GEOTECHNIQUE®
PTY LTD

ABN 64 002 841 063

Lemko Place, Penrith NSW 2750 PO Box 880, Penrith NSW 2751
Telephone (02) 4722 2700 Facsimile (02) 4722 2777
e-mail: info@geotech.com.au www.geotech.com.au

GEOTECHNIQUE® PTY LTD

ABN 64 002 841 063

Job No: 14160/1
Our Ref: 14160/1-AA Amended 2
21 June 2018

Blacktown City Council
P O Box 63
BLACKTOWN NSW 2148

Re: **Proposed Cemetery Extension**
St Bartholomew Place, Prospect
Geotechnical Investigation

This report presents results of a geotechnical investigation carried out for proposed cemetery extension at St Bartholomew Place, Prospect.

The proposal seeks to rezone 8.39 hectares of land to allow for the expansion of the existing St Bartholomew's Cemetery. The cemetery expansion will be developed in stages. New burial space is expected to become available in stages, approximately 5 years after development consent is granted for the cemetery.

This report provides (1) assessment of sub-surface profile across the site (2) statement that the geotechnical conditions across the site do not impose any constraint on proposed cemetery expansion and (3) geotechnical recommendations on cut and fill methods and design of batter slopes, footings and pavement.

If you have any questions, please do not hesitate to contact the undersigned.

Yours faithfully
GEOTECHNIQUE PTY LTD

INDRA JWORCHAN
Principal Geotechnical Engineer

Lemko Place, Penrith NSW 2750 PO Box 880, Penrith NSW 2751
Telephone (02) 4722 2700 Facsimile (02) 4722 2777
e-mail: info@geotech.com.au www.geotech.com.au

TABLE OF CONTENTS

page

****

Attached Drawing No 14160/1-AA1R1 Test Pit Location Plan
Excavation Logs
Laboratory Test Results

1.0 Background

The existing St Bartholomew's Church and Cemetery is located on a 3.17-hectares lot of Ponds Road, Prospect. The cemetery comprises approximately 3,600 occupied graves. In January 2016, Blacktown City Council (Council) received approximately 6 hectares of land east of St Bartholomew's Church from the New South Wales (NSW) State Government under a Land Transfer Agreement. In addition, Council intends to acquire approximately 2 hectares of land east of the existing cemetery. Further to this, Council is seeking to close St Bartholomew's Place (approximately 0.39 hectares), with the intention of including it in the expansion of the cemetery. This equates to a total of 11.56 hectares of land proposed to be used for the expanded cemetery.

A planning proposal (PP) is being prepared, which seeks to reactivate the existing church and cemetery on the 3.17-hectare land and to reclassify the Council-owned expansion lands from "community land" to "operational land" and to rezone the cemetery expansion lands from RE1 Public Recreation, RU4 Primary Production Small Lots and SP2 Classified Road, under BLEP2015 to SP1 Cemetery. In addition to the existing church and cemetery, the expanded cemetery is likely to include ancillary facilities such as an office, café, flower shop and potentially a chapel. They will most likely be in the vicinity of Tarlington Place. Details will be determined at the DA stage.

2.0 Existing Conditions

2.1 Land Use

The site is located on land between the Great Western Highway (GWH) to the north and M4 Western Motorway (M4) to the south and is bounded by the Prospect Highway to the west. The existing cemetery has an area of approximately 3.17 hectares, with the newly acquired land adding a further 6 hectares. A further 2.39 hectares of land is also intended to be acquired, including 2 hectares from other land owners and 0.39 hectares from the closure of St Bartholomew's Place, bringing the total area for the proposed cemetery site to 11.56 hectares. This is an increase of 8.39 hectares to the existing cemetery.
The existing cemetery is zoned SP1 Cemetery under Blacktown LEP 2015. The cemetery expansion land:

- Is predominantly zoned RE1 Public Recreation
- Includes land zoned RU4 Primary Production Small Lots (the site of the old Prospect Post Office)
- Includes land zoned SP2 Classified Road to the south of the existing cemetery.

The existing cemetery contains approximately 3,600 utilised graves. As the last church service was held on the site in 1967 and no new interment rights have been sold at the cemetery since 1972, the existing cemetery site does not regularly attract many visitors.

The cemetery expansion land has been largely vacant and unused since the former Prospect Village (along Tarlington Place) was disrupted and eventually vacated/demolished following the realignment of the Great Western Highway in 1968 and the construction of the M4 Western Motorway in 1990.
The location of the site and its surrounding environs is shown in Figure 1.

Figure 1: Subject Site and its Environs

2.2 Access to the Site

Access to and from Tarlington Place can be achieved through the Great Western Highway in the eastbound and westbound directions. Eastbound access is gained via a right turn bay. Access points to the existing cemetery are from Ponds Road, Prospect.

2.3 Road Network

2.3.1 Adjoining Roads

Great Western Highway

The GWH is classified as a Roads and Maritime State Road and is aligned in an east-west direction to the site's north. It is a two-way road with 3 westbound lanes and 4 eastbound lanes near the site, set within a 32 metre carriageway with an approximately 9 metre central median. Being an arterial road, no parking is permitted. The GWH has a posted speed limit of 80 km/h.

Prospect Highway

The Prospect Highway is classified as a Roads and Maritime State Road and is aligned in a north-south direction to the site's west. It is a two-way road with generally one lane in each direction, set within an approximately seven-metre carriageway. Kerbside parking is not permitted, and the road has a posted speed limit of 60 km/h.

Ponds Road
Ponds Road is classified as a Roads and Maritime State Road and is aligned in an east-west direction along with the site's north-western boundary. It is a two-way road with 1 lane in each direction, set within an approximately 7 metre carriageway. Ponds Road functions as an exit-ramp to the GWH and connects with the Prospect Highway to the west. It also provides access to the existing cemetery and St Bartholomew's Church. Ponds Road has a posted speed limit of 60 km/h.

M4 Western Motorway
The M4 is classified as a Roads and Maritime State Road and is aligned in an east-west direction to the site's south. It is a two-way road with generally 3 lanes in each direction, set over an approximately 22-metre-wide carriageway including a central separation barrier. The Western Motorway has a posted speed limit of 100km/h in the vicinity of the site, with off and on ramps provided to/from the Prospect Highway.

Tarlington Place and St Bartholomew's Place
Tarlington Place and St Bartholomew's Place are classified as Local Roads and are internal roads located within the subject site. St Bartholomew's Place is an unsealed road which runs along the eastern boundary of the existing cemetery while Tarlington Place is a sealed road and primarily functions as the access road to 23 Tarlington Place (the old Prospect Post Office).

Council is looking to close St Bartholomew's Place (0.39 hectares) and absorb it into the cemetery expansion lands. It could, however, still function as an access point and internal cemetery road.

Vehicle access to the site is proposed via the existing 2 driveways along Ponds Road (access 1 and access 2) and Tarlington Place (access three3 St Bartholomew's Place, whilst proposed to be closed, may also be used as an access point, depending on how the development is staged.

The internal road network will be determined at the Development Application stage. It is recommended that an internal link between the existing and expanded cemetery areas to be provided.

3.0 Future Conditions

3.1 Land Use

The proposal seeks to rezone 8.39 hectares of land to allow for the expansion of the existing St Bartholomew's Cemetery. The cemetery expansion will be developed in stages. New burial space is expected to become available in stages, approximately 5 years after development consent is granted for the cemetery. The site plan is outlined above in Figure 1. The expanded cemetery is expected to ultimately include:

- Over 10,000 burial plots
- Above ground crypts
- Columbarium walls for ashes interment
- Ancillary facilities (such as an office, café, flower shop and potentially a chapel) with associated car parking, in the vicinity of Tarlington Place.

Area Schedule

Use		Size
Existing Cemetery	Reactivation of existing church and cemetery [1]	3.17 hectares
Future Cemetery Expansion	Cemetery expansion and ancillary facilities [2]	8.39 hectares
Total		**11.56 hectares**

4.0 Executive Summary of Report

The sub-surface profile across the site comprises a sequence of topsoil and clayey residual soils (to depths of 1.6m to more than 2.5m) underlain by bedrock shale. The depth to groundwater level across the site is likely to be in excess of 2.5m from existing ground surface. Geotechnical investigation indicates that the geotechnical conditions across the site do not impose any constraint on proposed cemetery expansion and provides the following recommendations:

- Earthworks should be carried out in accordance with recommended Saline Soil Management Plan.
- Controlled fill should comprise suitable materials after environmental validation and compacted to a Minimum Dry Density Ratio (MDDR) of 95% Standard, at moisture content within 2% of Optimum Moisture Content (OMC). However, upper 500mm of controlled fill forming subgrade for roads should be compacted to a MDDR of 100% Standard, at moisture content within 2% of OMC.
- Permanent cut and fill slopes should be battered at 1 vertical to 2.5 horizontal or retained with engineered retaining structures.
- Footings may be founded in controlled fill, residual soils or bedrock and designed for allowable bearing pressure of 100kPa, 125kPa and 700kPa respectively.
- Road and car park pavements are designed for indicative subgrade CBR value of 3.0%

5.0 Review of Available Information

Reference to the Geological Map of Penrith (scale 1:100,000) indicates that the bedrock at the site is Bringelly Shale, belonging to the Wianamatta Group of rocks and comprising shale, carbonaceous claystone, laminite, fine to medium grained lithic sandstone and rare coal.

Reference to the Soil Landscape Map of Sydney (scale 1:100,000) indicates that the landscape at the site belongs to Blacktown Group, which is characterised with gently undulating rises on Wianamatta Group shales, with local relief to 30.0m, ground slope of less than 5 percent and broad rounded crests. The sub-surface soil within this landscape is likely to be up to 3.0m thick, moderately reactive, highly plastic and with poor drainage.

Department of Infrastructures, Planning and Natural Resources prepared a Map showing Salinity Potential in Western Sydney (2002) that indicates moderate salinity potential at the proposed development site.

6.0 Field Work

Field work for the geotechnical investigation was carried out on 13 March 2018 and included the following:

- Reviewing available geological information relevant to the proposed development site.
- Attend site safety induction provided by Blacktown City Council.

