems in the Hawkesbury Sandstone if leachate penetrates the shallow low permeability sandstone and enters the groundwater system at depth. In this regard monitoring of the low permeability sandstone around the site boundary (up to a depth of 30 m bgl) is recommended. The impact of landfill leachate (if any) on groundwater should be identified in the low permeability formation before it encounters the deep fracture systems, whereupon undertaking remediation and / or containment of such contamination would become far more difficult.

Interpreted groundwater contours from 1992, 1997, 2005 and 2014 (extracted from GHD 2015d), are presented in Appendix G. The figures demonstrate that the direction of groundwater flow at the site is and has been consistently to the north to north-west. Interpretive geological cross sections from the same years (also extracted from GHD 2015d) are also presented in Appendix G. The cross sections further demonstrate the groundwater gradient to the north to north-west in relation to the depth and position of Cells 5.2 and 5.3 and the depth of the test bores / groundwater wells through the profile. The figures clearly demonstrate that the test bores were drilled well below the design depths of the landfill cells and therefore will more than adequately profile the underlying geology and the groundwater at and below the site.

4.2 Existing groundwater use in region

The 1:2,000,000 Groundwater in New South Wales, Assessment and Pollution Risk Map indicated that the LHRRP is likely to be underlain at depth (below the Hawkesbury sandstone that extends up to 200 m bgl) by fractured pre-Permian rocks, mainly of igneous and metamorphic origins; with a low to medium potential for groundwater movement. The map also indicates that groundwater salinity is likely to be between 0 mg/L and 1,000 mg/L, which is suitable for stock, domestic and some irrigation purposes.

At present little use is made of the groundwater of the Woronora Plateau for either domestic or agricultural purposes. Douglas conducted a review of existing registered groundwater borehole records using the NSW Water Information Database. The location of the registered groundwater bores is presented in Figure 4 and the bore details are summarised in Table 1. The licenced groundwater bores are associated with three different properties and all are used for monitoring purposes. The majority of the bores are located within or to the north of the LHRRP, eleven of the bores were related to the former Lucas Heights Waste and Recycling Centre Lucas Heights Landfill located approximately 2.5 km north-east of the site and fifteen of the registered bores are associated with ANSTO which is located the south east of the LHRRP on the opposite side of New Illawarra Road.

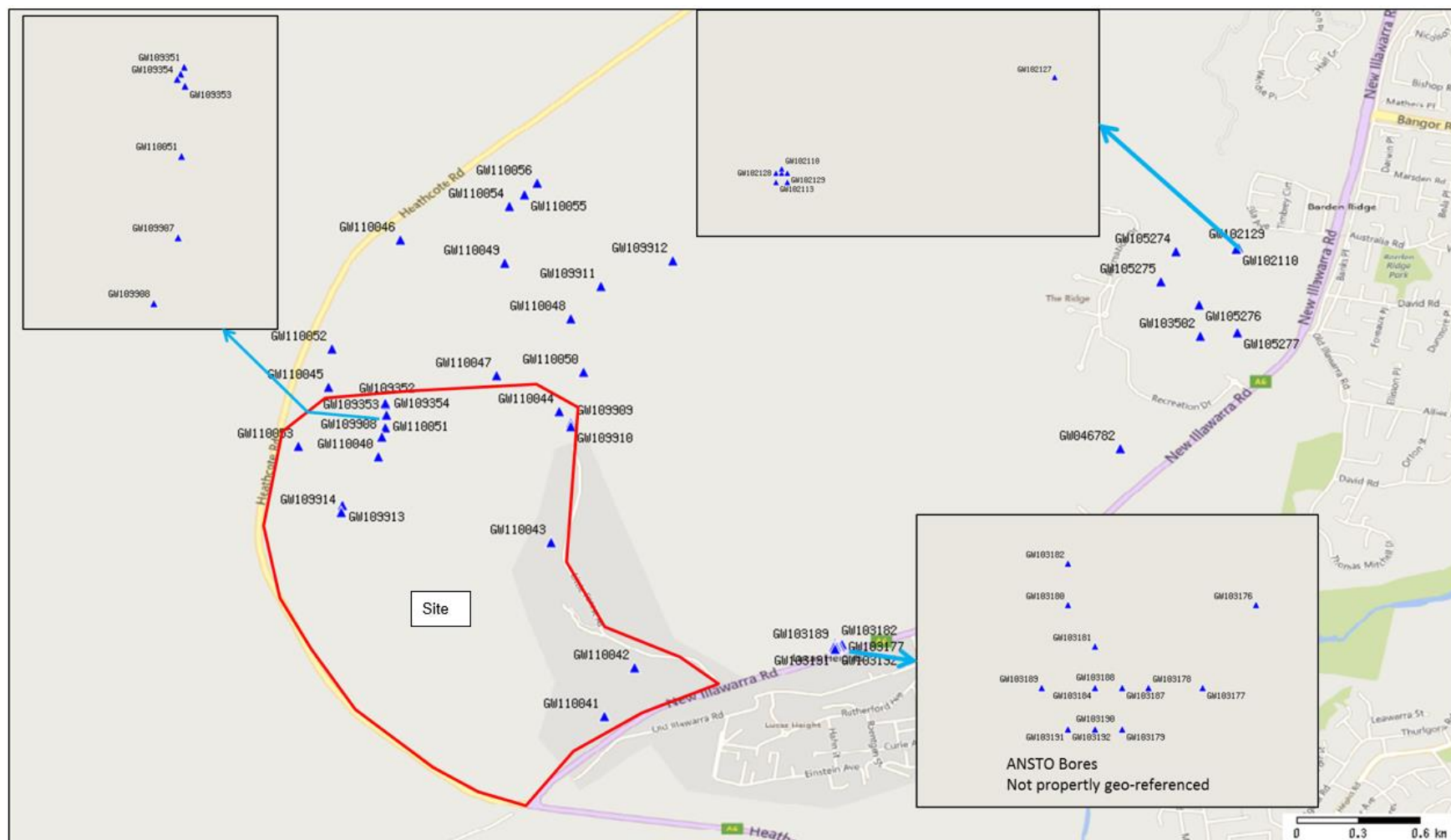


Figure 4: Registered groundwater bores

Table 1: Summary of registered groundwater bores

Bore Licence No.	Date Installed	Purpose	Property Licenced To	Bore Depth	Water Level	Location
GW046782	Jan-97	Test Bore / Groundwater Exploration	-	30.00	not provided	Lucas Heights Waste and Recycling Centre Lucas Heights Landfill located approximately 2.5 km north-east of LHRRP
GW102116	Jun-96	Monitoring Bore	-	23.00	9.50	
GW103176	May-98	Monitoring Bore	-	45.00	18.42	
GW103177	May-98	Monitoring Bore	-	9.00	not provided	
GW103180	May-98	Monitoring Bore	-	24.00	15.00	
GW103182	May-98	Monitoring Bore	-	30.00	not provided	
GW103502	May-98	Monitoring Bore	Lucas Heights Landfill	23.00	not provided	
GW105274	Jan-97	Monitoring Bore	Lucas Heights	13.30	not provided	
GW105275	Jan-97	Monitoring Bore	Lucas Heights	21.30	7.00	
GW105276	Jan-97	Monitoring Bore	Lucas Heights	30.20	17.00	
GW105277	Jan-97	Monitoring Bore	Lucas Heights	22.90	4.00	
GW113699	Sep-10	Monitoring Bore	ANSTO	6.5	not provided	ANSTO facility located approximately 500 m south-east of the LHRRP
GW113700	Sep-10	Monitoring Bore	ANSTO	20.5	not provided	
GW113701	Sep-10	Monitoring Bore	ANSTO	13.5	not provided	
GW113702	Sep-10	Monitoring Bore	ANSTO	5	not provided	
GW113703	Sep-10	Monitoring Bore	ANSTO	7	not provided	
GW113704	Sep-10	Monitoring Bore	ANSTO	5.5	not provided	
GW113705	Feb-14	Monitoring Bore	ANSTO	4.3	not provided	
GW113706	Feb-14	Monitoring Bore	ANSTO	5.8	not provided	

Bore Licence No.	Date Installed	Purpose	Property Licenced To	Bore Depth	Water Level	Location
GW113707	Sep-10	Monitoring Bore	ANSTO	6	not provided	
GW113708	Sep-10	Monitoring Bore	ANSTO	7	not provided	
GW113710	Sep-10	Monitoring Bore	ANSTO	3.5	not provided	
GW113711	Sep-10	Monitoring Bore	ANSTO	4.8	not provided	
GW113714	Sep-10	Monitoring Bore	ANSTO	5.5	not provided	
GW113715	Sep-10	Monitoring Bore	ANSTO	9	not provided	
GW113716	Sep-10	Monitoring Bore	ANSTO	7	not provided	
GW100908	January 2004	Monitoring Bore	WSN Environmental Solutions	12.5	1.5	LHRRP and Region to the (up to 1-1.5 km) north of the facility
GW109909	January 2004	Monitoring Bore	WSN Environmental Solutions	25.5	20.2	
GW109910	January 2004	Monitoring Bore	WSN Environmental Solutions	8.4	7.6	
GW109911	January 2004	Monitoring Bore	WSN Environmental Solutions	32.8	8.6	
GW109912	January 2004	Monitoring Bore	WSN Environmental Solutions	30.15	11.4	
GW109913	January 2004	Monitoring Bore	WSN Environmental Solutions	41.5	8.2	
GW109914	March 2009	Monitoring Bore	WSN Environmental Solutions	19.4	5.6	
GW110040	January 1992	Monitoring Bore	Waste Services NSW	10	0.77	
GW110041	January 1992	Monitoring Bore	Waste Services NSW	50.95	15	
GW110042	January 1992	Monitoring Bore	Waste Services NSW	52	4.77	
GW110043	January 1992	Monitoring Bore	Waste Services NSW	30	6.72	
GW110044	January 1992	Monitoring Bore	Waste Services NSW	53.6	26	
GW110045	January 1992	Monitoring Bore	Waste Services NSW	53.6	26	
GW110046	January 1992	Monitoring Bore	Waste Services NSW	25	20.14	

Bore Licence No.	Date Installed	Purpose	Property Licenced To	Bore Depth	Water Level	Location
GW110047	April 2008	Monitoring Bore	Waste Services NSW	81	11.37	
GW110048	January 1992	Monitoring Bore	Waste Services NSW	29.95	7.67	
GW110049	January 1992	Monitoring Bore	Waste Services NSW	48	9	
GW110050	January 1992	Monitoring Bore	Waste Services NSW	84	18.57	
GW110051	January 1992	Monitoring Bore	Waste Services NSW	84	18.57	
GW110052	January 1992	Monitoring Bore	Waste Services NSW	51	27.58	
GW110053	January 1992	Monitoring Bore	Waste Services NSW	21	8.51	
GW110054	January 2003	Monitoring Bore	Waste Services NSW	2.8	1.9	
GW110055	January 2003	Monitoring Bore	Waste Services NSW	30	1.8	
GW110056	January 2003	Monitoring Bore	Waste Services NSW	50	14.2	
GW112696	July 1992	Monitoring Bore	WSN Environmental Solutions	29.55	Not provided	
GW112697	July 1992	Monitoring Bore	WSN Environmental Solutions	51	Not provided	
GW112699	April 2007	Monitoring Bore	WSN Environmental Solutions	50	Not provided	
GW112700	April 2008	Monitoring Bore	WSN Environmental Solutions	35	Not provided	
GW112701	June 2004	Monitoring Bore	WSN Environmental Solutions	9.05	Not provided	
GW112702	June 2004	Monitoring Bore	WSN Environmental Solutions	19.4	Not provided	
GW113194	April 2008	Monitoring Bore	WSN Environmental Solutions	35	Not provided	
GW113195	April 2008	Monitoring Bore	WSN Environmental Solutions	35	Not provided	
GW113196	Sept 2008	Monitoring Bore	WSN Environmental Solutions	25	Not provided	
GW113197	April 2008	Monitoring Bore	WSN Environmental Solutions	12	Not provided	

Bore Licence No.	Date Installed	Purpose	Property Licenced To	Bore Depth	Water Level	Location
GW113198	April 2008	Monitoring Bore	WSN Environmental Solutions	47.5	9	
GW113199	April 2008	Monitoring Bore	WSN Environmental Solutions	23.5	Not provided	

Based on the licenced groundwater bores within 4 km of the site there is no known beneficial reuse of groundwater currently in operation. It is also noted that based on the generally low groundwater flow rates (refer to Section 4.1) it would be unlikely that the rate of flow (yield) would be high enough to support such uses (including irrigation and drinking water bores), particularly in the top 30 m of the profile.

4.3 Leachate and groundwater extraction

Currently there are no direct groundwater extraction activities being undertaken at the site for beneficial reuse. During construction of landfill Cells 5.2 (A and B) and Cells 5.3 (A and B) groundwater is intercepted and diverted away from the landfill basal liner system to prevent possible uplift damage from groundwater below. Groundwater collected from these depressurisation drains is then treated as per the requirements of the site Environmental Protection Licence (EPL 5065). The groundwater and leachate extraction processes are summarised in the following sub-sections.

4.3.1 Current groundwater interception on-site

A groundwater depressurisation system has been installed as part of the construction of Cells 5.2 A/B and Cell 5.3A/B (located on the northern side of the site). The water being collected and extracted from this system is treated as per the requirements of the EPL. The description of the system provided below is taken from GHD (2015).

The groundwater system is constructed below the landfill liner system and protects the liner from possible uplift damage from the groundwater below. It comprises of trenches cut into the natural rock subgrade which drain to sumps located along the western boundary of the cells. These trenches contain perforated pipe and are backfilled with aggregate to promote flow to the sump, from which any collected water can be extracted for treatment and disposal.

Three separate systems have been installed - one below the interface between Cell 5.2 and Cell 5.2B, one around the perimeter of the base of Cell 5.2B and one around the perimeter of the base of Cell 5.3A. These systems were designed and constructed as hydraulically independent systems to minimise mixing of different water sources. To date, the system has been partly constructed. The remainder of the system would be constructed progressively with the remaining cells.

The water in this system is likely to come from two sources:

- *Groundwater from the small recharge catchment to the east and south of the site and travelling beneath the existing waste into the Cell 5.2 and Cell 5.3 area. Water consistent with this source was observed during the construction of Cell 5.2B. Based on the average annual recharge rate of 0.06 m (GHD, 2015b) per year, it was estimated that up to 25 m³/day of groundwater could be entering the groundwater system from the south; and*
- *Water recharging from the west directly into the batter of Cell 5.2 and Cell 5.3. Some dampness was noted on the western batter of these cells prior to lining. Based on the average annual recharge rate of 0.06 m (GHD, 2015b) per year, it was estimated that between 1 m³/day and 4.5 m³/day of groundwater could be entering the groundwater system from the west.*

It should be noted that construction of landfill Cells 5.2a/b and 5.3a/b have now been completed. Once waste is placed in the cells and the risk to the liner system is reduced from possible ground water pressure extraction from the depressurisation system will cease in time once groundwater levels stabilise.

A groundwater review was undertaken (GHD 2015d)². The key findings of GHD (2015d) are summarised below:

- *An extensive suite of existing groundwater monitoring data (approximately 25 years) suggests that the combination of the in situ geology and current leachate collection system is resulting in concentrations of parameters in groundwater which are below the level where impacts on the surrounding groundwater and surface water systems may occur. As similar conditions would be maintained with the proposal, it is expected that there would be no significant impact on groundwater from the proposed landfilling activities at the LHRRP; and*
- *The Stage 5 landfill leachate collection system and control measures have been designed and installed in accordance with best practice to facilitate preferential capture of leachate from up gradient landfill areas and further minimise the potential for impacts to underlying groundwater. The existing groundwater drainage system located beneath Stage 5 provides additional capacity for interception of groundwater in the unlikely event that adverse groundwater impacts are detected. Groundwater elevation observations and the hydrogeological conditions identified around the existing landfill suggest that any reduction in groundwater recharge and hence flow associated with the proposal would be minimal during construction and operation and after closure. This is supported by the overall footprint of the landfill remaining similar to existing conditions.*

Based on the findings of GHD (2015d) it was concluded that there are currently no significant impacts on groundwater quality and no significant impacts on the community or environment.

It is also noted that based on the findings of GHD (2015) it is considered that “*with the adoption of the proposed mitigation measures and a long term commitment to monitor for the emergence of impacts (should they occur) and respond if required, the potential for adverse impacts on groundwater would be acceptably minimised.*”

Therefore, it is considered that currently no significant impacts on groundwater have been identified at the site and that the proposal is unlikely to result in unacceptable impacts to groundwater or the environment.

4.3.2 Leachate collection and review of water balance

GHD (2015) prepared a leachate water balance. Water entering the cells is prevented from recharging to the local groundwater environment by the leachate collection system in the base of the landfill cells. The leachate containment and collection system varies throughout the site as described below (from GHD 2015).

² GHD Australia. SITA Australia, Lucas Heights Resource Recovery Park Project, Groundwater Assessment October 2015

Stages 1-3

Leachate is collected through 300 mm concrete slotted leachate drainage pipes on the floor of the landfill under the waste that run from the south end of the site to the leachate dam situated in the north-western corner of the site.

Leachate collection is facilitated by the construction of leachate collection trenches that have a maximum spacing of 100 m and are arranged in a grid layout. This minimises the potential for leachate to perch within waste lifts. The trenches are graded at 1% and drain to the boundary bund where a second leachate trench directs the leachate through a 300 mm slotted HDPE leachate collection pipe and to the leachate dam.

Leachate collection trenches also help eliminate ponding of leachate on the covered waste and evenly distribute the leachate through the waste layers enhancing leachate absorption and waste decomposition.

Following the 1999 expansion approval and prior to overtopping of Stages 1-3 with waste, a series of 2 m diameter holes were excavated through the existing cover material into the waste. Vertical, slotted leachate re-injection pipes were inserted into the holes and backfilled with rubble.

In areas of where waste overtopping occurred additional leachate drains were constructed around the perimeter to collect leachate and gravity feed it to the leachate dam.

Leachate is substantially contained above the natural low permeability sandstone that underlies the site.

Stage 4

Leachate is managed via a set of leachate pipes laid within every lift of waste (inter-lift leachate extraction). The leachate collection pipes connect to a main HDPE leachate pipe servicing the eastern side of Stage 4 via a vertical riser, which then flows to the leachate dam. Containment in Stage 4 is via the natural low permeability sandstone.

Stage 5 – Cell 5.1 and Cell 5.2A

Cell 5.1 and Cell 5.2A were developed prior to SITA operating the site. The leachate barrier for these cells consist of a 900 mm thick engineered clay layer with 10⁻⁹ m/s permeability sitting on an engineered subgrade layer underlain by the naturally low permeability sandstone base.

The leachate extraction system includes HDPE leachate pipes surrounded by 500 mm of protective aggregate ranging between 20-40 mm constructed within each waste lift. The leachate pipes connect to leachate main risers from which the leachate is pumped to the leachate dam.

In addition to inter-lift leachate collection, leachate is conveyed through parallel basal leachate collection trenches, typically spaced at 50 m and draining west at a grade of 1%. In Cell 5.2A, the base of the landfill liner was graded with a longitudinal grade of 1% and a transverse grade of 0.5%.

Stage 5 – Cell 5.2B and Cell 5.3

Cell 5.2B and Cell 5.3A have been constructed by SITA. These cells have been constructed with groundwater, leachate barrier and leachate collection systems.

Refer to Section 2.10.2 for a description of the groundwater collection system. The leachate barrier for these cells consists of 900 mm low permeability compacted clay overlain by 2.5 mm HDPE geomembrane (double liner). The leachate barrier system is continuous along the base and the sidewalls of these cells, to 10 m above the base of the cells and above this height the leachate barrier would consist of the 900 mm low permeability compacted clay liner in accordance with the EPA's requirements. The double lined design exceeds NSW EPA guideline for landfill liner systems and provides significantly more environmental protection. The additional geomembrane barrier was voluntarily installed by SITA and was approved by the EPA. Cell 5.2B was graded to the north and west with a temporary leachate sump. The entire base contains a 300 mm blanket of leachate drainage aggregate and perforated HDPE leachate collection pipes placed within aggregate filled trenches. To promote leachate drainage over the lined sidewalls, a tri-planar drainage geocomposite was installed over the sidewall liner. Internal bund walls were removed to allow leachate from surrounding cells (Cell 5.2A and 5.1) to drain into Cell 5.2B.

In Cell 5.3A the base grades to the south and west and a leachate sump and risers constructed at the middle of the western batter for leachate extraction. The drainage layer has the same arrangement as Cell 5.2B. SITA voluntarily undertook leak location survey to identify any damage holes in the geomembrane liner and undertook repairs prior to placing waste in this cell.

The remainder of Cell 5.3 would be constructed as the landfill airspace is required and would be constructed to be continuous with and to the same standard as Cell 5.3A.

In addition to the leachate collection system located in the base of each stage, leachate is removed from a series of gas extraction wells which have been installed within the waste mass. The leachate is extracted using air lift pumps, flowing by gravity to the leachate collection dam via a perimeter leachate ring main. SITA continue to install gas extraction wells across the site and leachate is extracted from these as required.

The existing leachate treatment system is a sequencing batch reactor (SBR) treatment system that discharges directly to sewer at Lucas Heights 1.

The treatment process biologically oxidises the ammonia in the leachate, converting it to nitrate and nitrate species. Two reactors work in parallel with independent diffused air systems, pH controls and decant systems, allowing shut down for maintenance and to provide a more uniform plant throughput through staggered cycles.

This system has a current average leachate treatment capacity of 570kL/day. The current annual average sewer discharge limit is 800 kL/day at a maximum daily discharge of 1,500 kL, in accordance with the Trade Waste Agreement contained in Appendix B (Sydney Water, 2013). SITA can discharge other waters with concentration of substances below the agreed limits without it first passing through the leachate treatment plant. SITA has advised that it would increase the treatment plant capacity to 870 kL/day and the average daily sewer discharge limit to 1,200 kL/day by early 2017.

The leachate water balance by GHD (GHD 2015) assessed the leachate impacts of the project including the proposed leachate management system and the capacity of the system to treat and dispose of leachate.

The GHD report also provides a cumulative assessment of the leachate impacts considering all sources of water being treated by the Lucas Heights 1 treatment plant, including the leachate from the LHRRP landfill, Harrington's Quarry and Lucas Heights 1.

The key findings of GHD (2015) are summarised below:

- *The existing leachate management system has the capacity to manage the volumes of leachate estimated to be generated in the modelled average rainfall and wet rainfall years through the use of emergency leachate containment in the double lined emergency leachate containment dam and Cell 5.2 and Cell. 5.3. These containment structures were designed for this purpose;*
- *The following is recommended throughout the development of the proposal:*
 - o *Ongoing monitoring of leachate volumes extracted from LHRRP landfill and other sources;*
 - o *Periodic review of the leachate water balance model; and*
 - o *Monitoring of groundwater and surface water quality, as required by the site EPL.*
- *It is further recommended that SITA seek to increase the average daily leachate treatment capacity to 870 kL/day and the trade waste limit to 1,200 kL/day which is within their current maximum daily discharge limit. It is recommended that this increase be obtained by early 2017.*

Based on the findings of GHD (2015) it is considered that the current leachate containment, collection, disposal and treatment procedures and facilities provide adequate protection of the local groundwater environments and that there is sufficient capacity in the system to manage and treat the leachate that is being generated at the site.

Following the recommendation from GHD, SUEZ has commenced discussion in 2017 with Sutherland Shire Council regarding lodgement of a development application to expand the leachate treatment capacity. This would be the subject of separate consultation with DCCEEW.

4.3.3 Predicted annual leachate and groundwater extraction

The estimated groundwater inflow into the groundwater collection system (by GHD, GHD 2015) below the Cell 5.2 and Cell 5.3 area is 29.5 m³/day (or 29.5 kL). Therefore, the estimated annual groundwater inflow into the collection system is 10,767.5 kL. The recommended capacity of the leachate treatment plant is 870 kL/day (or 317,550 kL/year).

The treated leachate and collected groundwater is disposed to the sewer under a trade waste agreement with Sydney Water. At the recommended limit of 1200 kL/day the maximum combined treated leachate and extracted groundwater that can be disposed is 438,000 kL/year, which represents the maximum total combined groundwater (primarily landfill leachate) that is extracted from the site.

4.4 Groundwater dependant ecosystems

The BOM definition of groundwater dependent ecosystems (GDEs) is natural ecosystems that require access to groundwater to meet all or some of their water requirements on a permanent or intermittent basis, so as to maintain their communities of plants and animals, ecosystem processes and ecosystem services. GDEs can be surface water features that rely on ground water inflows or other ecological communities, usually vegetation, that obtain water from subsurface groundwater (often when groundwater is shallow).

The primary potential groundwater dependant ecosystem in the vicinity of the site is that of Mill Creek. A biodiversity report was prepared by GHD (GHD 2015b³).

The GHD report assess the condition of aquatic habitats within and downstream of the LHRRP. The scope and findings of the report are provided below:

- *A literature review found conflicting information on the likelihood of GDEs being present in the study area. The Atlas of Groundwater Dependent Ecosystems maps vegetation in most of the Project footprint as having no or low potential for groundwater interaction although vegetation with high potential for interaction with groundwater is identified down-stream of the site by the GDE Atlas. Conversely, native vegetation types identified in the study area by GHD are likely to be GDEs according to Kuginis et al (2012). According to that study, groundwater dependency can be inferred for many parts of the landscape as there is a strong association between floristic composition, topography and groundwater. Coastal Sandstone Ridgetop Woodland (with which Red Bloodwood - Scribbly Gum heathy woodland on sandstone plateaux is commensurate), Shale Sandstone Transition Forest and Coastal Upland Swamps are all identified as having a high probability of being a GDE (Kuginis et al 2012);*
- *Mill Creek is not mapped by the GDE Atlas of Groundwater Dependent Ecosystems as being groundwater dependent. The only waterway in the vicinity of the proposal with potential dependence of groundwater is the Woronora River. Given its position near the top of the ridge, much of the water flow in Mill Creek is likely to be dependent on rainfall within the immediate area. As such, Mill Creek in the project footprint is not likely to be a groundwater inflow dependent ecosystem”;*
- *The uppermost site is at approximately 170 m altitude and considered upland (above 150 m). Mill creek has a comparatively broader channel and lower banks at this location. All sites downstream of the LHRRP had a mostly natural and continuous riparian vegetation zone with the community almost completely dominated by native species. The geomorphic nature of these sites was generally similar and characteristic of a small coastal lowland (below 150 m altitude) catchment. Habitat condition was generally good, although disturbance to the ground surface associated with recreational vehicle activities was observed at MC3, leading to increased levels of sediment deposition near this site; and*

³ GHD Australia. SITA Australia, Lucas Heights Resource Recovery Park Project, Biodiversity Assessment Report, September 2015 (GHD 2015b).

- *A relatively high number of macro-invertebrate taxa were identified across the monitored locations suggesting that physical conditions are sufficient to support diverse macro-invertebrate life. Assessment of the pollution tolerances of taxa present found most monitoring locations had communities dominated by pollution tolerant taxa, although some sensitive taxa were present.*

Based on the results of the field survey and data analysis, the following conclusions were made:

- *Results of the in situ water quality monitoring suggested that dissolved oxygen was slightly below the ANZECC assessment criteria at the majority of the monitoring locations. Electrical conductivity and pH were within the recommended ranges. The LHRRP and offsite recreational vehicle users may be having some minor impacts on Mill Creek in relation to turbidity values, although turbidity may have been affected by a recent rainfall event;*
- *Habitat was found to be generally in good condition. The LHRRP may be having some minor impacts on Mill Creek in relatively close proximity to the LHRRP (MC1), as condition here is lower than at the upstream site. Habitat condition improves at MC2. A decline at MC3 is likely to be the result of disturbance caused by recreational vehicle users. Aquatic and riparian habitat at MC 4 (located furthest from the LHRRP) was in a reasonably pristine condition. The recovery of habitat condition at this monitoring location suggests that any impacts of the LHRRP are spatially limited and that the natural condition of the surrounding catchment downstream will ensure minimal impacts to the Georges River receiving environment;*
- *Macro-invertebrate communities present at the monitoring locations were generally in a healthy condition. Communities were dominated by pollution tolerant taxa, although some sensitive taxa were present. Recent studies of urban streams in the Georges River catchment found few or no pollution-sensitive taxa, suggesting that Mill Creek is one of the better condition streams in the area. Key drivers of losses in taxonomic diversity in Mill Creek are currently unclear and are spatially limited and which may be linked to offsite activities in certain locations (such as recreational vehicle use); and*
- *The proposal should result in a lower potential for impacts on the Mill Creek aquatic environment due to the proposed reprofiling of the site, increasing over time the capped and revegetated areas and via a number of best practice operational controls documented in the OEMPs.*

It was noted that the River Health Monitoring Program monitors three important ecological indicators to provide an assessment of catchment health; water quality, vegetation and macro-invertebrates and that their findings reinforce the conclusions of this report. That is, any impacts of the LHRRP on Mill Creek are spatially limited as further downstream the health of Mill Creek was found to be in an excellent condition.

Therefore, based on the findings of GHD (2015b), despite a period of greater than 30 years of landfilling at the site there does not appear to be a significant impact on Mill Creek. Based on the groundwater and leachate protection measures installed at the site, and the low permeability of the geology it is unlikely that significant impacts on Mill Creek will eventuate. That said the monitoring programme currently adopted at the site and detailed in this report should identify any potential future risks to this environment.

5. Monitoring programme

The primary objectives of GMP are to detect, prevent and if necessary remediate water pollution by assessing the water quality over time. The surface water and leachate monitoring program has similarly objectives.

The monitoring locations are described in Table 2. The locations of the groundwater bores currently monitored under the EPL are shown on Drawings 1 and 2, Appendix B. In addition, for reference, the locations of the previous monitoring wells are also shown on Drawings 1 and 2, Appendix B. The status of the wells from an audit by the landfill operator (Suez) in 2006 is presented in Appendix C.

Appendix C also includes the details of the status of each of the groundwater monitoring wells and indicates which have been abandoned. The reasons for abandonment of the wells at the time of abandonment was not recorded. Drawings 1 and 2 show the location of the decommissioned wells (green coloured bores).

Based on the current EPL the quarterly and annual groundwater, surface water and leachate monitoring requirements are detailed in Table 3. The results of the groundwater monitoring should be forwarded to the DOI Water (in addition to the reporting requirements under the EPL).

The monitoring programme also includes proposed additional monitoring points for the GO Facility (groundwater wells MW510 to MW512), seepage monitoring point SP510 and landfill gas well LW510. The additional monitoring requirements are based upon the recommendations of GHD report LHRRP Modification – Organics Facility, Groundwater Assessment dated 24 August 2023 (GHD 2023). The GO Facility monitoring programme includes a requirement for baseline monitoring (prior to commencement of construction), construction phase monitoring and the operational phase (as defined in GHD 2023).

The groundwater well installation reports for the most recently installed groundwater wells (MB048, MB049, MB057 and MB058) are provided in Appendix H.

Table 2: Monitoring locations

Monitoring designation	Type	EPA ID	Monitoring Bore Licence No.	Co-ordinates			Description of Location	Date Installed	Depth (m)	Diameter (mm)	Casing Diameter (mm)	Casing	Screened Interval (m)	Description
				Easting	Northing	mAH D								
MC1	Surface Water	1	n/a	312001	6231750	n/a	north-western corner of Site	n/a	n/a	n/a	n/a	n/a	n/a	Discharge Point at Mill Creek labelled as "1" on map titled "Lucas Heights Waste & Recycling Centre - Licence Monitoring Points" (Plan R46-310) prepared by WSN Environmental Solutions.
LD001	Leachate	3	n/a	311987E	6231582N	n/a	north-western corner of Site	n/a	n/a	n/a	n/a	n/a	n/a	Surface Water Monitoring Point from Leachate Dam (LD001) labelled as "3" on map titled "Lucas Heights Waste & Recycling Centre - Licence Monitoring Points" (Plan R46-310) prepared by WSN Environmental Solutions.
LH1	Leachate	40	n/a	n/a	n/a	n/a	north-western corner of Site	n/a	n/a	n/a	n/a	n/a	n/a	Surface Water Monitoring Point from Leachate Dam LH1
DS002	Sediment Dam	20	n/a	312031	6231701	n/a	north-western corner of Site	n/a	n/a	n/a	n/a	n/a	n/a	Discharge Point from Sediment Dam 5 labelled as "20" on map titled "Lucas Heights Waste & Recycling Centre - Licence Monitoring Points" (Plan R46-310) prepared by WSN Environmental Solutions.
DS001	Discharge from Stormwater treatment plant	21	n/a	312039	6231730	n/a	north-western corner of Site	n/a	n/a	n/a	n/a	n/a	n/a	Discharge Point from stormwater treatment plant adjacent to Sediment Dam 5 labelled as "21" on map titled "Lucas Heights Waste & Recycling Centre - Licence Monitoring Points" (Plan R46-310) prepared by WSN Environmental Solutions.
OF001	Overflow of Sediment Dam	22	n/a	312031	6231701	n/a	north-western corner of Site	n/a	n/a	n/a	n/a	n/a	n/a	Monitoring Point from Overflow of Sediment Dam (SD005) labelled as "22" on map titled "Lucas Heights Waste & Recycling Centre - Licence Monitoring Points" (Plan R46-310) prepared by WSN Environmental Solutions.

Monitoring designation	Type	EPA ID	Monitoring Bore Licence No.	Co-ordinates			Description of Location	Date Installed	Depth (m)	Diameter (mm)	Casing Diameter (mm)	Casing	Screened Interval (m)	Description
				Easting	Northing	mAH D								
SD005	Surface Water from Sediment Dam	23	n/a	312000	6231662	n/a	north-western corner of Site	n/a	n/a	n/a	n/a	n/a	n/a	Surface Water Monitoring Point from Sediment Dam (SD005) labelled as "23" on map titled "Lucas Heights Waste & Recycling Centre - Licence Monitoring Points" (Plan R46-310) prepared by WSN Environmental Solutions.
MB008	Groundwater	4	10BL164393	312981.3	6230332	166.06	south-eastern corner of the site, up-gradient of landfill	27/5/92	50.95	90 -100	50	PVC slotted	49.95	Groundwater Monitoring Point from MB008 labelled as "4" on map titled "Lucas Heights Waste & Recycling Centre - Licence Monitoring Points" (Plan R46-310) prepared by WSN Environmental Solutions
MB023	Groundwater	n/a	10BL164393	297457	1232728	119.31	Off-Site – north-east of landfill	2/7/92	29.95	90 -100	50	PVC slotted	28.95	Groundwater Monitoring Bore
MB032	Groundwater	7	10BL602007	312117.1	6231969	103	north-western corner of Site, down-gradient of Landfill	24/11/06	50.00	125	50	PVC slotted	32 - 38	Groundwater Monitoring Point from MB032 labelled as "7" on map titled "Lucas Heights Waste & Recycling Centre - Licence Monitoring Points" (Plan R46-310) prepared by WSN Environmental Solutions.
MB033	Groundwater	18	10BL602007	312115.1	6231964	103	north-western corner of Site, down-gradient of Landfill	27/11/06	30.50	125	50	PVC slotted	25.5 - 30.5	Groundwater Monitoring Point from MB033 labelled as "18" on map titled "Lucas Heights Waste & Recycling Centre - Licence Monitoring Points" (Plan R46-310) prepared by WSN Environmental Solutions.
MB034	Groundwater	8	10BL602007	312119.3	6231955	103	north-western corner of Site, down-gradient of Landfill	29/11/06	14.50	125	50	PVC slotted	11.5 - 14.5	Groundwater Monitoring Point from MB034 labelled as "8" on map titled "Lucas Heights Waste & Recycling Centre - Licence Monitoring Points" (Plan R46-310) prepared by WSN Environmental Solutions.

Monitoring designation	Type	EPA ID	Monitoring Bore Licence No.	Co-ordinates			Description of Location	Date Installed	Depth (m)	Diameter (mm)	Casing Diameter (mm)	Casing	Screened Interval (m)	Description
				Easting	Northing	mAH D								
MB035	Groundwater	19	10BL602007	312115.2	6231960	103	north-western corner of Site, down-gradient of Landfill	28/11/06	8.80	125	50	PVC slotted	4.8 - 8.8	Groundwater Monitoring Point from MB035 labelled as "19" on map titled "Lucas Heights Waste & Recycling Centre - Licence Monitoring Points" (Plan R46-310) prepared by WSN Environmental Solutions.
MB038	Groundwater	24	10BL603147	312338.3	6231908	123	north-western corner of Site, down-gradient of Landfill	17/04/08	27.00	125	50	PVC slotted	20-27	Groundwater Monitoring Point labelled "MB038" on map titled "Figure 2: Site plan showing the location of groundwater monitoring bores" in "Preliminary Groundwater Installation Report, Lucas Heights" (CES020510-WS-76-F)
MB039	Groundwater	25	10BL603147	312332.3	6231907	123	north-western corner of Site, down-gradient of Landfill	02/05/08	13.50	125	50	PVC slotted	9-13.5	Groundwater Monitoring Point labelled "MB039" on map titled "Figure 2: Site plan showing the location of groundwater monitoring bores" in "Preliminary Groundwater Installation Report, Lucas Heights" (CES020510-WS-76-F)
MB040	Groundwater	26	10BL603147	312178.4	6231903	115	north-western corner of Site, down-gradient of Landfill	22/04/08	25.00	125	50	PVC slotted	19-25	Groundwater Monitoring Point labelled "MB040" on map titled "Figure 2: Site plan showing the location of groundwater monitoring bores" in "Preliminary Groundwater Installation Report, Lucas Heights" (CES020510-WS-76-F)
MB041	Groundwater		10BL603147	312175.5	6231897	115	north-western corner of Site, down-gradient of Landfill	01/05/08	12.00	125	50	PVC slotted	6-12	Groundwater Monitoring Point labelled "MB041" on map titled "Figure 2: Site plan showing the location of groundwater monitoring bores" in "Preliminary Groundwater Installation Report, Lucas Heights" (CES020510-WS-76-F)

Monitoring designation	Type	EPA ID	Monitoring Bore Licence No.	Co-ordinates			Description of Location	Date Installed	Depth (m)	Diameter (mm)	Casing Diameter (mm)	Casing	Screened Interval (m)	Description
				Easting	Northing	mAH D								
MB044	Groundwater	n/a	10BL603147	312987.3	6230334	165	south-eastern corner of the site, up-gradient of landfill	28/04/08	47.00	125	50	PVC slotted	41-47	Groundwater Monitoring Bore
MB045	Groundwater	n/a	10BL603147	312989.2	6230337	165	south-eastern corner of the site, up-gradient of landfill	29/04/08	23.50	125	50	PVC slotted	17.5-23.5	Groundwater Monitoring Bore
MB046	Groundwater	n/a	n/a	312803	6231839	-	200 m NE of Site near former bore MB022	13/8/2013	26	125	50	PVC slotted	11-26.0	Groundwater Monitoring Bore
MB047	Groundwater	n/a	n/a	312796	6231842	-	200 m NE of Site near former bore MB022	14/8/2013	47	125	50	PVC slotted	37-47.0	Groundwater Monitoring Bore
MB048	Groundwater	n/a	n/a	312315	6232000	114.5	150 m north-west of MB038/MB039	15/12/17	50	125	50	PVC slotted	41-50	Groundwater Monitoring Bore
MB049	Groundwater	n/a	n/a	312323	6231987	114.3	150 m north-west of MB038/MB039	6/12/17	30	125	50	PVC slotted	24-30	Groundwater Monitoring Bore
MB305	Groundwater	16	10BL601302	311964	6231407	120	western boundary of site	24/06/04	41.50	100	50	PVC slotted	38.0 - 41.0	Groundwater Monitoring Point from MB305 labelled as "16" on map titled "Lucas Heights Waste & Recycling Centre - Licence Monitoring Points" (Plan R46-310) prepared by WSN Environmental Solutions.
MB306	Groundwater	17	10BL601302	311962.9	6231410	120	western boundary of site	24/06/04	19.40	100	50	PVC slotted	14.4 - 18.9	Groundwater Monitoring Point from MB306 labelled as "17" on map titled "Lucas Heights Waste & Recycling Centre - Licence Monitoring Points" (Plan R46-310) prepared by WSN Environmental Solutions.
GO Facility Monitoring Requirements														
MB056	Groundwater	MB056	-	312019	6230602	151	North-east of GO Facility	28/6/23	29.8	100	50	PVC slotted	24.8-29.8	Groundwater Monitoring Bore

Monitoring designation	Type	EPA ID	Monitoring Bore Licence No.	Co-ordinates			Description of Location	Date Installed	Depth (m)	Diameter (mm)	Casing Diameter (mm)	Casing	Screened Interval (m)	Description
				Easting	Northing	mAH D								
MB057	Groundwater	MB057	-	312012	6230928	150	South-east of GO Facility	29/6/23	29.8	100	50	PVC slotted	24.8-29.8	Groundwater Monitoring Bore
MW510	Proposed Groundwater Well	MW510	-	-	-	-	New well intercepting the shallow (perched) aquifer outside but adjacent to the eastern site boundary.	-	6 (proposed)	100	50	PVC slotted	2-6	Groundwater Monitoring Bore
MW511	Proposed Groundwater Well	MW511	-	-	-	-	New well upgradient of the GO Facility to the south.	-	30 (proposed)	100	50	PVC slotted	24-30	Groundwater Monitoring Bore
MW512	Proposed Groundwater Well	MW512	-	-	-	-	New deeper well to the west.	-	30 (proposed)	100	50	PVC slotted	24-30	Groundwater Monitoring Bore
SP510	Seepage	SP510	-	-	-	-	Groundwater seepage collection point on the eastern side of the GO Facility	-	-	-	-	-	-	Groundwater seepage collection point on the eastern side of the GO Facility
LW510	Existing Landfill Gas Well	LW510	-	-	-	-	Existing landfill gas well that extends to the base of the landfill and is located at the western edge of the landfill adjacent to the southern end of the GO facility	-	-	100	50	PVC slotted	-	Landfill gas well

Table 3: Monitoring analytes and frequency

Type	Monitoring Designation	EPA ID	Analytes	
Surface Water	MC1	1	Special Frequency 1 Analytes ¹ Conductivity, dissolved oxygen, nitrogen (ammonia), pH, potassium, total dissolved solids, total organic carbon, total phenolics, total suspended solids.	
Leachate	LD001	3	Quarterly Analytes conductivity, pH	Annual Analytes Alkalinity (as calcium carbonate), aluminium, arsenic, barium, benzene, benzo(a)pyrene, bicarbonate alkalinity, biological oxygen demand, cadmium, calcium, chloride, chemical oxygen demand, chromium (hexavalent), chromium (total), cobalt, copper, ethyl benzene, fluoride, lead, magnesium, manganese, mercury, nickel, nitrate, nitrite, nitrogen (ammonia), organochlorine pesticides, organophosphate pesticides, phosphorus, polycyclic aromatic hydrocarbons, potassium, sodium, sulfate, toluene, total dissolved solids, total organic carbon, total phenolics, total petroleum hydrocarbons, total phenolics, total suspended solids, xylene and zinc.
	LH1	40		
Sediment Dam	DS002	20	Special Frequency 2 Analytes ² Nitrogen, total suspended solids Special Frequency 1 for OF001 as per EPL	
	DS001	21		
	OF001	22		
Surface Water from Sediment Dam	SD005	23	Quarterly Analytes Nitrogen, total suspended solids	
Type	Monitoring Designation	EPA ID	Analytes	
Groundwater	MB008	4	Quarterly Analytes Alkalinity (as calcium carbonate), Bicarbonate alkalinity, calcium, chloride,	Annual Analytes Aluminium, arsenic, barium, benzene, benzo(a)pyrene cadmium, chromium (hexavalent), chromium (total),
	MB023	44		
	MB032	7		
	MB033	18		

Type	Monitoring Designation	EPA ID	Analytes	
	MB034	8	magnesium, nitrogen (ammonia), pH, potassium, redox potential, sodium, standing water level, sulfate, temperature, total dissolved solids, total organic carbon,	cobalt, copper, ethyl benzene, fluoride, lead, manganese, mercury, nickel, nitrate, nitrite, organochlorine pesticides, organophosphate pesticides, polycyclic aromatic hydrocarbons, PCB, selenium, tetrachloroethene, toluene, total petroleum hydrocarbons, total phenolics, trichloroethene, xylene, zinc
	MB035	19		
	MB038	24		
	MB039	25		
	MB040	26		
	MB041	27		
	MB044	45		
	MB045	46		
	MB046	47		
	MB047	48		
	MB048	49		
	MB049	50		
	MB305	16		
	MB306	17		

Notes:

Special Frequency 1 means, if discharges occur, the collection of samples within 24 hours of discharge

Special Frequency 2 means, the collection of samples at minimal weekly intervals during discharge

The GO Facility monitoring requirements are specified in Table 4 as per GHD (2023).

Table 4: Go facility monitoring requirements

Location	Project Stage	Monitoring Media	Monitoring Frequency	Monitoring Parameters and Analytes	Purpose
LW510	Baseline	Leachate	Baseline (monthly for 3 months)	Leachate elevation (m AHD) <i>In situ</i> field parameters (pH, DO redox, EC and temperature) Annual parameters per Location LH1 in Table 3	To establish leachate levels and quality at the landfill base and waste depth and inform the potential for migration of leachate into the GO Facility.
MB057	Baseline, construction and operation (all stages)	Groundwater	Monthly (baseline), Quarterly (construction and operation)	Groundwater elevation (m AHD) <i>In situ</i> field parameters (pH, DO redox, EC and temperature) Quarterly and annual analytes as per Groundwater locations in Table 3.	To characterise baseline conditions. To assess emergence of impacts in the deeper aquifer system potentially migrating downgradient and understand the relationship with the shallow aquifer systems intersected by the GO facility.
MB056	Baseline, construction and operation (all stages)	Groundwater	Monthly (baseline), Quarterly (construction and operation)	Groundwater elevation (m AHD) <i>In situ</i> field parameters (pH, DO redox, EC and temperature) Quarterly and annual analytes as per Groundwater locations in Table 3.	To characterise baseline conditions. To understand relationship with the shallow aquifer systems intersected by the GO facility and emergence of impacts in the deeper aquifer system.
MW510	Baseline, construction and operation (all stages)	Groundwater	Monthly (baseline), Quarterly (construction and operation)	Groundwater elevation (m AHD) <i>In situ</i> field parameters (pH, DO redox, EC and temperature) Quarterly and annual analytes as per Groundwater locations in Table 3.	To characterise baseline groundwater conditions and to characterise the emergence of seepage influenced by landfill leachate. Inform conceptual understanding of potential for leachate interaction
MW511	Baseline, construction	Groundwater	Monthly (baseline), Quarterly	Groundwater elevation (m AHD)	To characterise background/upgradient

Location	Project Stage	Monitoring Media	Monitoring Frequency	Monitoring Parameters and Analytes	Purpose
	and operation (all stages)		(construction and operation)	<i>In situ</i> field parameters (pH, DO redox, EC and temperature) Quarterly and annual analytes as per Groundwater locations in Table 3.	groundwater conditions based on which impacts downgradient can be assessed during operations.
MW512	Baseline, construction and operation (all stages)	Groundwater	Monthly (baseline), Quarterly (construction and operation)	Groundwater elevation (m AHD) <i>In situ</i> field parameters (pH, DO redox, EC and temperature) Quarterly and annual analytes as per Groundwater locations in Table 3.	To characterise background/upgradient groundwater conditions before construction. To monitor for unforeseen impacts downgradient lateral to / downgradient of the GO facility to the west.
SP510	Construction and operation	Seepage	Quarterly (construction and operation)	Groundwater elevation (m AHD) <i>In situ</i> field parameters (pH, DO redox, EC and temperature) Quarterly and annual analytes as per Groundwater locations in Table 3.	To inform discharge management requirements

6. Groundwater investigation trigger levels

The groundwater investigation levels (GILs) adopted for the groundwater monitoring programme are based on the following NSW EPA endorsed guidelines:

- Australian Water Quality Guidelines 2000 (AWQG);
- NHMRC, NRMCC Australian Drinking Water Guidelines 6 2011, Version 3.2 (NHMRC, NRMCC, 2022).
- Environmental Protection Licence 5065;
- Guidelines for Managing Risk in Recreational Waters 2008 (GMRRW); and
- National water quality management strategy. Australia and New Zealand Guidelines for Fresh and Marine Water Quality 2000 (ANZECC and ARMCANZ).
- ANZG Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018).

The adopted GILs for the analytes included in this assessment and the corresponding source documents, are shown in Table 5. An exceedance of the GIL will trigger further assessment of the groundwater quality.

Other factors will also be considered including data trends at each location and local conditions (i.e., from background bores hydraulically up-gradient of the LHRRP) which may include data provided from the ANSTO site (if available) and bores MB008, MB044 and MB045. An exceedance of the GIL will not be considered to be significant if the background concentration in the up-gradient locations is equal to or greater than the concentrations in the bores down-gradient of the landfill.

Data trends will also be considered in determining the significant of exceedances at individual sampling points. It is recommended that Mann-Kendall Trend Analysis be conducted on an annual basis to determine if there are statistically significant trends at the sampling points. Sampling points where increasing trends are identified will require further assessment. In cases where elevated, but stable or decreasing trends are identified further assessment and/or remediation may not be required (on a case by case basis).

Table 5: Groundwater investigation levels (in µg/L unless stated otherwise)

Analyte		Groundwater Investigation Level (µg/L)		
		ANZG (2018) ^a	EPL Limits	NHMRC (2011) ^b
		Fresh Water		Drinking Water
Metals	Aluminium	55	-	-
	Arsenic (V)	13 as As (V)	-	10 (Arsenic)
	Arsenic (III)	24 as As (III)	-	
	Barium	-	-	2000
	Cadmium	0.2	-	2
	Chromium (III)	3.3 ^c	-	-
	Chromium (VI)	1	-	50
	Cobalt	1 ^f	-	-
	Copper	1.4	-	2,000
	Iron - Fe (III)	0.0003 ^c	-	300 ^d
	Lead	3.4	-	10
	Manganese	1900	-	500
	Mercury (total)	0.06	-	1
	Nickel	11	-	20
	Selenium	5	-	10
	Zinc	8	-	-
PAH	Benzo(a)pyrene	0.1 ^c	-	0.01
	Naphthalene	16	-	-
	Anthracene	0.01 ^c	-	-
	Phenanthrene	0.6 ^c	-	-
	Fluoranthene	1 ^c	-	-
OCP	Heptachlor	0.01	-	-
	Aldrin + Dieldrin	-	-	0.3
	Aldrin	0.001 ^c	-	-
	Dieldrin	0.01 ^c	-	-
	DDE	0.03 ^c	-	-
	Lindane	0.2	-	10
	Chlordane (trans + cis)	0.03	-	2

Analyte	Groundwater Investigation Level (µg/L)			
		ANZG (2018) ^a	EPL Limits	NHMRC (2011) ^b
		Fresh Water		Drinking Water
	DDT	0.006	-	9
	Endrin	0.01	-	-
	Endosulphan	0.03	-	20
OPP	Chlorpyrifos	0.01	-	10
	Diazinon	0.01	-	4.
	Dimethoate	0.15	-	7
	Fenitrothion	0.20	-	7
	Ethion	-	-	4
PCB	Total PCB	-	-	-
	Aroclor 1221	1 ^c	-	-
	Aroclor 1232	0.3 ^c	-	-
	Aroclor 1242	0.3	-	-
	Aroclor 1248	0.03 ^c	-	-
	Aroclor 1254	0.01	-	-
	Aroclor 1260	-	-	-
Phenols	Phenol	320	320*	-
MAH	Benzene	950	-	1
	Toluene	180 ^c	-	800
	Ethylbenzene	80 ^c	-	300
	o-xylene	350	-	600 (xylene)
	m-xylene	75 ^c	-	
	p-xylene	200	-	
	Styrene	-	-	30
Non-metallic Inorganics	Ammonia ^e	900	2500*#	-
	Cyanide	7	-	80
	Fluoride	-	-	1,500
	Sulphate	-	-	500,000
	Nitrate (NO ₃)	700 ^c	-	50,000
	Nitrite (NO ₂)	refer ANZECC	-	3,000

Analyte		Groundwater Investigation Level (µg/L)		
		ANZG (2018) ^a	EPL Limits	NHMRC (2011) ^b
		Fresh Water		Drinking Water
		(2000)		
VOC	Chloroethene (vinyl chloride)	100 ^c	-	0.3
	1,1-Dichloroethene	700 ^c	-	30
	1,2-Dichloroethene	-	-	60
	Tetrachloroethene (PCE)	70 ^c	-	50
	Chloroform	370 ^c	-	3
	Dichloromethane	4,000 ^c	-	4
	Carbon Tetrachloride	240 ^c	-	3
	1,1-Dichloroethane	90 ^c	-	-
	1,2-Dichloroethane	1,900 ^c	-	3
	1,1,1-Trichloroethane	270 ^c	-	-
	1,1,2-Trichloroethane	6,500	-	-
	Hexachloroethane	290	-	-
	Carbon Tetrachloride	-	-	-
	1,2-Dichloropropane	-	-	-
	1,1,2-Trichloroethylene	330 ^c	-	-
	cis-1,3-Dichloropropene	-	-	-
	trans-1,3-Dichloropropene	-	-	-
	1,3-Dichloropropane	-	-	-
	1,1,2,2-Tetrachlorethane	400 ^c	-	-
	Chlorobenzene	5 ^c	-	300
	1,3-Dichlorobenzene	260	-	-
	1,4-Dichlorobenzene	60	-	40
	1,2-Dichlorobenzene	160	-	1,500
	1,2,4-Trichlorobenzene	85	-	30 (trichlorobenzene)
	1,2,3-Trichlorobenzene	3	-	
	1,3,5-Trichlorobenzene	8,000 ^c	-	
Physical Parameters	Conductivity (µS/cm)	-	1500*	-

Analyte	Groundwater Investigation Level (µg/L)		
	ANZG (2018) ^a	EPL Limits	NHMRC (2011) ^b
	Fresh Water		Drinking Water
Dissolved Oxygen (mg/L)	-	6*	-
pH	5.5-8.5	5.5-8.5*	-
TSS (mg/L)	-	50*/ 50#	-
TOC	-	-	-
TDS	-	-	-
Anions and Cations	Fluoride	-	-
	Alkalinity	-	-
	Calcium	-	-
	Chloride	-	-
	Magnesium	-	-
	Potassium	-	-
	sulphate	-	-

Notes

- a: ANZG (2018) Trigger Values for a slightly to moderately disturbed system
 b: NHMRC & NRMCC (2011) drinking water criteria (health)
 c: insufficient data for reliable trigger value; interim working value or low reliability value used
 d: based on aesthetics
 e: based on pH 8; refer to ANZECC (2000) for changes to GILs based on pH
 f: ANZECC Marine Value adopted in lieu of Fresh Water Guideline
 * Discharge Limits in EPL for Monitoring Point No. 1 (MC1)
 # EPL Limits for Monitoring Points 21, 22 and 23 (DS002, DS001 and SD005)

7. Investigation, notification and mitigation procedure

As stated in Section 6, a number of factors will be considered in the assessment of the groundwater and surface water monitoring data. Exceedances of the adopted GIL will be considered to be significant where:

- The concentration in the down gradient monitoring wells significantly exceeds the local background conditions (in up-gradient monitoring points to the south-east of the LHRRP);
- Trend analysis indicates that a statistically significant increasing trend is occurring; and
- It is considered likely that the sensitive receptors, specifically Mill Creek will or could be impacted by the identified contamination or where impacts to Mill Creek (related to the Landfill) have been identified.

While this GMP mainly considers groundwater management on site, the following section also discusses surface water as it has potential to infiltrate into the ground and subsequently impact on groundwater quality.

7.1 Groundwater

If the sampling of groundwater monitoring bores indicates any abnormality in the groundwater tests (as described above) the following will be adopted:

- The affected monitoring bores will be re-sampled on receipt of the laboratory tests;
- Characteristics of pollutant will be identified including data trends via Mann-Kendall Trend Analysis;
- Possible sources/point of pollutant will be identified including other factors that may have impacted results (such as weather conditions);
- If required additional sentinel groundwater monitoring points will be installed;
- The NSW EPA, The NSW Department of Climate Change, Energy, the Environment and Water (DCCEEW) , Sutherland Shire Council, and any affected sites (such as neighbours, if appropriate) will be notified;
- Full analysis of the results will be prepared;
- If the contamination persists (or is trending upwards) then a specific groundwater remediation plan will be prepared;
- Groundwater remediation pilot trials will be undertaken (if required);
- A groundwater remediation action plan (GRAP) will be prepared and implemented based on the outcomes of pilot trials in consultation with the relevant parties including DCCEEW; and
- On-going sampling and testing will be performed to ensure remediation actions are effective. An appropriate monitoring programme will be determined in the GRAP and the results provided to the NSW EPA and Sutherland Council.

The groundwater contamination response plan and timeline is summarised in Table 6.

Table 6: Groundwater contamination response plan

Action	Timeframe
Re-sampling of affected groundwater wells Identification of possible point sources	Within 2 weeks of receiving initial monitoring results
Undertake Trend analysis	Within 2 weeks of completing all testing (including the above re-sampling)
Installation of Additional Sentinel Wells	Within 6-8 weeks of completing trend analysis and re-testing (if groundwater contamination is confirmed) subject to the availability of suitable plant
Notification to Council, DOI Water and NSW EPA	Within 3 weeks of completing trend analysis of contamination confirmed. Council and EPA to be informed further investigations being undertaken (i.e. sentinel wells)

Action	Timeframe
Analysis report (on all of the above)	Within four weeks of installation of sentinel wells / completion of testing. Report to be provided to Council and NSW EPA upon completion.
Preparation of specific groundwater remediation plant	Within 4-6 weeks of completion (and subsequent) feedback from relevant authorities) of analysis report
Groundwater Remediation Pilot Trials	Commencement within 4-6 weeks of approval of the GRAP (by NSW EPA)
Final GRAP	Within 4-6 weeks of completion of pilot trial

7.2 Surface water

Surface water monitoring is currently undertaken at the site as a condition of the EPL 5065 (refer to Section 5). The development consent (dated 23 January 2017) includes the following provisions that address the management of surface water at the site and the surrounding environments:

- Condition C32 requires the applicant (SUEZ) to prepare and submit a detailed design for managing surface water from the GO Facility. The design is to be approved by the NSW EPA prior to the commencement of operations at the GO Facility and will include a program for on-going water quality discharge monitoring from the GO Facility to Mill Creek;
- Condition C33 requires the applicant (SUEZ) to prepare an Aquatic Habitat Monitoring Plan (for Mill Creek) in consultation with DPI Water prior to commencement of construction of the GO Facility and updated prior to construction of the ARRT Facility. The plan will include a detailed monitoring plan and the measures to be implemented if monitoring indicates that habitat quality of Mill Creek is decreasing as a result of site activities; and.
- Condition C34 requires the applicant (SUEZ) to prepare a Mill Creek stream Rehabilitation, Stabilisation and Vegetative Management Plan in consultation with DPI Water prior to the construction of the GO Facility and ARRT Facility.

The above Programs / Plans will be prepared by appropriately qualified persons by / or on behalf of SUEZ in accordance with the development consent conditions. The management and remediation (if required) of surface water will be addressed in the reports described above and will be prepared prior to the construction of the GO Facility and ARRT Facility.

7.3 Water level triggers

DOI Water required further detail on the water level monitoring from monitoring bores for the purpose of maintaining a buffer beneath the landfill that will limit water pressure on the landfill liner. Douglas note that the water level in the surrounding groundwater wells is by its nature above the level of the landfill liner (hence the need for the depressurization system) and that establishment of a measurable buffer zone may not be practical. Moreover, measurement of water levels in the groundwater monitoring network is unlikely to provide an accurate indication of the water level below the landfill liner and the potential risk of uplift of the liner due to water pressure. Therefore, Douglas recommend that the following considerations are made:

- Comparison of actual volumes of groundwater extracted versus the predicted volume of groundwater extracted (by GHD, GHD 2015d). If the actual volume of groundwater extracted is significantly greater than predictions then it may be evidence that there is a potential risk of increasing pressures below the landfill liner; and
- An increase in water levels at key monitoring points (MB305, MB306, MB039 to MB041) of greater than 2 m.

If either of these triggers are observed further investigation into the water levels within and adjacent to the landfill cells may be warranted.

7.4 GO facility trigger response plan

The trigger response plan for the GO Facility has been extracted from GHD (2023) and is presented in Table 7.

Table 7: Go facility trigger action response plan

Parameter	Frequency	Purpose	Trigger	Action	Person responsible	Timing
Groundwater Quality (MW510)	Quarterly during construction and operation	Early detection of groundwater quality that is influenced by landfill leachate. Inform changes to leachate management strategy.	Analytes indicative of landfill leachate at the site that are outside the range of background groundwater concentrations at MW511 in baseline data and other background concentrations across the site.	Engage an appropriately qualified consultant to investigate exceedances and develop a management / remedial strategy	Site owner (or delegate)	Consultant engaged within one month.
Groundwater quality (MB056, MB057 and MW512)	Quarterly during construction and operation	Early detection of groundwater migrating offsite that is impacted by GO facility construction and operation. Inform changes to site practices.	Emergence of impacts outside of background conditions in MB056 and MB057. Water quality changes outside of range of background concentrations at MW511 in baseline data and other background concentrations across the site.	Engage an appropriately qualified consultant to investigate exceedances and develop a management / remedial strategy	Site owner (or delegate)	Consultant engaged within one month.

Parameter	Frequency	Purpose	Trigger	Action	Person responsible	Timing
Groundwater seepages volumes (all areas of the landfill)	Quarterly during construction and operation	To characterise the requirement for groundwater access licence.	Average groundwater seepage volumes greater than 8.2 m ³ /day (3 ML/yr).	Engage an appropriately qualified consultant to assess groundwater seepage volume data, implement methods to reduce seepage further and/or apply for a water access license if flows are greater than 8.2 m ³ /day (3 ML/yr).	Site owner (or delegate)	Consultant engaged within one month.
Eastern wall seepage quality (SP510)	Quarterly during construction and operation	Direct detection of seepage quality that is influenced by landfill leachate. Prevention of discharge to Mill Creek. Inform changes to leachate management strategy.	Presence of analytes indicative of landfill leachate at levels above background conditions.	Stop discharge to downgradient environment (E.g. Mill Creek) and divert seepage to leachate management system. Engage an appropriately qualified consultant to investigate exceedances and develop a management / remedial strategy.	Site owner (or delegate)	Consultant engaged within one month.
Eastern seepage volumes	Quarterly during construction and operation	Direct detection of seepage volumes that are more than can be managed with the designed system.	Inflows greater than design capacity.	Engage an appropriately qualified consultant to investigate exceedances and develop a management / remedial strategy.	Site owner (or delegate)	Consultant engaged within one month.

Parameter	Frequency	Purpose	Trigger	Action	Person responsible	Timing
		Inform interim leachate management requirements.				

In the event of an exceedance of the triggers outlined in Table 7 the actions outlined in Table 7 would be instigated. This includes:

- Engaging an appropriately qualified consultant to investigate the exceedances and develop a management strategy / response program.

In developing an appropriate management strategy for site trigger exceedances, the consultant engaged to investigate and develop a management / remedial strategy will consider:

- Prevention of discharge of leachate influenced groundwater and groundwater impacted by site activities, that has a quality outside background water quality conditions, to the downgradient environment, e.g. Mill Creek.
- Immediacy of actions required to prevent impact to the surrounding environment.

8. Remediation options

If groundwater and/or surface water contamination issues are identified then a specific remediation plan will be developed tailored the type, extent and degree of contamination present.

There are a number of approaches / technologies that can be applied. The adopted strategy will need to consider the type of contamination present, the extent of contamination identified, the nature of sub-surface conditions (depth to rock, hydraulic conductivity of soils, etc.), efficiency, risk to health and the environment, cost and timing.

The main types of physical and chemical remedial methods considered include:

- Continue with monitoring (if result is not persistent / repeatable);
- Bulk excavation of affected soils and removal of accessible (perched) groundwater;
- Monitored natural attenuation;
- Air Sparging;
- Pump and treat;
- Recirculation well methods; and
- Surfactant and Co-solvent Flushing.

Biochemical (enhanced bioremediation) methods include:

- Bio-stimulation involving injection of a substrate to accelerate natural biological breakdown;
- Bio-augmentation involving the introduction of bacteria (bugs) not normally present in the substrate to kick-start remediation; and
- Installation of permeable reactive barriers comprising carbon source materials deployed as a vertical barrier.

The Site Management options that should be considered include:

- Impermeable cut-off walls; and

- Institutional controls.

8.1 Groundwater contamination

The nature of groundwater remediation that will be undertaken will be dependent on the location and extent of the identified contamination and the types of contaminants present. Prior to the commencement of any groundwater remediation strategy a detailed groundwater remediation action plan will be prepared by a suitably qualified person to the satisfaction of the NSW EPA, Sutherland Shire Council and DCCEEWS (NSW Water Sector). The plan should include a comprehensive review of the available remedial options listed above (plus others as appropriate) to determine the most effective and cost efficient remedial approach.

Hydraulic containment will be used as Contingency Option 1 i.e. where the situation is considered urgent. Hydraulic containment by groundwater pumping is possibly easier to implement in the relatively low-permeability fractured Hawkesbury Sandstone. Groundwater pumping also has the potential to pull back some groundwater that has already passed beyond the boundary of the site by reversing the gradient. Treatment and re-use of relatively small volumes of groundwater would be feasible in terms of cost / benefit ratio particularly where the rate of increasing concentration identified is statistically significant and high.

The implementation of this strategy may require the installation of additional groundwater extraction wells in the impacted area and additional monitoring locations further down-gradient of the impacted area. Such an approach may be able to make use of the existing leachate treatment plant or trade waste agreement that allows the disposal of groundwater collected from below the cells.

Extracted groundwater could be pumped from extraction wells to the existing leachate treatment plant (depending on volumes and type of contaminants present) and then following treatment disposed to sewer under the trade waste agreement. In this event it may be necessary to increase, temporarily, the daily limits in the trade waste agreement.

The cause of the groundwater contamination will also need to be identified and where possible rectified. If significant on-going groundwater contamination is occurring, then cut off walls or reactive barrier walls may be considered if deemed appropriate.

9. Conclusions

This report comprises the proposed Groundwater Management Plan (GMP) for the Lucas Heights Resource Recovery Park as required by Condition C36 of SSD 6835. The GMP provides the required groundwater, leachate and surface water monitoring programme, the protocols for investigation, notification and mitigation of any exceedances of the identified trigger levels and the measures that could be implemented to respond to identified groundwater contamination. Implementation of this plan will facilitate the identification of groundwater impacts and then determine, what, if any remedial actions are required.

10. References

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6. D. J. Douglas & Partners 1994. Report on Hydrogeology and Groundwater Monitoring, Waste Depot, Lucas Heights. Report 14780 dated 11 May 1994 (Douglas 1994).
7. Douglas Partners 2000. Report on Geotechnical Assessment, Assessment of Fractured Rock, Lucas Heights Waste Management Depot, Lucas Heights, Douglas Project 14780 X, dated May 2000 (Douglas 2000)
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9. Douglas (2018) Groundwater Management Plan, Lucas Heights Resource Recovery Park, 19 Little Forest Road, Lucas Heights NSW, Report 85988.00.R.001.Rev2 dated 31 January 2018
10. Australian Water Quality Guidelines 2000 (AWQG).
11. Australian Drinking Water Guidelines 2011 (ADWG).
12. Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018).
13. Guidelines for Managing Risk in Recreational Waters 2008 (GMRRW).
14. National water quality management strategy. Australia and New Zealand Guidelines for Fresh and Marine Water Quality 2000 (ANZECC and ARMCANZ).
15. Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018).

11. Limitations

Douglas Partners Pty Ltd (Douglas) has prepared this report) for this project at 19 Little Forest Road, Lucas Heights NSW in accordance with Douglas' proposal dated {22 April 2024 and acceptance received from LC Chiang dated 16 May 2024. The work was carried out under Master Consultancy Agreement (Contract No. 5806875841, dated 21 February 2024 and Statement of Work dated 16 May 2024. This report is provided for the exclusive use of Cleanaway Operations Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of Douglas, does so entirely at its own risk and without recourse to Douglas for any loss or damage. In preparing this report Douglas has necessarily relied upon information provided by the client and / or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and / or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after Douglas' field testing has been completed.

Douglas' advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by Douglas in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and / or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

The assessment of atypical safety hazards arising from this advice is restricted to the (environmental / groundwater) components set out in this report and based on known project conditions and stated design advice and assumptions. While some recommendations for safe controls may be provided, detailed 'safety in design' assessment is outside the current scope of this report and requires additional project data and assessment.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. Douglas cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by Douglas. This is because this report has been written as advice and opinion rather than instructions for construction.

Appendix A

About This Report

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

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This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at

the time of construction as are indicated in the report; and

- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

continued next page

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

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Appendix B

Drawings



SITE LOCATION

LEGEND

- Bore locations
- Decommisioned
 - Quarterly Monitoring
 - Unused

NOTE:
1. Test locations are approximate only and were located using differential GPS typically accurate to ± 0.1 m depending on satellite coverage

0 40 80 120 160 200 m



CLIENT: Cleanaway Operations P/L

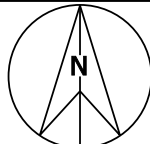
OFFICE: Sydney

DRAWN BY: KDP

SCALE: 1:5000 @A3

DATE: 11.June.2024

TITLE: **Monitoring Well Location Plan**
Groundwater Management Plan
19 Little Forest Road, Lucas Heights



PROJECT: 85988.06

DRAWING No: 1

REVISION: 0



SITE LOCATION

LEGEND

- Bore locations
- Decommisioned
 - Quarterly Monitoring
 - Unused
 - Proposed Additional GO Facility Monitoring Locations

NOTE:
1. Test locations are approximate only and were located using differential GPS typically accurate to ± 0.1 m depending on satellite coverage

0 40 80 120 160 200 m



CLIENT: Cleanaway Operations P/L

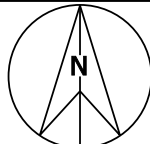
OFFICE: Sydney

DRAWN BY: KDP

SCALE: 1:5000 @A3

DATE: 11.June.2024

TITLE: **Monitoring Well Location Plan**
Groundwater Management Plan
19 Little Forest Road, Lucas Heights



PROJECT: 85988.06

DRAWING No: 2

REVISION: 0

Appendix C

Monitoring Bore Status

Boreholes checked September 2006																						
Borehole	Monitoring Designation	Monitoring Bore Licence No.	Co-ordinates (ISG)			MGA 94		Date Installed	Who	Depth (m)	Diameter (mm)	Casing Diameter (mm)	Casing	Screened Interval (m)	Depth to Water (m)						Other Information	Status
			Easting	Northing	mAHD	Easting	Northing								Install'tn Date		1997 / 2005		2006			
															m bgl	m AHD	m bgl	m AHD	m bgl	m AHD		
BH1	MB001		296598	1232180	104.14	312748.92	6232087.51	8/5/92	Douglas Partners	50.50	90 -100	50	PVC slotted	49.50								Sealed 06/2004
BH2			296692	1231750	116.69	312180.12	6231352.19	11/5/92	Douglas Partners	51.50	50		PVC slotted									Sealed ~ 1992
BH3	MB003		296768	1231501	118.30	312260.98	6231104.70	14/5/92	Douglas Partners	51.15	90 -100	50	PVC slotted	49.15								Sealed ~ 01/1996
BH4			296596	1232171	104.37	312075.91	6231771.27	14/5/92	Douglas Partners	14.00	90 -100	50	PVC slotted	13.00								Sealed 06/2004
BH5	MB005	10BL164393	296596	1232161	105.48	312076.10	6231761.27	16/5/92	Douglas Partners	10.00	90 -100	50	PVC slotted	9.00								Sealed 08/2006
BH6			296960	1232092	134.46	312441.41	6231699.39	21/5/92	Douglas Partners	60.10	50		PVC slotted									Angle bore -- sealed ~ 2000
BH7			296254	1231573	137.39	311745.63	6231166.64	27/5/92	Douglas Partners	68.00	50		PVC slotted		6.07	131.32	8.29	129.10				Angle bore - lost in gun club works
BH8	MB008	10BL164393	297473	1230714	166.06	312981.30	6230331.56	27/5/92	Douglas Partners	50.95	90 -100	50	PVC slotted	49.95	16.08	149.98	14.60	151.46	15.07	150.99		Monitored quarterly
BH9	MB009	10BL164393	297564	1231055	155.64	313065.62	6230674.30	29/5/92	Douglas Partners	52.00	90 -100	50	PVC slotted	51.00	4.67	150.97	4.77	150.87				part of external research project
BH10			296784	1231468	120.58	312277.63	6231072.01	29/5/92	Douglas Partners	10.00	50		PVC slotted									Sealed ~ 1992
BH11			296779	1231348	119.30	312274.97	6230951.93	1/6/92	Douglas Partners	21.00	50		PVC slotted									Sealed ~ 1992
BH12			296880	1232254		312358.26	6231859.81	3/6/92	Douglas Partners	25.75	50		PVC slotted									Angle bore - to be sealed 2006
BH13			197086	1233453	143.92	312540.81	6233062.72	10/6/92	Douglas Partners	46.70	50		PVC slotted									Angle bore - sealed ~ 1992
BH14			297269	1233453	84.57	312723.79	6233066.29	10/6/92	Douglas Partners	11.00	90 -100	50	PVC slotted	10.00								Sealed 05/2003
BH15			297272	1233454	84.94	312726.77	6233067.35	10/6/92	Douglas Partners	20.00	90 -100	50	PVC slotted	19.00								Sealed 05/2003
BH16	MB016		297275	1232474	84.66	312748.92	6232087.51	11/6/92	Douglas Partners	50.10	90 -100	50	PVC slotted	49.10								Sealed 05/2003
BH17	MB027/MBH	10BL164393	297480	1232251	131.77	312958.25	6231868.54	24/6/92	Douglas Partners	84.00	90 -100	50	PVC slotted	83.00	16.58	115.19	18.57	113.20	21.12	110.65		
BH18	MB020		297367	1231659	136.58	312856.84	6231274.39	25/6/92	Douglas Partners	36.00	90 -100	50	PVC slotted	35.00	11.03	125.55	15.31	121.27				Destroyed by equipment ~05/1998
BH19	MB019	10BL164393	297329	1231664	147.72	312818.74	6231278.65	29/6/92	Douglas Partners	30.00	90 -100	50	PVC slotted	29.00	5.91	141.81	6.72	141.00	5.41	142.31		
BH20	MB018	10BL164393	296303	1232403	130.93	311778.40	6231997.52	1/7/92	Douglas Partners	53.60	90 -100	50	PVC slotted	52.60	24.17	106.76	25.35	105.58	27.99	102.94		
BH21	MB021	10BL164393	296758	1233236	116.89	312217.08	6232839.33	1/7/92	Douglas Partners	29.25	90 -100	50	PVC slotted	28.25	17.99	98.90	20.14	96.75			10.02	wet, depth of silt
BH22	MB022	10BL164393	297217	1232382	129.88	312692.72	6231994.39	7/7/92	Douglas Partners	81.00	90 -100	50	PVC slotted	80.00	10.54	119.34	11.37	118.51				damaged at monument
BH23	MB023	10BL164393	297457	1232728	119.31	312925.94	6232345.04	2/7/92	Douglas Partners	29.95	90 -100	50	PVC slotted	28.95	5.63	113.68	7.67	111.64	4.55	114.76		monitored quarterly
BH24			297605	1233144	101.78	313065.79	6232763.89	8/7/92	Douglas Partners	29.35	90 -100	50	PVC slotted	28.35	1.16	100.62			2.80	98.98		High silt due to trail bikes
BH25	MB025	10BL164393	296603	1234207	104.01	312043.13	6233807.21	9/7/92	Douglas Partners	48.00	90 -100	50	PVC slotted	47.00	5.74	98.27	8.07	95.94	8.60	95.41		
BH26			297735	1234195	101.37	313175.25	6233817.32	15/7/92	Douglas Partners	48.00	90 -100	50	PVC slotted	47.00	13.40	87.97						10 m inside Army firing range
BH27	MB017	10BL164393	296310	1232410	104.21	311785.26	6232004.66	16/7/92	Douglas Partners	51.00	150	50	PVC slotted	50.00								Sealed 06/2004
BH28			296251	1232403	135.01	311726.41	6231996.51	18/8/92	Douglas Partners	54.00	90-100	50	PVC slotted	53.00	23.15	111.86					6.36	wet, depth of silt
BH29	MB029	10BL164393	296291	1232457	131.87	311765.35	6232051.28	18/8/92	Douglas Partners	51.00	90-100	50	PVC slotted	50.00	26.64	105.23	27.58	104.29			14.86	blockage, not suitable for sampling
BH30	MB030	10BL164393	296244	1232202	135.66	311723.33	6231795.39	20/8/92	Douglas Partners	21.00	90-100	50	PVC slotted	20.00	6.47	129.19	8.51	127.15				lost in gun club works
BH31			296429	1232850	128.33	311895.65	6232446.94	21/8/92	Douglas Partners	54.00	90-100	50	PVC slotted	53.00	24.35	103.98					dry	silt at 6.12 m
	MB032	10BL602007	296641	1232368	103	312117.05	6231969.13	24/11/06	CES	50.00	125	50	PVC slotted	32 - 38								Monitored quarterly
	MB033	10BL602007	296639	1232363	103	312115.15	6231964.09	27/11/06	CES	30.50	125	50	PVC slotted	25.5 - 30.5								Monitored quarterly
	MB034	10BL602007	296643	1232354	103	312119.33	6231955.17	29/11/06	CES	14.50	125	50	PVC slotted	11.5 - 14.5								Monitored quarterly
	MB035	10BL602007	296639	1232359	103	312115.23	6231960.09	28/11/06	CES	8.80	125	50	PVC slotted	4.8 - 8.8								Monitored quarterly
	MB038	10BL603147	296861	1232303	123	312338.3	6231908.44	17/04/08	CES	27.00	125	50	PVC slotted	20-27	17.00	106.00						Monitored quarterly
	MB039	10BL603147	296855	1232302	123	312332.32	6231907.32	02/05/08	CES	13.50	125	50	PVC slotted	9-13.5								Monitored quarterly
	MB040	10BL603147	296701	1232301	115	312178.36	6231903.31	22/04/08	CES	25.00	125	50	PVC slotted	19-25	10.00	105.00						Monitored quarterly
	MB041	10BL603147	296698	1232295	115	312175.47	6231897.25	01/05/08	CES	12.00	125	50	PVC slotted	6-12								Monitored quarterly
	MB044	10BL603147	297479	1230716	165	312987.26	6230333.67	28/04/08	CES	47.00	125	50	PVC slotted	41-47	14.00	151.00						Monitored quarterly
	MB045	10BL603147	297481	1230719	165	312989.2	6230336.71	29/04/08	CES	23.50	125	50	PVC slotted	17.5-23.5								Monitored quarterly
BH101	MB101	10BL601302	296																			

Appendix D

EPL



Environment Protection Licence

Licence - 5065

Licence Details	
Number:	5065
Anniversary Date:	21-August

Licensee
CLEANAWAY PTY LTD
LEVEL 4, 441 ST KILDA RD
MELBOURNE VIC 3004

Premises
LUCAS HEIGHTS RESOURCE RECOVERY PARK
NEW ILLAWARRA ROAD
LUCAS HEIGHTS NSW 2234

Scheduled Activity
Waste disposal (application to land)
Waste processing (non-thermal treatment)
Waste storage

Fee Based Activity	Scale
Non-thermal treatment of liquid waste	Any annual processing capacity
Waste disposal by application to land	Any capacity
Waste storage - other types of waste	Any other types of waste stored
Waste storage - waste tyres	> Any tyres stored

Contact Us
NSW EPA
6 Parramatta Square
10 Darcy Street
PARRAMATTA NSW 2150
Phone: 131 555
Email: info@epa.nsw.gov.au
Locked Bag 5022
PARRAMATTA NSW 2124



Environment Protection Licence

Licence - 5065

INFORMATION ABOUT THIS LICENCE	4
Dictionary	4
Responsibilities of licensee	4
Variation of licence conditions	4
Duration of licence	4
Licence review	4
Fees and annual return to be sent to the EPA	4
Transfer of licence	5
Public register and access to monitoring data	5
1 ADMINISTRATIVE CONDITIONS	6
A1 What the licence authorises and regulates	6
A2 Premises or plant to which this licence applies	6
A3 Other activities	7
A4 Information supplied to the EPA	7
2 DISCHARGES TO AIR AND WATER AND APPLICATIONS TO LAND	7
P1 Location of monitoring/discharge points and areas	7
3 LIMIT CONDITIONS	11
L1 Pollution of waters	11
L2 Concentration limits	12
L3 Waste	13
L4 Hours of operation	15
L5 Potentially offensive odour	15
4 OPERATING CONDITIONS	15
O1 Activities must be carried out in a competent manner	15
O2 Maintenance of plant and equipment	15
O3 Dust	15
O4 Processes and management	16
O5 Waste management	16
O6 Other operating conditions	18
5 MONITORING AND RECORDING CONDITIONS	20
M1 Monitoring records	20
M2 Requirement to monitor concentration of pollutants discharged	20
M3 Testing methods - concentration limits	24
M4 Weather monitoring	25
M5 Recording of pollution complaints	25



Environment Protection Licence

Licence - 5065

M6	Telephone complaints line	26
M7	Requirement to monitor volume or mass	26
M8	Other monitoring and recording conditions	26
6	REPORTING CONDITIONS	27
R1	Annual return documents	27
R2	Notification of environmental harm	28
R3	Written report	28
R4	Other reporting conditions	29
7	GENERAL CONDITIONS	30
G1	Copy of licence kept at the premises or plant	30
G2	Other general conditions	30
8	POLLUTION STUDIES AND REDUCTION PROGRAMS	31
U1	Implementation of odour risk reduction measures	34
9	SPECIAL CONDITIONS	31
E1	Requirement To Maintain Financial Assurance	34
E2	Environmental Obligations of Licensee (Works and Programs)	32
E3	EPA May Claim On a Financial Assurance	32
E4	Final Capping Layer	32
E5	Expansion of Landfill Gas Field Infrastructure	34
E6	Construction of Landfill - Dual Gas and Leachate Trench	34
E7	Reprofiling (overtopping) works	34
E8	Design and construction of stormwater drainage works	35
E9	Closure Plan	35
E10	Northwall Preparation Works	35
E11	Special Dictionary	36
DICTIONARY		37
	General Dictionary	37

Environment Protection Licence

Licence - 5065

Information about this licence

Dictionary

A definition of terms used in the licence can be found in the dictionary at the end of this licence.

Responsibilities of licensee

Separate to the requirements of this licence, general obligations of licensees are set out in the Protection of the Environment Operations Act 1997 ("the Act") and the Regulations made under the Act. These include obligations to:

- ensure persons associated with you comply with this licence, as set out in section 64 of the Act;
- control the pollution of waters and the pollution of air (see for example sections 120 - 132 of the Act);
- report incidents causing or threatening material environmental harm to the environment, as set out in Part 5.7 of the Act.

Variation of licence conditions

The licence holder can apply to vary the conditions of this licence. An application form for this purpose is available from the EPA.

The EPA may also vary the conditions of the licence at any time by written notice without an application being made.

Where a licence has been granted in relation to development which was assessed under the Environmental Planning and Assessment Act 1979 in accordance with the procedures applying to integrated development, the EPA may not impose conditions which are inconsistent with the development consent conditions until the licence is first reviewed under Part 3.6 of the Act.

Duration of licence

This licence will remain in force until the licence is surrendered by the licence holder or until it is suspended or revoked by the EPA or the Minister. A licence may only be surrendered with the written approval of the EPA.

Licence review

The Act requires that the EPA review your licence at least every 5 years after the issue of the licence, as set out in Part 3.6 and Schedule 5 of the Act. You will receive advance notice of the licence review.

Fees and annual return to be sent to the EPA

For each licence fee period you must pay:

- an administrative fee; and
- a load-based fee (if applicable).



Environment Protection Licence

Licence - 5065

The EPA publication “A Guide to Licensing” contains information about how to calculate your licence fees. The licence requires that an Annual Return, comprising a Statement of Compliance and a summary of any monitoring required by the licence (including the recording of complaints), be submitted to the EPA. The Annual Return must be submitted within 60 days after the end of each reporting period. See condition R1 regarding the Annual Return reporting requirements.

Usually the licence fee period is the same as the reporting period.

Transfer of licence

The licence holder can apply to transfer the licence to another person. An application form for this purpose is available from the EPA.

Public register and access to monitoring data

Part 9.5 of the Act requires the EPA to keep a public register of details and decisions of the EPA in relation to, for example:

- licence applications;
- licence conditions and variations;
- statements of compliance;
- load based licensing information; and
- load reduction agreements.

Under s320 of the Act application can be made to the EPA for access to monitoring data which has been submitted to the EPA by licensees.

This licence is issued to:

CLEANAWAY PTY LTD
LEVEL 4, 441 ST KILDA RD
MELBOURNE VIC 3004

subject to the conditions which follow.



Environment Protection Licence

Licence - 5065

1 Administrative Conditions

A1 What the licence authorises and regulates

A1.1 This licence authorises the carrying out of the scheduled activities listed below at the premises specified in A2. The activities are listed according to their scheduled activity classification, fee-based activity classification and the scale of the operation.

Unless otherwise further restricted by a condition of this licence, the scale at which the activity is carried out must not exceed the maximum scale specified in this condition.

Scheduled Activity	Fee Based Activity	Scale
Waste processing (non-thermal treatment)	Non-thermal treatment of liquid waste	Any annual processing capacity
Waste disposal (application to land)	Waste disposal by application to land	Any capacity
Waste storage	Waste storage - other types of waste	Any other types of waste stored
Waste storage	Waste storage - waste tyres	> tyres stored

A2 Premises or plant to which this licence applies

A2.1 The licence applies to the following premises:

Premises Details
LUCAS HEIGHTS RESOURCE RECOVERY PARK
NEW ILLAWARRA ROAD
LUCAS HEIGHTS
NSW 2234
LOT 1 DP 233333, LOT 2 DP 605077, PART LOT 101 DP 1009354, LOT 3 DP 1032102, LOT 111 DP 1050235, LOT 4 DP 1149334, LOT 6 DP 1149334
EXCLUDING AREA LABELLED AS "GARDEN ORGANICS" ON MAP TITLED "CLEANAWAY LICENCE BOUNDARY: LITTLE FOREST ROAD LUCAS HEIGHTS" DATED 29 SEPTEMBER 2022, JOB NUMBER 2220317, PRODUCED BY LANDAIR SURVEYS.
EXCLUDING PART LOT 101 DP1009354 SHOWN ON THE MAP RECEIVED BY THE EPA ON 6 MAY 2009 AND TITLED "PLAN SHOWING AREA LICENSED TO PCYC PART LOT 101 IN DP1009354 LUCAS HEIGHTS", DATED 28 APRIL 2009 AND MARKED AS PROPOSED NEW BIKE TRACK AREA. MAP REF: 11925.

A2.2 The premises also includes the areas in a 10 metre radius of all infrastructure in connection to the operation of the gas wells associated with the landfill identified at A2.1 excluding any infrastructure within the area defined as the Premises of Environment Protection Licence no. 6345 and the Premises of Environment Protection Licence no. 4805.



Environment Protection Licence

Licence - 5065

During gas well maintenance, the premises at the gas well head comprises an area of 18 metre radius from the well head.

A3 Other activities

A3.1 This licence applies to all other activities carried on at the premises, including:

Ancillary Activity
Crushing, grinding or separating

A4 Information supplied to the EPA

A4.1 Works and activities must be carried out in accordance with the proposal contained in the licence application, except as expressly provided by a condition of this licence.

In this condition the reference to "the licence application" includes a reference to:

- a) the applications for any licences (including former pollution control approvals) which this licence replaces under the Protection of the Environment Operations (Savings and Transitional) Regulation 1998; and
- b) the licence information form provided by the licensee to the EPA to assist the EPA in connection with the issuing of this licence.

2 Discharges to Air and Water and Applications to Land

P1 Location of monitoring/discharge points and areas

P1.1 The following points referred to in the table below are identified in this licence for the purposes of monitoring and/or the setting of limits for the emission of pollutants to the air from the point.

Air			
EPA identification no.	Type of Monitoring Point	Type of Discharge Point	Location Description
28	Subsurface Gas Monitoring Point - MB036SG		Eastern boundary, adjacent to site office and weighbridge. Gas Monitoring point labelled "MB036" on Map showing monitoring points. Map ref: 32438, version sent to EPA on 5/12/18. EPA Ref: DOC17/605191
29	Subsurface Gas Monitoring Point - MB037SG		Eastern Boundary, adjacent to site office and weighbridge. Gas Monitoring Point labelled "MB037" on map titled "Figure 2: Site plan showing the location of gas bores", prepared by CES and dated 17 June 2008, 312897E 6230983N.



Environment Protection Licence

Licence - 5065

30	Subsurface Gas Monitoring Point - MB042SG	North Western boundary, behind demountable office. Gas Monitoring point labelled "MB042" on Map showing monitoring points. Map ref: 32438, version sent to EPA on 5/12/18. EPA Ref: DOC17/605191
31	Subsurface Gas Monitoring Point - MB043SG	North Western boundary, behind demountable office. Gas Monitoring point labelled "MB043" on Map showing monitoring points. Map ref: 32438, version sent to EPA on 5/12/18. EPA Ref: DOC17/605191
32	Subsurface Gas Monitoring Point - MB046SG	South Eastern corner of site, adjacent to New Illawarra Rd. Gas Monitoring point labelled "MB046SG" on Map showing monitoring points. Map ref: 32438, version sent to EPA on 5/12/18. EPA Ref: DOC17/605191
33	Subsurface Gas Monitoring Point - MB047SG	South Eastern corner of site, adjacent to New Illawarra Rd. Gas Monitoring point labelled "MB047SG" on Map showing monitoring points. Map ref: 32438, version sent to EPA on 5/12/18. EPA Ref: DOC17/605191
51	Subsurface Gas Monitoring Point - MB036-1	Gas monitoring point labelled "MB036-1" on map showing monitoring points. Map ref: 32438, version sent to EPA on 5/12/18. EPA Ref: DOC17/605191
52	Subsurface Gas Monitoring Point - MB037-1	Gas monitoring point labelled "MB037-1" on map showing monitoring points. Map ref: 32438, version sent to EPA on 5/12/18. EPA Ref: DOC17/605191
53	Subsurface Gas Monitoring Point - MB048SG	Gas monitoring point labelled "MB048SG" on map showing monitoring points. Map ref: 32438, version sent to EPA on 5/12/18. EPA Ref: DOC17/605191
54	Subsurface Gas Monitoring Point - MB049SG	Gas monitoring point labelled "MB049SG" on map showing monitoring points. Map ref: 32438, version sent to EPA on 5/12/18. EPA Ref: DOC17/605191

P1.2 The following points referred to in the table are identified in this licence for the purposes of the monitoring and/or the setting of limits for discharges of pollutants to water from the point.

Water and land

EPA Identification no.	Type of Monitoring Point	Type of Discharge Point	Location Description
1	Discharge to waters Overflow quality monitoring - MC1	Discharge to waters Overflow quality monitoring - MC1	Discharge point at Mill Creek labelled "MC1" on Map showing monitoring points. Map ref: 32438, version sent to EPA on 5/12/18. EPA Ref: DOC17/605191

Environment Protection Licence

Licence - 5065

3	Leachate quality monitoring - LD001		Surface Water Monitoring Point from Leachate Dam labelled "LD001" on Map showing monitoring points. Map ref: 32438, version sent to EPA on 5/12/18. EPA Ref: DOC17/605191
4	Groundwater quality monitoring - MB008		Groundwater Monitoring Point labelled "MB008" on Map showing monitoring points. Map ref: 32438, version sent to EPA on 5/12/18. EPA Ref: DOC17/605191
7	Groundwater quality monitoring - MB032		Groundwater Monitoring Point labelled as "MB032" on Map showing monitoring points. Map ref: 32438, version sent to EPA on 5/12/18. EPA Ref: DOC17/605191
8	Groundwater quality monitoring - MB034		Groundwater Monitoring Point labelled as "MB034" on Map showing monitoring points. Map ref: 32438, version sent to EPA on 5/12/18. EPA Ref: DOC17/605191
16	Groundwater quality monitoring - MB305		Groundwater Monitoring Point labelled "MB305" on Map showing monitoring points. Map ref: 32438, version sent to EPA on 5/12/18. EPA Ref: DOC17/605191
17	Groundwater quality monitoring - MB306		Groundwater Monitoring Point labelled "MB306" on Map showing monitoring points. Map ref: 32438, version sent to EPA on 5/12/18. EPA Ref: DOC17/605191
18	Groundwater quality monitoring - MB033		Groundwater Monitoring Point labelled as "MB033" on Map showing monitoring points. Map ref: 32438, version sent to EPA on 5/12/18. EPA Ref: DOC17/605191
19	Groundwater quality monitoring - MB035		Groundwater Monitoring Point labelled as "MB035" on Map showing monitoring points. Map ref: 32438, version sent to EPA on 5/12/18. EPA Ref: DOC17/605191
20	Pumped Discharge from Sediment Dam 5 - DS002	Pumped Discharge from Sediment Dam 5 - DS002	Discharge Point from Sediment Dam 5 labelled as "DS002" on Map showing monitoring points. Map ref: 32438, version sent to EPA on 5/12/18. EPA Ref: DOC17/605191
21	Pumped Discharge from Stormwater Treatment Plant - DS001	Pumped Discharge from Stormwater Treatment Plant - DS001	Discharge Point from Stormwater Treatment Plant adjacent to Sediment Dam 5. Labelled as "DS001" on Map showing monitoring points. Map ref: 32438, version sent to EPA on 5/12/18. EPA Ref: DOC17/605191

Environment Protection Licence

Licence - 5065

22	Overflow from Sediment Dam 5 - OF001	Overflow from Sediment Dam 5 - OF001	Monitoring Point for Overflow from Sediment Dam 5, labelled as "OF001" on Map showing monitoring points. Map ref: 32438, version sent to EPA on 5/12/18. EPA Ref: DOC17/605191
23	Sediment Dam 5 - SD005		Surface Water Monitoring Point from Sediment Dam labelled as "SD005" on Map showing monitoring points. Map ref: 32438, version sent to EPA on 5/12/18. EPA Ref: DOC17/605191
24	Groundwater quality monitoring - MB038		Groundwater Monitoring Point labelled "MB038" on Map showing monitoring points. Map ref: 32438, version sent to EPA on 5/12/18. EPA Ref: DOC17/605191
25	Groundwater quality monitoring - MB039		Groundwater Monitoring Point labelled "MB039" on Map showing monitoring points. Map ref: 32438, version sent to EPA on 5/12/18. EPA Ref: DOC17/605191
26	Groundwater quality monitoring - MB040		Groundwater Monitoring Point labelled "MB040" on Map showing monitoring points. Map ref: 32438, version sent to EPA on 5/12/18. EPA Ref: DOC17/605191
27	Groundwater quality monitoring - MB041		Groundwater Monitoring Point labelled "MB041" on Map showing monitoring points. Map ref: 32438, version sent to EPA on 5/12/18. EPA Ref: DOC17/605191
40	Leachate quality monitoring - LH1DAM		Surface Water Monitoring Point from Leachate Dam labelled "LH1DAM" on map showing monitoring points. Map ref: 32438, version sent to EPA on 5/12/18. EPA Ref: DOC17/605191
41	Leachate flow monitoring - LH2 Leachate Flow Meter		Leachate Flow Monitoring Point within the LH2 leachate dam holding tanks compound labelled "LH2 FLOW METER" on map showing monitoring points. Map ref: 32438, version sent to EPA on 5/12/18. EPA Ref: DOC17/605191
42	Leachate flow monitoring - LH1 Leachate Flow Meter		Leachate Flow Monitoring Point located within the LH1 sump compound labelled as "LH1 FLOW METER" on Map showing monitoring points. Map ref: 32438, version sent to EPA on 5/12/18. EPA Ref: DOC17/605191

Environment Protection Licence

Licence - 5065

43	Leachate flow monitoring - Harrington's Quarry Leachate Flow Meter	Leachate Flow Monitoring Point located at the second gate on Little Forest Road referred to as Harrington's Corner Gate labelled as "HARRINGTON'S" on Map showing monitoring points. Map ref: 32438, version sent to EPA on 5/12/18. EPA Ref: DOC17/605191
44	Groundwater quality monitoring - MB023	Groundwater monitoring point labelled as "MB023" on Map showing monitoring points. Map ref: 32438, version sent to EPA on 5/12/18. EPA Ref: DOC17/605191
45	Groundwater quality monitoring - MB044	Groundwater monitoring point labelled as "MB044" on Map showing monitoring points. Map ref: 32438, version sent to EPA on 5/12/18. EPA Ref: DOC17/605191
46	Groundwater quality monitoring - MB045	Groundwater monitoring point labelled "MB045" on Map showing monitoring points. Map ref: 32438, version sent to EPA on 5/12/18. EPA Ref: DOC17/605191
47	Groundwater quality monitoring - MB046	Groundwater monitoring point labelled as "MB046" on Map showing monitoring points. Map ref: 32438, version sent to EPA on 5/12/18. EPA Ref: DOC17/605191
48	Groundwater quality monitoring - MB047	Groundwater monitoring point labelled as "MB047" on Map showing monitoring points. Map ref: 32438, version sent to EPA on 5/12/18. EPA Ref: DOC17/605191
49	Groundwater quality monitoring - MB048	Groundwater monitoring point labelled as "MB048" on Map showing monitoring points. Map ref: 32438, version sent to EPA on 5/12/18. EPA Ref: DOC17/605191
50	Groundwater quality monitoring - MB049	Groundwater monitoring point labelled as "MB049" on Map showing monitoring points. Map ref: 32438, version sent to EPA on 5/12/18. EPA Ref: DOC17/605191

3 Limit Conditions

L1 Pollution of waters

- L1.1 Except as may be expressly provided in any other condition of this licence, the licensee must comply with section 120 of the Protection of the Environment Operations Act 1997.



Environment Protection Licence

Licence - 5065

L2 Concentration limits

- L2.1 For each monitoring/discharge point or utilisation area specified in the table/s below (by a point number), the concentration of a pollutant discharged at that point, or applied to that area, must not exceed the concentration limits specified for that pollutant in the table.
- L2.2 Where a pH quality limit is specified in the table, the specified percentage of samples must be within the specified ranges.
- L2.3 To avoid any doubt, this condition does not authorise the pollution of waters by any pollutant other than those specified in the table/s.
- L2.4 Water and/or Land Concentration Limits

POINT 1

Pollutant	Units of Measure	50 percentile concentration limit	90 percentile concentration limit	3DGM concentration limit	100 percentile concentration limit
Conductivity	microsiemens per centimetre				1500
Dissolved Oxygen	milligrams per litre				6
Nitrogen (ammonia)	milligrams per litre				2.5
pH	pH				5.5-8.5
Phenol	milligrams per litre				0.32
TSS	milligrams per litre				50

POINT 20,21,22

Pollutant	Units of Measure	50 percentile concentration limit	90 percentile concentration limit	3DGM concentration limit	100 percentile concentration limit
Nitrogen (ammonia)	milligrams per litre				2.5
TSS	milligrams per litre				50

- L2.5 The licensee is taken not to have breached the licence total suspended solids concentration limits for Point 1 and Point 22 if:



Environment Protection Licence

Licence - 5065

- a) the overflow is caused by a rainfall event; and
- b) the licensee has taken all practical measures to avoid and minimise water pollution.

L3 Waste

L3.1 The licensee must not cause, permit or allow any waste to be received at the premises, except the wastes expressly referred to in the column titled “Waste” and meeting the definition, if any, in the column titled “Description” in the table below.

Any waste received at the premises must only be used for the activities referred to in relation to that waste in the column titled “Activity” in the table below.

Any waste received at the premises is subject to those limits or conditions, if any, referred to in relation to that waste contained in the column titled “Other Limits” in the table below.

This condition does not limit any other conditions in this licence.

Code	Waste	Description	Activity	Other Limits
NA	Leachate	Leachate generated at the Cleanaway Garden Organics Facility, Part lot 101 DP1009354 labelled as "Garden Organics" on map titled "Cleanaway licence boundary: Little Forest Road Lucas Heights" dated 29 September 2022, Job Number 2220317, produced by Landair Surveys	Waste processing (non-thermal treatment)	80 kL/day
NA	General solid waste (putrescible)	As defined in Schedule 1 of the POEO Act, as in force from time to time.	Waste storage Waste disposal (application to land)	NA
NA	General solid waste (non-putrescible)	As defined in Schedule 1 of the POEO Act, as in force from time to time.	Waste storage Waste disposal (application to land)	NA
NA	Asbestos waste	As defined in Schedule 1 of the POEO Act, as in force from time to time.	Waste storage Waste disposal (application to land)	NA
T140	Tyres	The tyre has a diameter of 1.2 metres or more; and/or the tyre has been shredded or had its walls removed; and/or the tyre was delivered to the premises as part of a domestic load. For the purposes of this description: · Tyres are taken to be shredded	Waste storage Waste disposal (application to land)	Tyres stockpiled on the premises must not exceed fifty (50) tonnes of tyres at any one time.



Environment Protection Licence

Licence - 5065

		only if the tyres are in pieces measuring no more than 250mm in any direction; and · Domestic load means a load containing no more than 5 tyres having a diameter of less than 1.2 metres.		
NA	Leachate	Landfill leachate only generated at the premises known as “Harrington’s Quarry” and “Lucas Heights 1” and conveyed via the leachate reticulation system to the Lucas Heights Leachate Treatment Plant	Waste processing (non-thermal treatment)	1500 kL/day
NA	Waste	Any waste received on site that is below licensing thresholds in Schedule 1 of the POEO Act, as in force from time to time	-	NA

- L3.2 If the licence permits the disposal of asbestos waste, the licensee must comply with Part 7 of the Protection of the Environment Operations (Waste) Regulation 2014.
- L3.3 The disposal of waste is permitted within Cell 5.3A, Cell 5.3B and Cell 5.3C. The disposal of waste is also permitted within Cell 5.1 and Cell 5.2 defined as areas " Stage 5-1" and "Stage 5-2" in the plan prepared for Suez Recycling and Recovery Pty Ltd by Mamdoh Ibrahim of PE Civil and titled "*Drawing number LH-160526-1-R0 Location of waste cells (stages)*" and dated 26 May 2016.
- L3.4 The disposal of waste is permitted within the areas marked "Area E", "Area D", "Area B" and "Area A" on the below plans received by the EPA on 12 October 2017:
Proposed Reprofilng Development Plan, Drawing Job number 21-23482, Landform marked "Phase 1" (Revision C, 3 July 2015) prepared by GHD,
Proposed Reprofilng Development Plan, Drawing Job number 21-23482, Landforms marked "Phase 2" and "Phase 3", (Revision C, 3 July 2017), prepared by GHD, and
Proposed Reprofilng Development Plan, Drawing Job number 21-23482, Landform marked "Phase 4", (Revision C, 3 July 2017), prepared by GHD.
- The disposal of waste is permitted within the areas marked "Area G", "Area C" and "Area F" on the Proposed Profiling Development Plan - Phase 4, 5, 6 and 7, Drawing Job No. 21-27039 (Revised D, 13 November 2020) prepared by GHD.
- The disposal of waste is permitted within the areas marked "Area H" and "Area I" on the Proposed Reprofilng Development Plan - Phase 8 & 9, Drawing 21-27039 (Revised D, 13 November 2020), prepared by GHD (EPA Ref: DOC24/307489).