- Brief Safe Work Method Statement (SWMS) to all sub-contractors to ensure that the field works are carried out safely with due regards to risks associated with test pit excavation and possibility that excavation works may encounter asbestos.
- Reviewing services plans obtained from "Dial Before You Dig" to determine locations of services across the site.
- Carrying out a walk over survey to assess existing site conditions.
- Scanning proposed test pit locations for underground services to ensure that services were not damaged during field work. A specialist services locator was engaged for this purpose.
- Excavating nine test pits (TP4 to TP12) using a backhoe. Test pits were uniformly distributed across the site ensuring these pits are located away from locations with known asbestos occurrence. Test pits were terminated at backhoe refusal in bedrock or depth of about 2.5m from existing ground surface. Approximate test pit locations are indicated on the attached Drawing No 14160/1-AA1R1. Excavation logs are also attached.
- Conducting Dynamic Cone Penetration (DCP) tests adjacent to selected test pits to assess strength of subsurface soils. DCP tests were terminated at refusal or depth of about 1.5m from existing ground surface.
- Recovering representative soil samples for visual assessment and laboratory tests.
- Measuring depths to groundwater level or seepage in the test pits, where encountered.
- Backfill the test pits with excavated materials after logging and sampling.

Field work was supervised by a Field Engineer from this company who was responsible for nominating the test locations, conducting DCP tests, sampling and preparation of field logs.

7.0 Sub-Surface Conditions

Sub-surface profiles encountered in test pits are detailed in attached excavation logs and summarised below in Table 1.

Table 1 – Sub-surface Profiles encountered in Test Pits

Test Pit No	Termination Depth (m)	Depth Range for Topsoil (m)	Depth Range for Residual Soil (m)	Depth to Bedrock (m)
TP4	1.6	0.0-0.2	0.2-1.6	1.6
TP5	2.5	0.0-0.2	0.2->2.5	Not Encountered
TP6	2.5	0.0-0.2	0.2->2.5	Not Encountered
TP7	2.5	0.0-0.2	0.2->2.5	Not Encountered
TP8	2.5	0.0-0.2	0.2->2.5	Not Encountered
TP9	1.7	0.0-0.2	0.2-1.6	1.6
TP10	2.0	0.0-0.2	0.2-2.0	2.0
TP11	2.5	0.0-0.2	0.2->2.5	Not Encountered
TP12	2.5	0.0-0.2	0.2->2.5	Not Encountered

Table 1 indicates that the sub-surface profile across the site comprises a sequence of topsoil and residual underlain by bedrock. However, bedrock was encountered in only three test pits. Remaining six test pits did not encounter bedrock up to termination depths of about 2.5m.

It should be noted that the test pits during this geotechnical investigation were intentionally located away from areas where asbestos contaminated fill could occur. Therefore, even if subsurface profiles described in this report do not show presence of fill, it is possible that localised fill may be encountered in some portions of the site. Assessment of asbestos contaminated fill was beyond the scope of this geotechnical investigation. We understand an Environmental Consultant has been commissioned to carry out contamination assessment.

The subsurface materials may generally be described as follows.

Topsoil/Fill	Silty CLAY, low to medium plasticity, brown, with roots
Residual Soil	Silty CLAY, medium to high plasticity, orange, brown, moisture content lower than or equal to plastic limit, firm to stiff
	Shaley CLAY, medium to high plasticity, grey, brown, moisture content lower than or equal to plastic limit, with some shale fragments and ironstone, stiff to very stiff
Bedrock	SHALE, grey, pale grey, brown, extremely weathered to fresh, very low to medium strength

Groundwater level was not encountered up to borehole termination depth of 0.9m to 2.5m from existing ground surface. Based on observation during test pit, it is our assessment that the depth to groundwater level across the site is likely to be in excess of 2.5m from existing ground surface. It should however be noted that fluctuations in the level of groundwater might occur due to variations in rainfall and/or other factors not evident during drilling.

8.0 Laboratory Testing

Representative soil samples recovered from test pits were tested in the NATA accredited laboratories of SGS Environmental Services and Geotech Testing Pty Ltd to determine Chemical properties including Electrical Conductivity (EC), pH and Exchangeable Sodium Percentage (ESP) and physical properties including Atterberg Limits, optimum moisture content, maximum dry density and California Bearing Ratio (CBR). Detailed laboratory test results are attached and summaries are presented below in the Tables 2 and 3.

Table 2 – Results of Soil Chemical Properties Tests

Test Pit No	Depth (m)	Exchangeable Sodium Percentage (%)	EC (µS/cm)	pH	Sulphate (mg/kg)
TP4	0.2-0.4	-	150	-	-
TP4	0.8-1.0	-	470	-	-
TP4	1.4-1.6	-	190	-	-
TP5	0.4-0.6	-	73	-	-
TP5	1.3-1.5	-	210	-	-
TP5	2.3-2.5	-	690	-	-
TP6	1.6-1.8	-	350	-	-
TP7	0.3-0.5	14.1	420	5.4	150
TP7	1.1-1.3	21.1	620	4.9	190
TP8	0.5-0.7	-	95	-	-
TP8	1.0-1.7	-	390	-	-
TP9	0.4-0.6	15.2	170	5.3	130

Test Pit No	Depth (m)	Exchangeable Sodium Percentage (%)	EC (µS/cm)	pH	Sulphate (mg/kg)
TP9	1.3-1.5	16.4	350	5.1	170
TP9	1.6-1.7	22.6	730	4.9	390
TP10	0.2-0.4	-	43	-	-
TP10	1.8-2.0	-	230	-	-
TP11	0.5-0.7	-	160	-	-
TP11	1.8-2.0	20.8	340	5.3	300
TP12	0.4-0.6	16.8	120	5.6	96

Table 3 – Results of Soil Physical Properties Tests

Test Pit No	Depth (m)	Liquid Limit (%)	Plasticity Index (%)	Linear Shrinkage (%)	Optimum Moisture Content (%)	Maximum Dry Density (t/m^3)	California Bearing Ratio (%)
TP6	0.8-1.0	57.0	35.0	14.0	-	-	-
TP10	0.5-0.9	62.0	38.0	16.0	25.3	1.56	4.5
TP12	1.2-1.4	67.0	39.0	14.0	-	-	-

9.0 Discussion and Recommendations

9.1 Soil Erodibility

Erosion is the detachment and movement of soil materials. The process might be natural or accelerated by human activity. Susceptibility of soils to erosion depends on dispersibility of soils, which is generally assessed by conducting physical properties tests to determine Emerson Class, Dispersion Percent and Pinhole Class and chemical property tests to determine sodicity in terms of Exchangeable Sodium Percentage (ESP) and Sodium Absorption Ratio (SAR). It should be noted that assessment of soil dispersibility based on the above tests might differ from each other.

For the current investigation only Exchangeable Sodium Percentage (ESP) for representative samples were determined. Soils with ESP values of more than 5.0% are considered sodic and those with ESP more than 15.0% are considered highly sodic (Reference 1).

ESP values for 7 representative soil samples are presented in Table 2 which indicates that the ESP values for representative soil samples vary from 14.1% to 22.6%. Six of seven samples have ESP value of more than 15.0%. Therefore, it is our assessment that the soils across the proposed development site are dispersive and therefore susceptible to excessive erosion. Therefore, we recommend that the earthworks for the proposed cemetery expansion works are carried out in accordance with a Soil Management Plan (SMP) in order to minimise the risk of excessive erosion.

9.2 Soil Salinity

Salinity refers to the presence of excess salt in the environment, either in soil or water. Soil salinity is generally assessed by measuring Electrical Conductivity (EC) of a soil sample made up of 1:5 soil water suspension. Thus determined Electrical Conductivity (EC) is multiplied by a factor varying from 6 to 17, based on the texture of the soil sample, to obtain Equivalent/corrected Electrical Conductivity designated as EC_e (Reference 2). Alternatively, EC_e may also be directly measured in soil saturation extract. The criteria for assessment of soil salinity classes are shown in the following Table 4 (Reference 2).

Table 4 – Soil Salinity Classes

Classification	EC_e (dS/m)	Comments
Non-saline	<2	Salinity effects mostly negligible
Slightly saline	2 – 4	Yields of very sensitive crops may be affected
Moderately saline	4 – 8	Yields of many crops affected
Very saline	8 – 16	Only tolerant crops yield satisfactorily
Highly saline	>16	Only a few tolerant crops yield satisfactorily

A multiplication factor of 8 to 10 is assessed to be appropriate for clayey soils encountered across the site. For a factor of 10, the Equivalent Electrical Conductivity (ECe) values for 19 representative soil samples summarised in Table 2 are estimated to be in range 0.43dS/m to 7.3dS/m. Only 5 of 19 samples have ECe of more than 4.0dS/m and these samples are predominantly from depths exceeding 1.0m from existing ground surface. Although localised saline soils may be encountered at shallow depths, it is our assessment that the soils up to depth of 1.0m may be considered to be non-saline soils. However, soils likely to be disturbed and excavated at depths exceeding 1.0m should be considered saline. Therefore, earthworks for the proposed cemetery expansion works should be carried out in accordance with a Saline Soil Management Plan (SSMP) to reduce and manage impacts from the saline soils on the proposed expansion works. Recommended SSMP that also addresses issues with dispersive soils in presented below in this report.

9.3 Exposure Classification

Australian Standard AS2870 (Reference 3) provides guidelines to assess soil aggressivity and exposure classification for saline and sulphate soils. Table 5 below provides salinity and exposure classification based on Electrical Conductivity (EC_e) and Table 6 provides exposure classification for sulphate soils.

Table 5 – Exposure Classifications for Saline Soils

Electrical Conductivity, EC_e (dS/m)	Exposure Classification	Salinity Classification
<2	A1	Non-saline
2 – 4	A1	Slightly saline
4 – 8	A2	Moderately saline
8 – 16	B1	Very saline
>16	B2	Highly saline

Table 6 – Exposure Classifications for Sulphate Soils

Sulphate expressed as SO_3		pH	Exposure Classification*	
In Soil (ppm)	In Groundwater (ppm)		Soil Condition A	Soil Condition B
<5000	<1000	>5.5	A2	A1
5000-10000	1000-3000	4.5-5.5	B1	A2
10000-20000	3000-10000	4.0-4.5	B2	B1
>20000	>10000	<4.0	C2	B2

Approximately 100ppm of SO_4 = 80ppm of SO_3

*Soil Condition A = high permeability soils (e.g. sands and gravels) which are below groundwater

*Soil Condition B = low permeability soils (e.g. silts and clays) and all soils above groundwater

Soil across the site is clayey in nature and therefore appropriate site condition for predominant soils across the site is assessed to be “Condition B”. Therefore, based on laboratory test results presented in Table 2 and guidelines on exposure classifications presented in Tables 5 and 6, it is our assessment that the foundation soils across the site belong to Exposure Classifications A1 to A2 in accordance with Australian Standard AS2870 (Reference 3). Therefore, we recommend use of construction materials and technique that are appropriate for Exposure Classifications A2.