Environment Protection Licence

Licence - 5065

L4 Hours of operation

L4.1 The licensee must comply with the operating hours in the table below:

Activity	Day	Time
Construction	Monday to Friday	7 am - 5 pm
Construction	Saturday and Sunday	8 am - 5 pm
Landfilling operations	Monday to Friday	5 am - 5 pm
Landfilling operations	Saturday	6 am - 5pm
Landfilling operations	Sunday	8 am - 5 pm
Other landfilling operations	Monday to Sunday	Anytime

L5 Potentially offensive odour

L5.1 No condition of this licence identifies a potentially offensive odour for the purposes of section 129 of the Protection of the Environment Operations Act 1997.

Note: Section 129 of the Protection of the Environment Operations Act 1997, provides that the licensee must not cause or permit the emission of any offensive odour from the premises but provides a defence if the emission is identified in the relevant environment protection licence as a potentially offensive odour and the odour was emitted in accordance with the conditions of a licence directed at minimising odour.

4 Operating Conditions

O1 Activities must be carried out in a competent manner

O1.1 Licensed activities must be carried out in a competent manner.

This includes:

- a) the processing, handling, movement and storage of materials and substances used to carry out the activity; and
- b) the treatment, storage, processing, reprocessing, transport and disposal of waste generated by the activity.

O2 Maintenance of plant and equipment

O2.1 All plant and equipment installed at the premises or used in connection with the licensed activity:

- a) must be maintained in a proper and efficient condition; and
- b) must be operated in a proper and efficient manner.

O3 Dust

O3.1 All operations and activities occurring at the premises must be carried out in a manner that will minimise the emission of dust from the premises.

Environment Protection Licence

Licence - 5065

O4 Processes and management

Control Entry to Premises

- O4.1 The licensee must take all practicable steps to control entry to the premises.

O5 Waste management

Incineration or Burning of any Waste

- O5.1 There must be no incineration or burning of any waste at the premises.

Waste Recycling

- O5.2 The licensee must ensure that, as much as practicable, recycling facilities are provided for the following materials:

- a) Glass – clear, brown and green;
- b) Paper and cardboard;
- c) Batteries;
- d) Sump engine oil;
- e) Aluminium and steel cans; and
- f) Reusable timber, firewood and green waste.

- O5.3 Recycling facilities at the premises must be clearly marked and be available for access by the public.

Tyre Storage

- O5.4 The licensee must ensure that stockpiles of used, rejected or unwanted tyres (including shredded tyres and tyre pieces) are located in a clearly defined area.
- O5.5 The licensee must ensure that stockpiles of used, rejected or unwanted tyres (including shredded tyres and tyre pieces) are managed so as not to cause or to be likely to cause the spread of disease by vermin.
- O5.6 The licensee must ensure that measures are taken to prevent stockpiles of used, rejected or unwanted tyres (including shredded tyres and tyre pieces) from catching on fire.

Covering of Waste

- O5.7 a) Daily Cover

Daily cover material must be either:

- i) virgin excavated natural material (VENM); or
- ii) approved alternative daily cover (ADC).

Daily cover material must be applied to a minimum depth of 15 centimetres over all exposed landfill waste prior to ceasing operations at the end of each day.

Environment Protection Licence

Licence - 5065

b) Intermediate Cover

Virgin excavated natural material (VENM) must be applied to a depth of 30 centimetres over surfaces of the landfilled waste at the premises which are to be exposed for more than 90 days.

c) Cover Material Stockpile

At least two weeks cover material must be available at the premises under all weather conditions. This material may be won on site, or alternatively a cover stockpile must be maintained adjacent to the tip face.

O5.8 For the purposes of condition O5.7 (a) (ii) the approved ADC is:

1. ConCover that achieves the performance criteria specified in Section 8 Covering of Waste of NSW EPA Environmental Guidelines Solid Waste Landfills Second Edition, 2016; or
2. A tarpaulin system (Tarpomatic or similar); or
3. Recovered Fines that meet the requirements of the Recovered Fines Alternative Daily Cover Specifications as gazetted and amended by the EPA from time to time, in accordance with clause 12(7)(c) of the Protection of the Environment Operations (Waste) Regulation 2014.

O5.9 Asbestos waste disposed of at the Premises must be covered:

1. at the time of disposal: with either VENM to a depth of at least 0.15 metres, or with general solid waste to a depth of at least 0.5 metres; and
2. at the end of each day's operation: with VENM to a depth of at least 0.5 metres, or general solid waste to a depth of at least 1 metre.

O5.10 The licensee must progressively final cap completed stages of filling as soon as practicable.

Disposal of Immobilised Waste

O5.11 The licensee must cover the immobilised waste on the day of receipt.

Uncovering of Landfilled Waste

O5.12 The licensee must not carry out any activity that exposes previously landfilled waste at the premises, except as expressly permitted by a condition of this licence.

O5.13 A maximum area of 1 hectare of existing intermediate cover or 2 hectares of existing final capped cover may be stripped of cover in advance of landfilling to form the "Prepared Surface". The Prepared Surface must retain capping of at least 300mm in depth.

O5.14 Each day, a maximum of 2,500m² of the Prepared Surface may be stripped back to expose previously landfilled waste, forming the "Stripped Back Area".

O5.15 The Active Tip Face must not be more than 2,500m² at any one time.

O5.16 For the purposes of Condition O5.11; Final trimming, levelling, and compaction to achieve final landfill level contours, may be completed within the Stripped Back Area.

O5.17 A maximum of 5,000 m² of landfilled waste may be exposed at any one time, unless the following circumstances are met:

Environment Protection Licence

Licence - 5065

1. the written approval of the EPA has been provided to the licensee, and
2. this approval specifies the circumstances including the area and the timeframe this approval covers, or
3. the exceedance is required for emergency conditions.

O5.18 The licensee must carry out works in accordance with the document titled Odour Management Plan for Landfill Gas Extraction Systems provided with the letter received from Waste Service NSW dated 28 June 2002.

Landfill Leachate

O5.19 Landfill leachate must not be irrigated except as expressly permitted by a condition of this licence.

O5.20 The licensee must not inject leachate back into the landfill waste.

O5.21 Leachate must be lawfully disposed of to sewer, or removed by tanker to a premises which may lawfully receive the leachate for treatment.

Landfill Gas

O5.22 Except in emergency conditions or short periods of shutdowns the licensee must ensure that landfill gas generated by the disposal of waste and collected at the premises is treated by oxidation to carbon dioxide.

O5.23 With the exception of the Prepared Surface, landfill gas field infrastructure located within the re-profiling area outlined at E7.1 must be retained and operating at all times.

O6 Other operating conditions

Management of Collected Groundwater

O6.1 The licensee must manage any groundwater extracted from groundwater depressurisation works in the same manner as leachate if the ammonia concentration in the groundwater is greater than 1 mg/L.

Household Chemical Collection Program

O6.2 Chemicals which have been collected in conjunction with a "Household Chemical Collection Program" must be stored in a secure and bunded location within the premises pending lawful off site disposal or recycling of these chemicals.

Closure Plan

O6.3 The licensee must prepare and submit to the EPA within twelve months prior to the last load of waste being landfilled, a closure plan in accordance with section 76 of the *Protection of the Environment Operations Act 1997*.

Preventing Fires

Environment Protection Licence

Licence - 5065

- O6.4 All operations and activities occurring at the premises must be carried out in a manner that will prevent and minimise the risk of fire at the premises.

Management of Surface Waters

- O6.5 Surface waters must be diverted away from any area where waste is being or has been landfilled.
- O6.6 Suez must install and maintain freeboard markers in Sediment Dam 5. Freeboard markers must:
- indicate the 10ML settling zone,
 - indicate 2ML increments,
 - be permanently installed, and
 - be positioned in location/s that allow freeboard verification.
- O6.7 Sediment Dam 5 must be maintained at or below the base of the 10ML settling zone, except as specified in Condition O6.8.
- O6.8 During 2 day 90th percentile rainfall events of 34.8mm or more, the stormwater treatment plant must be engaged, as soon as the event is known, to treat sediment laden water. A 10ML capacity settling zone within Sediment Dam 5 must be re-established within 5 days of the rainfall event occurring.

Alternative Daily Cover Trial - MWOO

- O6.9 The licensee is permitted to undertake an Alternative Daily Cover (MWOO) trial at the tip face over a 6 month period, beginning on the first day the Alternative Daily Cover is applied.

The trial must be conducted in accordance with the following documents:

- the letter from the licensee titled: *RE Licence 5065 - Trial Proposal for Mixed Waste Organic Outputs as Alternative Daily Cover* dated 9 May 2019 and received by the EPA on 9 May 2019,
- the letter from the licensee titled *RE Licence variation application - MWOO as Alternative Daily Cover Additional information required dated 24 March 2019* and received by the EPA on 24 June 2019,
- the letter from Michael Assal of The Odour Unit Pty Ltd titled *Alternative Daily Cover - Odour Trial Study - Proposal dated 7 June 2019* and received by the EPA on 24 June 2019, and
- the EPA's *Environmental Guidelines: Solid Waste landfills* (2nd Edition, 2016)

- O6.10 Within 90 days of the trial at O6.13 beginning, the licensee must provide to the EPA a report containing a progress update on the MWOO trial.

The report must be submitted by email to info@epa.nsw.gov.au and include, but need not be limited to:

- a discussion of the outcomes of the trial so far,
- data on the volumes of MWOO used and specification compliance, and
- discussion of any issues or concerns encountered during the trial so far.

- O6.11 Within 30 days of the completion of the Alternative Daily Cover trial detailed at Condition O6.13, the licensee

Environment Protection Licence

Licence - 5065

must provide to the EPA a report containing the outcomes of the trial.

The report must be submitted by email to info@epa.nsw.gov.au and must include, but need not be limited to:

1. an assessment of the effectiveness and consistency of the alternative daily cover in meeting the Required Outcomes for the covering of waste at Section 8 and any other relevant sections of the Environmental Guidelines: Solid Waste Landfills (NSW EPA, Second Edition, 2016),
2. all data relating to the analytical testing of the Alternative Daily Cover material (including material that was tested and did not meet the specification) including but not limited to particle size distribution, physical contaminant levels, and waste classification testing in general, and
3. photographs of the Alternative Daily Cover prior to, during, and after placement at the tip face, and
4. a benchmark of the Alternative Daily Cover's performance against virgin excavated natural material as daily cover, and
5. any other relevant findings of the trial.

5 Monitoring and Recording Conditions

M1 Monitoring records

- M1.1 The results of any monitoring required to be conducted by this licence or a load calculation protocol must be recorded and retained as set out in this condition.
- M1.2 All records required to be kept by this licence must be:
- a) in a legible form, or in a form that can readily be reduced to a legible form;
 - b) kept for at least 4 years after the monitoring or event to which they relate took place; and
 - c) produced in a legible form to any authorised officer of the EPA who asks to see them.
- M1.3 The following records must be kept in respect of any samples required to be collected for the purposes of this licence:
- a) the date(s) on which the sample was taken;
 - b) the time(s) at which the sample was collected;
 - c) the point at which the sample was taken; and
 - d) the name of the person who collected the sample.
- M1.4 The licensee must record the date, duration and volume of any leachate discharge to surface water.

M2 Requirement to monitor concentration of pollutants discharged

- M2.1 For each monitoring/discharge point or utilisation area specified below (by a point number), the licensee must monitor (by sampling and obtaining results by analysis) the concentration of each pollutant specified in Column 1. The licensee must use the sampling method, units of measure, and sample at the frequency, specified opposite in the other columns:
- M2.2 Air Monitoring Requirements



Environment Protection Licence

Licence - 5065

POINT 28,29,30,31,32,33,51,52,53,54

Pollutant	Units of measure	Frequency	Sampling Method
Carbon dioxide	percent by volume	Quarterly	Special Method 1
Methane	percent by volume	Quarterly	Special Method 1

M2.3 Water and/ or Land Monitoring Requirements

POINT 1

Pollutant	Units of measure	Frequency	Sampling Method
Conductivity	microsiemens per centimetre	Special Frequency 1	Probe
Dissolved Oxygen	milligrams per litre	Special Frequency 1	Probe
Nitrogen (ammonia)	milligrams per litre	Special Frequency 1	Grab sample
pH	pH	Special Frequency 1	Probe
Potassium	milligrams per litre	Special Frequency 1	Grab sample
Total dissolved solids	milligrams per litre	Special Frequency 1	Grab sample
Total organic carbon	milligrams per litre	Special Frequency 1	Grab sample
Total Phenolics	milligrams per litre	Special Frequency 1	Grab sample
Total suspended solids	milligrams per litre	Special Frequency 1	Grab sample

POINT 3,40

Pollutant	Units of measure	Frequency	Sampling Method
Alkalinity (as calcium carbonate)	milligrams per litre	Yearly	Grab sample
Aluminium	milligrams per litre	Yearly	Grab sample
Arsenic	milligrams per litre	Yearly	Grab sample
Barium	milligrams per litre	Yearly	Grab sample
Benzene	milligrams per litre	Yearly	Grab sample
Benzo(a)pyrene	milligrams per litre	Yearly	Grab sample
Bicarbonate alkalinity	milligrams per litre	Yearly	Grab sample
BOD	milligrams per litre	Yearly	Grab sample
Cadmium	milligrams per litre	Yearly	Grab sample
Calcium	milligrams per litre	Yearly	Grab sample
Chemical oxygen demand	milligrams per litre	Yearly	Grab sample
Chloride	milligrams per litre	Yearly	Grab sample
Chromium (hexavalent)	milligrams per litre	Yearly	Grab sample



Environment Protection Licence

Licence - 5065

Chromium (total)	milligrams per litre	Yearly	Grab sample
Cobalt	milligrams per litre	Yearly	Grab sample
Conductivity	microsiemens per centimetre	Quarterly	Probe
Copper	milligrams per litre	Yearly	Grab sample
Ethyl benzene	milligrams per litre	Yearly	Grab sample
Fluoride	milligrams per litre	Yearly	Grab sample
Lead	milligrams per litre	Yearly	Grab sample
Magnesium	milligrams per litre	Yearly	Grab sample
Manganese	milligrams per litre	Yearly	Grab sample
Mercury	milligrams per litre	Yearly	Grab sample
Nickel	milligrams per litre	Yearly	Grab sample
Nitrate	milligrams per litre	Yearly	Grab sample
Nitrite	milligrams per litre	Yearly	Grab sample
Nitrogen (ammonia)	milligrams per litre	Yearly	Grab sample
Organochlorine pesticides	milligrams per litre	Yearly	Grab sample
Organophosphate pesticides	milligrams per litre	Yearly	Grab sample
pH	pH	Quarterly	Probe
Phosphorus	milligrams per litre	Yearly	Grab sample
Polycyclic aromatic hydrocarbons	milligrams per litre	Yearly	Grab sample
Potassium	milligrams per litre	Yearly	Grab sample
Sodium	milligrams per litre	Yearly	Grab sample
Sulfate	milligrams per litre	Yearly	Grab sample
Toluene	milligrams per litre	Yearly	Grab sample
Total dissolved solids	milligrams per litre	Yearly	Grab sample
Total organic carbon	milligrams per litre	Yearly	Grab sample
Total petroleum hydrocarbons	milligrams per litre	Yearly	Grab sample
Total Phenolics	milligrams per litre	Yearly	Grab sample
Total suspended solids	milligrams per litre	Yearly	Grab sample
Xylene	milligrams per litre	Yearly	Grab sample
Zinc	milligrams per litre	Yearly	Grab sample

POINT 4,7,8,16,17,18,19,24,25,26,27,44,45,46,47,48,49,50

Pollutant	Units of measure	Frequency	Sampling Method
Alkalinity (as calcium carbonate)	milligrams per litre	Quarterly	Grab sample
Aluminium	milligrams per litre	Yearly	Grab sample
Arsenic	milligrams per litre	Yearly	Grab sample
Barium	milligrams per litre	Yearly	Grab sample
Benzene	milligrams per litre	Yearly	Grab sample
Benzo(a)pyrene	milligrams per litre	Yearly	Grab sample
Bicarbonate alkalinity	milligrams per litre	Quarterly	Grab sample

Environment Protection Licence

Licence - 5065

Cadmium	milligrams per litre	Yearly	Grab sample
Calcium	milligrams per litre	Quarterly	Grab sample
Chloride	milligrams per litre	Quarterly	Grab sample
Chromium (hexavalent)	milligrams per litre	Yearly	Grab sample
Chromium (total)	milligrams per litre	Yearly	Grab sample
Cobalt	milligrams per litre	Yearly	Grab sample
Copper	milligrams per litre	Yearly	Grab sample
Ethyl benzene	milligrams per litre	Yearly	Grab sample
Fluoride	milligrams per litre	Yearly	Grab sample
Lead	milligrams per litre	Yearly	Grab sample
Magnesium	milligrams per litre	Quarterly	Grab sample
Manganese	milligrams per litre	Yearly	Grab sample
Mercury	milligrams per litre	Yearly	Grab sample
Nickel	milligrams per litre	Yearly	Grab sample
Nitrate	milligrams per litre	Quarterly	Grab sample
Nitrite	milligrams per litre	Quarterly	Grab sample
Nitrogen (ammonia)	milligrams per litre	Quarterly	Grab sample
Organochlorine pesticides	milligrams per litre	Yearly	Grab sample
Organophosphate pesticides	milligrams per litre	Yearly	Grab sample
PCBs	milligrams per litre	Yearly	Grab sample
pH	pH	Quarterly	Probe
Phosphorus	milligrams per litre	Quarterly	Grab sample
Polycyclic aromatic hydrocarbons	milligrams per litre	Yearly	Grab sample
Potassium	milligrams per litre	Quarterly	Grab sample
Redox potential	millivolts	Quarterly	Grab sample
Selenium	milligrams per litre	Yearly	Grab sample
Sodium	milligrams per litre	Quarterly	Grab sample
Standing Water Level	metres	Quarterly	In situ
Sulfate	milligrams per litre	Quarterly	Grab sample
Temperature	degrees Celsius	Quarterly	Probe
Tetrachloroethene (tetrachloroethylene)	milligrams per litre	Yearly	Grab sample
Toluene	milligrams per litre	Yearly	Grab sample
Total dissolved solids	milligrams per litre	Quarterly	Grab sample
Total organic carbon	milligrams per litre	Quarterly	Grab sample
Total petroleum hydrocarbons	milligrams per litre	Yearly	Grab sample
Total Phenolics	milligrams per litre	Yearly	Grab sample
Trichloroethylene	milligrams per litre	Yearly	Grab sample
Xylene	milligrams per litre	Yearly	Grab sample
Zinc	milligrams per litre	Yearly	Grab sample

POINT 20,21



Environment Protection Licence

Licence - 5065

Pollutant	Units of measure	Frequency	Sampling Method
Nitrogen (ammonia)	milligrams per litre	Special Frequency 2	Grab sample
Total suspended solids	milligrams per litre	Special Frequency 2	Grab sample

POINT 22

Pollutant	Units of measure	Frequency	Sampling Method
Nitrogen (ammonia)	milligrams per litre	Special Frequency 1	Grab sample
Total suspended solids	milligrams per litre	Special Frequency 1	Grab sample

POINT 23

Pollutant	Units of measure	Frequency	Sampling Method
Nitrogen (ammonia)	milligrams per litre	Quarterly	Grab sample
Total suspended solids	milligrams per litre	Quarterly	Grab sample

M2.4 For the purposes of the table(s) above:

- a) Special Frequency 1 means: if discharges occur, the collection of samples within 24 hours of discharge;
- b) Special Frequency 2 means: the collection of samples at a minimum of weekly intervals during discharge; and
- c) Special Method 1 means in accordance with the methods outlined in the Lucas Heights 2 Resource Recovery Park Landfill Gas Monitoring Programme prepared by GHD dated March 2020.

M2.5 Where a specified Groundwater Monitoring Well licence point from the above tables at M2.3 is not available for sampling (such as when the bore is dry) and requires sampling Quarterly, an adjacent and/or representative Groundwater Monitoring Well may be alternatively sampled. Any variation from the tables above at M2.3 must be identified and justified in the required monitoring report and annual return.

M3 Testing methods - concentration limits

- M3.1 Monitoring for the concentration of a pollutant emitted to the air required to be conducted by this licence must be done in accordance with:
- a) any methodology which is required by or under the Act to be used for the testing of the concentration of the pollutant; or
 - b) if no such requirement is imposed by or under the Act, any methodology which a condition of this licence requires to be used for that testing; or
 - c) if no such requirement is imposed by or under the Act or by a condition of this licence, any methodology approved in writing by the EPA for the purposes of that testing prior to the testing taking place.

Note: The *Protection of the Environment Operations (Clean Air) Regulation 2022* requires testing for certain



Environment Protection Licence

Licence - 5065

purposes to be conducted in accordance with test methods contained in the publication "Approved Methods for the Sampling and Analysis of Air Pollutants in NSW".

M3.2 Subject to any express provision to the contrary in this licence, monitoring for the concentration of a pollutant discharged to waters or applied to a utilisation area must be done in accordance with the Approved Methods Publication unless another method has been approved by the EPA in writing before any tests are conducted.

M4 Weather monitoring

Requirement to Monitor Meteorological Parameters

M4.1 The licensee must monitor (by sampling and obtaining results by analysis) the parameters specified in Column 1. The applicant must use the sampling method, units of measure, averaging period and sample at the frequency, specified opposite in the other columns.

Parameter	Units of Measure	Frequency	Averaging Period	Sampling Method
Rainfall	mm	Continuous	1 Hour	AM-4
Wind Speed @ 10 metres	m/s	Continuous	15 Minute	AM-2 & AM-4
Wind Direction @ 10 metres	Degrees	Continuous	15 Minute	AM-2 & AM-4
Temperature	Degrees Celsius	Continuous	15 Minute	AM-4
Sigma theta @ 10 metres	Degrees	Continuous	15 Minute	AM-2 & AM-4
Solar Radiation	W/m2	Continuous	15 Minute	AM-4
Additional Requirements - Siting - Measurement				AM-1 & AM-4 AM-2 & AM-4

M5 Recording of pollution complaints

M5.1 The licensee must keep a legible record of all complaints made to the licensee or any employee or agent of the licensee in relation to pollution arising from any activity to which this licence applies.

M5.2 The record must include details of the following:

- a) the date and time of the complaint;
- b) the method by which the complaint was made;
- c) any personal details of the complainant which were provided by the complainant or, if no such details were provided, a note to that effect;
- d) the nature of the complaint;
- e) the action taken by the licensee in relation to the complaint, including any follow-up contact with the complainant; and
- f) if no action was taken by the licensee, the reasons why no action was taken.

M5.3 The record of a complaint must be kept for at least 4 years after the complaint was made.



Environment Protection Licence

Licence - 5065

M5.4 The record must be produced to any authorised officer of the EPA who asks to see them.

M6 Telephone complaints line

- M6.1 The licensee must operate during its operating hours a telephone complaints line for the purpose of receiving any complaints from members of the public in relation to activities conducted at the premises or by the vehicle or mobile plant, unless otherwise specified in the licence.
- M6.2 The licensee must notify the public of the complaints line telephone number and the fact that it is a complaints line so that the impacted community knows how to make a complaint.
- M6.3 The preceding two conditions do not apply until 3 months after: the date of the issue of this licence.

M7 Requirement to monitor volume or mass

- M7.1 For each discharge point or utilisation area specified below, the licensee must monitor:
- a) the volume of liquids discharged to water or applied to the area;
 - b) the mass of solids applied to the area;
 - c) the mass of pollutants emitted to the air;
- at the frequency and using the method and units of measure, specified below.

POINT 41

Frequency	Unit of Measure	Sampling Method
Special Frequency 3	kilolitres	In line instrumentation

POINT 42

Frequency	Unit of Measure	Sampling Method
Special Frequency 3	kilolitres	In line instrumentation

POINT 43

Frequency	Unit of Measure	Sampling Method
Special Frequency 3	kilolitres	In line instrumentation

Note: Special Frequency 3 sampling requires a continuous inline flow meter with reporting of the total volume of leachate discharged quarterly.

M8 Other monitoring and recording conditions

Requirement to Monitor Landfill Gas

- M8.1 The licensee must undertake landfill gas monitoring in accordance with the document titled “Lucas Heights 2 Resource Recovery Park Landfill Gas Monitoring Programme” prepared by GHD dated March 2020.

Environment Protection Licence

Licence - 5065

The landfill gas monitoring results must be submitted to the EPA annually, accompanying the Annual Return.

M8.2 If the results of the landfill gas surface monitoring required by Condition M8.1 indicate the presence of methane in excess of 500 ppm at or near the ground level of capped areas, the licensee must:

- a) notify the EPA within 24 hours; and
- b) submit to the EPA a proposed program to investigate and/or correct the elevated gas levels within 14 days of this notification.

If the results of the landfill gas sub-surface monitoring or gas accumulation monitoring indicate the presence of methane in excess of 1% (volume/volume), the licensee must:

- a) notify the EPA within 24 hours; and
- b) submit to the EPA a proposed program for further investigation and/or remediation of the elevated gas levels within 14 days of this notification.

Requirement to Record Fires

M8.3 The licensee must record the following data in relation to all fires occurring at the premises:

- (a) time and date when the fire started;
- (b) whether the fire was authorised by the licensee, and, if not, the circumstances which ignited the fire;
- (c) the time and date that the fire burnt out or was extinguished;
- (d) the location of fire (e.g. clean timber stockpile, putrescible garbage cell);
- (e) prevailing weather conditions at the time of the fire;
- (f) observations made in regard to smoke direction and dispersion;
- (g) the amount of waste that was combusted by the fire;
- (h) action taken to extinguish the fire; and
- (i) action taken to prevent a reoccurrence.

6 Reporting Conditions

R1 Annual return documents

R1.1 The licensee must complete and supply to the EPA an Annual Return in the approved form comprising:

- 1. a Statement of Compliance,
- 2. a Monitoring and Complaints Summary,
- 3. a Statement of Compliance - Licence Conditions,
- 4. a Statement of Compliance - Load based Fee,
- 5. a Statement of Compliance - Requirement to Prepare Pollution Incident Response Management Plan,
- 6. a Statement of Compliance - Requirement to Publish Pollution Monitoring Data; and
- 7. a Statement of Compliance - Environmental Management Systems and Practices.

At the end of each reporting period, the EPA will provide to the licensee notification that the Annual Return is due.

Environment Protection Licence

Licence - 5065

- R1.2 An Annual Return must be prepared in respect of each reporting period, except as provided below.
- R1.3 Where this licence is transferred from the licensee to a new licensee:
- a) the transferring licensee must prepare an Annual Return for the period commencing on the first day of the reporting period and ending on the date the application for the transfer of the licence to the new licensee is granted; and
 - b) the new licensee must prepare an Annual Return for the period commencing on the date the application for the transfer of the licence is granted and ending on the last day of the reporting period.
- R1.4 Where this licence is surrendered by the licensee or revoked by the EPA or Minister, the licensee must prepare an Annual Return in respect of the period commencing on the first day of the reporting period and ending on:
- a) in relation to the surrender of a licence - the date when notice in writing of approval of the surrender is given; or
 - b) in relation to the revocation of the licence - the date from which notice revoking the licence operates.
- R1.5 The Annual Return for the reporting period must be supplied to the EPA via eConnect *EPA* or by registered post not later than 60 days after the end of each reporting period or in the case of a transferring licence not later than 60 days after the date the transfer was granted (the 'due date').
- R1.6 The licensee must retain a copy of the Annual Return supplied to the EPA for a period of at least 4 years after the Annual Return was due to be supplied to the EPA.
- R1.7 Within the Annual Return, the Statements of Compliance must be certified and the Monitoring and Complaints Summary must be signed by:
- a) the licence holder; or
 - b) by a person approved in writing by the EPA to sign on behalf of the licence holder.
- Note: The term "reporting period" is defined in the dictionary at the end of this licence. Do not complete the Annual Return until after the end of the reporting period.

Note: An application to transfer a licence must be made in the approved form for this purpose.

R2 Notification of environmental harm

- R2.1 Notifications must be made by telephoning the Environment Line service on 131 555.
- R2.2 The licensee must provide written details of the notification to the EPA within 7 days of the date on which they became aware of the incident.

Note: The licensee or its employees must notify all relevant authorities of incidents causing or threatening material harm to the environment immediately after the person becomes aware of the incident in accordance with the requirements of Part 5.7 of the Act.

R3 Written report

- R3.1 Where an authorised officer of the EPA suspects on reasonable grounds that:

Environment Protection Licence

Licence - 5065

a) where this licence applies to premises, an event has occurred at the premises; or
 b) where this licence applies to vehicles or mobile plant, an event has occurred in connection with the carrying out of the activities authorised by this licence,
 and the event has caused, is causing or is likely to cause material harm to the environment (whether the harm occurs on or off premises to which the licence applies), the authorised officer may request a written report of the event.

R3.2 The licensee must make all reasonable inquiries in relation to the event and supply the report to the EPA within such time as may be specified in the request.

R3.3 The request may require a report which includes any or all of the following information:

- a) the cause, time and duration of the event;
- b) the type, volume and concentration of every pollutant discharged as a result of the event;
- c) the name, address and business hours telephone number of employees or agents of the licensee, or a specified class of them, who witnessed the event;
- d) the name, address and business hours telephone number of every other person (of whom the licensee is aware) who witnessed the event, unless the licensee has been unable to obtain that information after making reasonable effort;
- e) action taken by the licensee in relation to the event, including any follow-up contact with any complainants;
- f) details of any measure taken or proposed to be taken to prevent or mitigate against a recurrence of such an event; and
- g) any other relevant matters.

R3.4 The EPA may make a written request for further details in relation to any of the above matters if it is not satisfied with the report provided by the licensee. The licensee must provide such further details to the EPA within the time specified in the request.

R4 Other reporting conditions

Notification of Fires

R4.1 The licensee must notify the details of the occurrence of all fires on the premises to the EPA in accordance with conditions R2.1, R2.2 and R2 note.

Notifications must include the data recorded under condition M8.5 at the time of notification.

Notification of Groundwater Contamination by Leachate and proposed remediation action

R4.2 In the event that monitoring detects ammonia in groundwater at a concentration above 1 mg/L in any of the points 4, 7, 8, 16, 17, 18, 19, 24, 25, 26, 27, 44, 45, 46, 47, 48, 49 or 50, the licensee must send written notification to the EPA within 14 days of the monitoring results becoming available.

R4.3 In the event that the monitoring results from samples obtained under M2.3 exceed a level of contamination set out in *National Environment Protection (Assessment of Site Contamination) Measure 1999* (NEPC 2013), then the licensee must consider its requirement to formally notify the EPA under section 60 of the *Contaminated Land Management Act 1997 (CLM Act)*. Reference should be made to the *EPA Guidelines on the Duty To Report Contamination under the CLM Act*. Details of any such occurrence should be documented in the licence Annual Report.

Environment Protection Licence

Licence - 5065

7 General Conditions

G1 Copy of licence kept at the premises or plant

G1.1 A copy of this licence must be kept at the premises to which the licence applies.

G1.2 The licence must be produced to any authorised officer of the EPA who asks to see it.

G1.3 The licence must be available for inspection by any employee or agent of the licensee working at the premises.

G2 Other general conditions

G2.1 Completed Programs

Program	Description	Completed Date
Trial Irrigation of Greenwaste Dam Water on Rehabi	Trial Irrigation of Greenwaste Dam Water on Rehabilitation areas.	30-April-2009
Submission of reports on water quality and odour incidents	Submission of Report including monthly water quality reports from Mill Pond & Sediment Dam, details of all odour incidents and improved environmental management of the site.	30-May-2009
Groundwater Depressurisation	Design & construction of stage 5 (cell 2 & 3) groundwater depressurisation system.	27-November-2012
Compacted Clay Liner	Compacted Clay Liner system installation & implement test regimes and procedures.	27-November-2012
Leachate Management System	Leachate Management System installation in stage 5 (cell 2 & 3) and implementation of test regimes and procedures.	27-November-2012
Construction QA Report - Stage 5 (Cell 2)	Submit construction quality assurance report - stage 5 (cell 2).	27-November-2012
Commencement of Landfilling Operations	Commencement of landfilling operations: waste must not be landfilled in cell 5 (stage 2 & 3) at the premises without EPA written approval.	16-January-2013
Report on leachate level in stage 5 (cell 1) risers	Submission of report on Leachate level in stage 5 (cell 1) including details quaterly monitoring of the leachate level in immediate risers in stage 5 - cell 1 and improved environmental management of the site.	02-August-2008
Implement 12 month surface water monitoring program	Implement 12 month surface water monitoring program - prepared by WSN Env. Solutions dated March 2006.	01-March-2009



Environment Protection Licence

Licence - 5065

Report on surface water monitoring program	At completion of surface water monitoring program, submit report on: a) statistical analysis data; b) graphical presentation data; c) geographical presentation data; d) comparison against leachate & groundwater characteristics.	01-June-2009
Ammonia investigation program	Prepare & submit an investigation program to lower Ammonia concentrations in stormwater.	11-August-2009
Odour Risk Reduction Study	Study the offensive odour risks on the premises and propose reasonable and feasible measures to reduce these risks.	15-April-2019

8 Pollution Studies and Reduction Programs

U1 Implementation of odour risk reduction measures

- U1.1 Licensee must implement and maintain measures to reduce risk of odours as per section 4.3 of the report titled “Review of Pollution Reduction Program EPL5065 U1”, prepared by Northstar Air Quality Pty Ltd (dated 4 June 2020) submitted to EPA on 5 June 2020) for an ongoing odour reduction program

9 Special Conditions

E1 Requirement To Maintain Financial Assurance

- E1.1 A financial assurance in the form of an unconditional and irrevocable and on demand guarantee from a bank, building society or credit union operating in Australia as “Authorised Deposit-taking Institutions” under the Banking Act 1959 of the Commonwealth of Australia and supervised by the Australian Prudential Regulatory Authority (APRA) must be maintained during the operation of the facility and thereafter until such time as the EPA is satisfied the premises are environmentally secure. The financial assurance must be in favour of the EPA in the amount of four million six hundred and forty four thousand dollars (\$4,644,000). The financial assurance is required to secure or guarantee funding for works or programs required by or under this licence. The financial assurance must contain a term that provides that any monies claimed can be paid to the EPA or, at the written direction of the EPA, to any other person.
- E1.2 The financial assurance must be replenished by the full amount claimed or realised if the EPA has claimed on or realised the financial assurance or any part of it to undertake a work or program required to be carried out by the licence which has not been undertaken by the licence holder.
- E1.3 The EPA may require an increase in the amount of the financial assurance at any time as a result of reassessment of the total likely costs and expenses of rehabilitation of the premises.
- E1.4 The licensee must provide to the EPA the original counterpart guarantee within five working days of the issue of:
(a) the financial assurance required by condition E1.1; or
(b) the adjusted financial assurance as required by condition E1.2 and E1.3

Environment Protection Licence

Licence - 5065

E2 Environmental Obligations of Licensee (Works and Programs)

- E2.1 While the licensee's premises are being used for the purpose to which the licence relates, the licensee must:
- (a) Clean up any spill, leak or other discharge of any waste(s) or other material(s) as soon as practicable after it becomes known to the licensee or to one of the licensee's employees or agents.
 - (b) In the event(s) that any liquid and non-liquid waste(s) is unlawfully deposited on the premises, such waste(s) must be removed and lawfully disposed of as soon as practicable or in accordance with any direction given by the EPA.
 - (c) Provide all monitoring data as required by the conditions of this licence or as directed by the EPA.
- E2.2 In the event of an earthquake, storm, fire, flood or any other event where it is reasonable to suspect that a pollution incident has occurred, is occurring or is likely to occur, the licensee (whether or not the premises continue to be used for the purposes to which the licence relates) must:
- (a) Make all efforts to contain all firewater on the licensee's premises;
 - (b) Make all efforts to control air pollution from the licensee's premises;
 - (c) Make all efforts to contain any discharge, spill or run-off from the licensee's premises;
 - (d) Make all efforts to prevent flood water entering the licensee's premises;
 - (e) Remediate and rehabilitate any exposed areas of soil and/or waste;
 - (f) Lawfully dispose of all liquid and solid waste(s) stored on the premises that is not already securely disposed of;
 - (g) At the request of the EPA monitor groundwater beneath the licensee's premises and its potential to migrate from the licensee's premises;
 - (h) At the request of the EPA monitor surface water leaving the licensee's premises; and
 - (i) Ensure the licensee's premises is secure.
- E2.3 After the licensee's premises cease to be used for the purpose to which the licence relates or in the event that the licensee ceases to carry out the activity that is the subject of this licence, that licensee must
- (a) remove and lawfully dispose of all liquid and non-liquid waste stored on the licensee's premises;
 - (b) rehabilitate the site, including conducting an assessment of and if required remediation of any site contamination.

E3 EPA May Claim On a Financial Assurance

- E3.1 The EPA may claim on a financial assurance under s303 of the POEO Act if a licensee fails to carry out any work or program required to comply with the conditions of this licence.

E4 Final Capping Layer

General Solid Waste (Non-Putrescible) WasteLandfill Cells - Final Capping

- E4.1 The final capping of the general solidwaste (non-putrescible) landfill cells must be undertaken in accordance with the conditions of this licence and in accordance with GHD Report SUEZ Recyclingand Recovery Pty Ltd: Lucas Heights Landfill Final Capping Works TechnicalSpecification October 2019 (Ref: 2127039) (the Report).
- E4.2 The final capping layer must be installed according to the specifications of the Report and comprise of the following layers (bottom to top):

Environment Protection Licence

Licence - 5065

- a) A 300mm thick seal-bearing layer. The material for this layer should:
 - i. Be selectively sourced material from on-site or imported VENM or ENM, or another material specifically approved for use by the EPA for this purpose;
 - ii. Not contain any unsuitable materials identified in Section 2.4 of the Report unless approved by the EPA;
 - iii. Be well graded in accordance Australian Standard AS 1726; and
 - iv. Comply with the acceptance criteria in Table 6 of the Report.
- b) A 600mm thick sealing layer, comprising of a compacted clay layer. The material used for this layer should:
 - i. Be selectively sourced material from on-site or imported from an approved source. Imported material shall be classed as VENM or ENM, or another material specifically approved for use by the EPA for this purpose;
 - ii. Not contain any unsuitable materials identified in Section 2.4 of the Report unless approved by the EPA;
 - iii. Be well graded in accordance with Australian Standard AS 1726;
 - iv. Comply with the acceptance criteria specified in Table 7 of the Report.

A Coated Geosynthetic Clay Layer (Coated GCL) may be used in place of compacted clay only if approved for use by the EPA.
- c) A 500mm subsoil layer. The material used for this layer should:
 - i. Be selectively sourced material from on-site or imported from an approved source. Imported material shall be classed as VENM or ENM, or another material specifically approved for use by the EPA;
 - ii. Not contain any unsuitable materials identified in Section 2.4 of the Report unless approved by the EPA;
 - iii. Be well graded in accordance with Australian Standard AS 1726;
 - iv. May contain 0% to 15% by mass pasteurised garden organics material blended through the subsoil layer (assuming a bulk density 0.6 t/m³ for pasteurised garden organics and 1.8 t/m³ for the subsoil material this equates to a mix of 1 part pasteurised garden organics to every 2 parts of subsoil material); and
 - v. Comply with the acceptance criteria specified in Table 10 of the Report.
- d) A 250mm revegetation layer. This material should:
 - i. Be selectively sourced material from on-site or imported from an approved source. Imported material shall be classed as VENM or ENM, or another material specifically approved for use by the EPA;
 - ii. Not contain any unsuitable materials identified in Section 2.4 of the Report unless approved by the EPA;
 - iii. Be well graded in accordance with Australian Standard AS 1726;
 - iv. May contain 0% to 15% by mass pasteurised garden organics material blended through the subsoil layer (assuming a bulk density 0.6 t/m³ for pasteurised garden organics and 1.8 t/m³ for the subsoil material this equates to a mix of 1 part pasteurised garden organics to every 2 parts of subsoil material); and
 - v. Comply with the acceptance criteria specified in Table 11 of the Report.
- e) A 100mm topsoil layer. The material used for this layer should:
 - i. Consist of a natural friable surface soil without admixtures of undesirable subsoil, refuse, or foreign materials. It shall be reasonably free from roots, hard clay, coarse gravel (greater than 20mm), noxious weeds, tall grass, brush, sticks, stubble or other material which would be detrimental to the proper development of vegetative growth;
 - ii. Contain not less than 3%, or more than 20% organic matter, by mass;
 - iii. Be obtained from naturally well drained sites, either on-site or off-site, where topsoil occurs at least 100mm deep. Topsoil shall not be obtained from bogs or marshes.

E4.3 The final capping of the general solid waste (non-putrescible) landfill cells must commence

Environment Protection Licence

Licence - 5065

within 12 months of final landform contours for waste being achieved for each waste cell and be completed within 18 months of commencement.

- E4.4 Within 3 months of completing the capping of the general solid (non-putrescible) waste landfill cells, the licensee must provide the EPA with a Construction Quality Assurance Report (CQA Report). The CQA Report must detail the construction and design details of any new overall final cap at the premises. This should include surveys and works as executed drawings, and results of a quality assurance/quality control program to verify that the cap was constructed in accordance with its design.

E5 Expansion of Landfill Gas Field Infrastructure

- E5.1 The licensee must install and maintain gas field infrastructure to minimise the emission of odours.

E6 Construction of Landfill - Dual Gas and Leachate Trench

- E6.1 The licensee must construct and install a dual gas and leachate management trench in accordance with Licence Condition O5.10 and the below plans and designs received by the EPA on 20 July 2017 and titled:

- *Construction Environmental Management Plan Part 1 - Landfill Related Construction works only Dual Gas and Leachate Trench construction works, Lucas Heights Resource Recovery Park (version no. 0031, July 2017), prepared by Suez,*
- *Phase 1 to 4 Filling, Proposed dual gas / leachate trench, sections and details, Drawing No. 147-Se-CL-LHRRP-DA-001 (Revision A, Issued for review on 13.07.17), prepared by Suez,*
- *Phase 1 to 4 Filling, Proposed dual gas / leachate trench, sections and details, Drawing No. 147-Se-CL-LHRRP-DA-002 (Revision A, Issued for review on 13.07.17), prepared by Suez, and*
- *Phase 1 to 4 Filling, Proposed dual gas / leachate trench, sections and details, Drawing No. 147-Se-CL-LHRRP-DA-003 (Revision A, Issued for review on 13.07.17), prepared by Suez.*
- *Phase 5 to 7 Filling, Proposed dual gas / leachate perimeter trench, sections and details, No. 100-SEV-LHRRP-DA-001 (Revision A, Issued for review 16 March 2021), prepared by SUEZ, and*
- *Phase 5 to 7 Filling, Proposed dual gas / leachate perimeter trench, sections and details, No. 100-SEV-LHRRP-DA-002 (Revision A, Issued for review 16 March 2021), prepared by SUEZ, and*
- *Phase 5 to 7 Filling, Proposed dual gas / leachate perimeter trench, sections and details, No. 100-SEV-LHRRP-DA-003 (Revision A, Issued for review 16 March 2021), prepared by SUEZ.*

E7 Reprofilling (overtopping) works

- E7.1 The licensee must conduct the re-profiling (stages 1, 2, 3, 4, 5, 6 and 7) works in accordance with the below plans and designs received by the EPA on 12 October 2017 and titled:

Environment Protection Licence

Licence - 5065

- *Development Consent under Section 89E of the Environmental Planning and Assessment Act 1979 for Application No SSD 6835 issued to SITA Australia Pty Ltd and Sutherland Shire Council, dated 23 January 2017 and signed by Joe Woodward PSM, Member of the Commission (Chair),*
- *Final Landform Phase 1 to 4 Fill Areas, Suez Recycling & Recovery Lucas Heights RRP, Drawing Job Number 21-20508 (Revision A), prepared by GHD, and*
- *Proposed Reprofilling Development Plan, Drawing Job number 21-23482, Landform marked "Phase 1" (Revision C, 3 July 2015) prepared by GHD,*
- *Proposed Reprofilling Development Plan, Drawing Job number 21-23482, Landforms marked "Phase 2" and "Phase 3", (Revision C, 3 July 2017), prepared by GHD, and*
- *Proposed Reprofilling Development Plan, Drawing Job number 21-23482, Landform marked "Phase 4", (Revision C, 3 July 2017), prepared by GHD, and*
- *Proposed Reprofilling Development Plan – Phase 4, 5, 6, and 7, Drawing Job number 21-27039, (Revised D, 13 November 2020) prepared by GHD.*

E8 Design and construction of stormwater drainage works

- E8.1 The licensee must construct and install the drainage works on the final landform in accordance with the stormwater designs and concepts received by the EPA on 8 November 2019 and titled:
- *"SUEZ Recycling & Recovery Pty Ltd Lucas Heights Resource Recovery Park Final Cap + Stormwater Design" (21-27039) prepared by GHD - limited to drawings No. 21-27039-C103, 21-27039-C104, 21-27039-C105, 21-27039-C106, 21-27039-C107, 21-27039-C108, 21-27039-C109, 21-27039-C110, 21-27039-C111 and 21-27039-C108.*
 - *Section 7 only of the document titled "Lucas Heights Landfill Final Capping Works Technical Specification" (dated October 2019) prepared by GHD.*
- Note: The condition above approves the stormwater design only and not the final cap design that is also detailed in the above mentioned documents."*

E9 Closure Plan

- E9.1 The licensee must prepare and submit to the EPA, within twelve months prior to the last load of waste being landfilled, a closure plan in accordance with section 76 of the Protection of the Environment Operations Act 1997.

E10 Northwall Preparation Works

- E10.1 Preparation works may be undertaken along the area known as the 'Northwall'. as specified in the document Cleanaway Pty Ltd Lucas Heights Northwall Lining 12591689, dated 15 December 2023, prepared by GHD (EPA Ref: DOC24/307482).
- E10.2 Works undertaken must be in accordance with the specifications detailed in the documents Lucas Heights - Technical Specification North Wall Lining, dated 19 December 2023, prepared by GHD (EPA Ref: 24/307485).



Environment Protection Licence

Licence - 5065

- E10.3 Materials and services used in construction of the excavated area and cell lining must meet the requirements detailed in the document Lucas Heights - North Wall Linings: Construction Quality Assurance Plan, dated 19 December 2023, prepared by GHD (EPA Ref: DOC24/307487).
- E10.4 Within 3 months of completing the preparation works, the Licensee must provide the EPA with a Construction Quality Assurance Report (CQA Report). The CQA Report must include the information specified in Section 2.9.3 of the Lucas Heights - North Wall Linings: Construction Quality Assurance Plan.

E11 Special Dictionary

E11.1 Special Dictionary

Term	Description
Active Tip Face	the area being actively landfilled
Cell	a discrete unit of a landfill that is physically separated from other waste emplacements at the premises
Daily cover	material applied on the tipping face of the landfill upon close of business each day to reduce environmental and amenity impacts
Final capping layer	the covering that is applied to the waste to rehabilitate the landfill once it has reached its maximum height
Intermediate cover	a cover of Virgin Excavated Natural Material or approved alternative that is at least 300 millimetres deep that must be applied to surfaces of the landfill that will be exposed for more than 90 days
Landfill gas	gaseous emissions from the anaerobic decomposition of organic waste materials placed in a landfill
Landfilling operations	any operations on the premises that are not Other landfilling operations.
Leachate	the liquid that passes through, or is released by, waste.
Other landfilling operations	Other landfilling operations includes only security guard control, machinery maintenance and/or repairs, site infrastructure maintenance and/or repairs (landfill gas and leachate), and emergency management activities related to site safety, emergency repairs and site infrastructure repairs.
Prepared Surface	a maximum area of 1 hectare of existing intermediate cover or 2 hectares of existing final capped cover that is stripped of cover in advance of landfilling.
Stripped Back Area	the area of the Prepared Surface that is stripped back to expose previously landfilled waste.
VENM / Virgin Excavated Natural Material	Virgin Excavated Natural Material as per the Dictionary of the Act.



Environment Protection Licence

Licence - 5065

Dictionary

General Dictionary

3DGM [in relation to a concentration limit]	Means the three day geometric mean, which is calculated by multiplying the results of the analysis of three samples collected on consecutive days and then taking the cubed root of that amount. Where one or more of the samples is zero or below the detection limit for the analysis, then 1 or the detection limit respectively should be used in place of those samples
Act	Means the Protection of the Environment Operations Act 1997
activity	Means a scheduled or non-scheduled activity within the meaning of the Protection of the Environment Operations Act 1997
actual load	Has the same meaning as in the Protection of the Environment Operations (General) Regulation 2009
AM	Together with a number, means an ambient air monitoring method of that number prescribed by the <i>Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales</i> .
AMG	Australian Map Grid
anniversary date	The anniversary date is the anniversary each year of the date of issue of the licence. In the case of a licence continued in force by the Protection of the Environment Operations Act 1997, the date of issue of the licence is the first anniversary of the date of issue or last renewal of the licence following the commencement of the Act.
annual return	Is defined in R1.1
Approved Methods Publication	Has the same meaning as in the Protection of the Environment Operations (General) Regulation 2009
assessable pollutants	Has the same meaning as in the Protection of the Environment Operations (General) Regulation 2009
BOD	Means biochemical oxygen demand
CEM	Together with a number, means a continuous emission monitoring method of that number prescribed by the <i>Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales</i> .
COD	Means chemical oxygen demand
composite sample	Unless otherwise specifically approved in writing by the EPA, a sample consisting of 24 individual samples collected at hourly intervals and each having an equivalent volume.
cond.	Means conductivity
environment	Has the same meaning as in the Protection of the Environment Operations Act 1997
environment protection legislation	Has the same meaning as in the Protection of the Environment Administration Act 1991
EPA	Means Environment Protection Authority of New South Wales.
fee-based activity classification	Means the numbered short descriptions in Schedule 1 of the Protection of the Environment Operations (General) Regulation 2009.
general solid waste (non-putrescible)	Has the same meaning as in Part 3 of Schedule 1 of the Protection of the Environment Operations Act 1997



Environment Protection Licence

Licence - 5065

flow weighted composite sample	Means a sample whose composites are sized in proportion to the flow at each composites time of collection.
general solid waste (putrescible)	Has the same meaning as in Part 3 of Schedule 1 of the Protection of the Environment Operations Act 1997
grab sample	Means a single sample taken at a point at a single time
hazardous waste	Has the same meaning as in Part 3 of Schedule 1 of the Protection of the Environment Operations Act 1997
licensee	Means the licence holder described at the front of this licence
load calculation protocol	Has the same meaning as in the Protection of the Environment Operations (General) Regulation 2009
local authority	Has the same meaning as in the Protection of the Environment Operations Act 1997
material harm	Has the same meaning as in section 147 Protection of the Environment Operations Act 1997
MBAS	Means methylene blue active substances
Minister	Means the Minister administering the Protection of the Environment Operations Act 1997
mobile plant	Has the same meaning as in Part 3 of Schedule 1 of the Protection of the Environment Operations Act 1997
motor vehicle	Has the same meaning as in the Protection of the Environment Operations Act 1997
O&G	Means oil and grease
percentile [in relation to a concentration limit of a sample]	Means that percentage [eg.50%] of the number of samples taken that must meet the concentration limit specified in the licence for that pollutant over a specified period of time. In this licence, the specified period of time is the Reporting Period unless otherwise stated in this licence.
plant	Includes all plant within the meaning of the Protection of the Environment Operations Act 1997 as well as motor vehicles.
pollution of waters [or water pollution]	Has the same meaning as in the Protection of the Environment Operations Act 1997
premises	Means the premises described in condition A2.1
public authority	Has the same meaning as in the Protection of the Environment Operations Act 1997
regional office	Means the relevant EPA office referred to in the Contacting the EPA document accompanying this licence
reporting period	For the purposes of this licence, the reporting period means the period of 12 months after the issue of the licence, and each subsequent period of 12 months. In the case of a licence continued in force by the Protection of the Environment Operations Act 1997, the date of issue of the licence is the first anniversary of the date of issue or last renewal of the licence following the commencement of the Act.
restricted solid waste	Has the same meaning as in Part 3 of Schedule 1 of the Protection of the Environment Operations Act 1997
scheduled activity	Means an activity listed in Schedule 1 of the Protection of the Environment Operations Act 1997
special waste	Has the same meaning as in Part 3 of Schedule 1 of the Protection of the Environment Operations Act 1997
TM	Together with a number, means a test method of that number prescribed by the <i>Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales</i> .



Environment Protection Licence

Licence - 5065

TSP	Means total suspended particles
TSS	Means total suspended solids
Type 1 substance	Means the elements antimony, arsenic, cadmium, lead or mercury or any compound containing one or more of those elements
Type 2 substance	Means the elements beryllium, chromium, cobalt, manganese, nickel, selenium, tin or vanadium or any compound containing one or more of those elements
utilisation area	Means any area shown as a utilisation area on a map submitted with the application for this licence
waste	Has the same meaning as in the Protection of the Environment Operations Act 1997
waste type	Means liquid, restricted solid waste, general solid waste (putrescible), general solid waste (non-putrescible), special waste or hazardous waste
Wellhead	Has the same meaning as in Schedule 1 to the Protection of the Environment Operations (General) Regulation 2021.

Mr John Sparkes

Environment Protection Authority

(By Delegation)

Date of this edition: 12-April-2001



Environment Protection Licence

Licence - 5065

End Notes	
1	Licence varied by notice 1011080, issued on 10-Apr-2002, which came into effect on 05-May-2002.
2	Licence varied by notice 1018739, issued on 04-Jul-2002, which came into effect on 04-Jul-2002.
3	Licence varied by notice 1019721, issued on 30-Aug-2002, which came into effect on 30-Aug-2002.
4	Licence fee period changed by notice 1026075 on 25-Mar-2003.
5	Licence varied by notice 1034582, issued on 17-Jun-2004, which came into effect on 25-Jun-2004.
6	Licence varied by notice 1041728, issued on 22-Oct-2004, which came into effect on 25-Oct-2004.
7	Licence varied by notice 1044509, issued on 15-Feb-2005, which came into effect on 16-Feb-2005.
8	Licence varied by notice 1044945, issued on 22-Mar-2005, which came into effect on 22-Mar-2005.
9	Licence varied by notice 1045900, issued on 22-Jun-2005, which came into effect on 17-Jul-2005.
10	Licence varied by notice 1056254, issued on 02-Mar-2006, which came into effect on 18-Mar-2006.
11	Licence varied by notice 1063380, issued on 17-Aug-2006, which came into effect on 17-Aug-2006.
12	Licence varied by notice 1073111, issued on 13-Feb-2008, which came into effect on 13-Feb-2008.
13	Licence varied by notice 1084039, issued on 26-Mar-2008, which came into effect on 26-Mar-2008.
14	Licence varied by notice 1084652, issued on 22-Apr-2008, which came into effect on 22-Apr-2008.
15	Licence varied by Change to schedule 1, issued on 14-May-2008, which came into effect on 14-May-2008.
16	Licence varied by notice 1090406, issued on 03-Nov-2008, which came into effect on 03-Nov-2008.
17	Condition A1.3 Not applicable varied by notice issued on <issue date> which came into effect on <effective date>
18	Licence varied by notice 1095614, issued on 19-Dec-2008, which came into effect on 19-Dec-2008.

Environment Protection Licence

Licence - 5065

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|----|---|
| 19 | Licence varied by notice 1096953, issued on 21-Jan-2009, which came into effect on 21-Jan-2009. |
| 20 | Licence varied by notice 1101542, issued on 05-Jun-2009, which came into effect on 05-Jun-2009. |
| 21 | Licence varied by notice 1119590, issued on 24-Dec-2010, which came into effect on 24-Dec-2010. |
| 22 | Licence varied by notice 1123930, issued on 31-Jan-2011, which came into effect on 31-Jan-2011. |
| 23 | Licence transferred through application 146428, approved on 01-Mar-2011, which came into effect on 01-Mar-2011. |
| 24 | Licence varied by notice 1126549, issued on 31-Mar-2011, which came into effect on 31-Mar-2011. |
| 25 | Licence varied by notice 1127070, issued on 13-Jul-2011, which came into effect on 13-Jul-2011. |
| 26 | Licence varied by notice 1510954 issued on 16-Jan-2013 |
| 27 | Licence varied by notice 1517539 issued on 21-Oct-2013 |
| 28 | Licence varied by notice 1518984 issued on 24-Dec-2013 |
| 29 | Licence varied by notice 1524621 issued on 29-Aug-2014 |
| 30 | Licence varied by notice 1526083 issued on 05-Nov-2014 |
| 31 | Licence varied by notice 1530664 issued on 15-May-2015 |
| 32 | Licence varied by notice 1532400 issued on 02-Dec-2015 |
| 33 | Licence varied by notice 1537321 issued on 22-Jan-2016 |
| 34 | Licence varied by notice 1537662 issued on 21-Jun-2016 |
| 35 | Licence varied by notice 1553888 issued on 17-Jul-2017 |
| 36 | Licence varied by notice 1555375 issued on 07-Dec-2017 |
| 37 | Licence varied by notice 1565771 issued on 27-Nov-2018 |
| 38 | Licence varied by notice 1576958 issued on 25-Mar-2019 |
| 39 | Licence varied by notice 1581513 issued on 10-Sep-2019 |
| 40 | Licence varied by notice 1608316 issued on 24-Nov-2021 |
| 41 | Licence transferred through application 1615363 approved on 20-Dec-2021 , which came into effect on 18-Dec-2021 |
| 42 | Licence varied by notice 1617516 issued on 01-Jun-2022 |
| 43 | Licence varied by notice 1623511 issued on 20-Dec-2022 |
| 44 | Licence varied by notice 1633805 issued on 01-Nov-2023 |

Environment Protection Licence



Licence - 5065

45	Licence varied by notice	1637474 issued on 09-May-2024
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Appendix E

Historic Test Bore Logs

Introduction to Terminology, Symbols and Abbreviations

Douglas Partners' reports, investigation logs, and other correspondence may use terminology which has quantitative or qualitative connotations. To remove ambiguity or uncertainty surrounding the use of such terms, the following sets of notes pages may be attached Douglas Partners' reports, depending on the work performed and conditions encountered:

- Soil Descriptions;
- Rock Descriptions; and
- Sampling, insitu testing, and drilling methodologies

In addition to these pages, the following notes generally apply to most documents.

Abbreviation Codes

Site conditions may also be presented in a number of different formats, such as investigation logs, field mapping, or as a written summary. In some of these formats textual or symbolic terminology may be presented using textual abbreviation codes or graphic symbols, and, where commonly used, these are listed alongside the terminology definition. For ease of identification in these note pages, textual codes are presented in these notes in the following style **XW**. Code usage conforms with the following guidelines:

- Textual codes are case insensitive, although herein they are generally presented in upper case; and
- Textual codes are contextual (i.e. the same or similar combinations of characters may be used in different contexts with different meanings (for example `PL` is used for plastic limit in the context of soil moisture condition, as well as in `PL(A)` for point load test result in the testing results column)).

Data Integrity Codes

Subsurface investigation data recorded by Douglas Partners is generally managed in a highly structured database environment, where records "span" between a top and bottom depth interval. Depth interval "gaps" between records are considered to introduce ambiguity, and, where appropriate, our practice guidelines may require contiguous data sets. Recording meaningful data is not always appropriate (for example assigning a "strength" to a concrete pavement) and the following codes may be used to maintain contiguity in such circumstances.

Term	Description	Abbreviation Code
Core loss	No core recovery	KL
Unknown	Information was not available to allow classification of the property. For example, when auguring in loose, saturated sand auger cuttings may not be returned.	UK
No data	Information required to allow classification of the property was not available. For example if drilling is commenced from the base of a hole predrilled by others	ND
Not Applicable	Derivation of the properties not appropriate or beyond the scope of the investigation. For example providing a description of the strength of a concrete pavement	NA

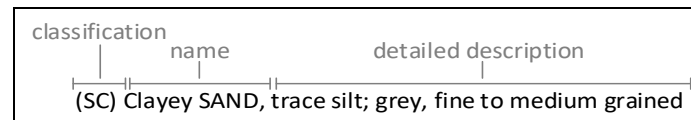
Graphic Symbols

Douglas Partners' logs contain a "graphic" column which provides a pictorial representation of the basic composition of the material. The symbols used are directly representing the material name stated in the adjacent "Description of Strata" column, and as such no specific graphic symbology legend has been provided in these notes.

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Introduction

All materials which are not considered to be “in-situ rock” are described in general accordance with the soil description model of AS 1726-2017 Part 6.1.3, and can be broken down into the following description structure:



The “classification” comprises a two character “group symbol” providing a general summary of dominant soil characteristics. The “name” summarises the particle sizes within the soil which most influence its behaviour. The detailed description presents more information about composition, condition, structure, and origin of the soil.

Classification, naming and description of soils require the relative proportion of particles of different sizes within the whole soil mixture to be considered.

Particle size designation and Behaviour Model

Solid particles within a soil are differentiated on the basis of size.

The engineering behaviour properties of a soil can subsequently be modelled to be either “fine grained” (also known as “cohesive” behaviour) or “coarse grained” (“non cohesive” behaviour), depending on the relative proportion of fine or coarse fractions in the soil mixture.

Particle Size Designation	Particle Size (mm)	Behaviour Model	
		Behaviour	Approximate Dry Mass
Boulder	>200	Excluded from particle behaviour model as “oversize”	
Cobble	63 - 200		
Gravel ¹	2.36 - 63	Coarse	>65%
Sand ¹	0.075 - 2.36		
Silt	0.002 - 0.075	Fine	>35%
Clay	<0.002		

¹ – refer grain size subdivision descriptions below

The behaviour model boundaries defined above are not precise, and the material behaviour should be assumed from the name given to the material (which considers the particle fraction which dominates the behaviour, refer “component proportions” below), rather than strict observance of the proportions of particle sizes. For example, if a material is named a “Sandy CLAY”, this is indicative that the material exhibits fine grained behaviour, even if the dry mass of coarse grained material may exceed 65%.

Component proportions

The relative proportion of the dry mass of each particle size fraction is assessed to be a “primary”, “secondary”, or “minor” component of the soil mixture, depending on its influence over the soil behaviour.

Component Proportion Designation	Definition ¹	Relative Proportion	
		In Fine Grained Soil	In Coarse Grained Soil
Primary	The component (particle size designation, refer above) which dominates the engineering behaviour of the soil	The clay/silt component with the greater proportion	The sand/gravel component with the greater proportion
Secondary	Any component which is not the primary, but is significant to the engineering properties of the soil	Any component with greater than 30% proportion	Any granular component with greater than 30%; or Any fine component with greater than 12%
Minor ²	Present in the soil, but not significant to its engineering properties	All other components	All other components

¹ As defined in AS1726-2017 6.1.4.4

² In the detailed material description, minor components are split into two further sub-categories. Refer “identification of minor components” below.

Composite Materials

In certain situations, a lithology description may describe more than one material, for example, collectively describing a layer of interbedded sand and clay. In such a scenario, the two materials would be described independently, with the names preceded or followed by a statement describing the arrangement by which the materials co-exist. For example, “INTERBEDDED Silty CLAY AND SAND”.

Classification

The soil classification comprises a two character group symbol. The first character identifies the primary component. The second character identifies either the grading or presence of fines in a coarse grained soil, or the plasticity in a fine grained soil. Refer AS1726-2017 6.1.6 for further clarification.

Soil Name

For most soils, the name is derived with the primary component included as the noun (in upper case), preceded by any secondary components stated in an adjective form. In this way, the soil name also describes the general composition and indicates the dominant behaviour of the material.

Component ¹	Prominence in Soil Name
Primary	Noun (eg "CLAY")
Secondary	Adjective modifier (eg "Sandy")
Minor	No influence

¹ – for determination of component proportions, refer component proportions on previous page

For materials which cannot be disaggregated, or which are not comprised of rock or mineral fragments, the names "ORGANIC MATTER" or "ARTIFICIAL MATERIAL" may be used, in accordance with AS1726-2017 Table 14.

Commercial or colloquial names are not used for the soil name where a component derived name is possible (for example "Gravelly SAND" rather than "CRACKER DUST").

Materials of "fill" or "topsoil" origin are generally assigned a name derived from the primary/secondary component (where appropriate). In log descriptions this is preceded by uppercase "FILL" or "TOPSOIL". Origin uncertainty is indicated in the description by the characters (?), with the degree of uncertainty described (using the terms "probably" or "possibly" in the origin column, or at the end of the description).

Identification of minor components

Minor components are identified in the soil description immediately following the soil name. The minor component fraction is usually preceded with a term indicating the relative proportion of the component.

Minor Component Proportion Term	Relative Proportion	
	In Fine Grained Soil	In Coarse Grained Soil
With	All fractions: 15-30%	Clay/silt: 5-12% sand/gravel: 15-30%
Trace	All fractions: 0-15%	Clay/silt: 0-5% sand/gravel: 0-15%

The terms "with" and "trace" generally apply only to gravel or fine particle fractions. Where cobbles/boulders are encountered in minor proportions (generally less than about 12%) the term "occasional" may be used. This term describes the sporadic distribution of the material within the confines of the investigation excavation only, and there may be considerable variation in proportion over a wider area which is difficult to factually characterise due to the relative size of the particles and the investigation methods.

Soil Composition

Plasticity

Descriptive Term	Laboratory liquid limit range	
	Silt	Clay
Non-plastic materials	Not applicable	Not applicable
Low plasticity	≤50	≤35
Medium plasticity	Not applicable	>35 and ≤50
High plasticity	>50	>50

Note, Plasticity descriptions generally describe the plasticity behaviour of the whole of the fine grained soil, not individual fine grained fractions.

Grain Size

Type	Particle size (mm)	
	Coarse	Fine
Gravel	19 - 63	6.7 - 19
	Medium	2.36 - 6.7
Sand	0.6 - 2.36	0.21 - 0.6
	Medium	0.075 - 0.21
	Fine	

Grading

Grading Term	Particle size (mm)
Well	A good representation of all particle sizes
Poorly	An excess or deficiency of particular sizes within the specified range
Uniformly	Essentially of one size
Gap	A deficiency of a particular size or size range within the total range

Note, AS1726-2017 provides terminology for additional attributes not listed here.

Soil Condition

Moisture

The moisture condition of soils is assessed relative to the plastic limit for fine grained soils, while for coarse grained soils it is assessed based on the appearance and feel of the material. The moisture condition of a material is considered to be independent of stratigraphy (although commonly these are related), and this data is presented in its own column on logs.

Applicability	Term	Tactile Assessment	Abbreviation code
Fine	Dry of plastic limit	Hard and friable or powdery	w<PL
	Near plastic limit	Can be moulded	w=PL
	Wet of plastic limit	Water residue remains on hands when handling	w>PL
	Near liquid limit	"oozes" when agitated	w=LL
	Wet of liquid limit	"oozes"	w>LL
Coarse	Dry	Non-cohesive and free running	D
	Moist	Feels cool, darkened in colour, particles may stick together	M
	Wet	Feels cool, darkened in colour, particles may stick together, free water forms when handling	W

The abbreviation code **NDF**, meaning "not-assessable due to drilling fluid use" may also be used.

Note, observations relating to free ground water or drilling fluids are provided independent of soil moisture condition.

Consistency/Density/Compaction/Cementation/Extremely Weathered Material

These concepts give an indication of how the material may respond to applied forces (when considered in conjunction with other attributes of the soil). This behaviour can vary independent of the composition of the material, and on logs these are described in an independent column and are generally mutually exclusive (i.e it is inappropriate to describe both consistency and compaction at the same time). The method by which the behaviour is described depends on the behaviour model and other characteristics of the soil as follows:

- In fine grained soils, the "consistency" describes the ease with which the soil can be remoulded, and is generally correlated against the materials undrained shear strength;
- In granular materials, the relative density describes how tightly packed the particles are, and is generally correlated against the density index;
- In anthropogenically modified materials, the compaction of the material is described qualitatively;
- In cemented soils (both natural and anthropogenic), the cemented "strength" is described qualitatively, relative to the difficulty with which the material is disaggregated; and
- In soils of extremely weathered material origin, the engineering behaviour may be governed by relic rock features, and expected behaviour needs to be assessed based the overall material description.

Quantitative engineering performance of these materials may be determined by laboratory testing or estimated by correlated field tests (for example penetration or shear vane testing). In some cases, performance may be assessed by tactile or other subjective methods, in which case investigation logs will show the estimated value enclosed in round brackets, for example **(VS)**.

Consistency (fine grained soils)

Consistency Term	Tactile Assessment	Undrained Shear Strength (kPa)	Abbreviation Code
Very soft	Extrudes between fingers when squeezed	<12	VS
Soft	Mouldable with light finger pressure	>12 - ≤25	S
Firm	Mouldable with strong finger pressure	>25 - ≤50	F
Stiff	Cannot be moulded by fingers	>50 - ≤100	St
Very stiff	Indented by thumbnail	>100 - ≤200	VSt
Hard	Indented by thumbnail with difficulty	>200	H
Friable	Easily crumbled or broken into small pieces by hand	-	Fr

Relative Density (coarse grained soils)

Relative Density Term	Density Index	Abbreviation Code
Very loose	<15	VL
Loose	>15 - ≤35	L
Medium dense	>35 - ≤65	MD
Dense	>65 - ≤85	D
Very dense	>85	VD

Note, tactile assessment of relative density is difficult, and generally requires penetration testing, hence a tactile assessment guide is not provided.

Compaction (anthropogenically modified soil)

Compaction Term	Abbreviation Code
Well compacted	WC
Poorly compacted	PC
Moderately compacted	MC
Variably compacted	VC

Cementation (natural and anthropogenic)

Cementation Term	Abbreviation Code
Moderately cemented	MOD
Weakly cemented	WEK

Extremely Weathered Material

AS1726-2017 considers weathered material to be soil if the unconfined compressive strength is less than 0.6 MPa (i.e. less than very low strength rock). These materials may be identified as “extremely weathered material” in reports and by the abbreviation code **XWM** on log sheets. This identification is not correlated to any specific qualitative or quantitative behaviour, and the engineering properties of this material must therefore be assessed according to engineering principles with reference to any relic rock structure, fabric, or texture described in the description.

Soil Origin

Term	Description	Abbreviation Code
Residual	Derived from in-situ weathering of the underlying rock	RS
Extremely weathered material	Formed from in-situ weathering of geological formations. Has strength of less than ‘very low’ as per as1726 but retains the structure or fabric of the parent rock.	XWM
Alluvial	Deposited by streams and rivers	ALV
Fluvial	Deposited by channel fill and overbank (natural levee, crevasse splay or flood basin)	FLV
Estuarine	Deposited in coastal estuaries	EST
Marine	Deposited in a marine environment	MAR
Lacustrine	Deposited in freshwater lakes	LAC
Aeolian	Carried and deposited by wind	AEO
Colluvial	Soil and rock debris transported down slopes by gravity	COL
Slopewash	Thin layers of soil and rock debris gradually and slowly deposited by gravity and possibly water	SW
Topsoil	Mantle of surface soil, often with high levels of organic material	TOP
Fill	Any material which has been moved by man	FILL
Littoral	Deposited on the lake or seashore	LIT
Unidentifiable	Not able to be identified	UID

Cobbles and Boulders

The presence of particles considered to be “oversize” may be described using one of the following strategies:

- Oversize encountered in a minor proportion (when considered relative to the wider area) are noted in the soil description; or
- Where a significant proportion of oversize is encountered, the cobbles/boulders are described independent of the soil description, in a similar manner to composite soils (described above) but qualified with “MIXTURE OF”.

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Sampling and Testing

A record of samples retained, and field testing performed is usually shown on a Douglas Partners' log with samples appearing to the left of a depth scale, and selected field and laboratory testing (including results, where relevant) appearing to the right of the scale, as illustrated below:

SAMPLE			DEPTH (m)	TESTING	
SAMPLE REMARKS	TYPE	INTERVAL		TEST TYPE	RESULTS AND REMARKS
	SPT		1.0 1.45	SPT	4,9,11 N=20

Sampling

The type or intended purpose for which a sample was taken is indicated by the following abbreviation codes.

Sample Type	Code
Auger sample	A
Acid Sulfate sample	ASS
Bulk sample	B
Core sample	C
Disturbed sample	D
Environmental sample	ES
Gas sample	G
Piston sample	P
Sample from SPT test	SPT
Undisturbed tube sample	U ¹
Water sample	W
Material Sample	MT
Core sample for unconfined compressive strength testing	UCS

¹ – numeric suffixes indicate tube diameter/width in mm

The above codes only indicate that a sample was retained, and not that testing was scheduled or performed.

Field and Laboratory Testing

A record that field and laboratory testing was performed is indicated by the following abbreviation codes.

Test Type	Code
Pocket penetrometer (kPa)	PP
Photo ionisation detector (ppm)	PID
Standard Penetration Test x/y = x blows for y mm penetration HB = hammer bouncing HW = fell under weight of hammer	SPT
Shear vane (kPa)	V
Unconfined compressive strength, (MPa)	UCS

Field and laboratory testing (continued)

Test Type	Code
Point load test, (MPa), axial (A), diametric (D), irregular (I)	PLT(L)
Dynamic cone penetrometer, followed by blow count penetration increment in mm (cone tip, generally in accordance with AS1289.6.3.2)	DCP/150
Perth sand penetrometer, followed by blow count penetration increment in mm (flat tip, generally in accordance with AS1289.6.3.3)	PSP/150

Groundwater Observations

▷	seepage/inflow
▽	standing or observed water level
NFGWO	no free groundwater observed
OBS	observations obscured by drilling fluids

Drilling or Excavation Methods/Tools

The drilling/excavation methods used to perform the investigation may be shown either in a dedicated column down the left-hand edge of the log, or stated in the log footer. In some circumstances abbreviation codes may be used.

Method	Abbreviation Code
Direct Push	DP
Solid flight auger. Suffixes: /T = tungsten carbide tip, /V = v-shaped tip	AD ¹
Air Track	AT
Diatube	DT ¹
Hand auger	HA ¹
Hand tools (unspecified)	HAND
Existing exposure	X
Hollow flight auger	HSA ¹
HQ coring	HQ3
HMLC series coring	HMLC
NMLC series coring	NMLC
NQ coring	NQ3
PQ coring	PQ3
Predrilled	PD
Push tube	PT ¹
Ripping tyne/ripper	R
Rock roller	RR ¹
Rock breaker/hydraulic hammer	EH
Sonic drilling	SON ¹
Mud/blade bucket	MB ¹
Toothed bucket	TB ¹
Vibrocure	VC ¹
Vacuum excavation	VE
Wash bore (unspecified bit type)	WB ¹

¹ – numeric suffixes indicate tool diameter/width in mm

TEST BORE REPORT

DATE 6-8/5/92

CLIENT WASTE RECYCLING & PROCESSING SERVICE

PROJECT No 14780

BORE No 1

PROJECT PROPOSED EXTENSION

SURFACE LEVEL 104.1AHD

SHEET 1 OF 6

LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

DIP OF HOLE 90°

AZIMUTH

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength		Fracture Spacing (m)		Sampling & In Situ Testing			
				B - Bedding S - Shear	J - Joint D - Drill Break	UC Very Low Low Medium High Very High	UC Very Low Low Medium High Very High	1.00 0.50 0.25 0.10 0.05	0.01	Sample Type	Core Rec. %	RQD %	Test Results & Comments
1.0	CLAYEY SAND - brown and yellow brown fine grained clayey sand												
1.5	SANDY CLAY - stiff light grey and brown sandy clay												
2.0													
2.25	SANDSTONE - very low strength light grey and brown fine to medium grained sandstone												
2.8													
3.0	SANDSTONE - medium to high strength fractured to slightly fractured light grey and brown fine to medium grained sandstone												
4.0													
5.0													
5.8													
6.0	SANDSTONE - high strength, slightly fractured, light grey fine to medium grained sandstone												
7.0													
8.0													
9.0													

RIG Scout

DRILLER Cooper

LOGGED Murray

CASING

NW to 4m

TYPE OF BORING Solid flight auger GL to 2.8m, rotary 2.8m to 4.2m then NQ coring with air

WATER OBSERVATIONS Free ground water observed at 1.80m

REMARKS

SAMPLING & IN SITU TESTING

A auger sample PL point load strength (f_{PL}) (MPa)
B bulk sample S standard penetration test
C core drilling Ux x mm dia. tube



D.J. Douglas & Partners

TEST BORE REPORT

DATE 8/5/92

CLIENT WASTE RECYCLING & PROCESSING SERVICE

PROJECT No 14780

BORE No 1

PROJECT PROPOSED EXTENSION

SURFACE LEVEL

SHEET 2 OF 5

LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

DIP OF HOLE 90°

AZIMUTH

Depth m	Description of Core	Degree of Weathering F S W H D	Graphic Log	Discontinuities		Rock Strength		Fracture Spacing (m)	Sampling & In Situ Testing			
				B - Bedding S - Shear	J - Joint D - Drill Break	UC V L H E C	UC V L H E C		Sample Type	Core Rec. %	RCD %	Test Results & Comments
11.0	SANDSTONE - as above				J 80° undulating rough							
					sandy clay seam 10mm				C	100	100	
12.0												12.28
13.0					sandy clay seam 3mm							
					sandy clay seam 10mm				C	100	100	
14.0					extremely low strength sandstone 30mm							
					sandy clay seam 10mm							
15.0					coaly laminae along bedding							15.25
16.0	*becoming medium strength below 15.90m				*below 16.0m there are several breaks due to drilling and handling							
					sandy clay seam 5mm				C	100	100	
17.0					sandy clay seam 3mm							
					2 sandy clay seams each 3mm							
18.0												
18.45												18.25
19.0	SANDSTONE - medium strength slightly fractured to unbroken light grey fine to medium grained sandstone				The core is unbroken from 18.45 - 21.05m				C	100	100	

RIG Scout

DRILLER Cooper

LOGGED Murray

CASING

NW to 4m

TYPE OF BORING Solid flight auger GL to 2.8m, rotary 2.8m to 4.2m then NQ coring with air

WATER OBSERVATIONS Free ground water observed at 1.80m

REMARKS

SAMPLING & IN SITU TESTING

- | | |
|-----------------|---------------------------------------|
| A auger sample | PL point load strength f_{PL} (MPa) |
| B bulk sample | S standard penetration test |
| C core drilling | Ux x mm dia. tube |



D.J. Douglas & Partners

TEST BORE REPORT

DATE 8/5/92

CLIENT WASTE RECYCLING & PROCESSING SERVICE

PROJECT No 14780

BORE No 1

PROJECT PROPOSED EXTENSION

SURFACE LEVEL 104.14M

SHEET 3 OF 5

LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

DIP OF HOLE 90°

AZIMUTH

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength				Fracture Spacing (m)		Sampling & In Situ Testing		
				B - Bedding S - Shear	J - Joint D - Drill Break	Unconf. Comp. Strength	Unconf. Tens. Strength	Point Load Strength	Rock Quality Index	Fracture Spacing (m)	Fracture Spacing (m)	Sample Type	Core Rec. %	Test Results & Comments
21.0	SANDSTONE - as above													
22.0														
23.0														
24.0														
25.0														
26.0														
27.0														
28.0														
29.0														
29.9	SANDSTONE - see below													

RIG Scout DRILLER Cooper LOGGED Murray CASING NW to 4m

TYPE OF BORING Solid flight auger GL to 2.8m, rotary 2.8m to 4.2m then NQ coring with air

WATER OBSERVATIONS Water loss at 29.35m

REMARKS

SAMPLING & IN SITU TESTING

A - auger sample PL - point load strength (1/50) (MPa)
B - bulk sample S - standard penetration test
C - core drilling U_x - x mm dia. tube



D.J. Douglas & Partners

TEST BORE REPORT

DATE 8/5/92

CLIENT WASTE RECYCLING & PROCESSING SERVICE

PROJECT No 14780

BORE No 1

PROJECT PROPOSED EXTENSION

SURFACE LEVEL 104.14m

SHEET 4 of 5

LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

DIP OF HOLE 90°

AZIMUTH

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength			Fracture Spacing (m)	Sampling & In Situ Testing			
				B - Bedding S - Shear	J - Joint O - Drill Break	Unconfined Compressive Strength σ _u (MPa)	Point Load Strength P ₁ (MPa)	Split Tensile Strength σ _t (MPa)		Sample Type	Core Rec. %	RQD %	Test Results & Comments
29.90	SANDSTONE - medium to high strength, fresh, slightly fractured, light grey fine to medium grained sandstone with minor fractured layers			29.90 - defects are B partings 0-10° planar to undulating rough - some may have opened during drilling									30.25
31.0													
32.0	-slightly fractured to unbroken below 33.0m												
33.0													
33.25													
34.0													
35.0													
36.0													
36.25													
37.0													
38.0													
39.0													
39.25													

RIG Scout DRILLER Cooper LOGGED Murray CASING NW to 4m

TYPE OF BORING Solid flight auger GL to 2.8m, rotary 2.8m to 4.2m then NQ coring with air

WATER OBSERVATIONS Hole making water at approx 5.9 litres per minute below 30m

REMARKS

SAMPLING & IN SITU TESTING

- A - auger sample
- B - bulk sample
- C - core drilling
- PL - point load strength P_1 (50% MPa)
- S - standard penetration test
- 12x - 12mm dia tube



D.J. Douglas & Partners

TEST BORE REPORT

DATE 8/5/92

CLIENT WASTE RECYCLING & PROCESSING SERVICE

PROJECT No 14780

BORE No 1

PROJECT PROPOSED EXTENSION

SURFACE LEVEL 104.14AHD

SHEET 5 OF 5

LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

DIP OF HOLE 90°

AZIMUTH

Depth m	Description of Core	Degree of Weathering F PS S M H L D	Graphic Log	Discontinuities		Rock Strength		Fracture Spacing (m)	Sampling & In Situ Testing			
				B - Bedding S - Shear	J - Joint D - Drill Break	Unconf Compressive Strength MPa	UCS MPa		Sample Type	Core Rec. %	RQD %	Test Results & Comments
	SANDSTONE - as above											
41.0												
41.6												
42.0	LAMINITE - medium strength fresh, slightly fractured dark grey shale and light grey fine grained sandstone with some fractured layers											
43.0												
44.0												
44.1												
45.0	SANDSTONE - high strength, fresh, slightly fractured to unbroken, light grey fine grained sandstone with some fractured layers below 45.8m											
46.0												
47.0												
48.0												
49.0												
	BORE DISCONTINUED AT 50.5 METRES											

RIG Scout

DRILLER Cooper

LOGGED Murray

CASING NW to 4m

TYPE OF BORING Solid flight auger GL to 2.8m, rotary 2.8m to 4.2m rhwn HQ coring with air

WATER OBSERVATIONS Free ground water observed at 1.80m

REMARKS

SAMPLING & IN SITU TESTING

- A - auger sample
- B - bulk sample
- C - core drilling
- PL - point load strength $f_{PL}(MPa)$
- S - standard penetration test
- Ux - x mm dia. tube



D.J. Douglas & Partners

TEST BORE REPORT

DATE 9/5/92

CLIENT WASTE RECYCLING & PROCESSING SERVICE

PROJECT No 14780

BORE No 2

PROJECT PROPOSED EXTENSION

SURFACE LEVEL 116.69AHD

SHEET 1 of 6

LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

DIP OF HOLE 90°

AZIMUTH

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength		Fracture Spacing (m)	Sampling & In Situ Testing			Test Results & Comments
				B - Bedding S - Shear	J - Joint D - Drill Break	Unconf. Compressive	Unconf. Tensile		Sample Type	Core Rec. %	RQD %	
1	CLAYEY SAND & SANDY CLAY - brown and yellow brown fine to medium grained clayey sand and sandy clay											
1.55	Auger refusal at 1.55 m											1.55
2	SANDSTONE - high strength, fresh, slightly fractured light grey, brown and purple brown fine to medium grained sandstone with some medium strength layers and minor fractured layers								C	81	98	
3												
4									C	100	98	
5												
6												
7												
8									C	100	99	
9												
									C	100	100	

RIG Scout

DRILLER Cooper

LOGGED Murray

CASING to 1.55m

TYPE OF BORING Solid flight auger GL to 1.55m, then ND coring with water to 51.50m

WATER OBSERVATIONS No free ground water observed whilst augering. Final level at 7.55m after 1 1/2 hrs

REMARKS 80-90% loss of water return below 21.0m

SAMPLING & IN SITU TESTING

A auger sample PL point load strength (1/50(MPa))
B bulk sample S standard penetration test
C cone drilling Uc 1 mm dia. tube



D.J. Douglas & Partners

DATE 9/5/92

PROJECT No 14780

BORE No. 2

SURFACE LEVEL 116.69AHD

SHEET 2 OF 6

DIP OF HOLE 90°

AZIMUTH

FIG	Scout	DRILLER	Cooper	LOGGED	Murray	CASING
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TYPE OF BORING Solid flight auger GL to 1.55m, then NQ coring with water to S1.50m

WATER OBSERVATIONS No free ground water observed whilst augering. Final level at 7.55m after 14hrs.

REMARKS 80-90% loss of water return below 21.0m

SAMPLING & IN SITU TESTING

A	super sample	PL	point load strength $I_p(50)(34^\circ\text{N})$
B	bulk sample	S	standard penetration test
C	core drilling	Ur	x mm dia. tube



D.J. Douglas & Partners

TEST BORE REPORT

DATE 9/5/92

CLIENT WASTE RECYCLING & PROCESSING SERVICE

PROJECT No 14780

BORE No 2

PROJECT PROPOSED EXTENSION

SURFACE LEVEL 116.69AHD

SHEET 3 OF 6

LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

DIP OF HOLE 90°

AZIMUTH

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength	Fracture Spacing (m)	Sampling & In Situ Testing			
				B - Bedding S - Shear	J - Joint D - Drill Break			Sample Type	Core Rec. %	RQD %	Test Results & Comments
21	SANDSTONE - high strength, fresh slightly fractured light grey fine to medium grained sandstone with some fractured layers										
							CORE LOSS 200mm				21.15
22											
							CORE LOSS 500mm				
23											
23.10											
24	SANDSTONE - high strength, fresh, slightly fractured light grey fine to medium grained sandstone										
25											
26											
27											
28											
29											

RIG Scout DRILLER Cooper LOGGED Murray CASING

TYPE OF BORING Solid flight auger GL to 1.55m, then NQ coring with water to 51.50m

WATER OBSERVATIONS No free ground water observed whilst augering. Final level at 7.55m after 1½hrs.

REMARKS 80-90% loss of water return below 21.0m

SAMPLING & IN SITU TESTING

- A - auger sample
- B - bulk sample
- C - core drilling
- PL - point load strength $I_{PS}(MPa)$
- S - standard penetration test
- U - 1 mm dia. tube



D.J. Douglas & Partners

TEST BORE REPORT

DATE 11/5/92

CLIENT WASTE RECYCLING & PROCESSING SERVICE

PROJECT No 14780

BORE No 22

PROJECT PROPOSED EXTENSION

SURFACE LEVEL 116.69AHD

SHEET 4 OF 6

LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

DIP OF HOLE 90°

AZIMUTH

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength		Fracture Spacing (m)	Sampling & In Situ Testing			
				B - Bedding S - Shear	J - Joint C - Drill Break	Unconf. Comp. UC	UC		Sample Type	Core Rec. %	RCD %	Test Results & Comments
31	SANDSTONE - high strength, fresh, slightly fractured light grey fine to medium grained sandstone			sandy clay seam 5mm sandy clay seam 15mm sandy clay seam 10mm								30.30
32	*some siltstone intraclasts and coarse grained sandstone layers below 31m								C	100	95	
32.84				32.84-40.80m: unless otherwise specified defects are B-partings 0-10° in laminite layers, undulating smooth, many of which are probably due to drilling. The core contains several breaks due to handling								33.30
33	LAMINITE - high strength, fresh slightly fractured interbedded dark grey siltstone and shale and light grey fine grained sandstone with some high to very high strength light grey fine grained sandstone layers								C	100	95	
34												
35												
36				clay seam 3mm								36.30
37												
37.17	SANDSTONE & LAMINITE - high strength, fresh, slightly fractured interbedded light grey fine grained sandstone and dark grey shale and siltstone								C	100	100	
38				J 45° slickensided displaced bedding in shale interbed								
39				clay seam in B-parting 5°, 3mm								39.30

RIG Scout

DRILLER Cooper

LOGGED Murray

CASING

TYPE OF BORING Solid flight auger GL to 1.55m, then NQ coring with water to 51.50m

WATER OBSERVATIONS No free ground water observed whilst augering. Final level at 7.55m after 1 1/2 hrs.

REMARKS 80-90% loss of water return below 21.0 m

SAMPLING & IN SITU TESTING

A auger sample PL point load strength f_p (MPa)
B bulk sample S standard penetration test
C core drilling Ux x mm dia. tube



D.J. Douglas & Partners

TEST BORE REPORT

DATE 11/5/92

CLIENT WASTE RECYCLING & PROCESSING SERVICE

PROJECT No 14780

BORE No 2

PROJECT PROPOSED EXTENSION

SURFACE LEVEL 116.69AHD

SHEET 5 OF 6

LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

DIP OF HOLE 90°

AZIMUTH

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength		Fracture Spacing (m)	Sampling & In Situ Testing			
				B - Bedding S - Shear	J - Joint D - Drill Break	Unconf. Comp.	UCS		Sample Type	Core Rec. %	RQD %	Test Results & Comments
40.80	SANDSTONE & LAMINITE - as above		J 45° undulating slickensided Fragmented layer possible shear zone J subvertical irregular									
41	SANDSTONE - high strength, fresh, fractured light grey fine to medium grained sand- stone with minor siltstone interbeds above 42.3m		J 20° irregular clay coated						C	100	70	
42			40.80-42.30m: unless specified defects are generally B-partings 0-10° undulating along shaley laminae. Some are due to drilling.									42.30
43	*slightly fractured below 42.85m		*Core loss may represent fractured sandstone ground away during drilling					Core Loss 250mm				
44			sandy clay seams 10mm						C	9	97	
45			42.30-51.50m: defects are generally B-part- ings 5-10° planar, some of which are clay coated									45.30
46												
47			sandy clay seams 3mm						C	100	100	
48												48.30
49									C	100	100	

RIG Scout

DRILLER Cooper

LOGGED Murray

CASING to 1.55m

TYPE OF BORING Solid flight auger GL to 1.55m, then NQ coring with water to 51.50m

WATER OBSERVATIONS No free ground water observed whilst augering. Final level at 7.55m after 1½hrs.

REMARKS 80-90% loss of water return below 21.0m

SAMPLING & IN SITU TESTING

A auger sample PL point load strength (f_{50})(MPa)
B bulk sample S standard penetration test
C core drilling Un x mm dia. tube



D.J. Douglas & Partners

TEST BORE REPORT

DATE 11/5/92

CLIENT WASTE RECYCLING & PROCESSING SERVICE

PROJECT No 14780

BORE No 2

PROJECT PROPOSED EXTENSION

SURFACE LEVEL 116.69AHD

SHEET 6 OF 6

LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

DIP OF HOLE 90°

AZIMUTH

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength		Fracture Spacing (m)		Sampling & In Situ Testing			
				B - Bedding S - Shear	J - Joint D - Drill Break	Unconf. Comp.	Unconf. Tens.	Unconf. Flex.	Unconf. Ext.	Sample Type	Core Rec. %	RQD %	Test Results & Comments
51	SANDSTONE - high strength, fresh, fractured light grey fine to medium grained sand- stone with minor siltstone interbeds above 42.3m			2 sandy clay seams 3mm and 5mm									
52	BORE DISCONTINUED AT 51.50 METRES												
53													
54													
55													
56													
57													
58													
59													

RIG Scout

DRILLER Cooper

LOGGED Murray

CASING to 1.55m

TYPE OF BORING Solid flight auger GL to 1.55m, then NQ coring with water to 51.50m

WATER OBSERVATIONS No free ground water observed whilst augering. Final level at 7.55m after 1 1/2 hrs.

REMARKS 80-90% loss of water return below 21.0m

SAMPLING & IN SITU TESTING

A - auger sample PL - point load strength I_{p50} (MPa)
 B - bulk sample S - standard penetration test
 C - cone penetration test T - 10 mm dia tube



D.J. Douglas & Partners

TEST BORE REPORT

DATE 13/5/92

CLIENT WASTE RECYCLING & PROCESSING SERVICE

PROJECT No 14780

BORE No 3

PROJECT PROPOSED EXTENSION

SURFACE LEVEL 118.30AHD

SHEET 1 OF 6

LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

DIP OF HOLE 90°

AZIMUTH

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength	Fracture Spacing (m)	Sampling & In Situ Testing			
				B - Bedding S - Shear	J - Joint D - Drill Break			Sample Type	Core Rec. %	RQD %	Test Results & Comments
1	CORE LOSS							C	12	11	
2											
2.75	SANDSTONE - high strength fresh slightly fractured yellow brown and grey medium grained sandstone			J 30° planar, rough B parting 5°, undulating rough							3.15
3											
3.15											
4	SANDSTONE - low to medium strength fresh, slightly fractured, light grey fine to medium grained sandstone			B parting 5°, undulating rough				C	100	95	6.20
5											
6											
6.20				J 20° J 20° planar, rough							
7	SANDSTONE - very low to low strength fresh fractured brown, yellow brown coarse grained sandstone with 10mm clay at 8.1 m			Defects are bedding partings 0-10° rough, planar				C	45	17	8.1
7.20											
8	SANDSTONE - medium to high strength, fresh, fractured to slightly fractured, yellow brown and light grey medium to coarse grained sandstone			8.10-10.30m: unless specified defects are B-partings 0-10° J 5° stepped, rough J 20° planar				C	100	78	9.15
9											
								C	91	54	

RIG Scout

DRILLER Cooper

LOGGED Yesil

CASING to 2.30m

TYPE OF BORING NQ coring with water

WATER OBSERVATIONS Water level at 6.60m, 1hr after drilling - water pouring into bore between 2.30m and 6.60m.
Final level after 1hrs. with no water entering hole - 6.60m.

REMARKS

SAMPLING & IN SITU TESTING

A - auger sample PL - point load strength (1/50)(34Pa)
B - bulk sample S - standard penetration test
C - core drilling Ux - x mm dia. tube



D.J. Douglas & Partners

DATE 13/5/92

AZIMUTH

D.J. Douglas & Partners

TEST BORE REPORT

DATE 13/5/92

CLIENT WASTE RECYCLING & PROCESSING SERVICE

PROJECT No 14780

BORE No 3

PROJECT PROPOSED EXTENSION

SURFACE LEVEL 118.30AHD

SHEET 3 OF 6

LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

DIP OF HOLE 90°

AZIMUTH

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength	Fracture Spacing (m)	Sampling & In Situ Testing			
				S - Bedding S - Shear	J - Joint D - Drill Break			Sample Type	Core Rec. %	RQD %	Test Results & Comments
21	SANDSTONE - medium to high strength, fresh, slightly fractured, light grey, fine to medium grained sandstone		J, 15° undulating 5mm clay filling								21.00
			J, horizontal 3mm clay filling								
			J, 5° planar, rough								
22	SILTSTONE - medium strength, fresh, slightly fractured, dark grey siltstone		22.00-24.00m: unless specified defects are								
			B-partings 0-5°, planar, smooth								
23											
24	SANDSTONE - high strength, fresh, slightly fractured light grey, fine to medium grained sandstone		24.05-24.55m: B-partings 20° planar								24.00
			J, 45° rough, planar								
25			J, 35° planar								
26											
27											
28											
29			J, 20° planar 2mm clay filling								
			J, 20° planar, smooth								
			J, 60° stepped, rough								
			J, 20° undulating, 10mm clay								30.00

RIG Scout

DRILLER Cooper

LOGGED Yeall

CASING to 2.30m

TYPE OF BORING NQ coring with water

WATER OBSERVATIONS No water return below 25.0m.

REMARKS

SAMPLING & IN SITU TESTING

- A - auger sample
- B - bulk sample
- C - core drilling
- PL - point load strength I_{p50} (MPa)
- S - standard penetration test
- Ux - x mm dia. tube



D.J. Douglas & Partners

TEST BORE REPORT

DATE 13-14/5/92

CLIENT WASTE RECYCLING & PROCESSING SERVICE

PROJECT No 14780

BORE No 3

PROJECT PROPOSED EXTENSION

SURFACE LEVEL 118.30AHD

SHEET 4 OF 6

LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

DIP OF HOLE 90°

AZIMUTH

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength		Fracture Spacing (m)	Sampling & In Situ Testing			
				B - Bedding S - Shear	J - Joint D - Drill Break	Unconf Comp	UCS		Sample Type	Core Rec. %	RCD %	Test Results & Comments
	SANDSTONE - as above			Unless specified defects are B- partings 0-10°								
31.0				J 10° undulating 2mm clay filling					C	100	98	
32.0												
33.0				33.25 - 33.33 fractured shale band								33.00
34.0				J 50° rough					C	100	93	
35.0				J 10° rough 5mm clay filling								
36.0				J 25° planar smooth								36.15
37.0									C	100	96	
38.0												
39.0												39.15
39.4				sandy clay seen 5mm in B-parting 10°					C	100		39.55
	SANDSTONE - see over								C	100		39.72

RIG Scout DRILLER Cooper LOGGED Yesil CASING to 2.30m

TYPE OF BORING NQ coring with water

WATER OBSERVATION: No water return below 25.0m

REMARKS

SAMPLING & IN SITU TESTING

- A - auger sample
- B - bulk sample
- C - core drilling
- PL - point load strength $I_{PS}(MPa)$
- S - standard penetration test
- U_s - 7.5mm dia tube



D.J. Douglas & Partners

TEST BORE REPORT

DATE 14/5/92

CLIENT WASTE RECYCLING & PROCESSING SERVICE

PROJECT No 14780

BORE No 3

PROJECT PROPOSED EXTENSION

SURFACE LEVEL 118.30AHD

SHEET 5 of 6

LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

DIP OF HOLE 90°

AZIMUTH

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength		Fracture Spacing (m)	Sampling & In Situ Testing			
				B - Bedding S - Shear	J - Joint O - Drill Break	Ex. Low Very Low	Med. Low High		Sample Type	Core Rec. %	RQD %	Test Results & Comments
41.0	SANDSTONE - high strength, fresh, slightly fractured light grey fine to medium grained sandstone with some fractured layers			39.40 - 42.45m unless otherwise specified defects are B-partings 0-10° undulating to planar some of which may have opened during drilling					C	100	96	
42.0				10mm sandy clay seam in B-parting 5°								
42.45				42.45 - 51.15m unless otherwise specified all defects are B-partings 0-10° generally planar but some undulating along coaly laminae probably opened during drilling								42.00
43.0	SANDSTONE - high strength, fresh, slightly fractured light grey fine to medium grained sandstone with minor fractured layers			2 sandy clay seams in B partings 5° both 3mm					C	100	96	
44.0				sandy clay seam 5mm in B-parting								
45.0												45.15
46.0				sandy clay seam 30mm								
47.0				sandy clay seam 10mm J 80° to subvertical undulating rough					C	100	88	
48.0				sandy clay seam 5mm in B-parting 5° 3mm sandy clay seam in B-parting								
49.0				B parting 15°, planar 1mm sandy clay coating								48.15
				J 75° undulating					C	100	95	
				B 20°								
				J 85° planar, rough, clay coated, closed								

RIG Scout

DRILLER

Cooper

LOGGED

Yes!!