9.4 Excavation Condition

Although details of the earthworks required for the proposed cemetery expansion works are yet to be finalised, the depth to excavation is anticipated to be up to about 2.1m deep. Therefore, materials to be excavated will comprise topsoil, residual soils and bedrock shale. However, excavation into bedrock will be localised and depth of excavation into bedrock, where required, is anticipated to be 1.0m or less. Bedrock up to depth of 2.1m is assessed to be extremely weathered shale of very low to medium strength. Therefore, it is our assessment that the proposed excavation up to depth of 2.1m can be achieved using conventional earthmoving equipment such as excavators and dozers.

Ground vibration during excavation is generally represented by maximum peak particle velocity. Houses and low rise residential buildings can generally tolerate ground vibration of about 5.0mm/s to 10.0mm/s. We anticipate excavation to depth of 2.1m will result in ground vibrations that are likely to be less than 10.0mm/s. Therefore, it is our assessment that the vibration during excavation for proposed development work is likely to be within tolerable limits for stability of existing structures in the vicinity of the site. However, especial care should be taken to reduce the vibrations to less than 2.0mm/s if any of existing structures within and in the vicinity of the site are heritage listed.

Observations during this investigation indicated that the depth to groundwater level is in excess of 2.5m. Although fluctuations in the level of groundwater might occur due to variations in rainfall and/or other factors not evident during field works, we do not anticipate any groundwater inflow during excavation for proposed development. Minor seepage may be managed by a conventional sump and pump method.

9.5 Fill Placement

We consider site preparation for the proposed development works will require some fill placement. The following procedures are recommended for placement of controlled fill, where required.

- Strip existing topsoil and fill and stockpile separately for possible future uses. Excess materials should be disposed off the site. Contaminated fill should be treated in accordance with recommendation from environmental consultant.
- Undertake proof rolling (using an 8 to 10 tonnes roller) of the exposed residual soils to detect potentially weak spots (ground heave). Excavate areas of localised heaving to a depth of about 300mm and replace with granular fill, compacted as described below.
- Undertake proof rolling of soft spots backfilled with granular fill, as described above. If the backfilled area shows movement during proof rolling, this office should be contacted for further recommendations.

- Place suitable fill materials on proof rolled residual soils. In general, controlled fill should be placed in horizontal layers of 200mm to 250mm maximum loose thickness and compacted to a Minimum Dry Density Ratio (MDDR) of 95% Standard, at moisture content within 2% of Optimum Moisture Content (OMC). However, upper 500mm of controlled fill forming subgrade for roads should be compacted to a MDDR of 100% Standard, at moisture content within 2% of OMC. Controlled fill should preferably comprise non-reactive fill (e.g. crushed sandstone) with a maximum particle size not exceeding 75mm, or low plasticity clay. The fill materials, residual soils and bedrock obtained from excavations within the site may be selectively used in controlled fill after environmental validation, removing deleterious materials, crushing to sizes finer than 75mm and moisture conditioning. This means that the residual soils and bedrock obtained from excavations within the site may be used in controlled fill even without being classified as VENM or ENM if uses of these materials are acceptable from environmental considerations.
- Fill placement should be supervised to ensure that material quality, layer thickness, testing frequency and compaction criteria conform to the specifications. We recommend "Level 2" or better supervision, in accordance with AS3798-2007 (Reference 4). It should be noted that a Geotechnical Inspection and Testing Authority will generally provide certification on the quality of the entire compacted fill only if Level 1 supervision and testing is carried out.

9.6 Batter Slopes and Retaining Structures

Site preparation works for the proposed cemetery expansion will involve some excavation and placement of some controlled fill. As indicated earlier the excavation depths are not known at this stage but anticipated to be less than about 2.0m in depth. Cut and fill slopes during and after development works should be battered for stability or retained by engineered retaining structures. We anticipate that the cut and fill slopes for the proposed development will be appropriately battered for short term and long term stability. We recommend the following batter slopes:

- For short term stability = 1 vertical to 1 horizontal
- For long term stability = 1 vertical to 2.5 horizontal

It is recommended that batter slope surfaces are protected from erosion by proper grassing. The crest of bettered slope should also be provided with drainage to divert surface water to stormwater disposal system in a controlled manner.

If cut and fill slopes steeper than those recommended above are required for whatever reason, the slopes should be retained with engineered retaining structures. Appropriate retaining structures for the proposed development will comprise gravity walls or cantilever walls. Earth pressure distribution on such retaining structures may be assumed to be triangular in shape and estimated as follows:

$$p_h = \gamma k H$$

Where,

p_h = Horizontal pressure (kN/m^2)
γ = Unit weight of materials retained ($18.5kN/m^3$)
k = Coefficient of earth pressure (k_a or k_o)
H = Retained height (m)

For design of flexible retaining structures where some lateral movement is acceptable, an active earth pressure coefficient (k_a) value of 0.35 is recommended. If it is critical to limit the horizontal deformation of retaining structure, use of an earth pressure coefficient at rest (k_0) value of 0.55 is recommended. The above coefficients are based on the assumptions that the ground level behind the retaining structure is horizontal and the retained material is effectively drained. Additional earth pressures resulting from surcharge load (buildings, infrastructures, etc) on retained materials and groundwater pressure, if any, should also be allowed for in design of retaining structures.

9.7 Impacts from Groundwater

Test pits excavated to depths of 2.5m from existing ground did not encounter groundwater level or seepage. Although fluctuations in the level of groundwater might occur due to variations in rainfall and/or other factors not evident during drilling, it is our assessment that the depth of groundwater across the site is more than 2.5m from existing ground surface.

We anticipate that the depths of excavations during proposed cemetery extension works as well as during the use of the site as future cemetery will be less than 2.5m from existing ground surface. Therefore, groundwater is unlikely to adversely impact on the proposed cemetery expansion works. However, we do recommend that the appropriately designed surface drainages are provided to ensure that the surface water is diverted to stormwater system in a controlled manner without impacting on the cemetery. In addition surface drainage should also be provided to divert surface waterway from the cemetery.

9.8 Footings

If cut and fill slopes are retained with engineered retaining structures, we anticipate appropriate footings would comprise shallow footing (pad and strip footings) founded on controlled fill and residual soils or deep footings (screw piles and bored piles) founded in bedrock. Footings for any other structures within the proposed development site may also be founded on controlled fill, residual soils or bedrock. Recommended allowable bearing pressures for design of footings are presented below in Table 7.

Table 7 – Recommended Allowable Bearing Pressures

Founding Material	Indicative Founding Depth (m)	Allowable Bearing Pressure (kPa)	Allowable Shaft Adhesion (kPa)
Controlled Fill	Not Applicable	100.0	Ignore
Residual Soil	0.5 to 2.0	125.0	Ignore
Bedrock -Shale	1.5m to >2.5	700.0	70.0

The indicative founding depths presented in Table 7 are from existing ground surface during current geotechnical investigation. However, after completion of earthworks involving cut and fill, these depths may change.

As depths to different foundation materials could vary across the site, the founding depths of footings to be constructed will also vary. The founding level at a specific location will have to be confirmed by an experienced Geotechnical Engineer on the basis of assessment made during footing excavation or pier hole drilling.

For footings founded on controlled fill and residual soils the total settlement under the recommended allowable bearing pressures is estimated to be about 2.5% of the minimum dimension of footings.

However, for footings founded in bedrock the total settlement under the recommended allowable bearing pressures is estimated to be about 1.0% of pier diameter. The differential settlements are estimated to be about half the estimated total settlements.

9.9 Preliminary Pavement Design

Design of road and car park pavement depends on strength of subgrade, which is usually represented by CBR value, and traffic load. Final pavement design should be based on results of laboratory tests on samples recovered after subgrade preparation is completed. However, this report provides preliminary pavement design based on the following assumptions:

- Road pavement will be constructed on residual soils and/or controlled fill subgrade and
- Residual soils obtained from excavations within the site or similar materials will be used as controlled fill materials for subgrade. Therefore, results of laboratory tests on residual soil samples can be considered to be indicative of final subgrade materials.

Table 3 indicates that the CBR value for samples recovered from residual soils vary from 1.5% to 4.5%. CBR value of less than 3.0% generally indicates very weak subgrade material. As residual soils are assessed to be reactive in nature, subgrade materials with CBR values of less than 3.0% could be widespread across the site. Therefore, we recommend the following options to improve subgrade strength:

- Strip upper 500mm of subgrade and replace with crushed sandstone compacted to dry density ratio of at least 100% standard.
- Blend upper 400mm of residual subgrade with 3.0% of lime by weight and compact to dry density ratio of at least 100% standard within moisture content within 2% of optimum moisture content.

We recommend an indicative CBR of 3.0% for design of pavement after subgrade is improved using one of the above options. However, if imported fill materials are used as subgrade for the road additional sampling and testing should be carried out to assess CBR of imported fill forming actual subgrade so that an appropriate pavement could be designed.

A traffic load of 2.0 x 10^5 Equivalent Standard Axles (ESA) is recommended for design of flexible pavement for local streets. Therefore, appropriate traffic load for design of road pavement within the proposed development site is assumed to be 2.0 x 10^5 ESA.

For recommended indicative design subgrade CBR value of 3.0% and traffic loading of 2.0 x 10^5 ESA the recommended flexible pavement design in accordance with Austroads Guideline (Reference 5) is presented in the following Table 8.

Table 8 – Recommended Flexible Pavement Design

Pavement Materials	Thickness
Asphaltic Concrete	50mm
Basecourse Material (DGB20)	150mm
Sub-base Material (DGS40)	210mm

Recommended pavement thicknesses presented in Table 8 are valid only if the subgrade and pavement materials are compacted to the following Minimum Dry Density Ratios.

Basecourse	98% Modified
Sub-basecourse	98% Modified
Subgrade	100% Standard

The pavement design assumes provision of adequate surface and sub-surface drainage. Recommended pavement design is valid for assumed traffic loading and an indicative subgrade CBR value, which should be determined after completion of subgrade preparation. Furthermore, it is possible that the subgrade improvement in accordance with one of two options recommended in this report may not be required if CBR values of residual soils exposed at the final subgrade level after subgrade preparation is 3.0% or more.