CASING to 2.30m

TYPE OF BORING NQ coring with water

WATER OBSERVATIONS No water return below 25.0m

REMARKS

SAMPLING & IN SITU TESTING

- A - auger sample PL - point load strength (1/160)(MPa)
 B - bulk sample S - standard penetration test
 C - core drilling Uv - x mm dia tube



D.J. Douglas & Partners

TEST BORE REPORT

DATE 14/5/92

CLIENT WASTE RECYCLING & PROCESSING SERVICE

PROJECT No 14780

BORE No 3

PROJECT PROPOSED EXTENSION

SURFACE LEVEL 118.30AHD

SHEET 6 OF 6

LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

DIP OF HOLE 90°

AZIMUTH

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength		Fracture Spacing (m)	Sampling & In Situ Testing			
				B - Bedding S - Shear	J - Joint D - Drill Break	Unconf. Compressive	UCS		Sample Type	Core Rec. %	RQD %	Test Results & Comments
51.0	SANDSTONE - as above				J 80° recemented 40mm siltstone interbed							
51.15					J 80° undulating							
	BORE DISCONTINUED AT 51.15 METRES											
52.0												
53.0												
54.0												
55.0												
56.0												
57.0												
58.0												
59.0												

RIG Scout DRILLER Cooper LOGGED Yesil CASING to 2.30m

TYPE OF BORING HQ coring with water

WATER OBSERVATIONS No water return below 25.0m

REMARKS

SAMPLING & IN SITU TESTING

- A auger sample
- B bulk sample
- C core drilling
- PL point load strength $U_{(50)}$ (MPa)
- S standard penetration test
- Ux x mm dia. tube



D.J. Douglas & Partners

TEST BORE REPORT

CLIENT WASTE RECYCLING & PROCESSING
SERVICE
PROJECT PROPOSED EXTENSION
LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

DATE 14th MAY, 1992 BORE No 4
PROJECT No 14780
SURFACE LEVEL 104.37AHD

Depth m	Description of Strata	Sampling & In Situ Testing			
		Type	Depth	Blows/150mm N Value	Core Recovery %
0.50	CLAYEY SAND - brown fine to medium grained clayey sand				
2.10	SANDY CLAY - yellow brown sandy clay				
4.00	SANDSTONE - very low strength brown fine to medium grained sandstone becoming low to medium strength below 3.0m				
	SANDSTONE - medium to high strength light grey fine to medium grained sandstone with minor clay seams to max. thickness of approx. 40mm				
	-siltstone interbed 9.2 - 9.4m				
	BORE DISCONTINUED AT 25.0 METRES				

RIG Scout DRILLER Cooper LOGGED Murray CASING to 5.5m

TYPE OF BORING Solid flight auger GL to 2.5m then roller bit to 25.0m

WATER OBSERVATIONS Free ground water observed at 0.95m

REMARKS

SAMPLING & IN SITU TESTING

A auger sample PL point load strength (f_{p50}) (MPa)
B bulk sample S standard penetration test
C core drilling Un x mm dia. tube
cc pocket penetrometer (kPa)



D.J. Douglas & Partners

TEST BORE REPORT

CLIENT WASTE RECYCLING & PROCESSING
SERVICE
PROJECT PROPOSED EXTENSION
LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

DATE 15-16th MAY, 1992 BORE No 5
PROJECT No 14780
SURFACE LEVEL 104.49MHD

Depth m	Description of Strata	Sampling & In Situ Testing			
		Type	Depth	Blows/150mm N Value	Core Recovery %
1.00	CLAYEY SAND - loose brown fine to medium grained clayey sand with some loamy				
2.25	SANDY CLAY - yellow brown sandy clay				
2.35	SANDSTONE - very low to low strength grey and purple brown fine to medium grained sandstone Auger refusal at 2.35m				
	SANDSTONE - medium to high strength light grey and brown fine to medium grained sandstone				
BORE DISCONTINUED AT 10.0 METRES					

RIG Scout DRILLER Cooper LOGGED Murray CASING to 5.5m
TYPE OF BORING Solid flight auger GL to 2.35m then roller bit to 10.0m
WATER OBSERVATIONS Water level at 2.25m after 1/2 hr
REMARKS

SAMPLING & IN SITU TESTING

A auger sample PL point load strength (1,000 MPa)
B bulk sample S standard penetration test
C core drilling Ux x mm dia. tube
DO double penetration test (kPa)



D.J. Douglas & Partners

TEST BORE REPORT

DATE 20TH MAY, 1992

CLIENT WASTE RECYCLING & PROCESSING SERVICE

PROJECT No 14780

BORE No. 6

PROJECT	PROPOSED EXTENSION
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SURFACE LEVEL 134.46AHD

SHEET 1 OF 6

LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS. . . DIP OF HOLE 45°

AZIMUTH 269⁰ GRID

Depth m	Description of Core	Degree of Weathering SE SW NW NE EW	Graphic Log	Discontinuities		Rock Strength						Fracture Spacing (m)		Sampling & In Situ Testing				
				B - Bedding S - Shear	J - Joint D - Drill Break	P _v Low Very Low Low Medium High P _c High P _t High	P _v Low Very Low Low Medium High P _c High P _t High	P _v Low Very Low Low Medium High P _c High P _t High	P _v Low Very Low Low Medium High P _c High P _t High	P _v Low Very Low Low Medium High P _c High P _t High	0.89 0.70 0.50 0.30	Sample Type	Core Rec. %	RQD %	Test Results & Comments			
0.50	CLAYEY SAND AND GRAVEL - brown and red brown clayey sand and lateritic gravel																	
4.0	SANDSTONE - extremely low to very low strength brown and red brown fine to medium grained sandstone with some clay layers																	
2.0																		
2.20																		
3.0	SANDSTONE - high strength, slightly fractured, grey, brown and red brown fine to medium grained sandstone with minor fractured layers			J subvertical J 30°														1.75
4.0				J 25° undulating 2.20 - 9.10m unless otherwise specified defects are B-partings 20-35° some of which are ironstained and or clay coated, some may have opened during drilling														3.00
5.0				2mm sandy clay seam in B partings 30° J 90° ironcoated														
6.0																		6.00
7.0																		
8.0																		
9.0																		
9.18	SANDSTONE - see over																	9.00
				J subhorizontal														

RIG Scout DRILLER Lamb LOGGED Murray CASING HW to 0.9m

TYPE OF BORING Roller Bit GL to 1.45m, then NQ coring

WATER OBSERVATIONS Obscured by drilling methods

REMARKS

SAMPLING & IN SITU TESTING

A	auger sample	PL	point load strength I_{500} (MPa)
B	bulk sample	S	standard penetration test
C	core drilling	Ux	a run dia tube



D.J. Douglas & Partners

TEST BORE REPORT

DATE 20-21 MAY, 1992

CLIENT WASTE RECYCLING & PROCESSING SERVICE

PROJECT No 14780

BORE No 6

PROJECT PROPOSED EXTENSION

SURFACE LEVEL 134.46AND

SHEET 2 OF 6

LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

DIP OF HOLE 45°

AZIMUTH 269° GRID

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength		Fracture Spacing (m)	Sampling & In Situ Testing				
				B - Bedding S - Shear	J - Joint D - Drill Break	Unconf. Comp. Strength	Unconf. Tens. Strength		Sample Type	Core Rec. %	RQD %	Test Results & Comments	
11.0	SANDSTONE - medium strength fractured to slightly fractured light grey and brown fine to medium grained sandstone with some very low to low strength layers			9.10-11.73m most defects are B-partings 20-35° The core contains some breaks in very low to low strength layers due to handling						C	94	96	
11.73													
12.0	SANDSTONE - high strength, slightly fractured light grey, brown and purple brown fine to medium grained sandstone			11.73-28.30m unless specified defects are generally B-partings 35-55° planar to undulating some of which are iron-coated The core contains some breaks due to drilling						C	97	98	12.00
13.0													
14.0				J's 2 parallel at 50° spacing 20mm, irregular iron-coated									15.00
15.0													
16.0				J 60° planar iron-coated 10mm clay seam in B-parting 50°						C	98	100	
17.0													
18.0	-predominantly light grey to light pink below 17.25m			Core loss 50mm									17.85
19.0													
				J subhorizontal to undulating, rough J subhorizontal to undulating, rough most B-partings below 19.0m are clay coated						C	99	100	

RIG Scout DRILLER Lamb LOGGED Murray CASING HW to 0.9m

TYPE OF BORING Roller Bit GL to 1.45m, then ND coring

WATER OBSERVATIONS Obscured by drilling methods

REMARKS

SAMPLING & IN SITU TESTING

- A auger sample
- B bulk sample
- C core drilling
- PL point load strength $L_{50}(MPa)$
- S standard penetration test
- Ua x mm dia. tube



D.J. Douglas & Partners

TEST BORE REPORT

DATE 21.5.92

CLIENT WASTE RECYCLING & PROCESSING SERVICE
PROJECT PROPOSED EXTENSION
LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

PROJECT No 14780
SURFACE LEVEL 134.46AHD
DIP OF HOLE 45°

BORE No 6
SHEET 3 OF 6
AZIMUTH 269° GRID

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength		Fracture Spacing (m)	Sampling & In Situ Testing			
				B - Bedding S - Shear	J - Joint O - Drill Break	SL Very Low	LL Low		Sample Type	Core Rec. %	RQD %	Test Results & Comments
21.0	SANDSTONE - high strength, slightly fractured light grey and pink fine to medium grained sandstone			See general description above								
				Some B-partings have probably opened during drilling								
								CORE LOSS 140mm				
22.0				*core loss possibly due to highly fractured to fractured layers grinding away during drilling					C	96	96	
24.0				2 parallel J's each 55° spacing 30mm iron-coated planar								
25.0									C	98	100	
26.0				*core loss 50mm possibly due to coarse grained sandstone core grinding away during drilling along subhorizontal joint								
27.0												
28.0				Sandy clay seam 5mm in B-parting 45°					C	100	100	
28.30				28.30-29.45m much of the core is broken due to drilling and handling along clay seams, generally 3 to 5mm thick and mostly sub- horizontal								
29.0	SANDSTONE - low to medium strength slightly fractured light grey fine grained sandstone with numerous extremely low strength sandstone and clay layers											
29.95	SANDSTONE - see over											
30.00												

RIG Scout

DRILLER Cooper

LOGGED Murray

CASING HW to 0.3m

TYPE OF BORING Roller Bit GL to 1.45m, then NQ coring

WATER OBSERVATIONS Obscured by drilling methods

REMARKS

SAMPLING & IN SITU TESTING

- A - auger sample
- B - bulk sample
- C - core drilling
- PL - point load strength $I_{p(50)}$ (MPa)
- S - standard penetration test
- Ux - x mm dia. tube



D.J. Douglas & Partners

TEST BORE REPORT

DATE 21.5.92

CLIENT WASTE RECYCLING & PROCESSING SERVICE
PROJECT PROPOSED EXTENSION
LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

PROJECT No 14780

SURFACE LEVEL 134.46AHD

DIP OF HOLE 45°

BORE No 6

SHEET 4 OF 6

AZIMUTH 269° GRID

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength		Fracture Spacing (m)	Sampling & In Situ Testing			
				B - Bedding S - Shear	J - Joint D - Drill Break	Unconf. Comp. Strength	Unconf. Tens. Strength		Sample Type	Core Rec. %	RCO %	Test Results & Comments
31.0	SANDSTONE - high strength slightly fractured light grey fine to medium grained sandstone with some unbroken layers and minor fractured layers											
32.0												
33.0												
34.0												
35.0												
36.0												
37.0												
38.0												
39.0												

RIG Scout

DRILLER Cooper

LOGGED Murray

CASING HW to 0.9m

TYPE OF BORING Roller Bit G1 to 1.45m, then NQ coring

WATER OBSERVATIONS Obscured by drilling methods

REMARKS

SAMPLING & IN SITU TESTING

A auger sample PL point load strength (f_{50})(MPa)
B bulk sample S standard penetration test
C core drilling Ur x mm dia. tube



D.J. Douglas & Partners

TEST BORE REPORT

DATE 21ST MAY, 1992

CLIENT WASTE RECYCLING & PROCESSING SERVICE

PROJECT No 14780

BORE No 6

PROJECT PROPOSED EXTENSION

SURFACE LEVEL 134.46AHD

SHEET 5 OF 6

LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

DIP OF HOLE 45°

AZIMUTH 269° GRID

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength	Fracture Spacing (m)	Sampling & In Situ Testing			
				B - Bedding S - Shear	J - Joint D - Drill Break			Sample Type	Core Rec. %	RQD %	Test Results & Comments
	SANDSTONE - high-strength, slightly fractured light grey fine to medium grained sandstone with some unbroken layers and minor fractured layers			J 55° undulating, rough							
41.0				41.00 - 49.00m all defects are B- partings generally 15-25°, planar to undulating clay coated, spacing typically 300-1500mm Many have probably opened during drilling				C	100	95	
42.0											42.10
43.0								C	100	100	
44.0				the core is unbroken from 44.05 - 47.15m							
45.0											45.10
46.0								C	100	100	
47.0	*brown colour between 46.6 - 48.75m										
48.0											48.10
49.0				5mm sand clay seam in B-parting 25°				C	100	97	
49.85	SANDSTONE - see over			J 50° planar rough							

RIG Scout

DRILLER

Cooper

LOGGED

Murray

CASING HW to 0.3m

TYPE OF BORING Roller Bit G1 to 1.45m, then NQ coring

WATER OBSERVATIONS Obscured by drilling methods

REMARKS

SAMPLING & IN SITU TESTING

- A - super sample PL - point load strength f_{PL} (MPa)
 B - bulk sample S - standard penetration test
 C - core drilling U - 7 mm dia. tube



D.J. Douglas & Partners

TEST BORE REPORT

DATE 21ST MAY, 1992

CLIENT WASTE RECYCLING & PROCESSING SERVICE

PROJECT No 14780

BORE No 6

PROJECT PROPOSED EXTENSION

SURFACE LEVEL 134.46AHD

SHEET 6 OF 6

LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

DIP OF HOLE 45°

AZIMUTH 269° GRID

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength							Fracture Spacing (m)		Sampling & In Situ Testing			
				B - Bedding S - Shear	J - Joint D - Drill Break	Q - Low Very Low Low	Very Low Low	Medium High	Very High Ext. High	1.00 0.50 0.25 0.01	0.10 0.05 0.01	0.01	Sample Type	Core Rec. %	RQD %	Test Results & Comments		
51.0	SANDSTONE - high strength, fresh, slightly fractured, light grey fine to medium grained sandstone with some fractured layers			J 65° undulating clay coated J subvertical 5mm sandy clay infill														51.10
52.0				10mm sandy clay seam in B-parting 20° J's 2 at horizontal														
53.0				J 5° irregular									C	100	92			
54.0				J 5° irregular 5mm sandy clay infill														
55.0				B 45° planar, clay coated 4 possible J's sub- horizontal														54.10
56.0				49.00 - 56.40m unless specified defects are B-partings 20-30° some of which have probably opened during drilling									C	100	97			
57.0				J 10° J's 45-60° spacing 15-50mm, closed, but easily opened during handling J 15° 10mm sandy clay infill														57.10
58.0				56.40 - 60.10m unless specified, defects are B- partings 40-50° some of which have probably opened during drilling														
59.0													C	100	98			
60.10				15mm sandy clay seam in B-parting 45°														60.10

BORE DISCONTINUED AT 60.10 M.

RIG Scout DRILLER Cooper LOGGED Murray CASING HW to 0.9m

TYPE OF BORING Roller Bit GL to 1.45m, then NQ coring

WATER OBSERVATIONS Approx. 35% of water return lost below 55.4m

REMARKS

SAMPLING & IN SITU TESTING

- A auger sample
- PL point load strength $I_p(50)(MPa)$
- B bulk sample
- S standard penetration test
- C core drilling
- U x mm dia. tube



D.J. Douglas & Partners

TEST BORE REPORT

DATE 25-26.5.92

CLIENT WASTE RECYCLING & PROCESSING SERVICE

PROJECT No 14780

BORE No 7

PROJECT PROPOSED EXTENSION

SURFACE LEVEL 137.39AMD

SHEET 1 OF 7

LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

DIP OF HOLE 45°

AZIMUTH 128°GR1D

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength		Fracture Spacing (m)		Sampling & In Situ Testing		
				B - Bedding S - Shear	J - Joint D - Drill Break	UC Low	UC Med	UC High	UC Very High	Sample Type	Core Rec. %	POD %
1.0	FILLING - grey and brown rippled sandstone filling with some sandstone boulders											
1.30	CLAYEY SAND - brown clayey sand with some gravel											
2.0												
2.25												
3.0	SANDSTONE - low to medium strength fractured to slightly fractured light grey and red brown fine to medium grained sandstone											
4.0												
5.0												
6.0												
6.65												
7.0	SANDSTONE - medium strength slightly fractured light grey brown and purple brown fine to medium grained sandstone with some fractured layers											
8.0												
8.50												
9.0	SANDSTONE - medium to high strength fractured to slightly fractured light grey brown and purple brown fine to medium grained sandstone with some low strength layers											

RIG Scout

DRILLER Cooper

LOGGED Murray

CASING

TYPE OF BORING Roller bit GL to 3.00m

WATER OBSERVATIONS Obscured by drilling methods

REMARKS

SAMPLING & IN SITU TESTING

A - auger sample PL - point load strength f_{PL} (MPa)
B - bulk sample S - standard penetration test
C - core drilling $f_{1/4}$ - 1/4 in dia tube



D.J. Douglas & Partners

TEST BORE REPORT

DATE 26.5.92

CLIENT WASTE RECYCLING & PROCESSING SERVICE

PROJECT No 14780

BORE No 7

PROJECT PROPOSED EXTENSION

SURFACE LEVEL 137.39AHD

SHEET 2 OF 7

LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

DIP OF HOLE 45°

AZIMUTH 128° GRID

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength	Fracture Spacing (m)	Sampling & In Situ Testing			
				B - Bedding S - Shear	J - Joint D - Drill Break			Sample Type	Core Rec. %	RQD %	Test Results & Comments
11.0	SANDSTONE - medium to high strength fractured to slightly fractured light grey brown and purple brown fine to medium grained sandstone with some low strength layers							C	100	75	10.70
11.50											
12.0	SANDSTONE - high strength slightly fractured light grey brown and purple brown fine to medium grained sandstone with fractured layers and unbroken layers							C	100	100	11.50
13.0											
14.0											
15.0											
16.0											
17.0											
17.10											
18.0	SANDSTONE - high strength slightly fractured light grey and brown fine to medium grained sandstone with some unbroken layers below 20.5m							C	100	90	17.50
19.0											

RIG Scout

DRILLER Cooper

LOGGED Murray

CASING

TYPE OF BORING Roller bit GL to 3.00m

WATER OBSERVATIONS Obscured by drilling methods

REMARKS

SAMPLING & IN SITU TESTING

- A - super sample
- B - bulk sample
- C - core drilling
- PL - point load strength $I_p(50)(MPa)$
- S - standard penetration test
- Ux - x mm dia. tube



D.J. Douglas & Partners

TEST BORE REPORT

DATE 26.5.92

CLIENT WASTE RECYCLING & PROCESSING SERVICE

PROJECT No 14780

BORE No 7

PROJECT PROPOSED EXTENSION

SURFACE LEVEL 137.39m

SHEET 3 of 7

LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

DIP OF HOLE 45°

AZIMUTH 128° GRID

Depth m	Description of Core	Degree of Weathering Fk Sk Ss Hw Sw	Graphic Log	Discontinuities		Rock Strength		Fracture Spacing (m)	Sampling & In Situ Testing			
				B- Bedding S- Shear	J- Joint D- Drill Break	Core Loss	Core Loss		Sample Type	Core Rec. %	RCD %	Test Results & Comments
21.0	SANDSTONE - high strength slightly fractured light grey and brown fine to medium grained sandstone with some unbroken layers below 20.5m			see description 11.50 - 24.50m								20.5
22.0									C	100	100	
23.0												
24.0	SANDSTONE - high strength fractured to slightly fractured light grey and brown fine to medium grained sandstone with some very low to low and medium strength layers			24.50 - 31.05m unless specified defects are B 30-50° generally planar ironstained and/or clay coated some may be opened during drilling								23.5
24.4				J 30° ironstained B's 35° planar 15mm sandy clay infill					C	84	80	
25.0				B 35° ironstained								
26.0				*core loss possibly due to very low to low strength or fractured sandstone being washed away during drilling		CORE LOSS 400mm						
26.5				J's 2 at 30° irregular 10mm sandy clay seam in B 40°					C	100		26.0
27.0				J 50°-80° undulating rough ironstained J subvertical stepped ironcoated								
28.0									C	86		
29.0				*core loss possibly due to highly fractured sandstone being ground away during drilling		CORE LOSS 350mm						
29.4				J 0-5° undulating					C	100		29.05
									C	100		29.4

RIG Scout DRILLER Cooper LOGGED Murray CASING

TYPE OF BORING Roller bit GL to 3.00m

WATER OBSERVATIONS Obscured by drilling methods

REMARKS

SAMPLING & IN SITU TESTING

A auger sample PL point load strength I_{PL} (MPa)
B bulk sample S standard penetration test
C core drilling Ux x mm dia. tube



D.J. Douglas & Partners

DATE 26-27, 5, 92

AZIMUTH 128⁰ GRID

D.J. Douglas & Partners

TEST BORE REPORT

DATE 27.5.92

CLIENT WASTE RECYCLING & PROCESSING SERVICE

PROJECT No 14780

BORE No 7

PROJECT PROPOSED EXTENSION

SURFACE LEVEL 137.39AHD

SHEET 5 OF 7

LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

DIP OF HOLE 45°

AZIMUTH 128° GRID

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength	Fracture Spacing (m)	Sampling & In Situ Testing			
				B - Bedding S - Shear	J - Joint D - Drill Break			Sample Type	Core Rec. %	RQD %	Test Results & Comments
41.0	SANDSTONE - high strength slightly fractured light grey fine to medium grained sandstone with some fractured layers			J 15-20° irregular							
42.0				41.00 - 43.85m several subhorizontal breaks in core spacing typically 100 - 500mm most likely drill breaks but some are possible J's			C	100	95	41.5	
43.0	SANDSTONE - high strength slightly fractured light grey fine to medium grained sandstone with some unbroken layers			very low to low strength interbedded siltstone layer							44.0
44.0				B 20°-40° undulating clay coated J 75° cased J 10°-20° irregular			C	100	100	44.5	
45.0			44.00 - 68.00m the core contains some subhorizontal breaks spacing typically 200 - 2000mm most are drill breaks but some could be joints B partings where noted may have opened during drilling							47.5	
46.0			J 40° planar to undulating J 0°-5° J 0°-5° B's 45° planar clay coated			C	100	97			

RIG Scout

DRILLER Cooper

LOGGED Murray

CASING

TYPE OF BORING Roller bit GL to 3.00m

WATER OBSERVATIONS Obscured by drilling methods

REMARKS

SAMPLING & IN SITU TESTING

- A - auger sample
- B - bulk sample
- C - core drilling
- PL - point load strength (JIS/MPa)
- S - standard penetration test
- Us - x mm dia. tube



D.J. Douglas & Partners

TEST BORE REPORT

DATE 27.5.92

CLIENT WASTE RECYCLING & PROCESSING SERVICE

PROJECT No 14780

BORE No 7

PROJECT PROPOSED EXTENSION

SURFACE LEVEL 137.39AHD

SHEET 6 OF 7

LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

DIP OF HOLE 45°

AZIMUTH 128° GRID

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength		Fracture Spacing (m)	Sampling & In Situ Testing			
				B - Bedding S - Shear	J - Joint D - Drill Break	UC Low	UC Med		Sample Type	Core Rec. %	RQD %	Test Results & Comments
51.0	SANDSTONE - high strength slightly fractured light grey fine to medium grained sandstone with some unbroken layers above 53.5m			see description for 44.00 - 68.00m								50.5
52.0				B's 2 at 50° planar clay coated probably opened during drilling					C	100	100	
53.0				B's 2 at 45-50°								53.6
54.0				J 0-10° irregular 15mm-silty clay infill					C	100		
55.0				B 50° clay coated J 80° irregular							95	55.65
56.0				B 45° planar clay coated					C	100		56.5
57.0				J 30°								
58.0				B 45° planar clay coated					C	100	98	
59.0				B 50° planar clay coated								59.5

RIG Scout

DRILLER

Cooper

LOGGED

Murray

CASING

TYPE OF BORING Roller bit GL to 3.00m

WATER OBSERVATIONS Obscured by drilling methods

REMARKS

SAMPLING & IN SITU TESTING

A - auger sample PL - point load strength I_{50} (MPa)
B - bulk sample S - standard penetration test
C - core drilling Ux - 2 mm dia. tube



D.J. Douglas & Partners

TEST BORE REPORT

DATE 27.5.92

CLIENT WASTE RECYCLING & PROCESSING SERVICE
PROJECT PROPOSED EXTENSION
LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

PROJECT No 14780
SURFACE LEVEL 137.39AHD
DIP OF HOLE 45°

BORE No 7
SHEET 7 OF 7
AZIMUTH 128° GRID

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength		Fracture Spacing (m)	Sampling & In Situ Testing				
				B - Bedding S - Shear	J - Joint D - Drill Break	PL MPa	UC mm		Sample Type	Core Rec. %	POD %	Test Results & Comments	
61.0	SANDSTONE - high strength slightly fractured light grey fine to medium grained sandstone		see description for 44.00 - 68.00m B 2 at 45° planar clay coated J 10° irregular J 45°-85° stepped							C	100	98	
62.0													
63.0													
64.0													
65.0													
66.0													
67.0													
68.0													
69.0													
70.0													
61.0	-some unbroken layers below 62.95m		J 30° J 10°-15° B 40° J subhorizontal							C	100	98	62.5
62.0													
63.0													
64.0													
65.0													
66.0													
67.0													
68.0													
69.0													
70.0													
61.0			J 0-5° B 40° clay coated							C	100	98	65.5
62.0													
63.0													
64.0													
65.0													
66.0													
67.0													
68.0													
69.0													
70.0													
61.0			B 45° planar										
62.0													
63.0													
64.0													
65.0													
66.0													
67.0													
68.0													
69.0													
70.0													
61.0	BORE DISCONTINUED AT 68.00 METRES												
62.0													
63.0													
64.0													
65.0													
66.0													
67.0													
68.0													
69.0													
70.0													

RIG Scout DRILLER Cooper LOGGED Murray CASING
TYPE OF BORING Roller bit GL to 3.00m
WATER OBSERVATIONS Obscured by drilling methods
REMARKS

SAMPLING & IN SITU TESTING

A auger sample PL point load strength f_{PL} (MPa)
B bulk sample S standard penetration test
C core drilling UC x mm dia. tube



D.J. Douglas & Partners

TEST BORE REPORT

DATE 25-27.5.92

CLIENT WASTE RECYCLING & PROCESSING SERVICE
PROJECT PROPOSED EXTENSION
LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

PROJECT No 14780
SURFACE LEVEL 166.06AMD
DIP OF HOLE 90°

BORE No 8
SHEET 1 OF 5
AZIMUTH

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength		Fracture Spacing (m)	Sampling & In Situ Testing				
				B - Bedding S - Shear	J - Joint D - Drill Break	Ex. Low Unconsolidated	Ex. High Consolidated		Sample Type	Core Rec. %	RQD %	Test Results & Comments	
	SANDY CLAY - stiff brown sandy clay												
1.00													
	LAMINITE - very low strength fractured grey and light grey clayey laminite			Core loss 0.22m *50mm red brown iron- stone					C	0	0		1.00
1.55				B, 0°									
	SANDSTONE - medium to high strength fractured to slightly fractured light grey and yellow brown fine to medium grained sandstone *red brown ironstaining along some bedding planes			B, 0° ironstained					C	100	78		
2				B, 0-5° ironstained									
3													
3.45				XB, 15° micaceous									3.45
	SANDSTONE - high strength, slightly fractured to un- broken light grey medium grained sandstone			B, 0-5°, ironstained carbonaceous stringers 0-10°					C	100	66		3.90
4													
5	5.735-6.00m fine grained								C	100	100		
6				Occasional drilling induced breaks along bedding and cross bedding									5.90
				B, 0°									
7	*7.00-7.55: numerous shaley and carbonaceous stringers 10-20°			XB, 15°					C	100	93		
	*coarse grained below 7.55m												
8													
9				B, 5° B, 0° B, 0°					C	100	100		8.9
10													

RIG B40

DRILLER B Lamb

LOGGED R Lloyd

CASING NW to 4.5m

TYPE OF BORING Solid flight auger to 1.0 m then NQ coring to 50.95 m

WATER OBSERVATIONS Obscured by drilling method

REMARKS

SAMPLING & IN SITU TESTING

- A - auger sample
- B - bulk sample
- C - core drilling
- PL - point load strength f_{p50} (MPa)
- S - standard penetration test
- Ux - x mm dia. tube



D.J. Douglas & Partners

TEST BORE REPORT

DATE 25-27.5.92

CLIENT WASTE RECYCLING & PROCESSING SERVICE
PROJECT PROPOSED EXTENSION
LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

PROJECT No 14780
SURFACE LEVEL 166.06AHD
DIP OF HOLE 90°

BORE No 8
SHEET 2 of 5
AZIMUTH

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength		Fracture Spacing (m)	Sampling & In Situ Testing			
				B - Bedding S - Shear	J - Joint D - Drill Break	Unconf. Comp. UC	Unconf. Tens. UT		Sample Type	Core Rec. %	RQD %	Test Results & Comments
10.75	SANDSTONE - high strength slightly fractured to unbroken light grey coarse grained sandstone			B, 5°								
11.0	SANDSTONE - high strength fractured to slightly fractured grey medium grained sandstone with occasional silty laminations			B, 5° silty					C	100	100	
12.0				B, 5° silty								11.95
13.0				B, 5° silty								
14.0				B, 5° silty								
	*14.65 - 14.80m yellow brown											
14.80				B, 0° low strength								14.95
15.0	SANDSTONE - high strength slightly fractured light grey coarse grained			B, 5°					C	100	100	
16.0				B, 10°								
17.0	*becoming light yellow red brown and light grey from 16.60 - 18.25m											
18.0				5mm sandy clay								17.95
19.0	*18.65m 10mm pebbly seam 18.75 - 18.95m pebbly seam 18.95 - 19.00m pebbly seam 19.00 - 19.05m pebbly seam			B, 5° fe stained					C	100	100	
				B, 5° silty								
				2mm sandy clay								
				x8 20° silty								
				3mm sandy clay								
				x8, 20° silty								
				x8, 40° silty								
				x8, 30° silty								

RIG B40 DRILLER B Lamb LOGGED R Lloyd CASING NW to 4.5m

TYPE OF BORING Solid flight auger to 1.0m then NQ coring to 50.95m

WATER OBSERVATIONS obscured by drilling method

REMARKS

SAMPLING & IN SITU TESTING

A - auger sample PL - point load strength (f_{PL}) (MPa)
B - bulk sample S - standard penetration test
C - core drilling Th - vane shear test



D.J. Douglas & Partners

TEST BORE REPORT

DATE 25-27.5.92

CLIENT WASTE RECYCLING & PROCESSING SERVICE

PROJECT No 14780

BORE No 8

PROJECT PROPOSED EXTENSION

SURFACE LEVEL 166.06AHD

SHEET 3 OF 5

LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

DIP OF HOLE 90°

AZIMUTH

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength	Fracture Spacing (m)	Sampling & In Situ Testing			
				B - Bedding S - Shear	J - Joint D - Drill Break			Sample Type	Core Rec. %	ROD %	Test Results & Comments
21.0	SANDSTONE - high strength slightly fractured light grey coarse grained sandstone		xR 15° silty xR 30° silty x 5° silty xR 5° silty					C	100	66	
21.60			xR 5° carbonaceous								20.95
22.0	SHALE - low to medium strength fractured to slightly fractured dark shale		numerous drilling induced breaks J x 2 30° clayey					C	100	99	
22.15	LAMINITE - medium strength slightly fractured dark grey laminita										
22.90	22.90 - 100mm fine grained sandstone										
23.0											
24.0	SANDSTONE - high strength slightly fractured grey medium and coarse grained sandstone with carbonaceous and silty laminations		xR 5° carbonaceous xR 10°								23.95
25.0			xR 10° carbonaceous					C	100	98	
26.0			xR 0° clayey								
27.0			xR 5° carbonaceous								26.95
28.0	*coarse grained below 27.60m		xR 5° silty xR 5° xR 15° silty					C	100	97	
29.0			xR 15° silty xR 15° silty								29.95

RIG B40

DRILLER B Lamb

LOGGED R Lloyd

CASING NM to 4.5m

TYPE OF BORING Solid flight auger to 1.0m then NQ coring to 50.95m

WATER OBSERVATIONS Obscured by drilling method

REMARKS

SAMPLING & IN SITU TESTING

A auger sample PL point load strength I_{p50} (MPa)
B bulk sample S standard penetration test
P pore pressure TPa - max slip torque



D.J. Douglas & Partners

DATE 25-27.5.92

AZIMUTH

D.J. Douglas & Partners

TEST BORE REPORT

DATE 25-27.5.92

CLIENT WASTE RECYCLING & PROCESSING SERVICE
PROJECT PROPOSED EXTENSION
LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

PROJECT No 14780
SURFACE LEVEL 166.06AHD
DIP OF HOLE 90°

BORE No '8
SHEET 5 OF 5
AZIMUTH

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength		Fracture Spacing (m)	Sampling & In Situ Testing			
				B - Bedding S - Shear	J - Joint D - Drill Break	UC MPa	LC MPa		Sample Type	Core Rec. %	RCD %	Test Results & Comments
41.0	SANDSTONE - high strength slightly fractured to unbroken light grey coarse grained sandstone											
41.95									C	100	99	
42.0												
43.0												
44.0												
44.95									C	100	100	
45.0												
45.25	SHALE INTRACLAST - high strength dark grey shale intraclast, pebbly conglomerate in parts											
46.0	SANDSTONE - high strength slightly fractured to unbroken grey coarse grained sandstone											
47.0	*46.70m 50mm fine grained											
47.95	*medium grained with discontinuous carbonaceous or micaceous stringers below 47.05m											
48.0												
49.0												
	BORE DISCONTINUED AT 50.95 M											

RIG B40 DRILLER B Lamb LOGGED R Lloyd CASING NM to 4.5m

TYPE OF BORING Solid flight auger to 1.0m then NQ coring to 50.95m

WATER OBSERVATIONS Obscured by drilling method

REMARKS

SAMPLING & IN SITU TESTING

A auger sample PL point load strength f_{PL} (MPa)
B bulk sample S standard penetration test
C core drilling Ux x mm dia. tube



D.J. Douglas & Partners

TEST BORE REPORT

DATE 27/28.5.92

CLIENT WASTE RECYCLING & PROCESSING SERVICE

PROJECT No 14780

BORE No 9

PROJECT PROPOSED EXTENSION

SURFACE LEVEL 155.64M

SHEET 1 OF 6

LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

DIP OF HOLE 90°

AZIMUTH

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength		Fracture Spacing (m)		Sampling & In Situ Testing			
				B - Bedding S - Shear	J - Joint D - Drill Break	Ext. Low Very Low Low Medium High Very High Ext. High	Ext. Low Very Low Low Medium High Very High Ext. High	1.00 0.50 0.25 0.10 0.05	0.01	Sample Type	Core Rec. %	RCD %	Test Results & Comments
0.10	SAND AND GRAVEL - brown and red brown sand & gravel												
1.0	SANDSTONE - very low to low strength brown and purple brown fine grained sandstone												
1.50													
2.0	SANDSTONE - low to medium strength fractured to slightly fractured light grey brown and purple brown fine grained sandstone with some very low strength layers												
2.7													
3.0													
4.0	*4.0 - 4.3m very low strength siltstone interbed												
4.3													
5.0													
5.60	SANDSTONE - high strength slightly fractured light grey to grey fine to medium grained sandstone												
5.7													
6.0													
7.0													
8.0													
8.7													
9.0													

RIG B40

DRILLER Lamb

LOGGED Murray

CASING NW 0.9 - 4.2m

TYPE OF BORING Solid flight auger GL to 2.7m then NQ coring to 52.00m

WATER OBSERVATIONS Obscured by drilling methods

REMARKS

SAMPLING & IN SITU TESTING

A auger sample PL point load strength (J50)(MPa)
B bulk sample S standard penetration test
C core drilling Ux x mm dia. tube



D.J. Douglas & Partners

TEST BORE REPORT

DATE 28.5.92

CLIENT WASTE RECYCLING & PROCESSING SERVICE

PROJECT No 14780

BORE No 9

PROJECT PROPOSED EXTENSION

SURFACE LEVEL 155.64AHD

SHEET 2 OF 6

LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

DIP OF HOLE 90°

AZIMUTH

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength		Fracture Spacing (m)		Sampling & In Situ Testing			
				B - Bedding S - Shear	J - Joint D - Drill Break	Unconf. Comp. Strength	Unconf. Tensile Strength	1.00 0.50 0.10 0.05 0.01	0.01	Sample Type	Core Rec. %	RQD %	Test Results & Comments
11.0	SANDSTONE - high strength slightly fractured light grey to grey fine to medium grained sandstone									C	100	99	
12.0													11.70
12.75										C	100	93	
13.0	SANDSTONE - high strength fractured to slightly fractured light grey and brown fine to medium grained sandstone												
14.0													14.70
15.0										C	100	98	
16.0													
17.0	*very low to low strength siltstone and shale interbed									C	40		16.80 16.95
17.75	*16.65 - 17.12m grades to silty sandstone 17.12 - 17.27m									C	100	100	
18.0	LAMINITE - medium to high strength slightly fractured interbedded dark grey shale and light grey fine grained sandstone												18.05
19.0										C	100	100	
19.20													
	SANDSTONE - see over												

RIG B40

DRILLER

Lamb / Cooper

LOGGED

Murray

CASING

TYPE OF BORING Solid flight auger GL to 2.7m then NQ coring to 52.00m

WATER OBSERVATIONS Obscured by drilling methods

REMARKS

SAMPLING & IN SITU TESTING

A auger sample PL point load strength (I_{PS} (MPa))
B bulk sample S standard penetration test
C core drilling Ux 4 mm dia. tube



D.J. Douglas & Partners

TEST BORE REPORT

DATE 28.5.92

CLIENT WASTE RECYCLING & PROCESSING SERVICE
PROJECT PROPOSED EXTENSION
LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

PROJECT No 14780
SURFACE LEVEL 155.64AHD
DIP OF HOLE 90°

BORE No 9
SHEET 3 OF 6
AZIMUTH

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength			Fracture Spacing (m)	Sampling & In Situ Testing		
				B - Bedding S - Shear	J - Joint D - Drill Break	Unconf. Compressive	Unconf. Tensile	Unconf. Flexure		Sample Type	Core Rec. %	RQD %
21.0	SANDSTONE - high strength slightly fractured light grey fine to medium grained sandstone with some unbroken layers below 22.00m			19.20 - 42.40m unless otherwise specified defects are B partings 0-15° generally along micaceous laminae typically few B partings in massive sandstone layers Most B have probably opened during drilling some B have clay coating						C	100	100
21.20												
22.0										C	100	100
23.0												
24.0				B spacing up to 2000mm below 22.0m								
25.0												
26.0										C	100	100
27.0												
28.0				B 10° 10mm sandy clay infill								
29.0												
				J 40-45° undulating								

RIG 840 DRILLER Cooper LOGGED Murray CASING

TYPE OF BORING Solid flight auger CL to 2.7m then NQ coring to 52.00m

WATER OBSERVATIONS Obscured by drilling methods

REMARKS

SAMPLING & IN SITU TESTING

A auger sample PL point load strength (1/50)MPa
B bulk sample S standard penetration test
C core drilling Ur x mm dia tube



D.J. Douglas & Partners

TEST BORE REPORT

DATE 28.5.92

CLIENT WASTE RECYCLING & PROCESSING SERVICE

PROJECT No 14780

BORE No 9

PROJECT PROPOSED EXTENSION

SURFACE LEVEL 155.64AHD

SHEET 4 of 6

LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

DIP OF HOLE 90°

AZIMUTH

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength		Fracture Spacing (m)	Sampling & In Situ Testing			
				B - Bedding S - Shear	J - Joint D - Drill Break	UC UC1 UC2 UC3 UC4 UC5 UC6 UC7 UC8 UC9 UC10	UC UC1 UC2 UC3 UC4 UC5 UC6 UC7 UC8 UC9 UC10		Sample Type	Core Rec. %	RQD %	Test Results & Comments
31.0	SANDSTONE - high strength slightly fractured to unbroken light grey medium grained sandstone				J 45° closed J's 2 sub parallel at 75-80° closed 1mm clay infill J 75° minor clay coating open							
32.0												
33.0	*minor coarse grained sandstone layers between 33.00-34.50m											
34.0					B 0-5° 1mm sandy clay coating							
35.0					B 0-5° 1mm sandy clay coating							
36.0												
37.0					B 10° planar 1mm clay coating							
38.0												
39.0												

RIG B40

DRILLER

Cooper

LOGGED

Murray

CASING

TYPE OF BORING Solid flight auger GL to 2.7m then NQ coring to 52.00m

WATER OBSERVATIONS Obscured by drilling methods

REMARKS

SAMPLING & IN SITU TESTING

A auger sample PL point load strength (f_{p50}) (MPa)
B bulk sample S standard penetration test
C cone drilling Ur 2 mm dia. tube



D.J. Douglas & Partners

TEST BORE REPORT

DATE 29.5.92

CLIENT WASTE RECYCLING & PROCESSING SERVICE

PROJECT No 14780

BORE No 9

PROJECT PROPOSED EXTENSION

SURFACE LEVEL 155.64AHD

SHEET 6 OF 6

LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

DIP OF HOLE 90°

AZIMUTH

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength		Fracture Spacing (m)	Sampling & In Situ Testing			
				B - Bedding S - Shear	J - Joint D - Drill Break	PL MPa	UC MPa		Sample Type	Core Rec. %	RQD %	Test Results & Comments
	LAMINITE - as above			see above description for 42.40-51.71m								
51.0				B 0-5° in sandstone interbed clay coated								51.00
51.71	SANDSTONE - high strength slightly fractured light grey medium grained sandstone			J 45° planar clay coated B 15° 10mm clay infill B 0-5° sandstone contact					C	100	90	
52.0	BORE DISCONTINUED AT 52.00 METRES											
53.0												
54.0												
55.0												
56.0												
57.0												
58.0												
59.0												

RIG

B40

DRILLER

Cooper

LOGGED

Murray

CASING

TYPE OF BORING Solid flight auger GL to 2.7m then NQ coring to 52.00m

WATER OBSERVATIONS Obscured by drilling methods

REMARKS

SAMPLING & IN SITU TESTING

- | | |
|-----------------|--|
| A auger sample | PL point load strength (I_{p50}) (MPa) |
| B bulk sample | S standard penetration test |
| C core drilling | UC x mm dia. tube |



D.J. Douglas & Partners

TEST BORE REPORT

DATE 29.5.92

CLIENT WASTE RECYCLING & PROCESSING SERVICE

PROJECT No 14780

BORE No 10

PROJECT PROPOSED EXTENSION

SURFACE LEVEL 120.58AHD

SHEET 1 OF 1

LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

DIP OF HOLE 90°

AZIMUTH

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength		Fracture Spacing (m)	Sampling & In Situ Testing				Test Results & Comments
				B - Bedding S - Shear	J - Joint D - Drill Break	Unconf. Comp. Strength	Unconf. Tensile Strength		Sample Type	Core Rec. %	RCO %		
0.10	FILLING - ripped sandstone and sand filling												
1.00	SANDSTONE - low to medium strength grey, brown and purple brown fine to medium grained sandstone Auger refusal at 1.00m				J 65° planar J 60° closed 1.00 - 10.00m unless otherwise specified defects are B partings 0-20° generally planar - many possible sub- horizontal J's								1.00
2.0	SANDSTONE - medium to high strength fractured to slightly fractured light grey, fine to medium grained sandstone with some low strength layers								C	93	70		
3.0													
4.0													
5.0					J 0-5° irregular								
6.0													
7.0													
8.0													
9.0													
10.00	BORE DISCONTINUED AT 10.00 M												

RIG B40

DRILLER Cooper

LOGGED Murray

CASING NW to 1.00m

TYPE OF BORING Solid flight auger GL to 1.0m then NQ coring to 10.00m

WATER OBSERVATIONS Obscured by drilling methods

REMARKS Water level at 1.00m after 1½ hrs - hole blocked off at 8.60m possibly by core left down in hole or jammed.

SAMPLING & IN SITU TESTING

- A auger sample
- B bulk sample
- C core drilling
- PL point load strength (f_{PL}) (MPa)
- S standard penetration test
- Ux x mm dia. tube



D.J. Douglas & Partners

TEST BORE REPORT

DATE 30.5.92

CLIENT WASTE RECYCLING & PROCESSING SERVICE
PROJECT PROPOSED EXTENSION
LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

PROJECT No 14780
SURFACE LEVEL 119.30AHD
DIP OF HOLE 90°

BORE No 11
SHEET 1 OF 3
AZIMUTH

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength		Fracture Spacing (m)	Sampling & In Situ Testing		
				B - Bedding S - Shear	J - Joint D - Drill Break	Very Low Low Medium High Very High	Very Low Low Medium High Very High		Sample Type	Core Rec. %	Test Results & Comments
0.80	SANDSTONE - medium to high strength fractured to slightly fractured light grey, brown and purple brown fine to medium grained sandstone										
1.0											
2.0											
3.0											
4.0	SANDSTONE - low to medium strength fractured light grey and brown medium to coarse grained sandstone with some very low strength layers										
4.65											
5.0											
6.0											
7.0	SANDSTONE - high strength, slightly fractured light grey fine to medium grained sandstone with some unbroken layers										
8.0											
8.28											
9.0											

RIG B40

DRILLER

Cooper

LOGGED

Murray

CASING

TYPE OF BORING Solid flight auger GL to 0.8m then NQ coring

WATER OBSERVATIONS Obscured by drilling methods

REMARKS Complete loss of water return at 18.5m. Water level at 7.1m after 1 hour.

SAMPLING & IN SITU TESTING

A auger sample PL point load strength f_{pL} (MPa)
B bulk sample S standard penetration test
C core drilling Ux x mm dia. tube



D.J. Douglas & Partners

TEST BORE REPORT

DATE 30.5/1.6.92

CLIENT WASTE RECYCLING & PROCESSING SERVICE

PROJECT No 14780

BORE No 11

PROJECT PROPOSED EXTENSION

SURFACE LEVEL 119.30AHD

SHEET 2 OF 3

LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

DIP OF HOLE 90°

AZIMUTH

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength		Fracture Spacing (m)	Sampling & In Situ Testing			
				B - Bedding S - Shear	J - Joint O - Drill Break	UCP UCS	UCP UCS		Sample Type	Core Rec. %	RCD %	Test Results & Comments
11.0	SANDSTONE - high strength, slightly fractured light grey fine to medium grained sandstone with minor fractured layers			8.28-19.25m unless otherwise specified defects are B partings 0-5° spacing typically 300-1500mm some of which are clay coated					C	100	100	
12.0				B's sub horizontal both with 10mm sandy clay infill								12.00
13.0				Many B partings have possibly opened during drilling					C	97	99	
14.0												
15.0				3mm sandy clay seam								15.00
16.0				J 60° J 45°								
17.0				J 40° B 5° 3mm sandy clay infill J 30° B 0-5° 3mm sandy clay infill					C	93	85	
18.0												18.00
19.0									C	92	85	
19.25				19.25-21.00m unless specified defects are B partings typically 0-10° undulating along coaly laminae 20mm clay seam								
	SANDSTONE - high strength fractured to slightly fractured light grey fine to medium grained sandstone											

RIG B40

DRILLER Cooper

LOGGED Murray

CASING NN to 1.00m

TYPE OF BORING Solid flight auger GL to 0.8m then NQ coring

WATER OBSERVATIONS Obscured by drilling methods

REMARKS Complete loss of water return at 18.5m. Water level at 7.1m after 1 hour.

SAMPLING & IN SITU TESTING

- A auger sample PL point load strength I_p (MPa)
 B bulk sample S standard penetration test
 C core drilling Ux x mm dia. tube



D.J. Douglas & Partners

TEST BORE REPORT

DATE 1.6.92

CLIENT WASTE RECYCLING & PROCESSING SERVICE

PROJECT No 14780

BORE No 11

PROJECT PROPOSED EXTENSION

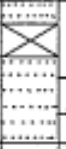
SURFACE LEVEL 119.30AHD

SHEET 3 of 3

LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

DIP OF HOLE 90°

AZIMUTH

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength	Fracture Spacing (m)	Sampling & In Situ Testing			
				B - Bedding S - Shear	J - Joint D - Drill Break			Sample Type	Core Rec. %	RQD %	Test Results & Comments
21.0	SANDSTONE - high strength fractured to slightly fractured light grey fine to medium grained sandstone						CORE LOSS 250mm				
	BORE DISCONTINUED AT 21.00 METRES										
22.0											
23.0											
24.0											
25.0											
26.0											
27.0											
28.0											
29.0											

RIG B40

DRILLER Cooper

LOGGED Murray

CASING

TYPE OF BORING Solid flight auger GL to 0.8m then NQ coring

WATER OBSERVATIONS Obscured by drilling methods

REMARKS Complete loss of water return at 18.5m. Water level at 7.1m after 1 hour.