10.0 Saline Soil Management Plan (SSMP)

Soils likely to be disturbed during the proposed development works are anticipated to be dispersive, with a high risk of erosion, as well as saline at depths exceeding 1.0m. Therefore, both soil dispersibility and salinity are of concern for earthworks during proposed cemetery expansion works. Furthermore, given the problems associated with erosion and soil salinity in Western Sydney, we recommend that some soil management principals are implemented during the proposed earthworks, as preventative measures in dealing with possible erosion and salinity problems.

The only effective way to remove salts from soils to reduce the salinity risk to a tolerable level is by leaching/flushing, which is accomplished by allowing fresh water to infiltrate through saline soils so that salty water is collected and discharged out of the site using an appropriate drainage system. However, leaching is not considered practical and appropriate for the proposed development site. Therefore, earthworks across the site should be carried out in accordance with an appropriate Saline Soil Management Plan (SSMP) and the objectives of the SSMP should include the following:

- Minimise erosion and sediment loss before, during and after construction.
- Minimise water pollution due to erosion, siltation and sedimentation.
- Maximise the re-use of onsite materials.
- Reduce and manage salinity within the site so that impacts on possible future structures and vegetation in the vicinity of the site are minimised and acceptable.
- Ensure that the natural flow of surface and groundwater is maintained as much as possible.
- Use building materials and technique appropriate for salinity conditions or aggressivity.

We recommended the following as part of the SSMP:

- Erosion and Sediment Control Plans must be developed and implemented by the earthworks contractors, in accordance with recommendations provided by the NSW Department of Housing (Reference 6). All sediment and erosion controls proposed by the Erosion and Sediment Control Plan are to be installed prior to commencement of any construction works.
- Map the current primary drainage lines and incorporate these into the surface water drainage system for the subdivision. Do not fill in or block these drainage lines unless appropriate alternative drainage is provided.
- Develop the best use of the existing topography in order to minimise cut and fill operations. Where cut are required limit to depth of 1.0m, if possible.
- Retaining walls for cut and fill slopes should be provided with adequate and appropriate drainage.

- If fill is to be placed in low lying areas, a drainage layer should be placed beneath the fill to prevent groundwater rise and the drainage layer should be drained off the site.
- Finished ground surface should be provided with adequate fall to allow run-off of water and prevent water ponding, waterlogging and infiltration of rainwater.
- Ensure that construction activities do not affect the natural flow of groundwater. Where groundwater is intercepted during development works/excavation, the flow should be diverted to stormwater drains or creeks by providing appropriate surface and sub-surface drainage.
- Reduce groundwater recharge through appropriate land use and land management practices. This can be achieved by minimising deep infiltration and through-flow and maximising vegetation cover, planting of deep rooted trees and use of salt tolerant plants.
- Utilise native and deep-rooted plants to minimise soil erosion. Where vegetation cover is not adequate to control erosion, improve soil resistance to erosion by stabilising dispersive soils with hydrated lime and gypsum. Exact proportions of lime and gypsum to be used can be determined on the basis of laboratory testing, but for preliminary planning purposes we suggest about 3% to 5% of lime and gypsum.
- On cut and fill batters provide a secured turf overlay or shotcreting, again to guard against erosion. Construction of a V-drain behind the crest of all slopes is also recommended to divert water away from the slope.
- Select construction materials and techniques suitable for assessed exposure classification.

11.0 Conclusions

Results of this investigation indicate that the geotechnical conditions across the site do not impose any constraint on proposed cemetery expansion. However, earthworks and design and construction of roads and any other structures should be carried out in accordance with recommendations provided in this report.

Assessments and recommendations presented in this report are based on site observation and information from only limited number of test pits and soil samples. Although we believe that the sub-surface profile presented in this report is indicative of the general profile across the site, it is possible that the sub-surface profile across the site could differ from that encountered in the boreholes. Likewise, comments on depth to groundwater level are based on observation during a short period of time. We recommend that this company is contacted for further advice if actual site conditions and depth to groundwater level encountered during basement excavation differ from those presented in this report.

References

1. *Fell, R., MacGregor, P and Stapledon, D. - Geotechnical Engineering of Embankment Dams, 1992.*
2. *Lillicrap, A and McGhie, S. - Site Investigation for Urban Salinity, Department of Land and Water Conservation, 2002.*
3. *Australian Standard AS2786-2011, Residential Slabs and Footings, 2011.*
4. *Australian Standard AS3798-2007 - Guidelines on Earthworks for Commercial and Residential Developments, 2007.*
5. *Austroads, Pavement Design for Light Traffic, A Supplement to Austroads Pavement Design Guide, AP-T36/06, 2006.*
6. *NSW Department of Housing: Managing Urban Stormwater, Soils and Construction, 1998.*

ATTACHMENTS

Drawing No 14160/1-AA1R1 Test Pit Location Plan

Excavation Logs

Laboratory Test Results

LEGEND

Test Pit

Slope

Boundary of Cemetery Expansion Land

Imagery ©2018 NearMap.com

0 30 60 90 120 150m

Scale 1:3000

GEOTECHNIQUE® PTY LTD

PO Box 880
Penrith NSW 2750
Tel: 02 4722 2700
Fax: 02 4722 2777
e-mail:info@geotech.com.au
www.geotech.com.au

NOTES

1. Site features are indicative and are not to scale.
2. This drawing has been produced using a base plan provided by others to which additional information e.g test pits, borehole locations or notes have been added. Some or all of the plan may not be relevant at the time of producing this drawing

Blacktown City Council
Proposed Cemetery Extension
St Bartholomew Place
Prospect

Test Pit Locations

Drawing No: 14160/1-AA1R1
Job No: 14160/1
Drawn By: MH
Date: 21 May 2018
Checked By: JH/IJ

File No: 14160-1
Layers: 0, AA1

GEOTECHNIQUE
PTY LTD

engineering log - excavation

Client : Blacktown City Council
Project : Proposed Cemetery Extension
Location : St Bartholomew Place Prospect

Job No : 14160/1
Pit No : TP4
Date : 13/03/2018
Logged/Checked by: JH

Equipment type and model: 5 Tonne Excavator
R.L. surface :
Excavation dimensions : 1.6 **m long** 0.4 **m wide** **datum :**

groundwater	env samples	PID reading (ppm)	geo samples	field tests	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
					0			TOPSOIL: Silty Clay, low to medium plasticity, brown, trace of root fibres				
			DS		0.5		CI-CH	Silty CLAY, medium to high plasticity, orange-brown	M≤PL	F-St		Residual
			DS		1		CI-CH	Silty CLAY, medium to high plasticity, grey, with ironstone fragments	M≤PL	St		
DRY			DS		1.5		CI-CH	Shaley CLAY, medium to high plasticity, grey-brown, with shale fragments				
					2			Test pit No 4 terminated at 1.6m due to refusal on shale bedrock				
					2.5							
					3							
					3.5							
					4							
					4.5							

GEOTECHNIQUE
PTY LTD

engineering log - excavation

Client : Blacktown City Council
Project : Proposed Cemetery Extension
Location : St Bartholomew Place Prospect

Job No : 14160/1
Pit No : TP5
Date : 13/03/2018
Logged/Checked by: JH

Equipment type and model: 5 Tonne Excavator
R.L. surface :
Excavation dimensions : 1.6 **m long** 0.4 **m wide** **datum :**

groundwater	env samples	PID reading (ppm)	geo samples	field tests	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
DRY					0			TOPSOIL: Silty Clay, low to medium plasticity, brown, trace of root fibres				
			DS		0.5		CI-CH	Silty CLAY, medium to high plasticity, orange-brown	M≤PL	F-St		Residual
			DS		1.5		CI-CH	Silty CLAY, medium to high plasticity, grey, with ironstone fragments	M≤PL	St		
			DS		2							
					2.5			Test pit No 5 terminated at 2.5m				
					3							
					3.5							
					4							
					4.5							

GEOTECHNIQUE
PTY LTD

engineering log - excavation

Client : Blacktown City Council
Project : Proposed Cemetery Extension
Location : St Bartholomew Place Prospect

Job No : 14160/1
Pit No : TP6
Date : 13/03/2018
Logged/Checked by: JH

Equipment type and model: 5 Tonne Excavator
R.L. surface :
Excavation dimensions : 1.6 **m long** 0.4 **m wide** **datum :**

groundwater	env samples	PID reading (ppm)	geo samples	field tests	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
DRY					0			TOPSOIL: Silty Clay, low to medium plasticity, brown, trace of root fibres				
					0.5		CI-CH	Silty CLAY, medium to high plasticity, orange-brown	M≤PL	F-St		Residual
			DS		1							
					1.5		CI-CH	Shaley CLAY, medium to high plasticity, grey-brown, with shale fragments	M≤PL	St		
			DS		2							
					2.5			Test pit No 6 terminated at 2.5m				
					3							
					3.5							
					4							
					4.5							

GEOTECHNIQUE
PTY LTD

engineering log - excavation

Client : Blacktown City Council
Project : Proposed Cemetery Extension
Location : St Bartholomew Place Prospect

Job No : 14160/1
Pit No : TP7
Date : 13/03/2018
Logged/Checked by: JH

Equipment type and model: 5 Tonne Excavator
R.L. surface :
Excavation dimensions : 1.6 **m long** 0.4 **m wide** **datum :**

groundwater	env samples	PID reading (ppm)	geo samples	field tests	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
					0			TOPSOIL: Silty Clay, low to medium plasticity, brown, trace of root fibres				
			DS		0.5		CI-CH	Silty CLAY, medium to high plasticity, orange-brown	M≤PL	F-St		Residual
DRY			DS		1		CI-CH	Shaley CLAY, medium to high plasticity, brown-grey, with shale fragments	M≤PL	St		
					1.5							
					2							
					2.5			Test pit No 7 terminated at 2.5m				
					3							
					3.5							
					4							
					4.5							

GEOTECHNIQUE
PTY LTD

engineering log - excavation

Client : Blacktown City Council
Project : Proposed Cemetery Extension
Location : St Bartholomew Place Prospect

Job No : 14160/1
Pit No : TP8
Date : 13/03/2018
Logged/Checked by: JH

Equipment type and model: 5 Tonne Excavator
R.L. surface :
Excavation dimensions : 1.6 **m long** 0.4 **m wide** **datum :**

groundwater	env samples	PID reading (ppm)	geo samples	field tests	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
					0			TOPSOIL: Silty Clay, low to medium plasticity, brown, trace of root fibres				
							CI-CH	Silty CLAY, medium to high plasticity, orange-brown	M≤PL	F-St		Residual
			DS		0.5							
					1		CI-CH	Silty CLAY, medium to high plasticity, brown-grey, with shale fragments	M≤PL	St		
			DS		1.5							
DRY					2							
					2.5			Test pit No 8 terminated at 2.5m				
					3							
					3.5							
					4							
					4.5							

GEOTECHNIQUE
PTY LTD

engineering log - excavation

Client : Blacktown City Council
Project : Proposed Cemetery Extension
Location : St Bartholomew Place Prospect

Job No : 14160/1
Pit No : TP9
Date : 13/03/2018
Logged/Checked by: JH

Equipment type and model: 5 Tonne Excavator
R.L. surface :
Excavation dimensions : 1.6 **m long** 0.4 **m wide** **datum :**

groundwater	env samples	PID reading (ppm)	geo samples	field tests	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
DRY					0			TOPSOIL: Silty Clay, low to medium plasticity, brown, trace of root fibres				
			DS		0.5		CI-CH	Silty CLAY, medium to high plasticity, orange-brown	M≤PL	F-St		Residual
			DS		1		CI-CH	Shaley CLAY, medium to high plasticity, brown-grey, with shale fragments	M≤PL	St-VSt		
			DS		1.5			SHALE, brown-grey, moderately weathered, medium strength				Bedrock
					2			Test pit No 9 terminated at 1.7m due to refusal on shale				
					2.5							
					3							
					3.5							
					4							
					4.5							

GEOTECHNIQUE
PTY LTD

engineering log - excavation

Client : Blacktown City Council
Project : Proposed Cemetery Extension
Location : St Bartholomew Place Prospect

Job No : 14160/1
Pit No : TP10
Date : 13/03/2018
Logged/Checked by: JH

Equipment type and model: 5 Tonne Excavator
R.L. surface :
Excavation dimensions : 1.6 **m long** 0.4 **m wide** **datum :**

groundwater	env samples	PID reading (ppm)	geo samples	field tests	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
DRY					0			TOPSOIL: Silty Clay, low to medium plasticity, brown, trace of root fibres				
			DS				CI-CH	Silty CLAY, medium to high plasticity, orange-brown	M≤PL	F-St		Residual
			DB		0.5							
					1		CI-CH	Shaley CLAY, medium to high plasticity, brown-grey, with shale fragments	M≤PL	St-VSt		
			DS		1.5							
					2			Test pit No 10 terminated at 2.0m due to refusal on shale bedrock				
					2.5							
					3							
					3.5							
					4							
					4.5							

GEOTECHNIQUE
PTY LTD

engineering log - excavation

Client : Blacktown City Council
Project : Proposed Cemetery Extension
Location : St Bartholomew Place Prospect

Job No : 14160/1
Pit No : TP11
Date : 13/03/2018
Logged/Checked by: JH

Equipment type and model: 5 Tonne Excavator
R.L. surface :
Excavation dimensions : 1.6 **m long** 0.4 **m wide** **datum :**

groundwater	env samples	PID reading (ppm)	geo samples	field tests	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
DRY					0			TOPSOIL: Silty Clay, low to medium plasticity, brown, trace of root fibres				
			DS		0.5		CI-CH	Silty CLAY, medium to high plasticity, orange-brown	M≤PL	F-St		Residual
			DS		1		CI-CH	Shaley CLAY, medium to high plasticity, grey-brown, with shale fragments	M≤PL	St-VSt		
					1.5							
					2							
					2.5			Test pit No 11 terminated at 2.5m				
					3							
					3.5							
					4							
					4.5							

GEOTECHNIQUE
PTY LTD

engineering log - excavation

Client : Blacktown City Council
Project : Proposed Cemetery Extension
Location : St Bartholomew Place Prospect

Job No : 14160/1
Pit No : TP12
Date : 13/03/2018
Logged/Checked by: JH

Equipment type and model: 5 Tonne Excavator
R.L. surface :
Excavation dimensions : 1.6 **m long** 0.4 **m wide** **datum :**

groundwater	env samples	PID reading (ppm)	geo samples	field tests	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
DRY					0			TOPSOIL: Silty Clay, low to medium plasticity, brown, trace of root fibres				
			DS		0.5		CI-CH	Silty CLAY, medium to high plasticity, orange-brown	M≤PL	F-St		Residual
			DS		1		CI-CH	Shaley CLAY, medium to high plasticity, brown-grey, with shale fragments	M≤PL	St-VSt		
					1.5							
					2							
					2.5			Test pit No 12 terminated at 2.5m				
					3							
					3.5							
					4							
					4.5							

KEY TO SYMBOLS

Symbol Description

Strata symbols

Topsoil

Silty Clay
medium to high plasticity

Shaley Clay
medium to high plasticity

Shale

Descriptions of various line types (solid, dotted, etc.)

Profile change

Gradual profile change

Notes:

1. **Exploratory borings were drilled between 13/03/2018 and 13/03/2018 using a 50, 100 and 125mm diameter continuous flight power auger.**

2. **These logs are subject to the limitations, conclusions and recommendations in this report.**

3. **Results of tests conducted on samples recovered are reported on the logs.**

Log Symbols & Abbreviations (Non-cored Borehole Log)

Log Column	Symbol/Value		Description
Drilling Method	V-bit TC-bit RR DB BB		Hardened steel 'V' shaped bit attached to auger Tungsten Carbide bit attached to auger Tricone (Rock Roller) bit Drag bit Blade bit
Groundwater	Dry 		Groundwater not encountered to the drilled or auger refusal depth Groundwater level at depths shown on log Groundwater seepage at depths shown on log
Environment Sample	GP G P		Glass bottle and plastic bag sample over depths shown on log Glass bottle sample over depths shown on log Plastic bag sample over depths shown on log
PID Reading	100		PID reading in ppm
Geotechnical Sample	DS DB U_{50}		Disturbed Small bag sample over depths shown on log Disturbed Bulk sample over depths shown on log Undisturbed 50mm tube sample over depths shown on log
Field Test	N=10 3,5,5 N=R 10,15/100		Standard Penetration Test (SPT) 'N' value. Individual numbers indicate blows per 150mm penetration. 'R' represents refusal to penetration in hard/very dense soils or in cobbles or boulders. The first number represents10 blows for 150mm penetration whereas the second number represents 15 blows for 100mm penetration where SPT met refusal
	DCP/PSP	5 6 R/10	Dynamic Cone Penetration (DCP) or Perth Sand Penetrometer (PSP). Each number represents blows per 100mm penetration. 'R/10' represents refusal after 10mm penetration in hard/very dense soils or in gravels or boulders.
Classification	GP GW GM GC SP SW SM SC ML MI MH CL CI CH		Poorly Graded GRAVEL Well graded GRAVEL Silty GRAVEL Clayey GRAVEL Poorly graded SAND Well graded SAND Silty SAND Clayey SAND SILT / Sandy SILT / clayey SILT, low plasticity SILT / Sandy SILT / clayey SILT, medium plasticity SILT / Sandy SILT / clayey SILT, high plasticity CLAY / Silty CLAY / Sandy CLAY / Gravelly CLAY, low plasticity CLAY / Silty CLAY / Sandy CLAY / Gravelly CLAY, medium plasticity CLAY / Silty CLAY / Sandy CLAY / Gravelly CLAY, high plasticity
Moisture Condition Cohesive soils Cohesionless soils	 M<PL M=PL M>PL D M W		 Moisture content less than Plastic Limit Moisture content equal to Plastic Limit Moisture content to be greater than Plastic Limit Dry - Runs freely through hand Moist - Tends to cohere Wet - Tends to cohere

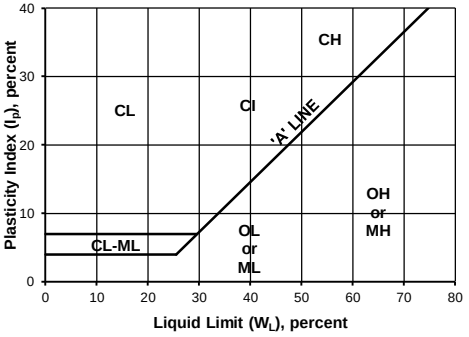
Consistency Cohesive soils	Term	Undrained shear strength, C_u (kPa)	Hand Penetrometer (Qu)
VS	Very Soft	≤12	<25
S	Soft	>12 ≤25	25 – 50
F	Firm	>25 ≤50	50 – 100
St	Stiff	>50 ≤100	100 – 200
VSt	Very Stiff	>100 ≤200	200 – 400
H	Hard	>200	>400

Density Index Cohesionless soils	Term	Density Index, I_D (%)	SPT 'N' (blows/300mm)
VL	Very Loose	≤15	≤5
L	Loose	>15 ≤35	>5 ≤10
M	Medium Dense	>35 ≤65	>10 ≤30
D	Dense	>65 ≤85	>30 ≤50
VD	Very Dense	>85	>50

Hand Penetrometer	100 200	Unconfined compressive strength (q_u) in kPa determined using pocket penetrometer, at depths shown on log
Remarks	 Residual Alluvium Colluvial Aeolian Marine	Geological origin of soils Residual soils above bedrock River deposited Alluvial soils Gravity deposited Colluvial soils Wind deposited Aeolian soils Marine Soils