SAMPLING & IN SITU TESTING

A auger sample PL point load strength f_{PL} (MPa)
B bulk sample S standard penetration test
C core drilling U 19 mm dia tube



D.J. Douglas & Partners

TEST BORE REPORT

DATE 1/2.6.92

CLIENT WASTE RECYCLING & PROCESSING SERVICE

PROJECT No 14780

BORE No 12

PROJECT PROPOSED EXTENSION

SURFACE LEVEL 134.62AHD

SHEET 1 OF 3

LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS: CHSIDIP OF HOLE 45°

AZIMUTH 282° GRID

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength	Fracture Spacing (m)	Sampling & In Situ Testing			
				B - Bedding S - Shear	J - Joint D - Drill Break			Sample Type	Core Rec. %	RQD %	Test Results & Comments
1.0	SANDSTONE - low to medium strength fractured to slightly fractured grey brown and purple brown fine to medium grained sandstone with some very low and high strength layers			*core loss possibly due to very low strength sandstone being ground away during drilling		CORE LOSS 550mm		C	63	50	1.75
2.0				J 60° B 60° irregular							
3.0	SANDSTONE - high strength slightly fractured light grey and brown fine to medium grained sandstone			*core loss probably due to high strength ironstone layer catching in drill bit and grinding away low to medium strength sandstone 0.00 - 4.70m The core contains many breaks 0-5° probably due to drilling		CORE LOSS 2750mm		C	8	0	4.75
4.0											
5.0	SANDSTONE - high strength slightly fractured light grey and brown fine to medium grained sandstone			J 25° irregular rough				C	100	95	7.75
6.0				J 20° rough 4.70 - 16.65m unless otherwise specified defects are B partings 20-35° typically planar some with a clay coated							
7.0	*the wire is unbroken from 7.80 - 10.20m			-many may have opened during drilling				C	100	97	
8.0				B 30° San sandy clay seam							
9.0											

RIG 820

DRILLER

Cooper

LOGGED

Murray

CASING

TYPE OF BORING MQ coring GL to 25.75m

WATER OBSERVATIONS Obscured by drilling methods, complete loss of water return at 4.1m prior to casing

REMARKS Bore hole located in shallow excavation, 0.2m below natural surface

SAMPLING & IN SITU TESTING

- A auger sample PL - point load strength $I_{p(50)}$ (MPa)
 B bulk sample S standard penetration test
 C core drilling Ux 2 mm dia. tube



D.J. Douglas & Partners

TEST BORE REPORT

DATE 2.6.92

CLIENT WASTE RECYCLING & PROCESSING SERVICE

PROJECT No 14780

BORE No 12

PROJECT PROPOSED EXTENSION

SURFACE LEVEL 134.62AHD

SHEET 2 OF 3

LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

DIP OF HOLE 45°

AZIMUTH 282° GRID

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength		Fracture Spacing (m)	Sampling & In Situ Testing						
				B - Bedding S - Shear	J - Joint D - Drill Break	UC Low	UC High		Sample Type	Core Rec. %	RQD %	Test Results & Comments			
11.0	SANDSTONE - high strength slightly fractured light grey, brown and purple brown fine to medium grained sandstone with minor fractured layers			B 45° planar 5mm sandy clay infill B 50° planar see general comment for 4.70 - 16.65m								10.55			
12.0				J 45° clay coated								C	100	96	
13.0				B 30° 20mm sandy clay and very low strength sandstone J 60-75° curved ironstained B 25° 5mm sandy clay infill J 70° rough											13.65
14.0				CORE LOSS 100mm											
15.0									C	100	99				
16.0															
17.0				*16.75 - 18.40m defects are B partings 30-45° planar to irregular, ironstained								16.75			
18.0				18.40 - 19.27m defects are predominantly B partings 40-50° generally irregular in pebbly sandstone or along lithology boundary mostly ironstained					C	99	80				
18.40	SANDSTONE, SILTSTONE AND LAMINITE - low to medium strength fractured inter- bedded grey and dark grey siltstone and laminite and light grey fine grained pebbly sandstone with minor highly fractured layers and very low strength layers SANDSTONE - see below			18.50 - 18.55m shattered laminite possibly in part due to drilling *minor pebble shaped voids to 15mm diameter *subvertical irregular J from 18.85 - 18.90m irregular								19.35			
19.0															45
19.25															19.75
												C	100		

RIG B20

DRILLER Cooper

LOGGED Murray

CASING

TYPE OF BORING NQ coring GL to 25.75AHD

WATER OBSERVATIONS Obscured by drilling methods, complete loss of water return at 4.1m prior to casing

REMARKS Bore hole located in shallow excavation 0.2m below natural surface

SAMPLING & IN SITU TESTING

- A. auger sample
- B. bulk sample
- C. core drilled
- P. point load strength (100MPa)
- S. standard penetration test
- U. 1 mm dia tube



D.J. Douglas & Partners

TEST BORE REPORT

DATE 2/3.6.92

CLIENT WASTE RECYCLING & PROCESSING SERVICE

PROJECT No 14780

BORE No 12

PROJECT PROPOSED EXTENSION

SURFACE LEVEL 134.62AHD

SHEET 3 OF 3

LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

DIP OF HOLE 45°

AZIMUTH 282° GRID

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength		Fracture Spacing (m)	Sampling & In Situ Testing				
				B - Bedding S - Shear	J - Joint D - Drill Break	Unconsolidated Very Low	Consolidated Low		Sample Type	Core Rec. %	RQD %	Test Results & Comments	
21.0	SANDSTONE - high strength slightly fractured light grey and brown fine to medium grained sandstone with some medium strength and minor low strength layers above 20.50m			19.27m unless otherwise specified defects are generally 8- partings 35-55° planar clay coated many of which have opened during drilling B 40° undulating 10mm coaly interbed			C	100	99				
22.0													
23.0				B 35° 10mm sandy clay infill							22.75		
24.0				J 60° slight iron- staining							C	100	94
25.0				J sub horizontal rough									
25.75											26.75		
26.0	BORE DISCONTINUED AT 25.75 METRES												
27.0													
28.0													
29.0													

RIG B20

DRILLER

Cooper

LOGGED

Murray

CASING

TYPE OF BORING NQ coring GL to 25.75m

WATER OBSERVATIONS Obscured by drilling methods, complete loss of water return at 4.1m prior to casing

REMARKS Bore hole located in shallow excavation 0.2m below natural surface

SAMPLING & IN SITU TESTING

- A - auger sample
- B - bulk sample
- C - core drilling
- PL - point load strength (f_{50}) (MPa)
- S - standard penetration test
- U_s - u mm dia tube



D.J. Douglas & Partners

TEST BORE REPORT

DATE 4.6.92

CLIENT WASTE RECYCLING & PROCESSING SERVICE

PROJECT No 14780

BORE No '13'

PROJECT PROPOSED EXTENSION

SURFACE LEVEL 143.92AHD

SHEET 1 OF 5

LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

DIP OF HOLE 45°

AZIMUTH 231° GRID

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength		Fracture Spacing (m)	Sampling & In Situ Testing			
				B - Bedding S - Shear	J - Joint D - Drill Break	UC UC1 UC2 UC3 UC4 UC5 UC6 UC7 UC8 UC9 UC10	UC UC1 UC2 UC3 UC4 UC5 UC6 UC7 UC8 UC9 UC10		Sample Type	Core Rec. %	RQD %	Test Results & Comments
1.0	SANDSTONE - high strength fractured to slightly fractured light grey brown and red brown fine to medium grained sandstone			0.45 - 6.75m unless otherwise specified defects are B partings 15-20° generally planar clay coated		CORE LOSS 450mm			C	55	60	1.00
									C	100		1.40
2.0									C	100	90	
3.0	SANDSTONE - high strength slightly fractured light grey medium grained sandstone			J 75° planar to undulating -10mm clay seam at 10° B 45° 5mm sandy clay infill								3.44
3.15				J 60° closed								
4.0				J 20° undulating 3mm sandy clay infill J 60° closed					C	100		
5.0	SANDSTONE - low strength slightly fractured light grey fine grained sandstone with some very low strength layers			J 80°								5.97
6.0												
6.75				6.75 - 11.00m defects are typically B partings 20-30° along micaceous laminae spacing 30-500mm most are due to drilling as B are easily parted during handling		CORE LOSS 350mm			C	88	99	8.97
7.0												
8.0												
9.0												

RIG B20 DRILLER Cooper LOGGED Murray CASING

TYPE OF BORING Roller bit GL to MQ coring to 1.0m, NMLC coring to

WATER OBSERVATIONS Obscured by drilling methods. Complete loss of water return at 11.77m

REMARKS

SAMPLING & IN SITU TESTING

A - sugar sample PL - point load strength $\sqrt{50}$ (MPa)
B - bulk sample S - standard penetration test
C - core drilling Ux - x mm dia. tube



D.J. Douglas & Partners

TEST BORE REPORT

DATE 4/5.6.92

CLIENT WASTE RECYCLING & PROCESSING SERVICE
PROJECT PROPOSED EXTENSION
LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

PROJECT No 14780
SURFACE LEVEL 143.92AHD
DIP OF HOLE 45°

BORE No 13
SHEET 2 OF 5
AZIMUTH

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength	Fracture Spacing (m)	Sampling & In Situ Testing			
				B - Bedding S - Shear	J - Joint D - Drill Break			Sample Type	Core Rec. %	RQD %	Test Results & Comments
11	SANDSTONE - low strength slightly fractured light grey fine grained sandstone with some very low strength layers							C	100	99	
12								C	56		11.77
13	SANDSTONE - high strength slightly fractured light grey and purple brown medium grained sandstone							C	100	80	12.90
14											
15								C	100	95	14.77
16								C	100		16.27
17	SANDSTONE - high strength light grey brown and red brown fine to medium grained sandstone -most likely slightly fractured							C	100	*	16.70
18								C	87		18.05
19	*coarse grained purple brown sandstone 19.05 - 20.15m							C	100		19.90

RIG Scout DRILLER Cooper LOGGED Murray CASING to 1.0m

TYPE OF BORING NQ coring GL to 1.0m NMEC to 16.27m then NQ coring to

WATER OBSERVATIONS Obscured by drilling methods - loss of water return at 11.77m

REMARKS Bore passes approx. 4-5m below edge of filling at 19.50m

SAMPLING & IN SITU TESTING

A - auger sample PL - point load strength I_{PS} (MPa)
B - bulk sample S - standard penetration test
C - core drilling Ur - 4 mm dia. tube



D.J. Douglas & Partners

TEST BORE REPORT

DATE 6/9.6.92

CLIENT WASTE RECYCLING & PROCESSING SERVICE

PROJECT No 14780

BORE No 13

PROJECT PROPOSED EXTENSION

SURFACE LEVEL 143.92AHD

SHEET 3 OF 5

LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

DIP OF HOLE 45°

AZIMUTH

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities B - Bedding J - Joint S - Shear D - Drill Break	Rock Strength	Fracture Spacing (m)	Sampling & In Situ Testing			
							Sample Type	Core Rec. %	RQD %	Test Results & Comments
21	SANDSTONE - medium to high strength light grey fine grained sandstone with some low strength siltstone interbeds - most likely slightly fractured *coarse grained purple brown sandstone 19.05 - 20.15m			*core losses due to vibration of core splits in barrel Driller records medium to high strength sandstone with siltstone or laminitic interbeds from cuttings returned - fracturing unknown	CORE LOSS 1500mm		C	86	#	20.65
22							C	0	#	
23										22.90
23.55	SANDSTONE - high strength slightly fractured light grey fine grained sandstone with some possible fractured layers generally medium to coarse grained below 28.0m			20.65 - 30.5m Most of the core is broken into lengths 30-60mm due to drilling. Some lengths are undersized due to tumbling in splits only defects appear to be B partings typically 20-30° planar spacing 300-500mm some clay coated Possible B spacing up to 1000mm	CORE LOSS 2900mm		C	78	#	
24										25.90
25										
26										
27							C	100	#	
28										28.90
29							C	100	#	

RIG Scout

DRILLER Cooper/Bannister

LOGGED

Murray

CASING

TYPE OF BORING NQ coring GL to 1.0m, NMLC to 16.27m then NQ coring to

WATER OBSERVATIONS Obscured by drilling methods - 60% loss of water return at 11.77m

REMARKS # indicates possibly greater than 90% prior to drilling

SAMPLING & IN SITU TESTING

A - auger sample	PL - point load strength I_{p50} (MPa)
B - bulk sample	S - standard penetration test
C - core drilling	Ur - x mm dia. tube



D.J. Douglas & Partners

TEST BORE REPORT

DATE 9/10.6.92

CLIENT WASTE RECYCLING & PROCESSING SERVICE
PROJECT PROPOSED EXTENSION
LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

PROJECT No 14780
SURFACE LEVEL 143.92AHD
DIP OF HOLE 45°

BORE No 13
SHEET 4 OF 5
AZIMUTH

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength		Fracture Spacing (m)	Sampling & In Situ Testing				Test Results & Comments
				B - Bedding S - Shear	J - Joint D - Drill Break	UC MPa	UC kN/m²		Sample Type	Core Rec. %	RQD %		
30.40	SANDSTONE - as above												
31.0	SANDSTONE - high strength slightly fractured light grey medium to coarse grained sandstone with some very low to low strength siltstone interbeds		J 30° J 45° 30.50 - 40.00m						C	100	#		30.50 31.40
32.0	SANDSTONE - high strength slightly fractured light grey fine to medium grained sandstone		unless otherwise specified defects are generally B 10-25° planar some are clay coated -many may have opened due to drilling J 40°						C	100	97		
34.0													34.40
35.0			J 60°						C	100	95		
37.0			J's 2 parallel at 60° B 25° 10mm sandy clay infill						C	100			37.40
38.0			J's 3 conjugate set at 45°, 45° and 60°						C		95		
39.0			B 40° 5mm clay infill										

RIG Scout DRILLER Cooper/Bannister LOGGED Murray CASING

TYPE OF BORING NQ coring GL to 1.0m, NMLC to 16.27m then NQ coring to

WATER OBSERVATIONS Obscured by drilling methods - loss of water return at 11.77m

REMARKS # Indicates possibly greater than 90% prior to drilling

SAMPLING & IN SITU TESTING

A: auger sample PL: point load strength $1_{(50)}$ (MPa)
B: bulk sample S: standard penetration test
C: core drilling U: x mm dia tube



D.J. Douglas & Partners

TEST BORE REPORT

DATE 10.6.92

CLIENT WASTE RECYCLING & PROCESSING SERVICE

PROJECT No 14780

BORE No 13

PROJECT PROPOSED EXTENSION

SURFACE LEVEL

SHEET 5 OF 5

LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

DIP OF HOLE 45°

AZIMUTH

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength		Fracture Spacing (m)	Sampling & In Situ Testing					
				B - Bedding S - Shear	J - Joint D - Drill Break	UC - Low UC - Low UC - Medium UC - High UC - Very High	UC - Low UC - Low UC - Medium UC - High UC - Very High		Sample Type	Core Rec. %	RQD %	Test Results & Comments		
	SANDSTONE - high strength slightly fractured light grey fine to medium grained sandstone with some unbroken layers												40.70	
41.0														
42.0										C	100	100		
43.0														
44.0													43.70	
45.0										C	100			
46.0												100	45.35	
46.7										C	100			
BORE DISCONTINUED AT 46.70M														

RIG 820

DRILLER

Bannister

LOGGED

Murray

CASING

TYPE OF BORING NQ coring GL to 1.0m, NMLC to 16.27m then NQ coring to 46.7m

WATER OBSERVATIONS Obscured by drilling methods - loss of water return at 11.77m

REMARKS # indicates possibly greater than 90% prior to drilling

SAMPLING & IN SITU TESTING

A - auger sample PL - point load strength (1/50)MPa
B - bulk sample S - standard penetration test
C - cone resistance



D.J. Douglas & Partners

TEST BORE REPORT

DATE 9/10.6.92

CLIENT WASTE RECYCLING & PROCESSING SERVICE
PROJECT PROPOSED EXTENSION
LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

PROJECT No 14780
SURFACE LEVEL
DIP OF HOLE 90°

BORE No 14
SHEET 1 of 1
AZIMUTH

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength		Fracture Spacing (m)	Sampling & In Situ Testing			
				B - Bedding S - Shear	J - Joint D - Drill Break	Very Low Low Medium High Very High	Very Low Low Medium High Very High		Sample Type	Core Rec. %	RQD %	Test Results & Comments
0.20	SAND - grey fine to medium grained sand											0.20
1.0	SANDSTONE - high strength fractured to slightly fractured light grey and brown fine to medium grained sandstone											
1.92												
2.0	SILTSTONE - very low strength slightly fractured dark grey siltstone											
2.45												2.45
3.0	SANDSTONE - high strength slightly fractured light grey fine to medium grained sandstone											
4.0												
5.0												
6.0												
7.0												
8.0												
9.0	SILTSTONE - very low strength dark grey siltstone											9.00
	SANDSTONE - as above											
	BORE DISCONTINUED AT 11.00 METRES											

RIG Scout DRILLER Cooper LOGGED Murray CASING NW to 2.4m

TYPE OF BORING Solid flight auger GL to 0.2m NMLC coring to 6.00m then NQ coring to 11.00m

WATER OBSERVATIONS Obscured by drilling methods

REMARKS

SAMPLING & IN SITU TESTING

A - auger sample PL - point load strength $\frac{1}{2}$ (MPa)
B - bulk sample S - standard penetration test
C - cone drilling (p - max r/b tube)



D.J. Douglas & Partners

TEST BORE REPORT

DATE 10.6.92

CLIENT WASTE RECYCLING & PROCESSING SERVICE

PROJECT No 14780

BORE No 15

PROJECT PROPOSED EXTENSION

SURFACE LEVEL

SHEET 1 of 2

LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

DIP OF HOLE 90°

AZIMUTH

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength		Fracture Spacing (m)	Sampling & In Situ Testing			
				B - Bedding S - Shear	J - Joint D - Drill Break	Unconf Compressive	UCS		Sample Type	Core Rec. %	RQD %	Test Results & Comments
0.50	SAND - grey fine to medium grained sand											
1.0	SANDSTONE - medium to high strength fractured to slightly fractured light grey and brown fine to medium grained sandstone with some very low to low strength layers											
2.0												
2.90												
3.0	SANDSTONE - high strength slightly fractured light grey fine to medium grained sandstone with minor fractured layers											
4.0												
5.0												
6.0												
7.0												
8.0												
8.60	SANDSTONE - medium to high strength fractured light grey fine grained sandstone with some siltstone interbeds, siltstone intraclasts and some very low strength silty sandstone interbeds											
9.0												

RIG Scout DRILLER Cooper LOGGED Murray CASING NW to 0.5m

TYPE OF BORING Solid flight auger GL to 0.5, NQ coring to 2.15m, rotary to 2.40 then NQ coring to 20.00m

WATER OBSERVATIONS Obscured by drilling methods

REMARKS

SAMPLING & IN SITU TESTING

A auger sample PL point load strength f_{pL} (MPa)
B bulk sample S standard penetration test
C core drilling Un x mm dia tube



D.J. Douglas & Partners

TEST BORE REPORT

DATE 10.6.92

CLIENT WASTE RECYCLING & PROCESSING SERVICE

PROJECT No 14780

BORE No 15

PROJECT PROPOSED EXTENSION

SURFACE LEVEL

SHEET 2 OF 2

LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

DIP OF HOLE 90°

AZIMUTH

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength		Fracture Spacing (m)	Sampling & In Situ Testing			
				B - Bedding S - Shear	J - Joint D - Drill Break	Unconf Compressive	UCS		Sample Type	Core Rec. %	RQD %	Test Results & Comments
11.0	SANDSTONE - high strength slightly fractured light grey fine to medium grained sandstone		10.00 - 20.00m unless otherwise specified defects are B 5-20° some of which are clay coated The core contains some breaks due to drilling and handling									11.60
12.0												
13.0			30mm siltstone interbed, shattered probably due to drilling						C	100	98	
14.0			J 45°									
15.0			15mm sandy clay seam									14.70
16.0									C	100	99	
17.0												
18.0									C	100		17.80
19.0			B 20° 5mm sandy clay infill						C	100	100	
			B 0-5° 10mm clay infill									
	BORE DISCONTINUED AT 20.00 METRES											

RIG Scout DRILLER Cooper LOGGED Murray CASING NW to 0.5m

TYPE OF BORING Solid flight auger GL to 0.5m, NQ coring to 2.15m, rotary to 2.40m then NQ coring to 20.00m

WATER OBSERVATIONS Obscured by drilling methods

REMARKS

SAMPLING & IN SITU TESTING

A auger sample PL point load strength I_p (MPa)
B bulk sample S standard penetration test
C core drilling Uv x mm dia tube



D.J. Douglas & Partners

TEST BORE REPORT

DATE 10/11.6.92

CLIENT WASTE RECYCLING & PROCESSING SERVICE
 PROJECT PROPOSED EXTENSION
 LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

PROJECT No 14780

SURFACE LEVEL

DIP OF HOLE 90°

BORE No 16

SHEET 1 OF 5

AZIMUTH

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength		Fracture Spacing (m)	Sampling & In Situ Testing			
				B - Bedding S - Shear	J - Joint D - Drift Break	UC Low	Very Low		Sample Type	Core Rec. %	RQD %	Test Results & Comments
0.80	SAND - grey brown fine to medium grained slightly clayey sand											
1.0	SANDSTONE - medium to high strength fractured to slightly fractured light grey and brown fine to medium grained sandstone											
1.90												
2.0	SANDSTONE - high strength slightly fractured light grey and brown fine to medium grained sandstone											
3.0												
4.0												
5.0												
6.0												
7.0												
8.0												
9.0												
	*8.50 - 8.65m medium strength fragmented siltstone interbed											
	SANDSTONE - see below											

RIG Scout

DRILLER Cooper

LOGGED Murray

CASING NW to 0.80m

TYPE OF BORING Solid flight auger GI to 0.80m then NQ coring to 50.00m

WATER OBSERVATIONS Obscured by drilling methods - approx 60% of drilling water

REMARKS

SAMPLING & IN SITU TESTING

A - auger sample PL - point load strength f_{PL} (500MPa)
 B - bulk sample S - standard penetration test



D.J. Douglas & Partners

TEST BORE REPORT

DATE 11.6.92

CLIENT WASTE RECYCLING & PROCESSING SERVICE

PROJECT No 14780

BORE No 16

PROJECT PROPOSED EXTENSION

SURFACE LEVEL

SHEET 2 OF 5

LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

DIP OF HOLE 90°

AZIMUTH

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength		Fracture Spacing (m)	Sampling & In Situ Testing			
				B - Bedding S - Shear	J - Joint D - Drill Break	Very Low Low Med High Very High	Very Low Low Med High Very High		Sample Type	Core Rec. %	RQD %	Test Results & Comments
11.0	SANDSTONE - high strength slightly fractured light grey fine to medium grained sandstone			9.90 - 20.40m unless otherwise specified defects are B 5-10° many of which may have opened during drilling - some are clay coated					C	100	97	
12.0												11.75
13.0				20mm fragmented siltstone interbed					C	100	93	
14.0				J 20°-40° irregular J 75° undulating								14.85
15.0												
16.0									C	100	95	
17.0												
18.0												17.85
19.0									C	100	100	
				2 sandy clay seam each 15mm								

RIG Scout

DRILLER

Cooper

LOGGED

Murray

CASING

NW to 0.80m

TYPE OF BORING Solid flight auger GL to 0.80m, then NQ coring to 30.00m

WATER OBSERVATIONS Obscured by drilling methods - approx 60% of drilling water

REMARKS

SAMPLING & IN SITU TESTING

A - auger sample PL - point load strength f_{pL} (MPa)
B - bulk sample S - standard penetration test



D.J. Douglas & Partners

TEST BORE REPORT

DATE 11.6.92

CLIENT WASTE RECYCLING & PROCESSING SERVICE
PROJECT PROPOSED EXTENSION
LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

PROJECT No 14780

SURFACE LEVEL

DIP OF HOLE 90°

BORE No 16

SHEET 3 OF 5

AZIMUTH

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength				Fracture Spacing (m)	Sampling & In Situ Testing			
				B - Bedding S - Shear	J - Joint D - Drill Break	Unconf. Comp. Strength	Unconf. Tensile Strength	Point Load Strength	Rock Quality Index		Sample Type	Core Rec. %	RQD %	Test Results & Comments
21.0	SANDSTONE - high strength slightly fractured light grey fine to medium grained sandstone			some B along coaly laminar										20.85
22.0				20.40 - 21.00m most likely opened during drilling										
23.0	*minor siltstone intraclasts between 22.30-22.85m and 28.90-29.10m			21.00 - 28.80m Defects are B 0-5° typically planar some with clay coating most have likely opened due to drilling							C	100	90	
24.0				minor sandy clay seams generally sub horizontal and 3-10cm thick marked as extremely low strength on rock strength log										23.85
25.0				The core contains some breaks due to drilling and handling							C	100	98	
26.0														
27.0														26.85
28.0											C	100	97	
29.0														28.83
											C	100		29.40

RIG Scout DRILLER Cooper LOGGED Murray CASING NW to 0.80m

TYPE OF BORING Solid flight auger GL to 0.80m then NQ coring to 50.00m

WATER OBSERVATIONS Obscured by drilling methods - approx 60% of drilling water

REMARKS

SAMPLING & IN SITU TESTING

A - auger sample PL - point load strength I_{50} (MPa)
B - bulk sample S - standard penetration test



D.J. Douglas & Partners

TEST BORE REPORT

DATE 11.6.92

CLIENT WASTE RECYCLING & PROCESSING SERVICE
PROJECT PROPOSED EXTENSION
LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

PROJECT No 14780
SURFACE LEVEL
DIP OF HOLE 90°

BORE No 16
SHEET 4 of 5
AZIMUTH

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength					Fracture Spacing (m)		Sampling & In Situ Testing			
				B - Bedding S - Shear	J - Joint O - Drill Break	Unconf Compressive	Unconf Tensile	Unconf Flexure	Unconf Split	Unconf Triaxial	1.00 0.50 0.10 0.05 0.01	0.01	Sample Type	Core Rec. %	RQD %	Test Results & Comments
31.0	SANDSTONE - high strength slightly fractured light grey fine to medium grained sandstone with some unbroken layers															
31.39	*low to medium strength silty sandstone interbed 31.39 - 31.46m												C	100	98	
32.0																
32.40																
33.0													C	100	100	
34.0																
35.0																
35.40																
36.0													C	100	100	
37.0																
38.0																
38.40																
39.0													C	100	100	

RIG Scout DRILLER Cooper LOGGED Murray CASING NW to 0.60m

TYPE OF BORING Obscured by drilling methods - approx 60% of drilling water

WATER OBSERVATIONS

REMARKS

SAMPLING & IN SITU TESTING

A - auger sample PL - point load strength f_{PL} (MPa)
S - bulk sample S - standard penetration test



D.J. Douglas & Partners

TEST BORE REPORT

DATE 11.6.92

CLIENT WASTE RECYCLING & PROCESSING SERVICE

PROJECT No 14780

BORE No 16

PROJECT PROPOSED EXTENSION

SURFACE LEVEL

SHEET 5 OF 5

LOCATION REGIONAL WASTE DEPOT, LUCAS HEIGHTS

DIP OF HOLE 90°

AZIMUTH

Depth m	Description of Core	Degree of Weathering	Graphic Log	Discontinuities		Rock Strength		Fracture Spacing (m)	Sampling & In Situ Testing			
				B - Bedding S - Shear	J - Joint D - Drill Break	CU Low	CU Med	CU High	Sample Type	Core Rec. %	RQD %	Test Results & Comments
41.0	SANDSTONE - high strength slightly fractured to unbroken light grey fine grained micaceous sandstone											
												41.40
42.0												
43.0									C	100	100	
44.0												
44.2												44.40
45.0	SANDSTONE - high strength slightly fractured light grey fine to medium grained sandstone								C	100	95	
46.0												
47.0												47.40
47.8	SANDSTONE - very low to low strength slightly fractured											
48.0	dark grey siltstone											
48.1	SILTY SANDSTONE - medium to high strength slightly											
48.45	fractured dark grey silty sandstone								C	100	95	
49.0	SANDSTONE - high strength slightly fractured light grey fine to medium grained sandstone											
	BORE DISCONTINUED AT 50.10M											50.10

RIG Scout DRILLER Cooper LOGGED Murray CASING NM to 0.80m

TYPE OF BORING Solid flight auger GL to 0.80m then NQ coring to 50.00m

WATER OBSERVATIONS Obscured by drilling methods - approx 60% of drilling water

REMARKS

SAMPLING & IN SITU TESTING

A - auger sample PL - point load strength I_{50} (MPa)
 S - bulk sample S - standard penetration test



D.J. Douglas & Partners

Appendix F

DPI / DOI Correspondence

Response to DOI Recommendations

Recommendation	Response
Further detail on the water level triggers from monitoring bores in relation to maintaining a buffer beneath the landfill that will limit water pressures beneath the liner. Note: observation bores located adjacent to the trench are likely to record lower water heads than that beneath the adjacent parts of the landfill.	Response provided in Section 7.1 of update groundwater management plan
An outline of the water licences held / required, the volumes of water authorised by those licences and / or any exemption that may apply	The application of water licences is an administrative matter that is not within the scope of the GWMP. Cleanaway will discuss with Department of Climate Change, Energy, the Environment and Water (DCCEEW) directly on this subject.
Details or a table of any destroyed and or replaced registered bores, including a brief explanation of the reasoning for this action.	Appendix C provides a summary of the condition of the groundwater wells
Correct 'Table 2 Monitoring locations'	Table 2 has been corrected
Groundwater remediation action plan should be included and results from ongoing monitoring programme should be forwarded to DoI Water.	Section 8.1 requires the relevant bodies to be consulted in the in the event that a groundwater remediation action plan is required

OUT18/13125

Kim Ross
NSW Landfill Advisor
Suez Recycling & Recovery
Australia and New Zealand
Lucas Heights Resource Recovery Park
New Illawarra Road
Lucas Heights NSW 2234
By email: kim.ross@suez.com

Dear Kim

Lucas Heights Resource Recovery Park - Groundwater Management Plan

Thank you for your email of 27 February 2018 requesting the Department of Industry – Water (DoI Water) review and comments on Lucas Heights Resource Recovery Park - Groundwater Management Plan (GMP, Jan. 2018) and associated report on Groundwater Monitoring Well Installation (31 Jan. 2018).

DoI Water advises that the updated GMP and associated report on well installation are considered to be generally satisfactory in relation to the Conditions of Approval. Further detailed comments are also provided in Attachment A.

Two key issues remain.

1. The on-going management of groundwater beneath the site is based on performance of the gravel trench. The trench is required to keep the site dry during construction and to limit the build-up of water pressure beneath the landfill. If the water pressure is sufficient, uplift of the high density polyethylene (HDPE) liner can occur, leading to perforation from content in the landfill.

DoI Water notes that although the GMP adequately covers requirements for groundwater quality assessment and trigger levels, no groundwater level limits are discussed that would limit the risk of water pressure beneath the HDPE liner. The Environmental Protection Licence specifies the standing water level to be measured quarterly in situ in monitoring bores, but the GMP does not include an outline of groundwater level trigger values or an explanation for the omission.

To add confidence in the ongoing monitoring and reporting program, further detail is recommended on the water level triggers from monitoring bores in relation to maintaining a buffer beneath the landfill to limit water pressure levels of groundwater which are considered detrimental to the continued stability of the landfill.

2. The estimated incidental groundwater take (inflow) into the collection system is approximately 11 ML/year. However there is no outline as to whether this groundwater yield is licensed under the *Water Management Act 2000*, or alternately discussion pertaining to any potential exemption under the *Water Management (General) Regulations 2018* (see Part 2 Division 2 Clause 18 and Schedule 5).

Dol Water provides the following recommendations to enhance the GMP.

- Further detail on the water level triggers from monitoring bores in relation to maintaining a buffer beneath the landfill that will limit water pressures beneath the liner. Note: observation bores located adjacent to the trench are likely to record lower water heads than that beneath the adjacent parts of the landfill.
- An outline of the water licences held/required, the volumes of water authorised by those licences and / or any exemption that may apply.
- Details or a table of any destroyed and or replaced registered bores, including a brief explanation of the reasoning for this action.
- Correct 'Table 2 Monitoring locations'.
- Groundwater remediation action plan should be included and results from ongoing monitoring programme should be forwarded to Dol Water.

A hydrogeologist from Dol Water can be made available for any further discussion with SUEZ / Douglas Partners if required.

Should you have any further enquiries about this matter, please contact Ms Marie Schildt, Audit Officer, Regional Water Operations East, to assist you on telephone number (02) 9842 8640 or by email marie.schildt@nrar.nsw.gov.au.

Yours sincerely



Irene Zinger
Manager, Regional Water Operations (East)
Natural Resources Access Regulator
Land and Water Division

ATTACHMENT A

SUEZ Lucas Heights Resource Recovery Park – Groundwater Management Plan and installation of groundwater monitoring wells on site

Dol Water has reviewed the revised Groundwater Management Plan (Jan. 2018) and associated report on Groundwater Monitoring Well Installation (31 Jan. 2018) in relation to the Conditions of Approval listed below.

SSD 6835 Schedule C	Proponent Response	Dol Water Response
Groundwater Management Plan (Jan. 2018)		
C 35. The Applicant shall prepare a Groundwater Management Plan for the site. The plan must:	The GMP has been prepared in accordance with Condition No. 35 of the development consent SSD 6835.	Acknowledged
a) be prepared by a suitably qualified and experienced person, in consultation with the EPA and DPI Water;	The GMP was commissioned by SUEZ Australia Pty Ltd (SUEZ) and was undertaken in accordance with Douglas Partners' proposal SYD170317.P.01.Rev01 dated 12 May 2017. ... the GMP takes into consideration comments from the Department of Industry Lands and Water (Dol Water), and NSW EPA provided throughout 2017 (refer to Appendix F).	Satisfactory
b) be submitted to the Secretary, prior to the commencement of construction;	This report presents the groundwater management plan (GMP) for Lucas Heights Resource Recovery Park (LHRRP) at New Illawarra Road, Lucas Heights. The site is currently licenced under an environmental protection licence (EPL) under Section 55 Protection of the Environment Operations Act 1997, EPL No. 5065. On 23 January 2017 SUEZ received approval of SSD 6835. The GMP has been prepared in accordance with Condition No. 35 of the development consent SSD 6835.	Satisfactory
c) detail the groundwater monitoring network including location and frequency of monitoring, the parameters for testing, relevant criteria and trigger levels for action;	Section 5 Monitoring Programme: Based on the [survey of] licenced groundwater bores within 4 km of the site there is no known beneficial reuse of groundwater currently in operation. The primary objectives of GMP are to detect, prevent and if necessary remediate water pollution by assessing the water quality over time. The monitoring locations are described in Table 2. The locations of the groundwater bores currently monitored under the EPL are shown on Attached diagrams and sections. Based on the current EPL the quarterly	Satisfactory Revision includes previously requested - hydrogeological cross sections - modelled groundwater flow nets - bore locations are to be presented in tables as MGA 94 zone 56 co-ordinates - bore holes MB046 and MB047 included in the bore hole status table Table 2: Monitoring locations' lists MB048 twice, the second

SSD 6835 Schedule C	Proponent Response	DoI Water Response
	and annual groundwater, surface water and leachate monitoring requirements are detailed in Table 3. Section 6. Groundwater Investigation Trigger Levels: The groundwater investigation levels (GILs) adopted for the groundwater monitoring programme are based on .. NSW EPA endorsed guidelines.. The adopted GILs for the analytes included in this assessment .. shown in Table 5. Exceedances of the adopted GIL will be considered (case by case basis) to be significant where: • The concentration in the down gradient monitoring wells significantly exceeds the local background conditions (in up-gradient monitoring points to the south east of the LHRRP); • Trend analysis indicates that a statistically significant increasing trend is occurring; and • It is considered likely that the sensitive receptors, specifically Mill Creek will or could be impacted by the identified contamination or where impacts to Mill Creek (related to the Landfill) have been identified.	listing details are noted to be for MB049. To be corrected. Incomplete, pending The section adequately covers requirements for groundwater quality assessment and trigger levels, however, no groundwater level limits are discussed. A discussion pertaining to assessment of groundwater levels, how this relates to the LHRRP operation and management, and most importantly groundwater level trigger values (levels of groundwater which are considered detrimental to the continued stability of and or at which excessive pressure within the landfill are considered to occur) for the site management should be included.
d) include a protocol for investigation, notification and mitigation of any exceedances of the identified trigger levels; and	Section 7 Investigation, Notification and Mitigation Procedure: .. any abnormality in the groundwater tests (as described above) the following will be adopted: • The affected monitoring bores will be re-sampled on receipt of the laboratory tests; • Characteristics of pollutant will be identified including data trends via Mann-Kendall Trend Analysis; • Possible sources/point of pollutant will be identified including other factors that may have impacted results (such as weather conditions); • If required additional sentinel groundwater monitoring points will be installed; • The NSW EPA, Sutherland Shire Council and any affected sites (such as neighbours, if appropriate) will be notified; • Full analysis of the results will be prepared; • If the contamination persists (or is trending upwards) then a specific groundwater remediation plan will be prepared; • Groundwater remediation pilot trials will be undertaken (if required);	Satisfactory pending Inclusion of DoI Water to be consulted with in regard to the developing a groundwater remediation action plan (GRAP). Plus include DoI water as a receiver of results from ongoing monitoring programme for the GRAP.

SSD 6835 Schedule C	Proponent Response	DoI Water Response
MB021 and MB022) to improve detection of leachate in groundwater systems to the north of the site. The EPL for the site and the groundwater management plan required under Condition C35.	“presents the record of the installation of two new groundwater monitoring wells”.. “also describes the attempts to refurbishment of groundwater well MB022” “two test bores located 120 m north-northwest of bores MB038 – MB039. The two bores were positioned approximately 10 m apart. The bores were a paired set of bores with one borehole drilled to a depth of approximately 50 m (BH401 / MB048) and one to 30 m (BH402 / MB049) below ground level. Groundwater wells were installed in each of the test bores” “It is considered that monitoring wells MB048 and MB049 are now suitable for monitoring per the modified environmental protection licence.” “MB022 is not suitable for monitoring. “An inspection of MB022 with a downhole camera indicated that silt was built up in the well to a depth of 1 m bgl. The well was pressured jetted (with water) and following the removal of the initial silt build up it was discovered that the groundwater well was bent at depth of 2 m bgl, possibly due to a vehicle impact and /or as the result of tree root incursion. Therefore it was determined that the well could not be refurbished via non-destructive means and further attempts to refurbish the well were abandoned.” Douglas Partners recommends that two additional groundwater monitoring points be installed along the western site boundary, south of points MB305 and MB306 as the groundwater gradient is to the north to north west. The purpose would be to assess the potential for off-site migration of leachate from the older landfill cells in the south of the site.	DoI Water acknowledges the outcome of the attempt to refurbish MB022. DoI Water is satisfied that newly installed MB048 and MB049 will be sufficient for purpose. DoI Water agree with this assessment

End of Attachment A.



Contact: Janne Grose
Phone: 02 8838 7505
Email: janne.grose@dpi.nsw.gov.au

Our ref: V14/157#90 & OUT17/15666
File No:
Your Ref:

Carol Ng
Suez Recycling and Recovery
Level 3, 3 Rider Boulevard
RHODES NSW 2138
Carol.ng@suez.com

19 April 2017

Dear Ms Ng

SUEZ Lucas Heights Resource Recovery Park – SSD-6835 - preparation of the Groundwater Management Plan and the installation of groundwater wells on site

Thank you for your emails regarding the proposed methodology for the Groundwater Management Plan (GWMP) and the installation of groundwater wells. DPI Water provides comments in Attachment A.

DPI Water requests it is provided with a copy of the final draft of the GWMP to review. A copy of the GWMP should be sent electronically to DPI Water via email to water.referrals@dpi.nsw.gov.au. Please note, the DPI Water's timeframe for the review of management plans is generally four weeks so please allow for this in your timeline.

For further information please contact Janne Grose, Water Regulation Officer at DPI Water (Parramatta Office) on t: (02) 8838 7505; e: janne.grose@dpi.nsw.gov.au.

Yours sincerely

Irene Zinger
Regional Manager - Metro
Water Regulation

ATTACHMENT A

SUEZ Lucas Heights Resource Recovery Park – preparation of the Groundwater Management Plan and installation of groundwater wells on site

DPI Water provides the following comments in relation to the preparation of the Groundwater Management Plan (GWMP) and installation of groundwater wells on site.

Preparation of the Groundwater Management Plan

The Douglas Partners proposal indicates the GWMP will be prepared to address Condition 35 of the Development Consent for SSD-6835. DPI Water recommends the GWMP also addresses the following.

The GWMP should be clearly and logically set-out with a table of contents showing where each of the prescribed inclusions of the GWMP (outlined in the conditions of approval) is addressed.

The GWMP should be a clear, stand-alone document that outlines all water management measures for the construction and operation of a project. Extensive cross-referencing to other reports should be avoided. Further detail can be included in appendices to the GWMP where required.

A brief description of the project and its location should be included to put the GWMP into context. The project approval number and the relevant condition/s under this approval that the GWMP addresses should be identified.

The proponent should identify the key water concerns/problems for the project upfront and how these are proposed to be managed and/or mitigated and cite the relevant sections of the Environmental Impact Statement (EIS) where these impacts were examined during the development assessment phase.

For ease of reference, it is suggested the entire wording of Condition 35 from the Development Consent for SSD-6835 (dated 23 January 2017), which requires the GWMP to be prepared, is included upfront in the GWMP in a table format and it identifies the relevant sections in the GWMP where the details of each part of the condition is addressed.

It is suggested the Introduction/Background to the GWMP includes:

- a brief context of existing water use or water dependent assets in the local area to assist in understanding the assets or users that may be impacted, or may be concerned about being impacted;
- a table listing water licensing details:
 - the predicted annual groundwater take for the project (including and distinguishing between operational requirements and incidental/non-consumptive take), including any variations in water take over the life of the project (i.e. may need more water during certain stages of a project);
 - all water licences, the relevant Water Sharing Plan/s and Water Source/s for these licenses, the volumetric entitlement for each licence (in ML)
 - any approvals held for the project under the Water Management Act 2000 and/or Water Act 1912
 - any EPLs issued by the EPA; and

- a list of guidelines and policies that were referred to when preparing the GWMP, including the versions used (e.g. NSW Aquifer Interference Policy, 2012). A list of key policies and guidelines that may be of use in preparing the GWMP include:
 - NSW Aquifer Interference Policy (DPI, 2012)
 - Aquifer Interference Assessment Framework (DPI, 2013)
 - Risk Assessment Guidelines for Groundwater Dependent Ecosystems (DPI, 2012)
 - Australian Groundwater Modelling Guidelines (NWC, 2012)
 - NSW State Groundwater Policy Framework Document (1997)
 - NSW State Groundwater Quality Protection Policy (1998)
 - NSW State Groundwater Dependent Ecosystems Policy (2002)

Site Water Balance

Preparing a Site Water Balance

When examining a Site Water Balance, DPI Water is essentially looking for an overall representation of where water is coming from, where it ends up and that all water take is appropriately licensed and accounted for. DPI Water's preference is for a water balance to be easily interpretable in terms of where water entitlement needs to be held or if exemptions may apply (e.g. Harvestable Rights, 'dirty' water management etc.), so the relevant points of water take from a water source (e.g. groundwater inflows, river extraction) need to be clearly defined.

Important things to remember when developing a Site Water Balance to the satisfaction of DPI Water.

- DPI Water encourages the use of photos and/or diagrams to explain the general layout of the project site and water management features.
- The proponent should clearly identify the source of data used for the site water balance (e.g. rainfall data), including whether water take is metered (actual volumes are known) or estimated, and the formulas and models used to calculate such estimates.
- DPI Water encourages the inclusion of a simplified water balance schematic. A table listing the main on-site water storages, the source and use of this water is also very useful in understanding the site water balance and movement of water around/off/onto the site should also accompany a site water balance schematic as they are often difficult to interpret on their own.

Basic elements of a Site Water Balance

The basic elements of a site water balance and related schematics should include:

- the actual volumes of water being taken (not only for consumptive use but water taken via induced flows from connected water sources and non-consumptive water take – e.g. dewatering of underground workings);
- total take rather than 'net' take of water;
- water sources (e.g. bores, dams – turkeys nest/runoff capture, rivers, sediment/stormwater ponds, recycling, rainfall/runoff into pits or underground workings, groundwater interception, etc.);
- water sources split based on unregulated/regulated or groundwater and the relevant water source;

- water losses (e.g. evaporation, entrainment in material, seepage, spills, discharges);
- water use points (e.g. processing plant, underground drilling, dust suppression);
- water transfer pathways and annual volumes;
- water infrastructure and capacities – storages, pipelines, etc;
- where meters exist, where relevant;
- clear separation of ‘clean’, ‘contaminated’ (produced water) and ‘dirty’ (sediment laden run-off) water management;
- minimising the production of ‘dirty’ water by minimising the area of disturbed land and diverting ‘clean’ water around any of these areas (N.B. ‘clean’ water diversions should be able to handle volumes of water expected in at least a 100 year ARI flood event).

Tips for developing a Site Water Balance

An unclear or poorly prepared Site Water Balance can make interpretation of key information difficult and slow down the review process by DPI Water. The table below provides some tips on what to avoid and what to include instead when preparing a Site Water Balance so that DPI Water can undertake a sound assessment of the WMP and minimise delays.

Table 1 Tips for preparing a Site Water Balance

What to avoid	What to include
A highly complex water balance schematic with little or no explanation of how it works.	A simplified schematic accompanied by a table outlining each of the components and the actual source/s of water.
Not identifying the components of water inputs and outputs (i.e. where the water is originally coming from). e.g. ‘external water supplies’ may include water from regulated, unregulated and groundwater sources	A water balance that clearly defines the components of water inputs and outputs (e.g. regulated, unregulated or groundwater sources), including: • the first point of water take (where the water is actually coming from and under what licence); and • the division of water inputs/take based on the individual water sources that they came from, particularly when there is multiple ‘takes’ from the same type of water source (e.g. two separate groundwater sources flowing into a mine).
Providing no indication of ongoing water requirements.	A clear identification of any ongoing water requirements. The water that will continue to be ‘taken’ following cessation of the project (e.g. inflow into abandoned mine or quarry voids).
Providing dewatering figures are not truly representative of the actual groundwater take.	The total groundwater take should be calculated as accurately as possible and appropriately licensed. All groundwater being removed from a water source, either as moisture content within extracted material or physically dewatered needs to be accounted for and included in the water balance licensed (e.g. total groundwater ‘take’ = dewatering volume + entrainment volume).
Not providing enough information to understand the source of runoff captured onsite.	A clear explanation of the source of any runoff being captured.
Providing little background information on the site/project.	Enough information on the project site (high quality site map of key water features, diagrams, etc.) so that the reviewer has a general understanding of the site and how it works, including the licences held and approved/proposed methods of management, if relevant. e.g. If there are many onsite water storages proposed, we need to know: ○ where they are located (minor streams, 3rd order or higher)

What to avoid	What to include
	○ the source/s of water in a water storage (e.g. a dam may capture runoff and hold water transferred from another point) ○ how large rainfall events are managed in terms of capturing, storing and discharging runoff.
	Provide visualisation assistance where necessary (e.g. cross sections, 3D diagrams).

Groundwater management

THE GWMP needs to demonstrate appropriate measures to prevent, monitor, detect and respond to potential impacts to groundwater levels (quantity) and quality as a result of the project. Groundwater management should be in accordance with the provisions of the NSW Aquifer Interference Policy (AIP).

The key requirements of the AIP are as follow.

- Account for, or prevent, the take of water. Where a proposed activity will take water from an aquifer or connected surface water source, adequate arrangements must be in place to account for this water. It is the proponent's responsibility to enable this to be estimated to a suitable level of accuracy, and to ensure necessary water licences are obtained and held.
- Characterise the likely impacts. Aquifer interference activities can adversely impact groundwater and connected surface water sources by decreasing groundwater pressure and/or lowering the water table; deteriorating groundwater and surface water quality either due to pollution or increases in salinity; by affecting the health or viability of a groundwater dependent ecosystem (GDE), or impacting on a culturally significant site (CSS). The AIP provides objective, measurable thresholds for considering the degree of impact an activity may have on the water table, groundwater pressure and water quality changes. The assessment criteria differ between aquifer types (e.g. alluvial, porous, fractured) and whether the aquifer is deemed 'highly' or 'less' productive on the basis of natural water quality and extraction yields.
- Manage risks. This includes appropriate monitoring and understanding what mitigation measures are available. Where impacts are greater than those that were predicted as part of the relevant approval, proposed remedial actions shall be in specified to manage those impacts.

Information on the baseline groundwater data requirements for aquifer interference activities related to a project is also outlined in the AIP.

Important information relating to groundwater management that is often overlooked includes the following.

- An assessment of impacts on privately-owned groundwater bores, GDEs and local sandstone aquifers (where present), in relation to water quality and/or quantity. Measures to appropriately manage these impacts need to be developed. Such measures may include the establishment of make-good provisions in consultation with affected parties.
- Details of all Groundwater Dependent Ecosystems (GDEs) and groundwater dependent culturally significant sites impacted by the development.
- Correct and consistent numbering of groundwater bores and works. Ensure the numbering of these works is consistent with the official numbering used by DPI Water

(some companies may use a different numbering/naming systems and this is difficult to cross-check against our records).

- Assessment of impacts to highly connected water sources (including surface water sources – e.g. baseflows to streams and rivers).
- A program to validate the groundwater model for the project, including the comparison of monitoring data with modelled predictions.

Groundwater monitoring network

Condition 35(c) requires the GWMP to detail the groundwater monitoring network. It is recommended the GWMP includes:

- a scaled plan showing all surveyed borehole locations including their coordinates and borelogs;
- a table which lists the borehole sites, easting and northing co-ordinates of the bores, the screened lithology and the bore depth.

In addition to re-establishing the historic groundwater monitoring bores (BH24, BH31, MB021 and MB022), DPI Water repeats the advice it provided in its submission on the EIS for SSD-6835 in relation to the longer term monitoring for the whole, expanded landfill site (LHRRP) that:

- further consideration be given to including additional, existent bores located on Lot 2 DP 1032102,
- the additionally sampled bores MB044 and MB045, described in the project's "Groundwater Assessment" (Appendix I of EIS), should also be included for regular monitoring.

DPI Water repeats the recommendations it provided in its submission on the EIS, for improvement in the following key considerations.

- More comprehensive monitoring bore coverage across the Waste Management Centre domain for the purpose of identifying the potential leachate pathways within the shallow sandstone aquifer.
- There is an assessment of post-closure potential lead in soil contamination in the NW corner of the site due to the clay-shooting range. Heavy metals associated with the lead shot residue have the potential to be mobilised in the acid soil and groundwater regime. These matters need to be addressed at or before closure.
- Additional monitoring of heavy metal contamination from purpose-built bores installed down gradient of the clay shooting range.
- Refinement of the management plans to include additional monitoring and revised trigger levels (e.g. lead concentrations down gradient of the clay shooting range) both during operation and post-closure.
- Maintenance of the leachate management system, as described in the management plans, to include regular periodic cleaning (i.e. flushing and repair) of the leachate system piping.
- Clarification of the current number, location and construction of the existing monitoring bores so that additional targeted installations can be designed to improve the likelihood of leachate detection in groundwater if leaks occur (i.e. sentinel monitoring in appropriate locations).

Groundwater Well Replacement

Condition 36 of the Development Consent for SSD-6835 requires the applicant to re-establish the historic groundwater monitoring bores (BH24, BH31, MB021 and MB022). In your email of 3 April 2017 you asked if there are any administrative procedures required for SUEZ to reinstate the bores. Please note, DPI Water has an interim position on the

regulation of monitoring bores. A Water Act 1912 licence is no longer required for monitoring bores that are constructed in accordance with the Minimum Construction Requirements for Water Bores in Australia 2012, and are:

- associated with State Significant Development, State Significant Infrastructure, or Public priority infrastructure projects; or
- located outside of the Great Artesian Basin and less than 40 m deep.

For public relations reasons, however SUEZ may still choose to seek a licence, in which case DPI Water would accept the licence application and issue a licence. A copy of an application form for a groundwater licence under Part 5 of the Water Act 1912 is attached. Please note, the driller will need to provide DPI Water with a Form A for the monitoring bores.

As noted above, it is recommended the GWMP includes a scaled plan which clearly shows the location of the historic groundwater monitoring bores (BH24, BH31, MB021 and MB022).

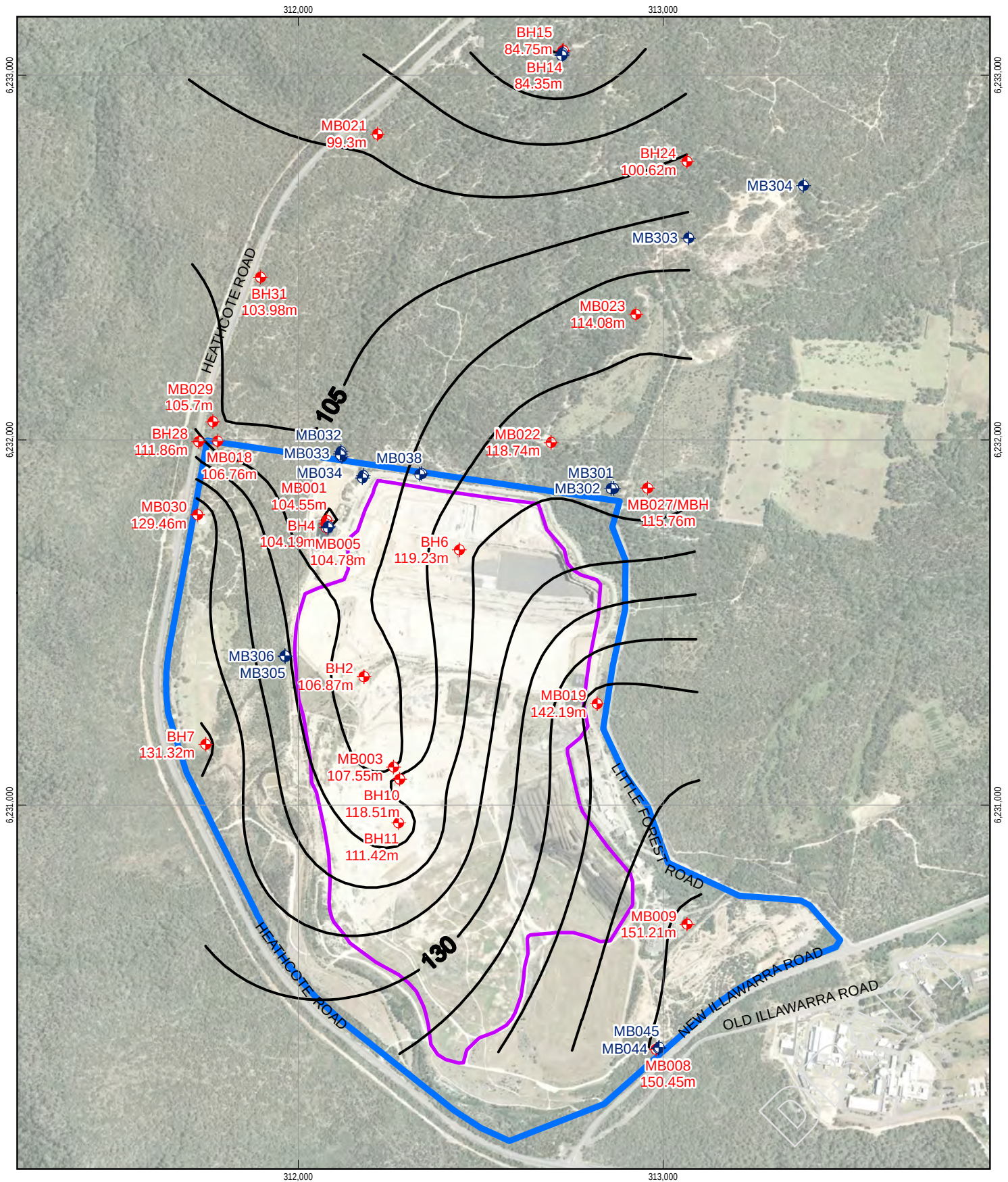
The Douglas Partners proposal indicates the reported depth of these bores is 29.35 m bgl, 54 m bgl, 29.25 m bgl and 81 m bgl respectively and proposes the installation of 30 m deep replacement wells. This amounts to a 50 m difference between the historic bore MB022 depth and the proposed replacement depth. DPI Water requires that the bores are reinstated to the same depth as the historic depths.

The Douglas Partners proposal assumes that rock core logging will not be required. DPI Water requires rock coring to be undertaken unless the rock core logs from the original 2003 drilling are provided as an Appendix in the GWMP.