GEOTECHNIQUE PTY LTD

AS1726 – Unified Soil Classification System

Major Divisions		Particle size (mm)	Group Symbol	Typical Names	Field Identifications Sand and Gravels			Laboratory classification				
	BOULDERS	200						% (2) < 0.075mm	Plasticity of Fine Fraction	$C_u = D_{60}/D_{10}$	$C_c = (D_{30})^2/(D_{10}D_{60})$	Notes
	COBBLES	63										
COARSE GRAINED SOILS (more than half of material less 63mm is larger than 0.075mm)	GRAVELS (more than half of coarse fraction is larger than 2.36mm)	Coarse 20	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength			0-5	-	>4	between 1 and 3	1. Identify lines by the method given for fine grained soils 2. Borderline classifications occur when the percentage of fines (fraction smaller than 0.075mm size) is greater than 5% and less than 12%. Borderline classifications require the use of dual symbols e.g. SP-SM, GW-GC
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines, uniform gravels	Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength			0-5	-	Fails to comply with above		
		Medium 6	GM	Silty gravels, gravel-sand-silt mixtures	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength			12-50	Below 'A' line or I_p<4	-	-	
		Fine 2.36	GC	Clayey gravels, gravel-sand-clay mixtures	'Dirty' materials with excess of plastic fines, medium to high dry strength			12-50	Above 'A' line or I_p>7	-	-	
	SANDS (more than half of coarse fraction is smaller than 2.36mm)	Coarse 0.6	SW	Well-graded sands, gravelly sands, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength			0-5	-	>6	between 1 and 3	
		Medium 0.2	SP	Poorly graded sands and gravelly sands; little or no fines, uniform sands	Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength			0-5	-	Fails to comply with above		
		Fine 0.075	SM	Silty sands, sand-silt mixtures	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength			12-50	Below 'A' line or I_p<4	-	-	
			SC	Clayey sand, sand-clay mixtures	'Dirty' materials with excess of plastic fines, medium to high dry strength			12-50	Above 'A' line of I_p>7	-	-	
FINE GRAINED SOILS (more than half of material less than 63mm is smaller than 0.075mm)					**Dry Strength**	**Dilatancy**	**Toughness**					
	SILTS & CLAYS (liquid limit < 50%)		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity	None to low	Quick to slow	None	More than 50% passing 0.075mm	Below 'A' line			
			CL, CI	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	Medium to high	None to very slow	Medium		Above 'A' line			
			OL	Organic silts and organic silty clays of low plasticity	Low to medium	Slow	Low		Below 'A' line			
	SILTS & CLAYS (liquid limit > 50%)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	Low to medium	Slow to none	Low to medium		Below 'A' line			
			CH	Inorganic clays of medium to high plasticity, fat clays	High to very high	None	High		Above 'A' line			
			OH	Organic clays of medium to high plasticity, organic silts	Medium to high	None to very slow	Low to medium		Below 'A' line			
	HIGHLY ORGANIC SOILS		Pt	Peat and highly organic soils	Identified by colour, odour, spongy feel and generally by fibrous texture			Effervesces with H_2O_2				

Use the gradation of material passing 63mm for classification of fractions according to the criteria given in 'Major Divisions'

Log Symbols & Abbreviations (Cored Borehole Log)

Log Column	Symbol	Description
Core Size		Nominal Core Size (mm)
	NQ	47
	NMLC	52
	HQ	63
Water Loss	◀	Complete water loss
	◁	Partial water loss
Weathering	FR	Fresh — Rock shows no sign of decomposition or staining
	SW	Slightly Weathered — Rock is slightly discoloured but shows little or no change of strength from fresh rock
	DW	Distinctly Weathered — Rock strength usually changed by weathering. The rock may be highly discoloured, usually by ironstaining. Porosity may be increased by leaching, or may be decreased by deposition of weathering products in pores
	EW	Extremely Weathered — Rock is weathered to such an extent that it has 'soil' properties, i.e. it either disintegrate or can be remoulded, in water
	RS	Residual Soil — Soil developed on extremely weathered rock; the mass structure and substance fabric are no longer evident; there is a large change in volume but soil has not been significantly transported
Strength		Term — Point Load Strength Index (I_{s50}, MPa)
	EL	Extremely Low — ≤0.03
	VL	Very Low — >0.03 ≤0.1
	L	Low — >0.1 ≤0.3
	M	Medium — >0.3 ≤1
	H	High — >1 ≤3
	VH	Very High — >3 ≤10
	EH	Extremely High — >10
Defect Spacing		Description — Spacing (mm)
		Extremely closely spaced — <20
		Very closely spaced — 20 to 60
		Closely spaced — 60 to 200
		Medium spaced — 200 to 600
		Widely spaced — 600 to 2000
		Very widely spaced — 2000 to 6000
		Extremely widely spaced — >6000
Defect Description		
Type	Bp	Bedding parting
	Fp	Foliation parting
	Jo	Joint
	Sh	Sheared zone
	Cs	Crushed seam
	Ds	Decomposed seam
	Is	Infilled seam
Macro-surface geometry	St	Stepped
	Cu	Curved
	Un	Undulating
	Ir	Irregular
	Pl	Planar
Micro-surface geometry	Ro	Rough
	Sm	Smooth
	Sl	Slickensided
Coating or infilling	cn	clean
	sn	stained
	vn	veneer
	cg	coating

AS1726 – Identification of Sedimentary Rocks for Engineering Purposes

Grain Size mm		Bedded rocks (mostly sedimentary)									
More than 20	20	Grain Size Description				At least 50% of grains are of carbonate				At least 50% of grains are of fine-grained volcanic rock	
	6	RUDACEOUS		CONGLOMERATE Rounded boulders, cobbles and gravel cemented in a finer matrix		LIMESTONE and DOLOMITE (undifferentiated)		Calcirudite		Fragments of volcanic ejecta in a finer matrix	SALINE ROCKS
	2			Breccia Irregular rock fragments in a finer matrix						Rounded grains AGGLOMERATE Angular grains VOLCANIC BRECCIA	Halite Anhydrite
	0.6	ARENACEOUS	Coarse	SANDSTONE Angular or rounded grains, commonly cemented by clay, calcite or iron minerals				Calcarenite		Cemented volcanic ash	Gypsum
	0.2		Medium	Quartzite Quartz grains and siliceous cement						TUFF	
	0.06		Fine	Arkose Many feldspar grains Greywacke Many rock chips							
	0.002	ARGILLACEOUS		MUDSTONE	SILTSTONE Mostly silt	Calcareous Mudstone		Calcisiltite	CHALK	Fine-grained TUFF	
	Less than 0.002			SHALE Fissile	CLAYSTONE Mostly clay			Calcilutite		Very fine-grained TUFF	
Amorphous or crypto-crystalline				Flint: occurs as hands of nodules in the chalk Chert: occurs as nodules and beds in limestone and calcareous sandstone							COAL LIGNITE
				Granular cemented – except amorphous rocks							
				SILICEOUS		CALCAREOUS				SILICEOUS	CARBONACEOUS
				SEDIMENTARY ROCKS Granular cemented rocks vary greatly in strength, some sandstones are stronger than many Igneous rocks. Bedding may not show in hand specimens and is best seen in outcrop. Only sedimentary rocks, and some metamorphic rocks derived from them, contain fossils Calcareous rocks contain calcite (calcium carbonate) which effervesces with dilute hydrochloric acid						

AS1726 – Identification of Metamorphic and Igneous Rocks for Engineering Purposes

Obviously foliated rocks (mostly metamorphic)		Rocks with massive structure and crystalline texture (mostly igneous)						Grain size (mm)
Grain size description			Grain size description	Pegmatite			Pyrosenite	More than 20
		MARBLE						20
COARSE	GNEISS Well developed but often widely spaced foliation sometimes with schistose bands	QUARTZITE	COARSE	GRANITE	Diorite	GABBRO	Peridorite	6
	Migmatite Irregularly foliated: mixed schists and gneisses	Granulite HORNFELS		These rocks are sometimes phorphyritic and are then described, for example, as porphyritic granite				2
MEDIUM	SCHIST Well developed undulose foliation; generally much mica	Amphibolite	MEDIUM	Micorgranite	Microdiorite	Dolerite		0.6
		Serpentine		These rocks are sometimes phorphyritic and are then described as porphyries				0.2
								0.06
FINE	PHYLLITE Slightly undulose foliation; sometimes 'spotted'		FINE	RHYOLITE	ANDESITE	BASALT		0.002
	SLATE Well developed plane cleavage (foliation)			These rocks are sometimes phorphyritic and are then described as porphyries				Less than 0.002
	Mylonite Found in fault zones, mainly in igneous and metamorphic areas			Obsidian	Volcanic glass			Amorphous or cryptocrystalline
CRYSTALLINE				Pale<----------->Dark				
SILICEOUS		Mainly SILICEOUS		ACID Much quartz	INTERMEDIATE Some quartz	BASIC Little or no quartz	ULTRA BASIC	
METAMORPHIC ROCKS Most metamorphic rocks are distinguished by foliation which may impart fissility. Foliation in gneisses is best observed in outcrop. Non-foliated metamorphics are difficult to recognize except by association. Any rock baked by contact metamorphism is described as 'hornfels' and is generally somewhat stronger than the parent rock Most fresh metamorphic rocks are strong although perhaps fissile			IGNEOUS ROCKS Composed of closely interlocking mineral grains. Strong when fresh; not porous Mode of occurrence : 1 Batholith; 2 Laccoliths; 3 Sills; 4 Dykes; 5 Lava Flows; 6 Veins					

GEOTECHNIQUE® PTY LTD

ABN 64 002 841 063

DYNAMIC CONE PENETRATION (DCP) TEST RESULTS

Hammer Weight 9kg
Drop 510mm
Rod Diameter 16mm

CLIENT:	Blacktown City Council	Job No:	14160/1
PROJECT:	Proposed Cemetery Expansion	Tested By:	JH
LOCATION:	St Bartholomew Place, Prospect	Checked By:	JH
		Date Tested:	13/3/18

Test Procedure: AS1289 6.3.2 DYNAMIC CONE PENETROMETER

Test Number	TP4	TP6	TP7	TP8	TP10
Depth (mm)	Number of Blows per 100mm				
0 – 100	1	3	2	1	3
100 – 200	1	4	1	3	2
200 – 300	3	3	2	2	2
300 – 400	5	4	3	3	1
400 – 500	7	10	5	3	1
500 – 600	8	11	4	3	1
600 – 700	8	7	4	5	2
700 – 800	10	8	5	3	3
800 – 900	15	7	6	4	5
900 – 1000	8	4	7	5	10
1000 – 1100	6	4	6	3	6
1100 – 1200	8	7	8	3	15R
1200 – 1300	15R	9	7	2	
1300 – 1400		15R	8	2	
1400 – 1500			8	3	
1500 – 1600					
1600 – 1700					
1700 – 1800					
1800 – 1900					
1900 – 2000					
2000 – 2100					
2100 – 2200					
2200 – 2300					
2300 – 2400					
2400 – 2500					

ANALYTICAL REPORT

Accreditation No. 2562

CLIENT DETAILS

Contact	Indra Jworchan
Client	Geotechnique
Address	P.O. Box 880 NSW 2751
Telephone	02 4722 2700
Facsimile	02 4722 6161
Email	indra.jworchan@geotech.com.au
Project	**14160-1 St Bartholomew Place, Prospect**
Order Number	(Not specified)
Samples	26

LABORATORY DETAILS

Manager	Huong Crawford
Laboratory	SGS Alexandria Environmental
Address	Unit 16, 33 Maddox St Alexandria NSW 2015
Telephone	+61 2 8594 0400
Facsimile	+61 2 8594 0499
Email	au.environmental.sydney@sgs.com
SGS Reference	**SE176794 R0**
Date Received	16/3/2018
Date Reported	23/3/2018

COMMENTS

Accredited for compliance with ISO/IEC 17025 - Testing. NATA accredited laboratory 2562(4354).

SIGNATORIES

Kamrul Ahsan
Senior Chemist

Shane McDermott
Inorganic/Metals Chemist

pH in soil (1:5) [AN101] Tested: 20/3/2018

PARAMETER	UOM	LOR	TP1 SOIL 0.2-0.4 15/3/2018 SE176794.001	TP1 SOIL 0.5-0.7 15/3/2018 SE176794.002	TP7 SOIL 0.3-0.5 15/3/2018 SE176794.015	TP7 SOIL 1.1-1.3 15/3/2018 SE176794.016	TP9 SOIL 0.4-0.6 15/3/2018 SE176794.019
pH	pH Units	0.1	7.3	6.6	5.4	4.9	5.3

PARAMETER	UOM	LOR	TP9 SOIL 1.3-1.5 15/3/2018 SE176794.020	TP9 SOIL 1.6-1.7 15/3/2018 SE176794.021	TP11 SOIL 1.8-2.0 15/3/2018 SE176794.025	TP12 SOIL 0.4-0.6 15/3/2018 SE176794.026
pH	pH Units	0.1	5.1	4.9	5.3	5.6

Conductivity and TDS by Calculation - Soil [AN106] Tested: 20/3/2018

PARAMETER	UOM	LOR	TP1 SOIL 0.2-0.4 15/3/2018 SE176794.001	TP1 SOIL 0.5-0.7 15/3/2018 SE176794.002	TP2 SOIL 0.4-0.6 15/3/2018 SE176794.003	TP2 SOIL 1.0-1.2 15/3/2018 SE176794.004	TP2 SOIL 1.4-1.5 15/3/2018 SE176794.005
Conductivity of Extract (1:5 dry sample basis)	µS/cm	1	37	46	120	270	300

PARAMETER	UOM	LOR	TP3 SOIL 0.6-0.8 15/3/2018 SE176794.006	TP3 SOIL 1.2-1.4 15/3/2018 SE176794.007	TP4 SOIL 0.2-0.4 15/3/2018 SE176794.008	TP4 SOIL 0.8-1.0 15/3/2018 SE176794.009	TP4 SOIL 1.4-1.6 15/3/2018 SE176794.010
Conductivity of Extract (1:5 dry sample basis)	µS/cm	1	44	190	150	470	190

PARAMETER	UOM	LOR	TP5 SOIL 0.4-0.6 15/3/2018 SE176794.011	TP5 SOIL 1.3-1.5 15/3/2018 SE176794.012	TP5 SOIL 2.3-2.5 15/3/2018 SE176794.013	TP6 SOIL 1.6-1.8 15/3/2018 SE176794.014	TP7 SOIL 0.3-0.5 15/3/2018 SE176794.015
Conductivity of Extract (1:5 dry sample basis)	µS/cm	1	73	210	690	350	420

PARAMETER	UOM	LOR	TP7 SOIL 1.1-1.3 15/3/2018 SE176794.016	TP8 SOIL 0.5-0.7 15/3/2018 SE176794.017	TP8 SOIL 1.0-1.7 15/3/2018 SE176794.018	TP9 SOIL 0.4-0.6 15/3/2018 SE176794.019	TP9 SOIL 1.3-1.5 15/3/2018 SE176794.020
Conductivity of Extract (1:5 dry sample basis)	µS/cm	1	620	95	390	170	350

PARAMETER	UOM	LOR	TP9 SOIL 1.6-1.7 15/3/2018 SE176794.021	TP10 SOIL 0.2-0.4 15/3/2018 SE176794.022	TP10 SOIL 1.8-2.0 15/3/2018 SE176794.023	TP11 SOIL 0.5-0.7 15/3/2018 SE176794.024	TP11 SOIL 1.8-2.0 15/3/2018 SE176794.025
Conductivity of Extract (1:5 dry sample basis)	µS/cm	1	730	43	230	160	340

PARAMETER	UOM	LOR	TP12 SOIL 0.4-0.6 15/3/2018 SE176794.026
Conductivity of Extract (1:5 dry sample basis)	µS/cm	1	120

Exchangeable Cations and Cation Exchange Capacity (CEC/ESP/SAR) [AN122] Tested: 22/3/2018

PARAMETER	UOM	LOR	TP1 SOIL 0.2-0.4 15/3/2018 SE176794.001	TP1 SOIL 0.5-0.7 15/3/2018 SE176794.002	TP7 SOIL 0.3-0.5 15/3/2018 SE176794.015	TP7 SOIL 1.1-1.3 15/3/2018 SE176794.016	TP9 SOIL 0.4-0.6 15/3/2018 SE176794.019
Exchangeable Sodium, Na	mg/kg	2	300	230	460	730	430
Exchangeable Sodium, Na	meq/100g	0.01	1.3	1.0	2.0	3.2	1.9
Exchangeable Sodium Percentage*	%	0.1	12.5	10.3	14.1	21.1	15.2

PARAMETER	UOM	LOR	TP9 SOIL 1.3-1.5 15/3/2018 SE176794.020	TP9 SOIL 1.6-1.7 15/3/2018 SE176794.021	TP11 SOIL 1.8-2.0 15/3/2018 SE176794.025	TP12 SOIL 0.4-0.6 15/3/2018 SE176794.026
Exchangeable Sodium, Na	mg/kg	2	500	720	700	400
Exchangeable Sodium, Na	meq/100g	0.01	2.2	3.1	3.0	1.7
Exchangeable Sodium Percentage*	%	0.1	16.4	22.6	20.8	16.8

Soluble Anions (1:5) in Soil by Ion Chromatography [AN245] Tested: 22/3/2018

PARAMETER	UOM	LOR	TP1 SOIL 0.2-0.4 15/3/2018 SE176794.001	TP1 SOIL 0.5-0.7 15/3/2018 SE176794.002	TP7 SOIL 0.3-0.5 15/3/2018 SE176794.015	TP7 SOIL 1.1-1.3 15/3/2018 SE176794.016	TP9 SOIL 0.4-0.6 15/3/2018 SE176794.019
Sulfate	mg/kg	5	36	67	150	190	130

PARAMETER	UOM	LOR	TP9 SOIL 1.3-1.5 15/3/2018 SE176794.020	TP9 SOIL 1.6-1.7 15/3/2018 SE176794.021	TP11 SOIL 1.8-2.0 15/3/2018 SE176794.025	TP12 SOIL 0.4-0.6 15/3/2018 SE176794.026
Sulfate	mg/kg	5	170	390	300	96

Moisture Content [AN002] Tested: 21/3/2018

PARAMETER	UOM	LOR	TP1 SOIL 0.2-0.4 15/3/2018 SE176794.001	TP1 SOIL 0.5-0.7 15/3/2018 SE176794.002	TP2 SOIL 0.4-0.6 15/3/2018 SE176794.003	TP2 SOIL 1.0-1.2 15/3/2018 SE176794.004	TP2 SOIL 1.4-1.5 15/3/2018 SE176794.005
% Moisture	%w/w	0.5	9.0	16	15	14	13

PARAMETER	UOM	LOR	TP3 SOIL 0.6-0.8 15/3/2018 SE176794.006	TP3 SOIL 1.2-1.4 15/3/2018 SE176794.007	TP4 SOIL 0.2-0.4 15/3/2018 SE176794.008	TP4 SOIL 0.8-1.0 15/3/2018 SE176794.009	TP4 SOIL 1.4-1.6 15/3/2018 SE176794.010
% Moisture	%w/w	0.5	16	12	17	12	9.6

PARAMETER	UOM	LOR	TP5 SOIL 0.4-0.6 15/3/2018 SE176794.011	TP5 SOIL 1.3-1.5 15/3/2018 SE176794.012	TP5 SOIL 2.3-2.5 15/3/2018 SE176794.013	TP6 SOIL 1.6-1.8 15/3/2018 SE176794.014	TP7 SOIL 0.3-0.5 15/3/2018 SE176794.015
% Moisture	%w/w	0.5	15	15	14	17	14

PARAMETER	UOM	LOR	TP7 SOIL 1.1-1.3 15/3/2018 SE176794.016	TP8 SOIL 0.5-0.7 15/3/2018 SE176794.017	TP8 SOIL 1.0-1.7 15/3/2018 SE176794.018	TP9 SOIL 0.4-0.6 15/3/2018 SE176794.019	TP9 SOIL 1.3-1.5 15/3/2018 SE176794.020
% Moisture	%w/w	0.5	17	17	19	16	16

PARAMETER	UOM	LOR	TP9 SOIL 1.6-1.7 15/3/2018 SE176794.021	TP10 SOIL 0.2-0.4 15/3/2018 SE176794.022	TP10 SOIL 1.8-2.0 15/3/2018 SE176794.023	TP11 SOIL 0.5-0.7 15/3/2018 SE176794.024	TP11 SOIL 1.8-2.0 15/3/2018 SE176794.025
% Moisture	%w/w	0.5	14	18	10	18	16

PARAMETER	UOM	LOR	TP12 SOIL 0.4-0.6 15/3/2018 SE176794.026
% Moisture	%w/w	0.5	15

METHOD	METHODOLOGY SUMMARY
AN002	The test is carried out by drying (at either 40°C or 105°C) a known mass of sample in a weighed evaporating basin. After fully dry the sample is re-weighed. Samples such as sludge and sediment having high percentages of moisture will take some time in a drying oven for complete removal of water.
AN101	pH in Soil Sludge Sediment and Water: pH is measured electrometrically using a combination electrode and is calibrated against 3 buffers purchased commercially. For soils, sediments and sludges, an extract with water (or 0.01M CaCl2) is made at a ratio of 1:5 and the pH determined and reported on the extract. Reference APHA 4500-H+.
AN106	Conductivity and TDS by Calculation: Conductivity is measured by meter with temperature compensation and is calibrated against a standard solution of potassium chloride. Conductivity is generally reported as µmhos /cm or µS/cm @ 25°C. For soils, an extract with water is made at a ratio of 1:5 and the EC determined and reported on the extract, or calculated back to the as-received sample. Salinity can be estimated from conductivity using a conversion factor, which for natural waters, is in the range 0.55 to 0.75. Reference APHA 2510 B.
AN122	Exchangeable Cations, CEC and ESP: Soil sample is extracted in 1M Ammonium Acetate at pH=7 (or 1M Ammonium Chloride at pH=7) with cations (Na, K, Ca & Mg) then determined by ICP OES/ICP MS and reported as Exchangeable Cations. For saline soils, these results can be corrected for water soluble cations and reported as Exchangeable cations in meq/100g or soil can be pre-treated (aqueous ethanol/aqueous glycerol) prior to extraction. Cation Exchange Capacity (CEC) is the sum of the exchangeable cations in meq/100g.
AN122	The Exchangeable Sodium Percentage (ESP) is calculated as the exchangeable sodium divided by the CEC (all in meq/100g) times 100. ESP can be used to categorise the sodicity of the soil as below: ESP < 6% non-sodic ESP 6-15% sodic ESP >15% strongly sodic Method is refernced to Rayment and Lyons, 2011, sections 15D3 and 15N1.-
AN245	Anions by Ion Chromatography: A water sample is injected into an eluent stream that passes through the ion chromatographic system where the anions of interest ie Br, Cl, NO2, NO3 and SO4 are separated on their relative affinities for the active sites on the column packing material. Changes to the conductivity and the UV-visible absorbance of the eluent enable identification and quantitation of the anions based on their retention time and peak height or area. APHA 4110 B

FOOTNOTES

*	NATA accreditation does not cover the performance of this service.	-	Not analysed.	UOM	Unit of Measure.
		NVL	Not validated.	LOR	Limit of Reporting.
**	Indicative data, theoretical holding time exceeded.	IS	Insufficient sample for analysis.	↑↓	Raised/lowered Limit of Reporting.
		LNR	Sample listed, but not received.		