End of Attachment A

Appendix G

Groundwater Contour Plots and Cross Sections

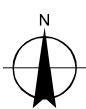


LEGEND

- Groundwater Bores
- Groundwater bores AHD*
- 1992, 5m Groundwater contour
- Landform reprofiling (R5 post-settlement)
- LHRRP boundary
- Roads

*Only groundwater bores with elevation were used to generate the groundwater contours

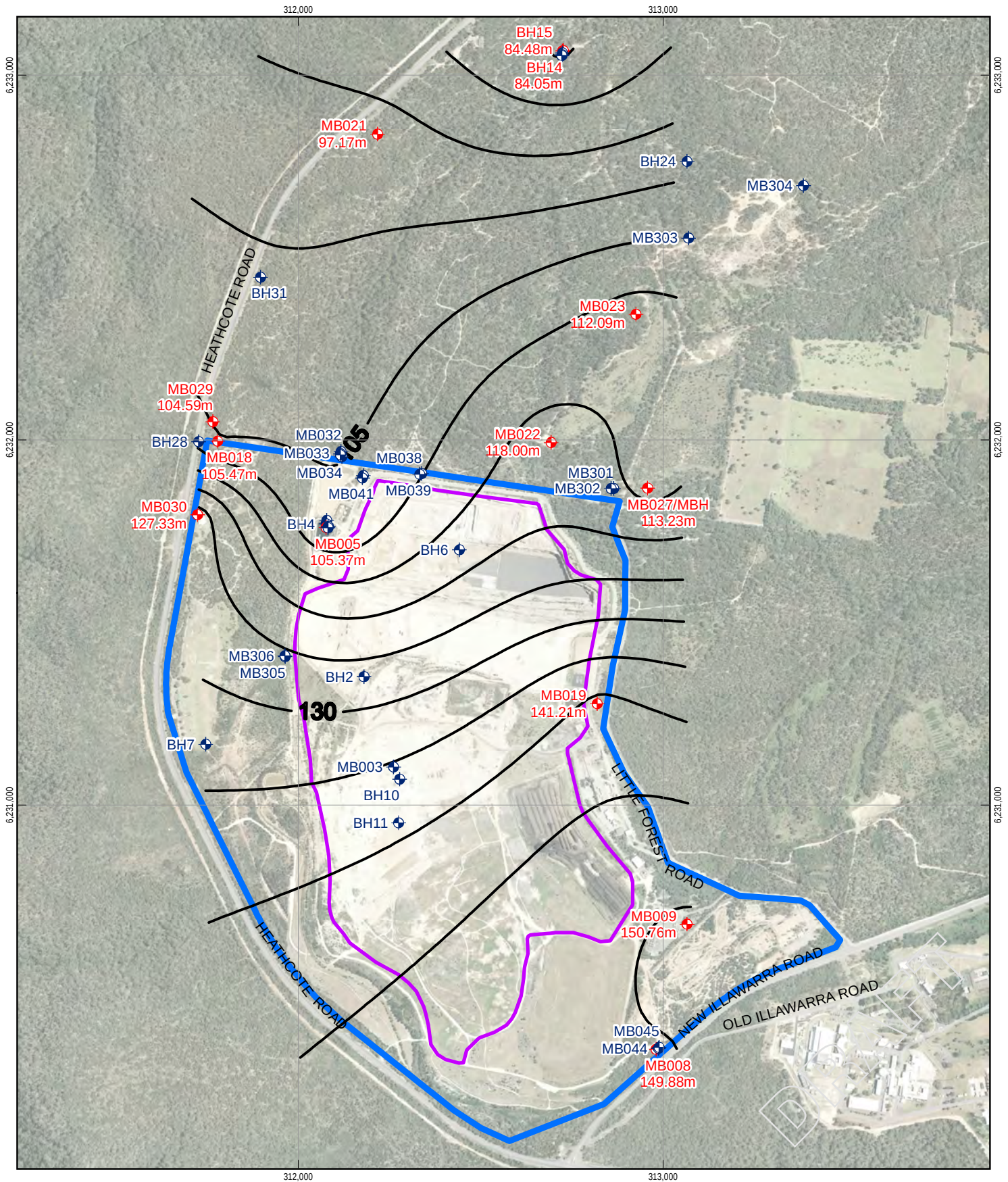
Paper Size A4
0 50 100 200 300 400
Metres
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56



SITA Australia
Lucas Heights Resource Recovery Park
Preliminary Environmental Assessment

Job Number	21-23482
Revision	B
Date	20 Aug 2014

1992 interpreted groundwater contours Figure 1

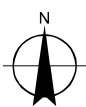


LEGEND

- Groundwater bores
- Groundwater bores AHD*
- LHRP boundary
- Roads
- 1997, 5m Groundwater contour
- Landform reprofiling (R5 post-settlement)

*Only groundwater bores with elevation were used to generate the groundwater contours

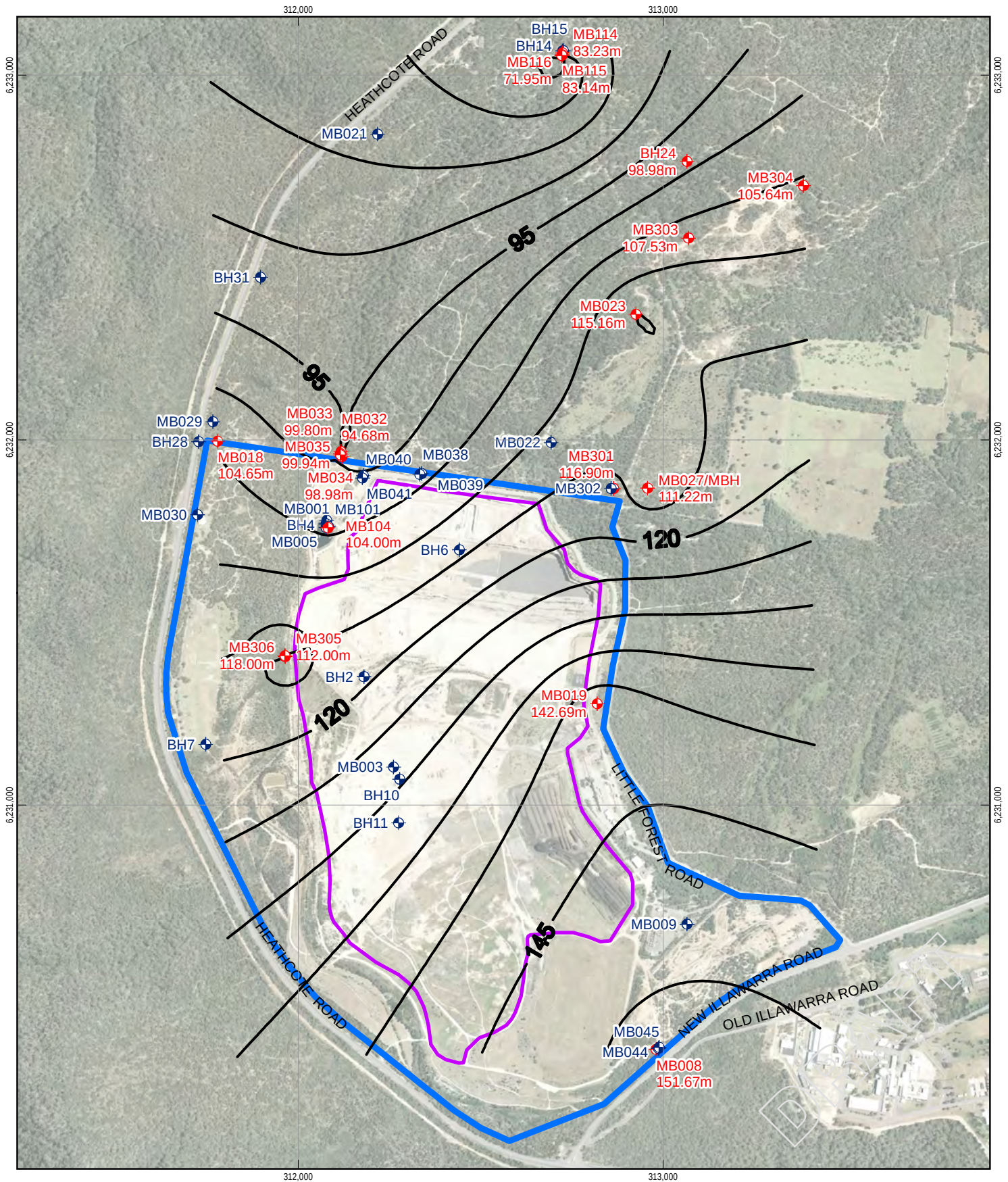
Paper Size A4
0 50 100 200 300 400
Metres
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56



SITA Australia
Lucas Heights Resource Recovery Park
Preliminary Environmental Assessment

Job Number	21-23482
Revision	B
Date	20 Aug 2014

1997 interpreted groundwater contours Figure 1

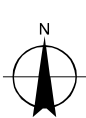


LEGEND

- Groundwater bores
- Groundwater bores AHD*
- LHRRP boundary
- Roads
- 2005, 5m Groundwater contour
- Landform reprofiling (R5 post-settlement)

*Only groundwater bores with elevation were used to generate the groundwater contours

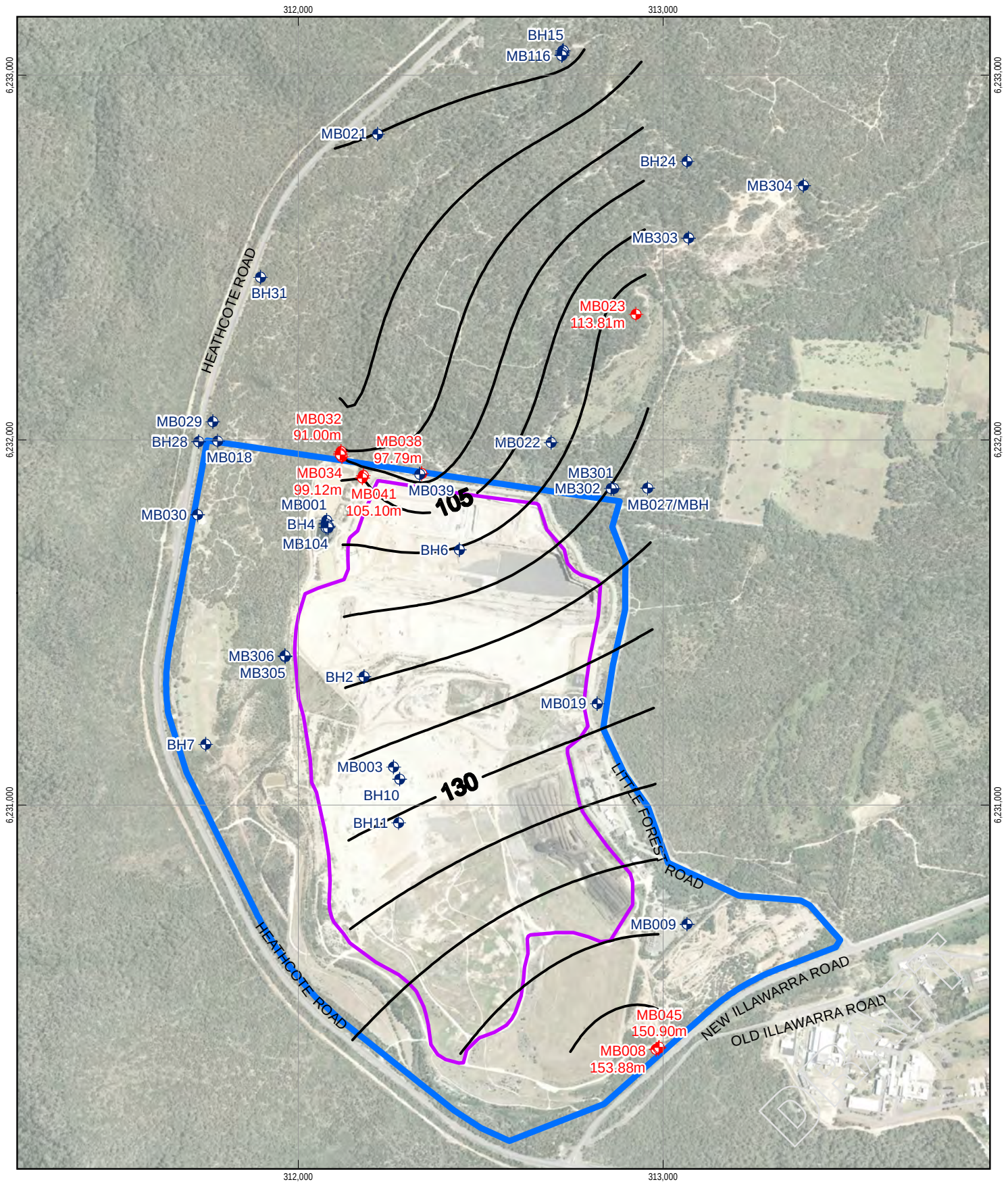
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Metres
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56



SITA Australia
Lucas Heights Resource Recovery Park
Preliminary Environmental Assessment

Job Number	21-23482
Revision	B
Date	20 Aug 2014

2005 interpreted groundwater contours Figure 1

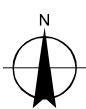


LEGEND

- Groundwater bores
- Groundwater bores AHD*
- 2014, 5m Groundwater contour
- Landform reprofiling (R5 post-settlement)
- LHRRP boundary
- Roads

*Only groundwater bores with elevation were used to generate the groundwater contours

Paper Size A4
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Metres
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

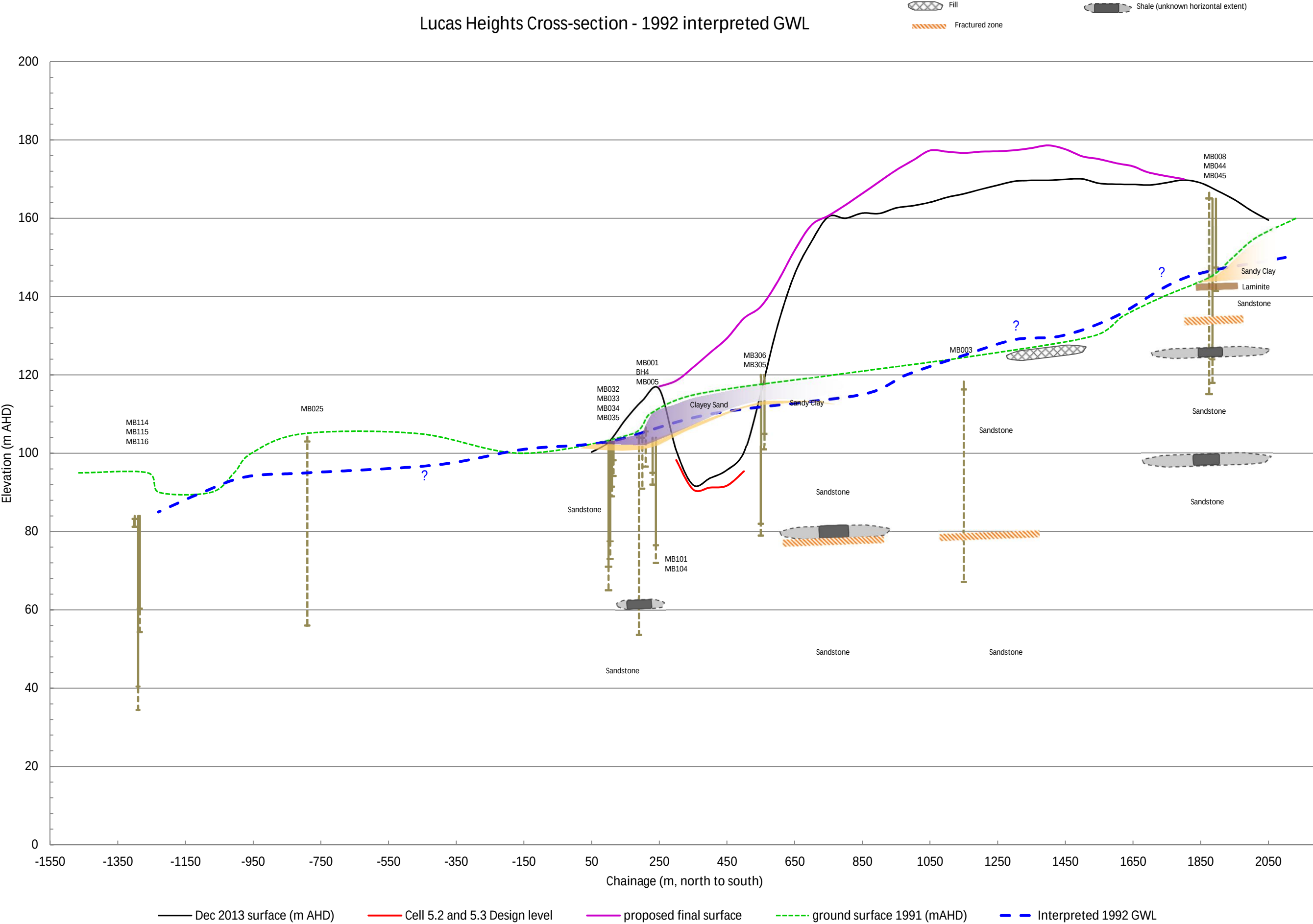


SITA Australia
Lucas Heights Resource Recovery Park
Preliminary Environmental Assessment

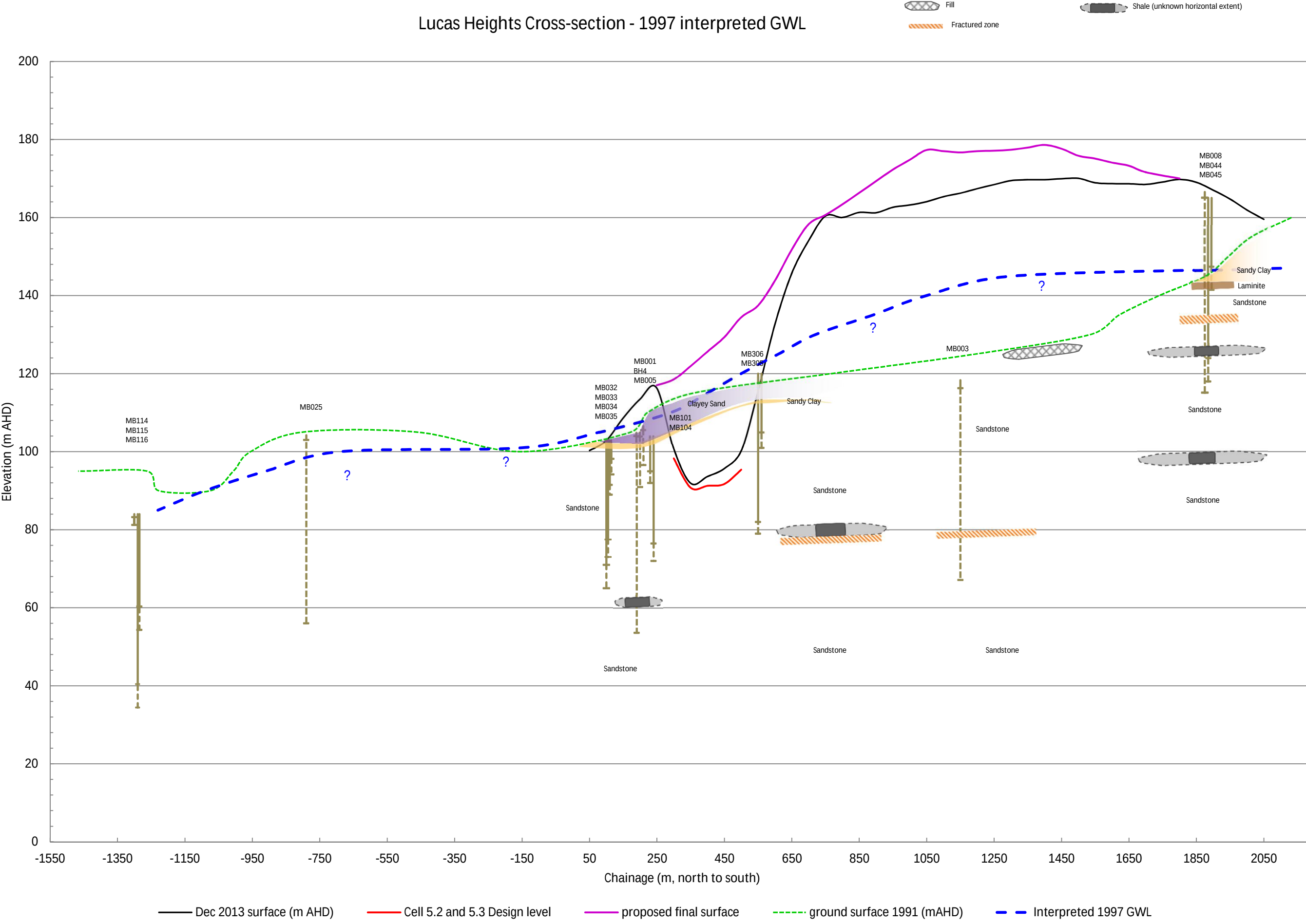
Job Number	21-23482
Revision	B
Date	20 Aug 2014

2014 interpreted groundwater contours Figure 1

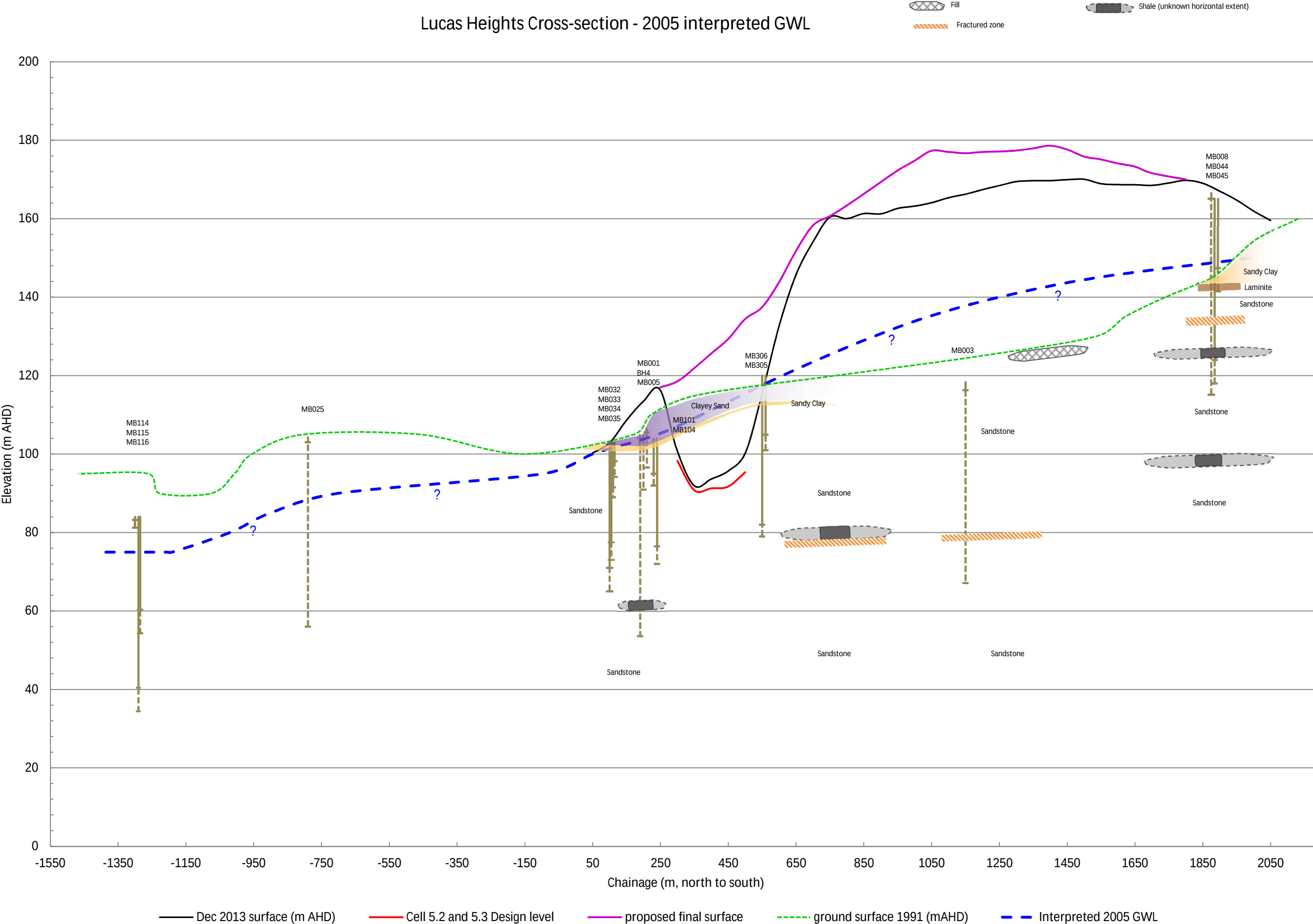
Lucas Heights Cross-section - 1992 interpreted GWL



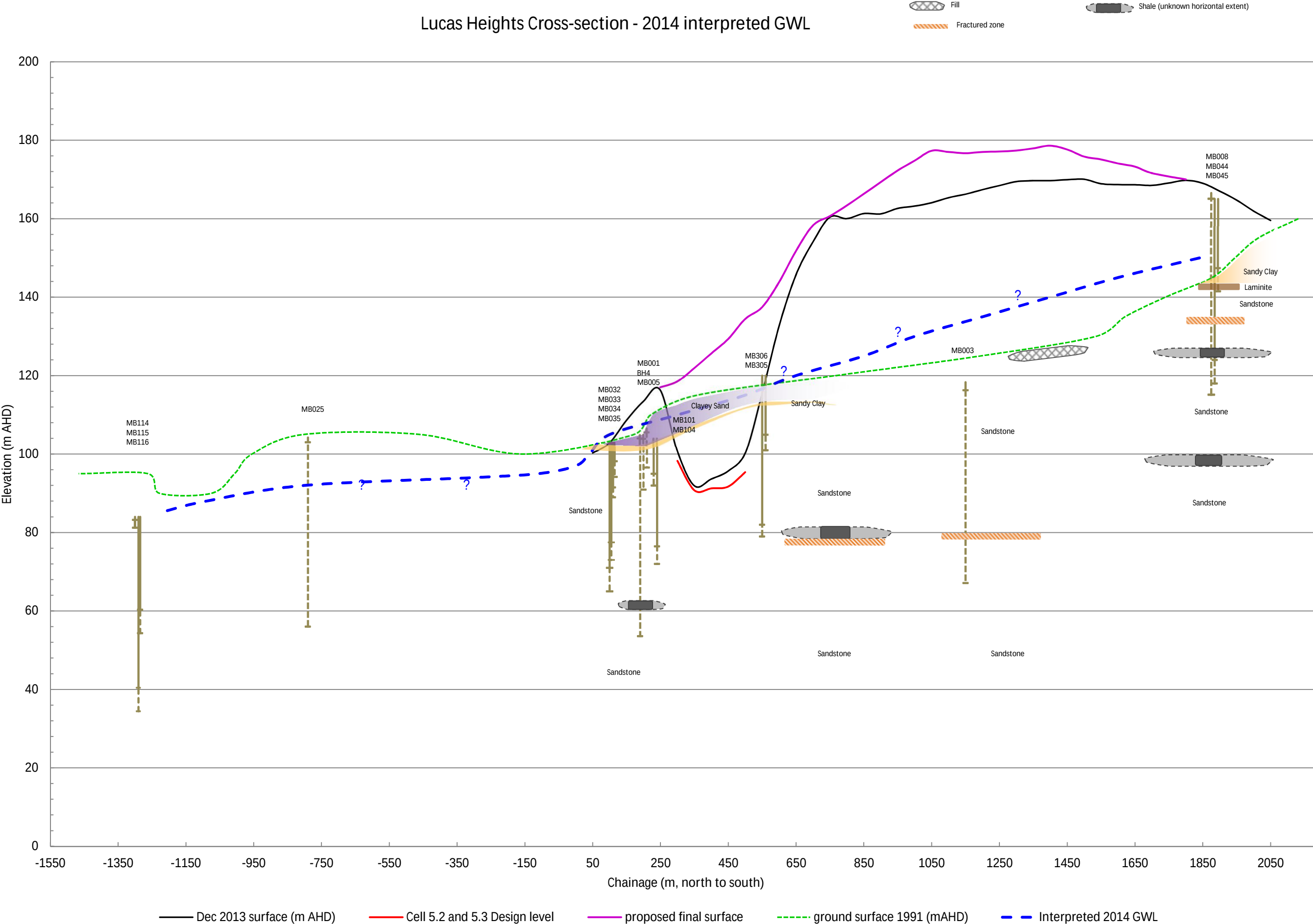
Lucas Heights Cross-section - 1997 interpreted GWL



Lucas Heights Cross-section - 2005 interpreted GWL



Lucas Heights Cross-section - 2014 interpreted GWL



Appendix H

Groundwater Well Installation Reports

SUEZ Australia Pty Ltd
PO Box 3500
Rhodes NSW 2138

Project 85988.01
31 January 2018
85988.01.R.001.Rev0
KDP:mm

Attention: Kim Ross

Email: kim.ross@suez.com

Dear Sirs

Report on Groundwater Monitoring Well Installation
Lucas Heights Resource Recovery Park
New Illawarra Road, Lucas Heights

1. Introduction

This report presents the record of the installation of two new groundwater monitoring wells at Lucas Heights Resource Recovery Park, New Illawarra Road, Lucas Heights (the Site). The investigation was commissioned by Mr Kim Ross of SUEZ Australia Pty Ltd (SUEZ) in accordance with Douglas Partners' proposal dated 6 November 2017.

This report also describes the attempts to refurbishment of groundwater well MB022 as described in the groundwater management plan¹.

2. Scope of Works

2.1 Well Installations

The scope of works was as follows:

¹ DP Report Groundwater Management Plan, Lucas Heights Resource Recovery Park, New Illawarra Road, Lucas Heights dated 5 September 2017 (DP Project 85988.01).

-) Set out of two test bores located 120 m north-northwest of bores MB038 – MB039. The two bores were positioned approximately 10 m apart. The bores were a paired set of bores with one borehole drilled to a depth of approximately 50 m (BH401 / MB048) and one to 30 m (BH402 / MB049) below ground level. Groundwater wells were installed in each of the test bores;
-) A rock core was recovered from the 50 m test bore for detailed rock core logging.
-) Provision of a factual report providing the results of the above investigations.

2.2 Groundwater Well Development

Following the installation of the groundwater monitoring wells the water levels were measured and the wells were developed by removing all standing water or a minimum of three bore volumes.

2.3 MB022 Inspection and Refurbishment

Per the requirements of groundwater management plan non-destructive methods of refurbishing MB022 were investigated. The monitoring well was inspected using a down hole camera and then the well was flushed out using a pressurised water jet.

3. Site Description

The site is identified as the Lucas Heights Resource Recovery Park (LHRRP). The site location is presented in Figure 1 (Figure 1.4 from GHD 2015). The LHRRP is located within the Sutherland local government area, approximately 30 kilometres (km) south west of the Sydney city centre.

MB048 and MB049 (the new groundwater monitoring wells) are located approximately 120 m north of the landfill at LHRRP in a council owned public reserve and are accessed by a publically accessible bike track. MB022 is located approximately 200 m north east of the landfill in the same public reserve.

Reprofiling of the landfill is proposed and would be located within the boundary of the existing LHRRP. The site is bounded to the west by Heathcote Road and New Illawarra Road to the south. Specifically, the proposed reprofiling would be located on:

-) Lot 101 DP 1009354;
-) Lot 3 DP 1032102; and
-) Lot 2 DP 605077.

It is noted that the proposal directly affects only a portion of each of these lots. There is minimal encroachment into the Sydney International Clay Target Association (SICTA) leased land (part of Lot 3 DP 1032102).

-) Landfill;
-) Resource recovery centre and waste collection point;
-) GO facility for processing garden organics;
-) Renewable energy production (operated by Energy Developments Ltd);
-) Truck parking area;
-) Community use areas (mini bike area at the southern extent of the site run by the Sutherland Police Citizens Youth Club and the SICTA leased land on the north western side of the site); and
-) There are also several ancillary buildings and structures (e.g. weighbridge, machinery workshop, administration offices, stormwater and leachate dams).

) Bushland areas that form part of ANSTO's exclusion zone (to the east and south); and
) ANSTO's facilities (to the east on the opposite side of New Illawarra Road).

-) Holsworthy Military Reserve (to the west, northwest and southwest);
-) The Ridge Sports Complex, a major regional sporting facility being developed on the site of the former Lucas Heights Waste and Recycling Centre (approximately 2.5 km to the north east);
-) Lucas Heights Conservation Area (immediately to the north of the LHRRP); and
-) The suburbs of North Engadine (approximately 2 km to the east) and Barden Ridge (approximately 3 km to the north east) Figure 1 shows these key areas.

The western boundary of the proposed development is Heathcote Road and the site extends east across Mill Creek to the edge of the existing Menai residential area close to New Illawarra Road.

4.1 Test Bore Drilling and Groundwater Well Installation

The bores were drilled using a track-mounted drilling rig with solid flight auger attachments followed by rotary drilling or HQ coring to extend the bores for the installation of groundwater monitoring wells.

Bore BH401 / MB048 was drilled using solid flight augers to a depth of 1.0 m bgl and then continued to a depth of 50.45 m bgl using HQ rock coring methods. The rock cores were placed into core boxes for logging.

Bore BH402 / MB049 was drilled using solid flight augers to a depth of 1.0 m bgl and then continued to a depth of 30.0 m bgl using rotary drilling methods. No rock core was recovered. The test bore was logged from rotary drilling returns with reference to the rock core recovered from BH401 / MB048

The date of drilling is indicated on the borehole logs (attached).

Both bores were converted into groundwater monitoring wells to enable monitoring of groundwater levels and sampling of the groundwater. The wells comprised 50 mm diameter, acid washed, Class 18, PVC casing and machine slotted well screens. The wells were completed with a gravel pack over the screened section (as indicated in the attached test bore logs), and sealed using a bentonite plug of at least 0.5 m thickness and then cement grout to the surface. The bores were finished with stainless steel well monuments. The ground surface level and GPS coordinates at each well were recorded. The well details are presented in the test bore logs, attached. The details of the test bore depths; locational rationale and groundwater well construction including screened interval details are provided in Table 1.

Table 1: Test Bore and Groundwater Well Details

Bore ID	Surface Level (m AHD)	Bore Depth	Groundwater Well Construction Details	
			Screen Interval	Casing
BH401 / MB048	144.5	50.45	41.45-50.45	0-41.45 m bgl
GW402 / MB049	114.3	30.0	24.0-30. mbgl	0 to 24 m bgl

4.2 Groundwater Bore Development

The groundwater wells were developed by removing all the standing water. Prior to pumping the water level was measured. The water level following purging was also measured and volume of water removed recorded and the results presented in Table .

5. Field Work Observations

5.1 Test Bore Conditions

The borehole conditions encountered in BH401 / MB048 is summarised below:

Bedrock: Extremely low to very low strength light grey was observed at the surface to a depth of 1.0 m bgl; underlain by

Low then medium strength sandstone, highly to moderately weathered, fractured and slightly fractured light grey medium grained sandstone with some very low strength bands to 7.7 m; underlain by

Medium then high strength sandstone, moderately then slightly weathered, fractured and unbroken brown and light grey medium and coarse grained sandstone to 13.0 m bgl; underlain by

High strength, fresh slightly fractured and unbroken light grey medium to coarse grained sandstone to 28.0 m bgl; underlain by

High strength, slightly weathered fresh slightly fractured and unbroken light grey medium to coarse grained sandstone with some siltstone bands and clasts to 35.0 m bgl; underlain by

High strength, fresh unbroken light grey medium to coarse grained sandstone to 38.0 m bgl; underlain by

High strength, slightly weathered and fresh slightly fractured and unbroken light grey medium to coarse grained sandstone with some siltstone and quartz gravel to 50.45 m bgl.

No free groundwater was observed whilst auguring. Addition of drilling fluid for drilling precluded any groundwater observations during drilling.

5.2 Groundwater Observations

The water levels measured in MB048 and MB049 are presented in Table 2 below. No obvious signs of groundwater contamination such as chemical odours or separate phase hydrocarbon contamination were observed.

Table 2: Water Levels

Bore ID	Bore Elevation (m AHD)	Groundwater Pre-purge – 23/3/16		Volume purged	Water Level (post purge)		Observations
		Depth (m bgl)	(m AHD)		Depth (m bgl)	(m AHD)	
MB048	114.5	20.18	94.32	180 L:	20.3	94.2	No signs of contamination
MB049	114.3	21.54	92.76	54 L	29.5	84.8	No signs of contamination

6. MB022 Refurbishment

An inspection of MB022 with a downhole camera indicated that silt was built up in the well to a depth of 1 m bgl. The well was pressured jetted (with water) and following the removal of the initial silt build up it was discovered that the groundwater well was bent at depth of 2 m bgl, possibly due to a vehicle impact and /or as the result of tree root incursion. Therefore it was determined that the well could not be refurbished via non-destructive means and further attempts to refurbish the well were abandoned.

7. Conclusion

It is considered that monitoring wells MB048 and MB049 are now suitable for monitoring per the modified environmental protection licence. MB022 is not suitable for monitoring.

8. Limitations

Douglas Partners (DP) has prepared this report this project at Lucas Heights Resource Recovery Park in accordance with DP's proposal dated 6 November 2017 and acceptance received from Ross Kim of SUEZ. The work was carried out under DP's Conditions of Engagement (Purchase Order No 4500090927). This report is provided for the exclusive use of SUEZ Australia for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the

work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

Please contact the undersigned if you have any questions on this matter.

Yours faithfully

Douglas Partners Pty Ltd



Kurt Plambeck
Environmental Scientist

Reviewed by



J M Nash
Principal

Attachments: About this Report
 Site Drawing
 Borehole Logs

About this Report

Douglas Partners



Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;

- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.



Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low

reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:
4,6,7
N=13
- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:
15, 30/40 mm

Sampling Methods

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.



Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726-1993, Geotechnical Site Investigations Code. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	20 - 63
Medium gravel	6 - 20
Fine gravel	2.36 - 6
Coarse sand	0.6 - 2.36
Medium sand	0.2 - 0.6
Fine sand	0.075 - 0.2

The proportions of secondary constituents of soils are described as:

Term	Proportion	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	20 - 35%	Sandy Clay
Slightly	12 - 20%	Slightly Sandy Clay
With some	5 - 12%	Clay with some sand
With a trace of	0 - 5%	Clay with a trace of sand

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	vs	<12
Soft	s	12 - 25
Firm	f	25 - 50
Stiff	st	50 - 100
Very stiff	vst	100 - 200
Hard	h	>200

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	SPT N value	CPT qc value (MPa)
Very loose	vl	<4	<2
Loose	l	4 - 10	2 - 5
Medium dense	md	10 - 30	5 - 15
Dense	d	30 - 50	15 - 25
Very dense	vd	>50	>25

Soil Descriptions

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Transported soils - formed somewhere else and transported by nature to the site; or
- Filling - moved by man.

Transported soils may be further subdivided into:

- Alluvium - river deposits
- Lacustrine - lake deposits
- Aeolian - wind deposits
- Littoral - beach deposits
- Estuarine - tidal river deposits
- Talus - scree or coarse colluvium
- Slopewash or Colluvium - transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.



Rock Strength

Rock strength is defined by the Point Load Strength Index ($Is_{(50)}$) and refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects. The test procedure is described by Australian Standard 4133.4.1 - 2007. The terms used to describe rock strength are as follows:

Term	Abbreviation	Point Load Index $Is_{(50)}$ MPa	Approximate Unconfined Compressive Strength MPa*
Extremely low	EL	<0.03	<0.6
Very low	VL	0.03 - 0.1	0.6 - 2
Low	L	0.1 - 0.3	2 - 6
Medium	M	0.3 - 1.0	6 - 20
High	H	1 - 3	20 - 60
Very high	VH	3 - 10	60 - 200
Extremely high	EH	>10	>200

* Assumes a ratio of 20:1 for UCS to $Is_{(50)}$. It should be noted that the UCS to $Is_{(50)}$ ratio varies significantly for different rock types and specific ratios should be determined for each site.

Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Abbreviation	Description
Extremely weathered	EW	Rock substance has soil properties, i.e. it can be remoulded and classified as a soil but the texture of the original rock is still evident.
Highly weathered	HW	Limonite staining or bleaching affects whole of rock substance and other signs of decomposition are evident. Porosity and strength may be altered as a result of iron leaching or deposition. Colour and strength of original fresh rock is not recognisable
Moderately weathered	MW	Staining and discolouration of rock substance has taken place
Slightly weathered	SW	Rock substance is slightly discoloured but shows little or no change of strength from fresh rock
Fresh stained	Fs	Rock substance unaffected by weathering but staining visible along defects
Fresh	Fr	No signs of decomposition or staining

Degree of Fracturing

The following classification applies to the spacing of natural fractures in diamond drill cores. It includes bedding plane partings, joints and other defects, but excludes drilling breaks.

Term	Description
Fragmented	Fragments of <20 mm
Highly Fractured	Core lengths of 20-40 mm with some fragments
Fractured	Core lengths of 40-200 mm with some shorter and longer sections
Slightly Fractured	Core lengths of 200-1000 mm with some shorter and longer sections
Unbroken	Core lengths mostly > 1000 mm

Rock Descriptions

Rock Quality Designation

The quality of the cored rock can be measured using the Rock Quality Designation (RQD) index, defined as:

$$\text{RQD \%} = \frac{\text{cumulative length of 'sound' core sections} \geq 100 \text{ mm long}}{\text{total drilled length of section being assessed}}$$

where 'sound' rock is assessed to be rock of low strength or better. The RQD applies only to natural fractures. If the core is broken by drilling or handling (i.e. drilling breaks) then the broken pieces are fitted back together and are not included in the calculation of RQD.

Stratification Spacing

For sedimentary rocks the following terms may be used to describe the spacing of bedding partings:

Term	Separation of Stratification Planes
Thinly laminated	< 6 mm
Laminated	6 mm to 20 mm
Very thinly bedded	20 mm to 60 mm
Thinly bedded	60 mm to 0.2 m
Medium bedded	0.2 m to 0.6 m
Thickly bedded	0.6 m to 2 m
Very thickly bedded	> 2 m

Symbols & Abbreviations

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Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U ₅₀	Undisturbed tube sample (50mm)
W	Water sample
pp	Pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	Lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

Symbols & Abbreviations

Graphic Symbols for Soil and Rock

General



Asphalt



Road base



Concrete



Filling

Soils



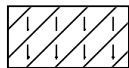
Topsoil



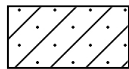
Peat



Clay



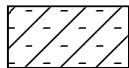
Silty clay



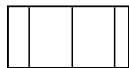
Sandy clay



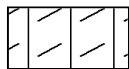
Gravelly clay



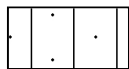
Shaly clay



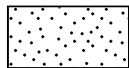
Silt



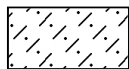
Clayey silt



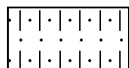
Sandy silt



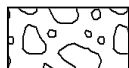
Sand



Clayey sand



Silty sand



Gravel



Sandy gravel



Cobbles, boulders



Talus

Sedimentary Rocks



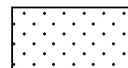
Boulder conglomerate



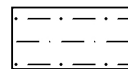
Conglomerate



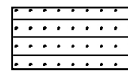
Conglomeratic sandstone



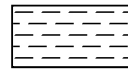
Sandstone



Siltstone



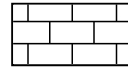
Laminite



Mudstone, claystone, shale

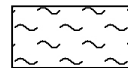


Coal

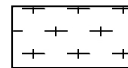


Limestone

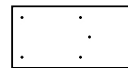
Metamorphic Rocks



Slate, phyllite, schist

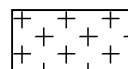


Gneiss

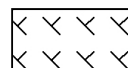


Quartzite

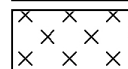
Igneous Rocks



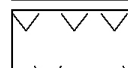
Granite



Dolerite, basalt, andesite



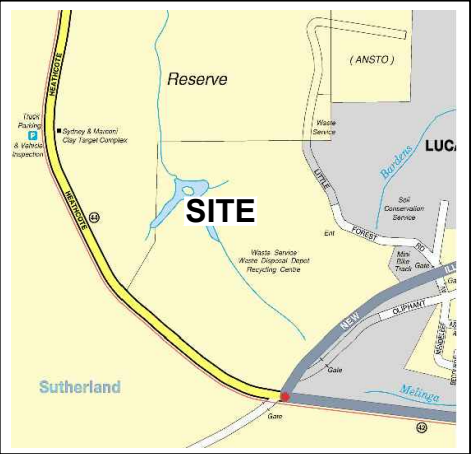
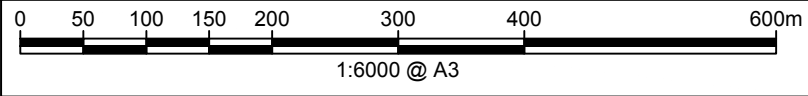
Dacite, epidote



Tuff, breccia



Porphyry



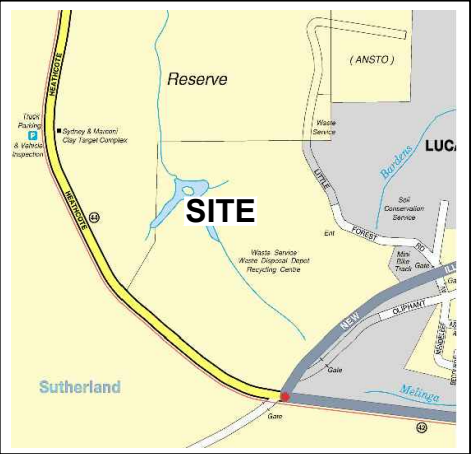
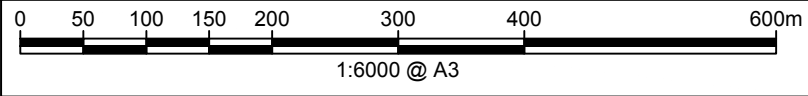
Locality Plan

NOTE:
1: Base image from Nearmap.com
(Dated 1.5.2017)
2: Test locations are approximate only and are shown
with reference to existing features.

LEGEND

- Decommissioned
- Unused
- Quarterly Monitoring
- Surface water/ Leachate monitoring point





Locality Plan

NOTE:
1: Base image from Nearmap.com
(Dated 1.5.2017)
2: Test locations are approximate only and are shown
with reference to existing features.

LEGEND

- Decommissioned
- Unused
- Quarterly Monitoring
- Surface water/ Leachate monitoring point



BOREHOLE LOG

CLIENT: Suez Australia Pty Ltd
PROJECT: Lucas Heights Monitoring Wells
LOCATION: New Illawarra Road, Lucas Heights

SURFACE LEVEL: 114.5 AHD
EASTING: 312315
NORTHING: 6232000
DIP/AZIMUTH: 90°/-

BORE No: 401/MB048
PROJECT No: 85988.01
DATE: 13 - 15/12/2017
SHEET 1 OF 6

RL	Depth (m)	Description of Strata	Degree of Weathering						Graphic Log	Rock Strength					Water	Fracture Spacing (m)	Discontinuities		Sampling & In Situ Testing																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
			EW	HW	MW	SW	FS	FR		Ex Low	Very Low	Low	Medium	High			Very High	Ex High	B - Bedding	J - Joint	Type	Core Rec. %	RQD %	Test Results & Comments																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
114	1.0	SANDSTONE - extremely low to very low strength, light grey-brown, fine grained sandstone																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															

RIG: Geo 305

DRILLER: LC

LOGGED: SI

CASING: HW to 1.0m

TYPE OF BORING: Solid flight auger to 1.0m; HQ-Coring to 50.45m

WATER OBSERVATIONS: No free groundwater observed whilst augering. 10% water loss from 15.0m; 30% from 20.0m; 100% water loss from 36.0m

REMARKS: Standpipe installed to 50.45m (screen 50.45-41.45m; gravel 50.45-40.5m; bentonite 40.5-38.0m; grout backfill 38.0m to GL, with stick-up within monument of 1.0m). *Estimated rock strength

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	S	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)



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BOREHOLE LOG

CLIENT: Suez Australia Pty Ltd
PROJECT: Lucas Heights Monitoring Wells
LOCATION: New Illawarra Road, Lucas Heights

SURFACE LEVEL: 114.5 AHD
EASTING: 312315
NORTHING: 6232000
DIP/AZIMUTH: 90°/--

BORE No: 401/MB048
PROJECT No: 85988.01
DATE: 13 - 15/12/2017
SHEET 2 OF 6

RL	Depth (m)	Description of Strata	Degree of Weathering					Graphic Log	Rock Strength					Water	Fracture Spacing (m)	Discontinuities	Sampling & In Situ Testing				
			EW	HW	MW	SW	FS		FR	Ex Low	Very Low	Low	Medium			High	Very High	Ex High	B - Bedding S - Shear	J - Joint F - Fault	Type
104		SANDSTONE - medium to high then high strength, moderately then slightly weathered, slightly fractured and unbroken, brown then light grey-brown, medium to coarse grained sandstone (<i>continued</i>) 10.7m: becoming cross-bedded at 10°- 20°																			
11																					
103																					
102																					
13	13.0	SANDSTONE - high strength, fresh, slightly fractured and unbroken, light grey-pale grey, medium to coarse grained sandstone. Cross bedding 10°- 20°, thinly bedded to medium 14.7m: becoming thickly bedded																			
101																					
14																					
100																					
15																					
99																					
16																					
98																					
17																					
97																					
18																					
96																					
19																					
95																					

RIG: Geo 305

DRILLER: LC

LOGGED: SI

CASING: HW to 1.0m

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B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	S	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)

BOREHOLE LOG

CLIENT: Suez Australia Pty Ltd
PROJECT: Lucas Heights Monitoring Wells
LOCATION: New Illawarra Road, Lucas Heights

SURFACE LEVEL: 114.5 AHD
EASTING: 312315
NORTHING: 6232000
DIP/AZIMUTH: 90°/-

BORE No: 401/MB048
PROJECT No: 85988.01
DATE: 13 - 15/12/2017
SHEET 3 OF 6

RL	Depth (m)	Description of Strata	Degree of Weathering					Graphic Log	Rock Strength					Water	Fracture Spacing (m)				Discontinuities		Sampling & In Situ Testing																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
			EW	HW	MW	SW	FS		FR	Ex Low	Very Low	Low	Medium		High	Very High	Ex High	0.01	0.05	0.10	0.50	1.00	B - Bedding S - Shear	J - Joint F - Fault	Type	Core Rec. %	RQD %	Test Results & Comments																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
94		SANDSTONE - high strength, fresh, slightly fractured and unbroken, light grey-pale grey, medium to coarse grained sandstone. Cross bedding 10°- 20°, thinly bedded to medium <i>(continued)</i>																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				

RIG: Geo 305

DRILLER: LC

LOGGED: SI

CASING: HW to 1.0m

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SAMPLING & IN SITU TESTING LEGEND

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C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	S	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)



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BOREHOLE LOG

CLIENT: Suez Australia Pty Ltd
PROJECT: Lucas Heights Monitoring Wells
LOCATION: New Illawarra Road, Lucas Heights

SURFACE LEVEL: 114.5 AHD
EASTING: 312315
NORTHING: 6232000
DIP/AZIMUTH: 90°/--

BORE No: 401/MB048
PROJECT No: 85988.01
DATE: 13 - 15/12/2017
SHEET 4 **OF** 6

[illegible]

CASING: HW to 1.0m

TYPE OF BORING: Solid flight auger to 1.0m: HQ-Coring to 50.45m

WATER OBSERVATIONS: No free groundwater observed whilst augering. 10% water loss from 15.0m; 30% from 20.0m; 100% water loss from 36.0m

REMARKS: Standpipe installed to 50.45m (screen 50.45-41.45m; gravel 50.45-40.5m; bentonite 40.5-38.0m; grout backfill 38.0m to GL, with stick-up within monument of 1.0m). *Estimated rock strength

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PLA	Point load axial test ls(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PLD	Point load diametral test ls(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W	Water seep	S	Standard penetration test
E	Environmental sample	W	Water level	V	Shear vane (kPa)



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BOREHOLE LOG

CLIENT: Suez Australia Pty Ltd
PROJECT: Lucas Heights Monitoring Wells
LOCATION: New Illawarra Road, Lucas Heights

SURFACE LEVEL: 114.5 AHD
EASTING: 312315
NORTHING: 6232000
DIP/AZIMUTH: 90°/--

BORE No: 401/MB048
PROJECT No: 85988.01
DATE: 13 - 15/12/2017
SHEET 5 OF 6

RL	Depth (m)	Description of Strata	Degree of Weathering						Graphic Log	Rock Strength						Water	Fracture Spacing (m)	Discontinuities		Sampling & In Situ Testing					
			EW	HW	MW	SW	FS	FR		Ex Low	Very Low	Low	Medium	High	Very High			Ex High	B - Bedding S - Shear	J - Joint F - Fault	Type	Core Rec. %	RQD %	Test Results & Comments	
74		SANDSTONE - high strength, slightly weathered and fresh, slightly fractured and unbroken, pale grey and brown, medium to coarse grained sandstone with some siltstone and quartz gravel. Cross-bedding 5°- 10° 38.78m: siltstone quartz clast, 10mm (continued)																							
41																									
73																									
42																									
72																									
43																									
71																									
44																									
70																									
45																									
69																									
46																									
68																									
47																									
67																									
48																									
66																									
49																									
65																									

RIG: Geo 305

DRILLER: LC

LOGGED: SI

CASING: HW to 1.0m

TYPE OF BORING: Solid flight auger to 1.0m; HQ-Coring to 50.45m

WATER OBSERVATIONS: No free groundwater observed whilst augering. 10% water loss from 15.0m; 30% from 20.0m; 100% water loss from 36.0m

REMARKS: Standpipe installed to 50.45m (screen 50.45-41.45m; gravel 50.45-40.5m; bentonite 40.5-38.0m; grout backfill 38.0m to GL, with stick-up within monument of 1.0m). *Estimated rock strength

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W	Water seep	S	Standard penetration test
E	Environmental sample	W	Water level	V	Shear vane (kPa)



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BOREHOLE LOG

CLIENT: Suez Australia Pty Ltd
PROJECT: Lucas Heights Monitoring Wells
LOCATION: New Illawarra Road, Lucas Heights

SURFACE LEVEL: 114.5 AHD
EASTING: 312315
NORTHING: 6232000
DIP/AZIMUTH: 90°/--

BORE No: 401/MB048
PROJECT No: 85988.01
DATE: 13 - 15/12/2017
SHEET 6 OF 6

RL	Depth (m)	Description of Strata	Degree of Weathering					Graphic Log	Rock Strength					Water	Fracture Spacing (m)				Discontinuities		Sampling & In Situ Testing				
			EW	HW	MW	SW	FS		FR	Ex Low	Very Low	Low	Medium		High	Very High	Ex High	0.01	0.05	0.10	0.50	1.00	B - Bedding S - Shear	J - Joint F - Fault	Type
64	50.45	SANDSTONE <i>-(continued)</i>																							
		Bore discontinued at 50.45m																				C	100	100	
	51																								
	63																								
	52																								
	62																								
	53																								
	61																								
	54																								
	60																								
	55																								
	59																								
	56																								
	58																								
	57																								
	57																								
	58																								
	56																								
	59																								
	55																								

RIG: Geo 305

DRILLER: LC

LOGGED: SI

CASING: HW to 1.0m

TYPE OF BORING: Solid flight auger to 1.0m; HQ-Coring to 50.45m

WATER OBSERVATIONS: No free groundwater observed whilst augering. 10% water loss from 15.0m; 30% from 20.0m; 100% water loss from 36.0m

REMARKS: Standpipe installed to 50.45m (screen 50.45-41.45m; gravel 50.45-40.5m; bentonite 40.5-38.0m; grout backfill 38.0m to GL, with stick-up within monument of 1.0m). *Estimated rock strength

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	S	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)

BOREHOLE LOG

CLIENT: Suez Australia Pty Ltd
PROJECT: Lucas Heights Monitoring Wells
LOCATION: New Illawarra Road, Lucas Heights

SURFACE LEVEL: 114.3 AHD
EASTING: 312323
NORTHING: 6231987
DIP/AZIMUTH: 90°/--

BORE No: 402/MB049
PROJECT No: 85988.01
DATE: 6 - 7/12/2017
SHEET 1 OF 3

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction	
				Type	Depth	Sample	Results & Comments		Details	
114	1	SANDSTONE - low to medium, becoming high strength, grey and brown sandstone							1.0m stickup	
113	2									
112	3									
111	4	Refer to Borehole log 401/MB048 for rock core details. Nested bore location approximately 10.0m from Bore 402/MB049								
110	5									
109	6									
108	7									
107	8									
106	9									
105										

RIG: Geo 305

DRILLER: JC

LOGGED: SI

CASING: HW to 1.0m

TYPE OF BORING: Solid flight auger to 1.0m, rotary to 30.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Standpipe installed to 30.0m (screen 24.0-30.0m; gravel 23.0-30.0m; bentonite 22.0-23.0m; grout from 22.0m to surface)

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	S	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)



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BOREHOLE LOG

CLIENT: Suez Australia Pty Ltd
PROJECT: Lucas Heights Monitoring Wells
LOCATION: New Illawarra Road, Lucas Heights

SURFACE LEVEL: 114.3 AHD
EASTING: 312323
NORTHING: 6231987
DIP/AZIMUTH: 90°/--

BORE No: 402/MB049
PROJECT No: 85988.01
DATE: 6 - 7/12/2017
SHEET 2 OF 3

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details		
				Type	Depth	Sample	Results & Comments				
104		SANDSTONE - low to medium, becoming high strength, grey and brown sandstone (<i>continued</i>)									
11									11 Grout 0.0-5.0m		
103											
12											
102											
13											
101											
14											
100											
15											
99											
16											
98											
17											
97											
18											
96											
19											
95											

RIG: Geo 305

DRILLER: JC

LOGGED: SI

CASING: HW to 1.0m

TYPE OF BORING: Solid flight auger to 1.0m, rotary to 30.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Standpipe installed to 30.0m (screen 24.0-30.0m; gravel 23.0-30.0m; bentonite 22.0-23.0m; grout from 22.0m to surface)

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U _t	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W _s	Water seep	S	Standard penetration test
E	Environmental sample	W _l	Water level	V	Shear vane (kPa)



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BOREHOLE LOG

CLIENT: Suez Australia Pty Ltd
PROJECT: Lucas Heights Monitoring Wells
LOCATION: New Illawarra Road, Lucas Heights

SURFACE LEVEL: 114.3 AHD
EASTING: 312323
NORTHING: 6231987
DIP/AZIMUTH: 90°/--

BORE No: 402/MB049
PROJECT No: 85988.01
DATE: 6 - 7/12/2017
SHEET 3 OF 3

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
94		SANDSTONE - low to medium, becoming high strength, grey and brown sandstone (<i>continued</i>)								
21										
22										
23										
24										
25										
26										
27										
28										
29										
30.0										

Bore discontinued at 30.0m

RIG: Geo 305

DRILLER: JC

LOGGED: SI

CASING: HW to 1.0m

TYPE OF BORING: Solid flight auger to 1.0m, rotary to 30.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Standpipe installed to 30.0m (screen 24.0-30.0m; gravel 23.0-30.0m; bentonite 22.0-23.0m; grout from 22.0m to surface)

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U _s	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W _s	Water seep	S	Standard penetration test
E	Environmental sample	W _l	Water level	V	Shear vane (kPa)



Douglas Partners
 Geotechnics | Environment | Groundwater

Cleanaway Operations Pty Ltd
Level 4 / 441 St Kilda Road
Melbourne VIC 3004

Attention: LC Chiang

Email: LC.Chiang@cleanaway.com.au

Project 85988.04
21 July 2023
R.001.Rev0
KDP:jl

Groundwater Well Installation Report
Lucas Heights Resource Recovery Park
19 Little Forest Road, Lucas Heights

1. Introduction

This report presents the record of the installation of two new groundwater monitoring wells at Lucas Heights Resource Recovery Park, New Illawarra Road, Lucas Heights (the Site). The work was commissioned by LC Chiang of Cleanaway Operations Pty Ltd in accordance with Douglas Partners' proposal dated 29 May 2023.

2. Scope of Works

2.1 Well Installations

The scope of works was as follows:

- Set out of two test bores (MB056 and MB057) located on the western side of the Site adjacent to the new proposed Garden Organics pad. The two bores were each drilled to a depth of 29.8 m followed by the installation of groundwater monitoring wells;
- Rock cores was recovered from each of the bores to facilitate detailed rock core logging; and
- Provision of a factual report providing the results of the above investigations.

2.2 Groundwater Well Development

Following the installation of the groundwater monitoring wells the water levels were measured and the wells were developed by removing all standing water or a minimum of three bore volumes.

3. Site Description

The site is identified as the Lucas Heights Resource Recovery Park (LHRRP), the location is presented on Drawing 1, attached. The LHRRP is located within the Sutherland local government area, approximately 30 kilometres (km) southwest of the Sydney city centre.

MB056 and MB057 (the new groundwater monitoring wells) are located approximate to the western side of the Site next to the proposed Garden Organics pad. The location of MB056 and MB057 is presented on Drawing 2, attached.

The LHRRP site is currently accessed from Little Forest Road, off New Illawarra Road. Current facilities at the LHRRP include:

- Landfill;
- Resource recovery centre and waste collection point;
- GO facility for processing garden organics;
- Renewable energy production (operated by Energy Developments Ltd);
- Truck parking area;
- Community use areas (mini bike area at the southern extent of the site run by the Sutherland Police Citizens Youth Club and the SICTA leased land on the north western side of the site); and
- Several ancillary buildings and structures (e.g., weighbridge, machinery workshop, administration offices, stormwater and leachate dams).

The following land uses are located in the immediate vicinity of the LHRRP:

- Bushland areas that form part of ANSTO's exclusion zone (to the east and south); and
- ANSTO's facilities (to the east on the opposite side of New Illawarra Road).

Land uses in the surrounding area include:

- Holsworthy Military Reserve (to the west, northwest and southwest);
- The Ridge Sports Complex, a major regional sporting facility being developed on the site of the former Lucas Heights Waste and Recycling Centre (approximately 2.5 km to the northeast);
- Lucas Heights Conservation Area (immediately to the north of the LHRRP); and
- The suburbs of North Engadine (approximately 2 km to the east) and Barden Ridge (approximately 3 km to the northeast) Figure 1 shows these key areas.

The Gandangara Local Aboriginal Land Council (GALC) is proposing a development in the West Menai area. The West Menai State Significant Site contains 849 ha of mostly undeveloped land, covering parts of Menai, Barden Ridge and Lucas Heights.

The western boundary of the proposed development is Heathcote Road and the site extends east across Mill Creek to the edge of the existing Menai residential area close to New Illawarra Road.

4. Field Work Methods

4.1 Test Bore Drilling and Groundwater Well Installation

The bores were drilled using a truck-mounted drilling rig with solid flight auger attachments followed by HQ coring to extend the bores for the installation of groundwater monitoring wells. The rock cores were placed into core boxes for logging.

Both bores were converted into groundwater monitoring wells to enable monitoring of groundwater levels and sampling of the groundwater. The wells comprised 50 mm diameter, acid washed, Class 18, PVC casing and machine slotted well screens. The wells were completed with a gravel pack over the screened section (as indicated in the attached test bore logs), and sealed using a bentonite plug of at least 0.5 m thickness and then cement grout to the surface. The bores were finished with stainless steel well monuments. The ground surface level and GPS coordinates at each well were recorded. The well details including the date of drilling are presented in the test bore logs, attached. Summary details of the test bore depths, locational rationale and groundwater well construction; including screened intervals are provided in Table 1.

The levels and coordinates were recorded using a differential GPS. It is noted that due to poor satellite coverage that the accuracy of the GPS was limited to 3-5 m. It is understood that Cleanaway intends to survey the test locations to get more accurate levels and coordinates.

Table 1: Test Bore and Groundwater Well Details

Bore ID	Surface Level (m AHD)*	Bore Depth	Groundwater Well Construction Details		
			Screen Interval	Casing	Stick – Up (monument)
MB056	151	29.8	23.8-29.8 m bgl	0-23.8 m bgl	1.0 m above surface level
MB057	150	29.8	23.8-29.8 m bgl	0-23.8 m bgl	1.0 m above surface level

* RLs of ground levels. RLs to be confirmed via survey. RLs based on DGPS accurate to 3-5. Top of Monument plus 1.0 m from ground level.

4.2 Groundwater Bore Development

The groundwater wells were developed by removing all the standing water. Prior to pumping the water level was measured. The water levels following purging were also measured and volume of water removed recorded and the results presented in Table 2.

5. Field Work Observations

5.1 Test Bore Conditions

The borehole conditions encountered is summarised below:

Depth (m bgl)	Unit	Description
MB056		
0-0.3	Fill / Sandy Silty Clay	Low to medium plasticity, dark-brown, trace sandstone and ironstone gravel, rootlet.s
0.3-1.5	Sandy Clay	Medium to high plasticity, orange-brown to red-brown, fine to medium sand, trace ironstone gravel, w~PL, extremely weathered Hawkesbury Sandstone.
1.5-8.25	Sandstone	Medium to coarse grained, red-brown and pale-grey, apparently medium and high strength slightly fractured, Hawkesbury Sandstone.
8.25-12.5		Fine to medium grained, pale grey, distinctly bedded 10°, high strength, slightly weathered to fresh, slightly fractured to unbroken, Hawkesbury Sandstone.
12.5-15.55		Medium to coarse grained, pale red-brown, thinly to medium bedded, very high strength, unbroken, slightly weathered to fresh, Hawkesbury Sandstone.
15.55-22.6		Fine to medium grained, pale grey, thinly bedded, medium strength with some low strength zones, slight weathered to fresh, slightly fractured, Hawkesbury Sandstone.
22.6-29.8		Medium to coarse grained, pale red-brown to pale grey, thinly to medium bedded, medium to high strength, weathered, slightly fractured to unbroken, Hawkesbury Sandstone. Between 23.9 to 24.7 m: grey, thinly laminated. Between 29-29.8 m: grey, unbroken.
MB057		
0-0.2	Sand	Fine to medium, brown, trace silt, moist, apparently loose, residual.
0.2-0.9	Sandstone	Fine to medium grained, orange-brown to red-brown, very low and low to medium strength, highly weathered, Hawkesbury Sandstone.
0.9-14.65		Medium to coarse grained, pale grey-brown and brown, cross bedded (10°-20°), medium then high strength, moderately to slightly weathered and fresh, slightly fractured with some fractured band and unbroken, Hawkesbury Sandstone.

Depth (m bgl)	Unit	Description
14.65-18.2		Fine to medium grained, pale grey, trace carbonaceous lamination, medium then high strength, fresh, slightly fractured and unbroken, Hawkesbury Sandstone
18.2-29.8		Medium to coarse grained, pale grey, cross bedded (10°-25°), high strength, fresh, slightly fractured and unbroken, Hawkesbury Sandstone between 20.75-22.1m: low and low to medium strength.

No free groundwater was observed whilst auguring. Addition of drilling fluid for drilling precluded any groundwater observations during drilling.

5.2 Groundwater Observations

The water levels measured in MB048 and MB049 are presented in Table 2 below. No obvious signs of groundwater contamination such as chemical odours or separate phase hydrocarbon contamination were observed.

Table 2: Water Levels

Bore ID	Bore Elevation (m AHD)*	Groundwater Pre-purge –		Volume purged	Water Level (post purge)		Observations
		Depth (m bgl)#	(m AHD)		Depth (m bgl)#	(m AHD)	
MB056	151	10.1	140.9	70	25.6	125.4	No signs of contamination
MB057	150	11.1	138.8	70	24.9	125.1	No signs of contamination

Notes

- * RLs of ground levels. RLs to be confirmed via survey. RLs based on DGPS accurate to 3-5 m. Top of Monument plus 1.0 m from ground level.
- # Depth below ground level at time of monitoring.
Groundwater levels are transient and are subject to changes due to human and natural influences.

6. Conclusion

It is considered that monitoring wells MB056 and MB057 are now suitable for monitoring per the modified environmental protection licence.

7. Limitations

Douglas Partners (DP) has prepared this report for this project at 19 Little Forest Road, Lucas Heights in accordance with DP's proposal dated 29 May 2023 and acceptance received from Cleanaway Operations Pty Ltd dated 31 May 2023. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Cleanaway Services Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

The assessment of atypical safety hazards arising from this advice is restricted to the (geotechnical / environmental / groundwater) components set out in this report and based on known project conditions and stated design advice and assumptions. While some recommendations for safe controls may be provided, detailed 'safety in design' assessment is outside the current scope of this report and requires additional project data and assessment.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

Please contact the undersigned if you have any questions on this matter.

Yours faithfully
Douglas Partners Pty Ltd



Kurt Plambeck
Senior Associate

Reviewed by

PP 

J.M. Nash
Principal

Attachments: About this Report
 Soil Descriptions
 Symbols and Abbreviations
 Drawing 1 and 2
 Borehole Logs and Core Photo Plates

About this Report

Douglas Partners



Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;

- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.



Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are generally based on Australian Standard AS1726:2017, Geotechnical Site Investigations. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	19 - 63
Medium gravel	6.7 - 19
Fine gravel	2.36 - 6.7
Coarse sand	0.6 - 2.36
Medium sand	0.21 - 0.6
Fine sand	0.075 - 0.21

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

The proportions of secondary constituents of soils are described as follows:

In fine grained soils (>35% fines)

Term	Proportion of sand or gravel	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	>30%	Sandy Clay
With	15 - 30%	Clay with sand
Trace	0 - 15%	Clay with trace sand

In coarse grained soils (>65% coarse)

- with clays or silts

Term	Proportion of fines	Example
And	Specify	Sand (70%) and Clay (30%)
Adjective	>12%	Clayey Sand
With	5 - 12%	Sand with clay
Trace	0 - 5%	Sand with trace clay

In coarse grained soils (>65% coarse)

- with coarser fraction

Term	Proportion of coarser fraction	Example
And	Specify	Sand (60%) and Gravel (40%)
Adjective	>30%	Gravelly Sand
With	15 - 30%	Sand with gravel
Trace	0 - 15%	Sand with trace gravel

The presence of cobbles and boulders shall be specifically noted by beginning the description with 'Mix of Soil and Cobbles/Boulders' with the word order indicating the dominant first and the proportion of cobbles and boulders described together.

Soil Descriptions

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	VS	<12
Soft	S	12 - 25
Firm	F	25 - 50
Stiff	St	50 - 100
Very stiff	VSt	100 - 200
Hard	H	>200
Friable	Fr	-

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	Density Index (%)
Very loose	VL	<15
Loose	L	15-35
Medium dense	MD	35-65
Dense	D	65-85
Very dense	VD	>85

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Extremely weathered material – formed from in-situ weathering of geological formations. Has soil strength but retains the structure or fabric of the parent rock;
- Alluvial soil – deposited by streams and rivers;

- Estuarine soil – deposited in coastal estuaries;
- Marine soil – deposited in a marine environment;
- Lacustrine soil – deposited in freshwater lakes;
- Aeolian soil – carried and deposited by wind;
- Colluvial soil – soil and rock debris transported down slopes by gravity;
- Topsoil – mantle of surface soil, often with high levels of organic material.
- Fill – any material which has been moved by man.

Moisture Condition – Coarse Grained Soils

For coarse grained soils the moisture condition should be described by appearance and feel using the following terms:

- Dry (D) Non-cohesive and free-running.
- Moist (M) Soil feels cool, darkened in colour.
Soil tends to stick together.
Sand forms weak ball but breaks easily.
- Wet (W) Soil feels cool, darkened in colour.
Soil tends to stick together, free water forms when handling.

Moisture Condition – Fine Grained Soils

For fine grained soils the assessment of moisture content is relative to their plastic limit or liquid limit, as follows:

- 'Moist, dry of plastic limit' or 'w < PL' (i.e. hard and friable or powdery).
- 'Moist, near plastic limit' or 'w ≈ PL' (i.e. soil can be moulded at moisture content approximately equal to the plastic limit).
- 'Moist, wet of plastic limit' or 'w > PL' (i.e. soils usually weakened and free water forms on the hands when handling).
- 'Wet' or 'w ≈ LL' (i.e. near the liquid limit).
- 'Wet' or 'w > LL' (i.e. wet of the liquid limit).

Symbols & Abbreviations

Douglas Partners



Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U ₅₀	Undisturbed tube sample (50mm)
W	Water sample
pp	Pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	Lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

Symbols & Abbreviations

Graphic Symbols for Soil and Rock

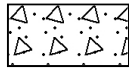
General



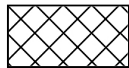
Asphalt



Road base



Concrete



Filling

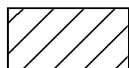
Soils



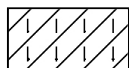
Topsoil



Peat



Clay



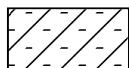
Silty clay



Sandy clay



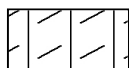
Gravelly clay



Shaly clay



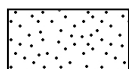
Silt



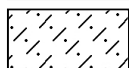
Clayey silt



Sandy silt



Sand



Clayey sand



Silty sand



Gravel



Sandy gravel



Cobbles, boulders



Talus

Sedimentary Rocks



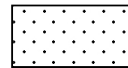
Boulder conglomerate



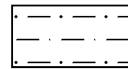
Conglomerate



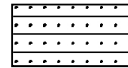
Conglomeratic sandstone



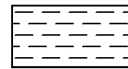
Sandstone



Siltstone



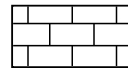
Laminite



Mudstone, claystone, shale

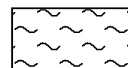


Coal

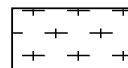


Limestone

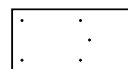
Metamorphic Rocks



Slate, phyllite, schist

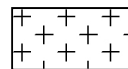


Gneiss

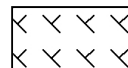


Quartzite

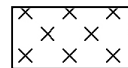
Igneous Rocks



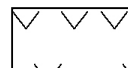
Granite



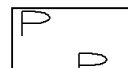
Dolerite, basalt, andesite



Dacite, epidote



Tuff, breccia



Porphyry



Site Location

Legend

- New Monitoring Well (2023)
- Previous Bore Location
- Quarterly Monitoring
- Decommisioned
- Unused

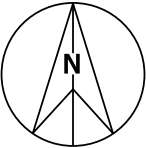
NOTE:
1. Drawing adapted from aerial imagery from Metromap dated 6 May 2023
2. Test locations are approximate only and were located using coordinates supplied by the client

0 100 200 300 400 500 m



CLIENT: Cleanaway Operations Pty Ltd	
OFFICE: Sydney	DRAWN BY: KDP
SCALE: 1:12000 @A3	DATE: 18.July.2023

TITLE:	Test Location Plan
	Groundwater Well Installtion
	19 :ittle Forest Road, Lucas Heights NSW



Project:	85988.04
DRAWING No:	1
REVISION:	0



Site Location

Legend

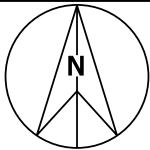
-  New Monitoring Well (2023)
-  Previous Bore Location
-  Decommissioned

NOTE:
1. Drawing adapted from aerial imagery from Metromap dated 6 May 2023
2. Test locations are approximate only and were located using coordinates supplied by the client



CLIENT: Cleanaway Operations Pty Ltd	
OFFICE: Sydney	DRAWN BY: KDP
SCALE: 1:2500 @A3	DATE: 18.July.2023

TITLE:	Location of New Monitoring Wells
	Groundwater Well Installtion
	19 :ittle Forest Road, Lucas Heights NSW



Project:	85988.04
DRAWING No:	2
REVISION:	0

BOREHOLE LOG

CLIENT: Cleanaway Operations Pty Ltd
PROJECT: Lucas Heights Resource Recovery Park
LOCATION: 19 Little Forest Road, Lucas Heights

SURFACE LEVEL: 151 AHD
EASTING: 312019.3
NORTHING: 6230601.6
DIP/AZIMUTH: 90°/--

BORE No: MB056
PROJECT No: 85988.04
DATE: 28/6/2023
SHEET 1 OF 3

RL	Depth (m)	Description of Strata	Degree of Weathering					Graphic Log	Rock Strength					Water	Fracture Spacing (m)	Discontinuities		Sampling & In Situ Testing			
			EW	HW	MW	SW	FS		FR	Ex Low	Very Low	Low	Medium			High	Very High	Ex High	B - Bedding S - Shear	J - Joint F - Fault	Type
151	0.3	FILL/Sandy Silty CLAY: low to medium plasticity, dark-brown, trace sandstone and ironstone gravel, rootlets, w~PL																			
150	1	Sandy CLAY: medium to high plasticity, orange-brown to red-brown, fine to medium sand, trace ironstone gravel, w~PL, extremely weathered Hawkesbury Sandstone																			
149	1.5	SANDSTONE: medium to coarse grained, red-brown and pale-grey, medium and high strength, slightly fractured, Hawkesbury Sandstone																			PL(A) = 1.4
148	2																				
147	3																				
146	4																				
145	5																				
144	6																				
143	7																				
142	8.25																				
141	9																				
140																					



Douglas Partners
Geotechnics | Environment | Groundwater

BOREHOLE LOG

CLIENT: Cleanaway Operations Pty Ltd
PROJECT: Lucas Heights Resource Recovery Park
LOCATION: 19 Little Forest Road, Lucas Heights

SURFACE LEVEL: 151 AHD
EASTING: 312019.3
NORTHING: 6230601.6
DIP/AZIMUTH: 90°/--

BORE No: MB056
PROJECT No: 85988.04
DATE: 28/6/2023
SHEET 2 OF 3

RL	Depth (m)	Description of Strata	Degree of Weathering					Graphic Log	Rock Strength					Water	Fracture Spacing (m)	Discontinuities		Sampling & In Situ Testing					
			EW	HW	MW	SW	FS		FR	Ex Low	Very Low	Low	Medium			High	Very High	Ex High	B - Bedding S - Shear	J - Joint F - Fault	Type	Core Rec. %	RQD %
141		SANDSTONE: fine to medium grained, pale grey, distinctly cross-bedded 10°, high strength, slightly weathered to fresh, slightly fractured to unbroken, Hawkesbury Sandstone <i>(continued)</i>																					
140	11																						PL(A) = 0.9
139	12																						
138	12.5	SANDSTONE: medium to coarse grained, pale red-brown, thinly to medium bedded, high strength, unbroken, slightly weathered to fresh, Hawkesbury Sandstone																					PL(A) = 1.2
137	13																						
136	14																						
135	15	SANDSTONE: fine to medium grained, pale grey, thinly bedded, medium strength with some low strength zones, slightly weathered to fresh, slightly fractured, Hawkesbury Sandstone																					PL(A) = 0.8
134	16																						
133	17																						PL(A) = 0.6
132	18																						
	19																						PL(A) = 0.2

RIG: Explorer

DRILLER: Ground Test

LOGGED: SI/ZW

CASING: HW to 1.5m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 1.5m, HQ Coring to 29.8m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Standpipe installed to 29.8m (screen 23.8-29.8m, PVC to ground level with stick up 1.0m, gravel 22.8-29.8m, bentonite 20.0-22.8m, backfill to ground level, monument with concrete)

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	S	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)

BOREHOLE LOG

CLIENT: Cleanaway Operations Pty Ltd
PROJECT: Lucas Heights Resource Recovery Park
LOCATION: 19 Little Forest Road, Lucas Heights

SURFACE LEVEL: 151 AHD
EASTING: 312019.3
NORTHING: 6230601.6
DIP/AZIMUTH: 90°/--

BORE No: MB056
PROJECT No: 85988.04
DATE: 28/6/2023
SHEET 3 OF 3

RL	Depth (m)	Description of Strata	Degree of Weathering						Graphic Log	Rock Strength						Water	Fracture Spacing (m)	Discontinuities		Sampling & In Situ Testing			
			EW	HW	MW	SW	FS	FR		Ex Low	Very Low	Low	Medium	High	Very High			Ex High	B - Bedding S - Shear	J - Joint F - Fault	Type	Core Rec. %	RQD %
131		SANDSTONE: fine to medium grained, pale grey, thinly bedded, medium strength with some low strength zones, slightly weathered to fresh, slightly fractured, Hawkesbury Sandstone <i>(continued)</i>																C	100	100	PL(A) = 1		
130	21																						
129	22																	C	100	100			
128	22.6	SANDSTONE: medium to coarse grained, pale red-brown to pale grey, thinly to medium bedded, high strenth, slightly weathered, slightly fractured to unbroken, Hawkesbury Sandstone																			PL(A) = 3.1		
127	23																						
126	24	Between 23.9 to 24.7m: grey, thinly laminated																					
125	25																	C	100	100	PL(A) = 2		
124	26																						
123	27																						
122	28																				PL(A) = 1.6		
121	29	Between 29-29.8m: grey, unbroken																					
120	29.8	Bore discontinued at 29.8m																					

RIG: Explorer

DRILLER: Ground Test

LOGGED: SI/ZW

CASING: HW to 1.5m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 1.5m, HQ Coring to 29.8m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Standpipe installed to 29.8m (screen 23.8-29.8m, PVC to ground level with stick up 1.0m, gravel 22.8-29.8m, bentonite 20.0-22.8m, backfill to ground level, monument with concrete)

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	S	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)

BOREHOLE LOG

CLIENT: Cleanaway Operations Pty Ltd
PROJECT: Lucas Heights Resource Recovery Park
LOCATION: 19 Little Forest Road, Lucas Heights

SURFACE LEVEL: 150 AHD
EASTING: 312011.5
NORTHING: 6230927.5
DIP/AZIMUTH: 90°/--

BORE No: MB057
PROJECT No: 85988.04
DATE: 29/6/2023
SHEET 1 OF 3

RL	Depth (m)	Description of Strata	Degree of Weathering					Graphic Log	Rock Strength					Water	Fracture Spacing (m)				Discontinuities		Sampling & In Situ Testing					
			EW	HW	MW	SW	FS		FR	Ex Low	Very Low	Low	Medium		High	Very High	Ex High	0.01	0.05	0.10	0.50	1.00	B - Bedding S - Shear	J - Joint F - Fault	Type	Core Rec. %
140	0.2	SAND: fine to medium, brown, trace silt, moist, apparently loose, residual																								
149	0.9	SANDSTONE: fine to medium grained, orange-brown to red-brown, very low and low to medium strength, highly weathered, Hawkesbury Sandstone																								PL(A) = 1.2
148	2	SANDSTONE: medium to coarse grained, pale grey-brown and brown, cross bedded (10°-20°), medium then high strength, moderately to slightly weathered and fresh, slightly fractured with some fractured band and unbroken, Hawkesbury Sandstone																		1.4m: B10°, cly co 5mm 1.8m: B0°, cly co 5mm 1.87m: B0°, cly co 5mm 2.17m: B5°, cly vn 1mm		C	100	98		
147	3																			3.27-3.80m: J80°, un, ro, fg 5mm					PL(A) = 1.3	
146	4																			3.9m: B0°, cly 10mm 4.05m: B5°, fe, cly 5mm		C	100	78		
145	5																									
144	6																			5.78m: B20°, fe, cly co 5mm 6.22m: B10°, cly vn					PL(A) = 1.5	
143	7																			7.2m: B0°, cly 5mm 7.36m: B5°, cly 3mm 7.44m: B0°, cly vn 7.65-7.75m: B(x3)10°-20°, fe, cly 7.83m: J45°, un, ro, fe 7.90-7.94m: fg, he		C	100	99	PL(A) = 0.2	
142	8																									
141	9																			9.2m: B5°, fe		C	100	100	PL(A) = 1.8	

RIG: Excaliper/Explorer

DRILLER: Ground Test

LOGGED: SI

CASING: HW to 0.9m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 0.9m, HQ Coring to 29.8m

WATER OBSERVATIONS: No free groundwater whilst augering

REMARKS: Standpipe installed to 29.8m (screen 23.8-29.8m, PVC to ground level with stick up 1.0m, gravel 22.8-29.8m, bentonite 20.0-22.8m, backfill to ground level, monument with concrete)

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	W	Water seep
E	Environmental sample	W	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)

BOREHOLE LOG

CLIENT: Cleanaway Operations Pty Ltd
PROJECT: Lucas Heights Resource Recovery Park
LOCATION: 19 Little Forest Road, Lucas Heights

SURFACE LEVEL: 150 AHD
EASTING: 312011.5
NORTHING: 6230927.5
DIP/AZIMUTH: 90°/--

BORE No: MB057
PROJECT No: 85988.04
DATE: 29/6/2023
SHEET 2 OF 3

RL	Depth (m)	Description of Strata	Degree of Weathering					Graphic Log	Rock Strength					Water	Fracture Spacing (m)	Discontinuities		Sampling & In Situ Testing				
			EW	HW	MW	SW	FS		FR	Ex Low	Very Low	Low	Medium			High	Very High	Ex High	B - Bedding S - Shear	J - Joint F - Fault	Type	Core Rec. %
140		SANDSTONE: medium to coarse grained, pale grey-brown and brown, cross bedded (10°-20°), medium then high strength, moderately to slightly weathered and fresh, slightly fractured with some fractured band and unbroken, Hawkesbury Sandstone <i>(continued)</i>															9.97m: B10°, cly co 5mm				PL(A) = 2.3	
139	11																		C	100	100	
138	12																					
137	13	SANDSTONE: fine to medium grained, pale grey, trace carbonaceous lamination, medium then high strength, fresh, slightly fractured and unbroken, Hawkesbury Sandstone																	C	100	99	PL(A) = 2.6
136	14																	13.59m: B5°, fe				
14.65	14.65																					PL(A) = 0.6
135	15																	14.63-14.65m: Cs 14.72m: J70°, pl, ro, cln 14.73-14.90m: J(x3)60°-70°, pl, ro, cln 15.07m: J45°, pl, ro, cly co 2mm 15.14m: B0°, cly 10mm 15.19m: B0°, cly co 2mm				PL(A) = 0.5
134	16	SANDSTONE: medium to coarse grained, pale grey, cross bedded (10°-25°), high strength, fresh, slightly fractured and unbroken, Hawkesbury Sandstone																	C	100	99	PL(A) = 2.3
133	17																	16.7m: B0°, cbs co 1mm				
132	18																					
18.2	18.2	SANDSTONE: medium to coarse grained, pale grey, cross bedded (10°-25°), high strength, fresh, slightly fractured and unbroken, Hawkesbury Sandstone																				
131	19																	18.2m: B10°, cbs co 1mm				PL(A) = 1.8
																		19.3m: B10°, cly vn 19.78m: B0°, cly vn				

RIG: Excaliper/Explorer

DRILLER: Ground Test

LOGGED: SI

CASING: HW to 0.9m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 0.9m, HQ Coring to 29.8m

WATER OBSERVATIONS: No free groundwater whilst augering

REMARKS: Standpipe installed to 29.8m (screen 23.8-29.8m, PVC to ground level with stick up 1.0m, gravel 22.8-29.8m, bentonite 20.0-22.8m, backfill to ground level, monument with concrete)

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	S	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)

BOREHOLE LOG

CLIENT: Cleanaway Operations Pty Ltd
PROJECT: Lucas Heights Resource Recovery Park
LOCATION: 19 Little Forest Road, Lucas Heights

SURFACE LEVEL: 150 AHD
EASTING: 312011.5
NORTHING: 6230927.5
DIP/AZIMUTH: 90°/--

BORE No: MB057
PROJECT No: 85988.04
DATE: 29/6/2023
SHEET 3 OF 3

RL	Depth (m)	Description of Strata	Degree of Weathering					Graphic Log	Rock Strength					Water	Fracture Spacing (m)	Discontinuities		Sampling & In Situ Testing				
			EW	HW	MW	SW	FS		FR	Ex Low	Very Low	Low	Medium			High	Very High	Ex High	B - Bedding S - Shear	J - Joint F - Fault	Type	Core Rec. %
130		SANDSTONE: medium to coarse grained, pale grey, cross bedded (10°-25°), high strength, fresh, slightly fractured and unbroken, Hawkesbury Sandstone (<i>continued</i>) Between 20.75-22.1m: low and low to medium strength																				
																			C	100	100	PL(A) = 0.2
	21																					
	22																		C	100	100	PL(A) = 0.3
	23																					PL(A) = 2.2
	24																					PL(A) = 2.1
	25																		C	100	100	
	26																					PL(A) = 1.1
	27																					
	28																		C	100	98	PL(A) = 1.5
	29																					
29.8		Bore discontinued at 29.8m																				

RIG: Excaliper/Explorer

DRILLER: Ground Test

LOGGED: SI

CASING: HW to 0.9m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 0.9m, HQ Coring to 29.8m

WATER OBSERVATIONS: No free groundwater whilst augering

REMARKS: Standpipe installed to 29.8m (screen 23.8-29.8m, PVC to ground level with stick up 1.0m, gravel 22.8-29.8m, bentonite 20.0-22.8m, backfill to ground level, monument with concrete)

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W	Water seep	S	Standard penetration test
E	Environmental sample	W	Water level	V	Shear vane (kPa)

BOREHOLE LOG

CLIENT: Cleanaway Operations Pty Ltd
PROJECT: Lucas Heights Resource Recovery Park
LOCATION: 19 Little Forest Road, Lucas Heights

SURFACE LEVEL: 151 AHD
EASTING: 312019.3
NORTHING: 6230601.6
DIP/AZIMUTH: 90°/--

BORE No: MB056
PROJECT No: 85988.04
DATE: 28/6/2023
SHEET 1 OF 3

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
151	0.3	FILL/Sandy Silty CLAY: low to medium plasticity, dark-brown, trace sandstone and ironstone gravel, rootlets, w~PL							Blank pipe 23.8m to surface, stick up to 0.65m above ground level	
150	1	Sandy CLAY: medium to high plasticity, orange-brown to red-brown, fine to medium sand, trace ironstone gravel, w~PL, extremely weathered Hawkesbury Sandstone								
149	1.5	SANDSTONE: medium to coarse grained, red-brown and pale-grey, medium and high strength, slightly fractured, Hawkesbury Sandstone			1.5		PL(A) = 1.4			
148	2			C	1.6					
148	3				2.8					
147	4			C						
146	5				4.8		PL(A) = 0.8			
145	6				5.8		PL(A) = 1.7		Backfill 0.0-20.0m	
144	7			C	7.0		PL(A) = 2.3			
143	8									
142	8.25	SANDSTONE: fine to medium grained, pale grey, distinctly cross-bedded 10°, high strength, slightly weathered to fresh, slightly factured to unbroken, Hawkesbury Sandstone			8.8		PL(A) = 0.8			
	9			C	9.0					

RIG: Explorer

DRILLER: Ground Test

LOGGED: SI/ZW

CASING: HW to 1.5m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 1.5m, HQ Coring to 29.8m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Standpipe installed to 29.8m (screen 23.8-29.8m, PVC to ground level with stick up 1.0m, gravel 22.8-29.8m, bentonite 20.0-22.8m, backfill to ground level, monument with concrete)

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	S	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)



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BOREHOLE LOG

CLIENT: Cleanaway Operations Pty Ltd
PROJECT: Lucas Heights Resource Recovery Park
LOCATION: 19 Little Forest Road, Lucas Heights

SURFACE LEVEL: 151 AHD
EASTING: 312019.3
NORTHING: 6230601.6
DIP/AZIMUTH: 90°/--

BORE No: MB056
PROJECT No: 85988.04
DATE: 28/6/2023
SHEET 2 OF 3

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details		
				Type	Depth	Sample	Results & Comments				
141		SANDSTONE: fine to medium grained, pale grey, distinctly cross-bedded 10°, high strength, slightly weathered to fresh, slightly fractured to unbroken, Hawkesbury Sandstone (<i>continued</i>)							Backfill 0.0-20.0m		
140	11			C	11.0		PL(A) = 0.9				
139	12				11.77						
138	12.5	SANDSTONE: medium to coarse grained, pale red-brown, thinly to medium bedded, high strength, unbroken, slightly weathered to fresh, Hawkesbury Sandstone									
137	13			C	13.0		PL(A) = 1.2				
136	14				14.79						
135	15				15.0		PL(A) = 0.8			Blank pipe 23.8m to surface, stick up to 0.65m above ground level	
134	15.55	SANDSTONE: fine to medium grained, pale grey, thinly bedded, medium strength with some low strength zones, slightly weathered to fresh, slightly fractured, Hawkesbury Sandstone									
133	16			C							
132	17				17.0		PL(A) = 0.6				
131	18				17.78						
130	19			C	19.0		PL(A) = 0.2				

RIG: Explorer

DRILLER: Ground Test

LOGGED: SI/ZW

CASING: HW to 1.5m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 1.5m, HQ Coring to 29.8m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Standpipe installed to 29.8m (screen 23.8-29.8m, PVC to ground level with stick up 1.0m, gravel 22.8-29.8m, bentonite 20.0-22.8m, backfill to ground level, monument with concrete)

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W	Water seep	S	Standard penetration test
E	Environmental sample	W	Water level	V	Shear vane (kPa)

BOREHOLE LOG

CLIENT: Cleanaway Operations Pty Ltd
PROJECT: Lucas Heights Resource Recovery Park
LOCATION: 19 Little Forest Road, Lucas Heights

SURFACE LEVEL: 151 AHD
EASTING: 312019.3
NORTHING: 6230601.6
DIP/AZIMUTH: 90°/--

BORE No: MB056
PROJECT No: 85988.04
DATE: 28/6/2023
SHEET 3 OF 3

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
131		SANDSTONE: fine to medium grained, pale grey, thinly bedded, medium strength with some low strength zones, slightly weathered to fresh, slightly fractured, Hawkesbury Sandstone (<i>continued</i>)		C	20.75					
130	21									
129	22			C						
128	22.6	SANDSTONE: medium to coarse grained, pale red-brown to pale grey, thinly to medium bedded, high strength, slightly weathered, slightly fractured to unbroken, Hawkesbury Sandstone			23.0		PL(A) = 1			
127	23				23.8					
126	24	Between 23.9 to 24.7m: grey, thinly laminated								
125	25			C	25.3		PL(A) = 3.1			
124	26				26.4		PL(A) = 2			
123	27				26.75					
122	28			C	28.1		PL(A) = 1.6			
121	29	Between 29-29.8m: grey, unbroken								
120	29.8	Bore discontinued at 29.8m			29.8					

RIG: Explorer

DRILLER: Ground Test

LOGGED: SI/ZW

CASING: HW to 1.5m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 1.5m, HQ Coring to 29.8m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Standpipe installed to 29.8m (screen 23.8-29.8m, PVC to ground level with stick up 1.0m, gravel 22.8-29.8m, bentonite 20.0-22.8m, backfill to ground level, monument with concrete)

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W	Water seep	S	Standard penetration test
E	Environmental sample	W	Water level	V	Shear vane (kPa)

BOREHOLE LOG

CLIENT: Cleanaway Operations Pty Ltd
PROJECT: Lucas Heights Resource Recovery Park
LOCATION: 19 Little Forest Road, Lucas Heights

SURFACE LEVEL: 150 AHD
EASTING: 312011.5
NORTHING: 6230927.5
DIP/AZIMUTH: 90°/--

BORE No: MB057
PROJECT No: 85988.04
DATE: 29/6/2023
SHEET 1 OF 3

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
150	0.2	SAND: fine to medium, brown, trace silt, moist, apparently loose, residual							Blank pipe 23.8m to surface, stick up to 0.65m above ground level	
149	0.9	SANDSTONE: fine to medium grained, orange-brown to red-brown, very low and low to medium strength, highly weathered, Hawkesbury Sandstone			0.9		PL(A) = 1.2	1		
148	1				1.0			2		
148	2			C				3		
147	3				2.77			4		
146	4				3.3		PL(A) = 1.3	5		
145	5			C				6		
144	6				5.73		PL(A) = 1.5	7		
143	7			C				8		
142	8				7.7		PL(A) = 0.2	9		
141	9				8.73					
				C			PL(A) = 1.8			
					9.0					
					10.0		PL(A) = 2.3			

RIG: Excaliper/Explorer

DRILLER: Ground Test

LOGGED: SI

CASING: HW to 0.9m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 0.9m, HQ Coring to 29.8m

WATER OBSERVATIONS: No free groundwater whilst augering

REMARKS: Standpipe installed to 29.8m (screen 23.8-29.8m, PVC to ground level with stick up 1.0m, gravel 22.8-29.8m, bentonite 20.0-22.8m, backfill to ground level, monument with concrete)

SAMPLING & IN SITU TESTING LEGEND

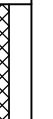
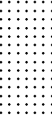
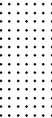
A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	S	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)

BOREHOLE LOG

CLIENT: Cleanaway Operations Pty Ltd
PROJECT: Lucas Heights Resource Recovery Park
LOCATION: 19 Little Forest Road, Lucas Heights

SURFACE LEVEL: 150 AHD
EASTING: 312011.5
NORTHING: 6230927.5
DIP/AZIMUTH: 90°/--

BORE No: MB057
PROJECT No: 85988.04
DATE: 29/6/2023
SHEET 2 OF 3

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details		
				Type	Depth	Sample	Results & Comments				
140		SANDSTONE: medium to coarse grained, pale grey-brown and brown, cross bedded (10°-20°), medium then high strength, moderately to slightly weathered and fresh, slightly fractured with some fractured band and unbroken, Hawkesbury Sandstone (<i>continued</i>)		C					Backfill 0.0-20.0m		
139	11				11.71						
138	12										
137	13	SANDSTONE: fine to medium grained, pale grey, trace carbonaceous lamination, medium then high strength, fresh, slightly fractured and unbroken, Hawkesbury Sandstone		C	13.0		PL(A) = 2.6				
136	14										
135	14.65				14.65		PL(A) = 0.6				
134	15	SANDSTONE: medium to coarse grained, pale grey, cross bedded (10°-25°), high strength, fresh, slightly fractured and unbroken, Hawkesbury Sandstone		C	14.7				Blank pipe 23.8m to surface, stick up to 0.65m above ground level		
133	16				15.8		PL(A) = 0.5				
132	17				16.95		PL(A) = 2.3				
131	18	SANDSTONE: medium to coarse grained, pale grey, cross bedded (10°-25°), high strength, fresh, slightly fractured and unbroken, Hawkesbury Sandstone			17.72						
130	18.2			C							
129	19				18.95		PL(A) = 1.8				

RIG: Excaliper/Explorer

DRILLER: Ground Test

LOGGED: SI

CASING: HW to 0.9m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 0.9m, HQ Coring to 29.8m

WATER OBSERVATIONS: No free groundwater whilst augering

REMARKS: Standpipe installed to 29.8m (screen 23.8-29.8m, PVC to ground level with stick up 1.0m, gravel 22.8-29.8m, bentonite 20.0-22.8m, backfill to ground level, monument with concrete)

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	S	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)

BOREHOLE LOG

CLIENT: Cleanaway Operations Pty Ltd
PROJECT: Lucas Heights Resource Recovery Park
LOCATION: 19 Little Forest Road, Lucas Heights

SURFACE LEVEL: 150 AHD
EASTING: 312011.5
NORTHING: 6230927.5
DIP/AZIMUTH: 90°/--

BORE No: MB057
PROJECT No: 85988.04
DATE: 29/6/2023
SHEET 3 OF 3

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
130		SANDSTONE: medium to coarse grained, pale grey, cross bedded (10°-25°), high strength, fresh, slightly fractured and unbroken, Hawkesbury Sandstone (continued)		C						
		Between 20.75-22.1m: low and low to medium strength			20.7 20.8		PL(A) = 0.2			
129	21									
									Bentonite 20.0-22.8m	
128	22			C	21.9		PL(A) = 0.3			
127	23									
					23.6 23.8		PL(A) = 2.2			
126	24									
					24.8		PL(A) = 2.1			
125	25			C						
					26.8 26.85		PL(A) = 1.1			
124	26									
									Gravel 22.8-29.8m	
123	27									
									Machine slotted PVC screen 23.8-29.8m	
122	28									
				C	28.5		PL(A) = 1.5			
121	29									
120	29.8	Bore discontinued at 29.8m			29.8					End cap

RIG: Excaliper/Explorer

DRILLER: Ground Test

LOGGED: SI

CASING: HW to 0.9m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 0.9m, HQ Coring to 29.8m

WATER OBSERVATIONS: No free groundwater whilst augering

REMARKS: Standpipe installed to 29.8m (screen 23.8-29.8m, PVC to ground level with stick up 1.0m, gravel 22.8-29.8m, bentonite 20.0-22.8m, backfill to ground level, monument with concrete)

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W	Water seep	S	Standard penetration test
E	Environmental sample	W	Water level	V	Shear vane (kPa)

BORE: MB056

PROJECT: 85988.04

July 2023



Project No: 89588.04
BH ID: MB050
Depth: 1.5 - 5.0m
Core Box No.: 1 of 8



89588.04 Lucas Heights MB050 START 1.5m
28/6/23



1.50 – 5.00m

BORE: MB056

PROJECT: 85988.04

July 2023



Project No: 89588.04
BH ID: MB050
Depth: 5.0 - 9.0m
Core Box No.: 2 of 8



5.00 – 9.00m

BORE: MB056

PROJECT: 85988.04

July 2023



9.00 – 13.00m

BORE: MB056

PROJECT: 85988.04

July 2023



13.00 – 17.00m

BORE: MB056

PROJECT: 85988.04

July 2023



17.00 – 21.00m

BORE: MB056

PROJECT: 85988.04

July 2023



21.00 – 25.00m

BORE: MB056

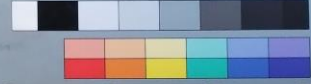
PROJECT: 85988.04

July 2023



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Project No: 89588.04
BH ID: M8050
Depth: 25.0 - 29.0m
Core Box No.: 7 of 8



25.00 - 29.00m

BORE: MB056

PROJECT: 85988.04

July 2023



Douglas Partners
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Project No: 89588.04
BH ID: M8050
Depth: 29.0 - 29.8m
Core Box No.: 8 of 8



29.00 - 29.800m

BORE: MB057

PROJECT: 85988.04

July 2023



Douglas Partners
Geotechnics | Environment | Groundwater

Project No: 85988.04
BH ID: BH-MB051
Depth: 0.90 - 4.00 m
Core Box No.: 1



LUCAS HEIGHTS 85988.04 BH MB051

START 0.90 m

10

20

30

M

0.90 - 4.00m

BORE: MB057

PROJECT: 85988.04

July 2023



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Project No: 85988.04
BH ID: BH-MB051
Depth: 4.00 - 8.00 m
Core Box No.: 2



40

50

60

70

M

4.00 - 8.00m

BORE: MB057

PROJECT: 85988.04

July 2023



Project No: 85988.04
BH ID: BH-MB051
Depth: 8.00-12.00 m
Core Box No.: 3



8.00 - 12.00 m

BORE: MB057

PROJECT: 85988.04

July 2023



Project No: 85988.04
BH ID: BH-MB051
Depth: 12.00-16.00 m
Core Box No.: 4



12.00 - 16.00 m

BORE: MB057

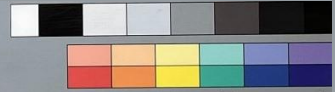
PROJECT: 85988.04

July 2023



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Project No: 85988.04
BH ID: BH-MB051
Depth: 16.00 - 20.00m
Core Box No.: 5



16.00 - 20.00m

BORE: MB057

PROJECT: 85988.04

July 2023



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Project No: 85988.04
BH ID: BH-MB051
Depth: 20.00 - 24.00m
Core Box No.: 6



20.00 - 24.00m

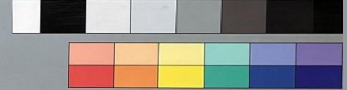
BORE: MB057

PROJECT: 85988.04

July 2023



Project No: 85988.04
BH ID: BH-MB051
Depth: 24.00 - 28.00m
Core Box No.: 7



24.00 - 28.00m

BORE: MB057

PROJECT: 85988.04

July 2023



Project No: 85988.04
BH ID: BH-MB051
Depth: 28.00 - 29.80m
Core Box No.: 8



28.00 - 29.800m