Samples analysed as received.
Solid samples expressed on a dry weight basis.

Where "Total" analyte groups are reported (for example, Total PAHs, Total OC Pesticides) the total will be calculated as the sum of the individual analytes, with those analytes that are reported as <LOR being assumed to be zero. The summed (Total) limit of reporting is calculated by summing the individual analyte LORs and dividing by two. For example, where 16 individual analytes are being summed and each has an LOR of 0.1 mg/kg, the "Totals" LOR will be 1.6 / 2 (0.8 mg/kg). Where only 2 analytes are being summed, the " Total" LOR will be the sum of those two LORs.

Some totals may not appear to add up because the total is rounded after adding up the raw values.

If reported, measurement uncertainty follow the ± sign after the analytical result and is expressed as the expanded uncertainty calculated using a coverage factor of 2, providing a level of confidence of approximately 95%, unless stated otherwise in the comments section of this report.

Results reported for samples tested under test methods with codes starting with ARS-SOP, radionuclide or gross radioactivity concentrations are expressed in becquerel (Bq) per unit of mass or volume or per wipe as stated on the report. Becquerel is the SI unit for activity and equals one nuclear transformation per second.
Note that in terms of units of radioactivity:

a. 1 Bq is equivalent to 27 pCi
b. 37 MBq is equivalent to 1 mCi

For results reported for samples tested under test methods with codes starting with ARS-SOP, less than (<) values indicate the detection limit for each radionuclide or parameter for the measurement system used. The respective detection limits have been calculated in accordance with ISO 11929.

The QC criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here : http://www.sgs.com.au/~/media/Local/Australia/Documents/ Technical%20Documents/MP-AU-ENV-QU-022%20QA%20QC%20Plan.pdf

This document is issued by the Company under its General Conditions of Service accessible at www.sgs.com/en/Terms-and-Conditions.aspx. Attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein.

Any holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client only. Any unauthorized alteration, forgery or falsification of the content or appearance of this document is unlawful and offenders may be prosecuted to the fullest extent of the law .

This report must not be reproduced, except in full.

STATEMENT OF QA/QC PERFORMANCE

SE176794 R0

CLIENT DETAILS

Contact	Indra Jworchan
Client	Geotechnique
Address	P.O. Box 880 NSW 2751
Telephone	02 4722 2700
Facsimile	02 4722 6161
Email	indra.jworchan@geotech.com.au
Project	**14160-1 St Bartholomew Place, Prospect**
Order Number	(Not specified)
Samples	26

LABORATORY DETAILS

Manager	Huong Crawford
Laboratory	SGS Alexandria Environmental
Address	Unit 16, 33 Maddox St Alexandria NSW 2015
Telephone	+61 2 8594 0400
Facsimile	+61 2 8594 0499
Email	au.environmental.sydney@sgs.com
SGS Reference	**SE176794 R0**
Date Received	16 Mar 2018
Date Reported	23 Mar 2018

COMMENTS

All the laboratory data for each environmental matrix was compared to SGS' stated Data Quality Objectives (DQO). Comments arising from the comparison were made and are reported below.

The data relating to sampling was taken from the Chain of Custody document and was supplied by the Client.
This QA/QC Statement must be read in conjunction with the referenced Analytical Report.
The Statement and the Analytical Report must not be reproduced except in full.

All Data Quality Objectives were met with the exception of the following:

Analysis Date	pH in soil (1:5)	9 items

SAMPLE SUMMARY

Samples clearly labelled	Yes	Complete documentation received	Yes
Sample container provider	Client	Sample cooling method	None
Samples received in correct containers	Yes	Sample counts by matrix	26 Soil
Date documentation received	15/3/18@9:54am	Type of documentation received	COC
Samples received in good order	Yes	Samples received without headspace	Yes
Sample temperature upon receipt	22.0°C	Sufficient sample for analysis	Yes
Turnaround time requested	Standard		

HOLDING TIME SUMMARY

SE176794 R0

SGS holding time criteria are drawn from current regulations and are highly dependent on sample container preservation as specified in the SGS “Field Sampling Guide for Containers and Holding Time” (ref: GU-(AU)-ENV.001). Soil samples guidelines are derived from NEPM "Schedule B(3) Guideline on Laboratory Analysis of Potentially Contaminated Soils". Water sample guidelines are derived from "AS/NZS 5667.1 : 1998 Water Quality - sampling part 1" and APHA "Standard Methods for the Examination of Water and Wastewater" 21st edition 2005.

Extraction and analysis holding time due dates listed are calculated from the date sampled, although holding times may be extended after laboratory extraction for some analytes. The due dates are the suggested dates that samples may be held before extraction or analysis and still be considered valid.

Extraction and analysis dates are shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria. If the sampled date is not supplied then compliance with criteria cannot be determined. If the received date is after one or both due dates then holding time will fail by default.

Conductivity and TDS by Calculation - Soil

Method: ME-(AU)-[ENV]AN106

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
TP1	SE176794.001	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	22 Mar 2018	22 Mar 2018
TP1	SE176794.002	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	22 Mar 2018	22 Mar 2018
TP2	SE176794.003	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	22 Mar 2018	22 Mar 2018
TP2	SE176794.004	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	22 Mar 2018	22 Mar 2018
TP2	SE176794.005	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	22 Mar 2018	22 Mar 2018
TP3	SE176794.006	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	22 Mar 2018	22 Mar 2018
TP3	SE176794.007	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	22 Mar 2018	22 Mar 2018
TP4	SE176794.008	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	22 Mar 2018	22 Mar 2018
TP4	SE176794.009	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	22 Mar 2018	22 Mar 2018
TP4	SE176794.010	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	22 Mar 2018	22 Mar 2018
TP5	SE176794.011	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	22 Mar 2018	22 Mar 2018
TP5	SE176794.012	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	22 Mar 2018	22 Mar 2018
TP5	SE176794.013	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	22 Mar 2018	22 Mar 2018
TP6	SE176794.014	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	22 Mar 2018	22 Mar 2018
TP7	SE176794.015	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	22 Mar 2018	22 Mar 2018
TP7	SE176794.016	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	22 Mar 2018	22 Mar 2018
TP8	SE176794.017	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	22 Mar 2018	22 Mar 2018
TP8	SE176794.018	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	22 Mar 2018	22 Mar 2018
TP9	SE176794.019	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	22 Mar 2018	22 Mar 2018
TP9	SE176794.020	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	22 Mar 2018	22 Mar 2018
TP9	SE176794.021	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	22 Mar 2018	22 Mar 2018
TP10	SE176794.022	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	22 Mar 2018	22 Mar 2018
TP10	SE176794.023	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	22 Mar 2018	22 Mar 2018
TP11	SE176794.024	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	22 Mar 2018	22 Mar 2018
TP11	SE176794.025	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	22 Mar 2018	22 Mar 2018
TP12	SE176794.026	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	22 Mar 2018	22 Mar 2018

Exchangeable Cations and Cation Exchange Capacity (CEC/ESP/SAR)

Method: ME-(AU)-[ENV]AN122

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
TP1	SE176794.001	LB144152	15 Mar 2018	16 Mar 2018	12 Apr 2018	22 Mar 2018	12 Apr 2018	23 Mar 2018
TP1	SE176794.002	LB144152	15 Mar 2018	16 Mar 2018	12 Apr 2018	22 Mar 2018	12 Apr 2018	23 Mar 2018
TP7	SE176794.015	LB144152	15 Mar 2018	16 Mar 2018	12 Apr 2018	22 Mar 2018	12 Apr 2018	23 Mar 2018
TP7	SE176794.016	LB144152	15 Mar 2018	16 Mar 2018	12 Apr 2018	22 Mar 2018	12 Apr 2018	23 Mar 2018
TP9	SE176794.019	LB144152	15 Mar 2018	16 Mar 2018	12 Apr 2018	22 Mar 2018	12 Apr 2018	23 Mar 2018
TP9	SE176794.020	LB144152	15 Mar 2018	16 Mar 2018	12 Apr 2018	22 Mar 2018	12 Apr 2018	23 Mar 2018
TP9	SE176794.021	LB144152	15 Mar 2018	16 Mar 2018	12 Apr 2018	22 Mar 2018	12 Apr 2018	23 Mar 2018
TP11	SE176794.025	LB144152	15 Mar 2018	16 Mar 2018	12 Apr 2018	22 Mar 2018	12 Apr 2018	23 Mar 2018
TP12	SE176794.026	LB144152	15 Mar 2018	16 Mar 2018	12 Apr 2018	22 Mar 2018	12 Apr 2018	23 Mar 2018

Moisture Content

Method: ME-(AU)-[ENV]AN002

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
TP1	SE176794.001	LB144011	15 Mar 2018	16 Mar 2018	29 Mar 2018	21 Mar 2018	26 Mar 2018	22 Mar 2018
TP1	SE176794.002	LB144011	15 Mar 2018	16 Mar 2018	29 Mar 2018	21 Mar 2018	26 Mar 2018	22 Mar 2018
TP2	SE176794.003	LB144011	15 Mar 2018	16 Mar 2018	29 Mar 2018	21 Mar 2018	26 Mar 2018	22 Mar 2018
TP2	SE176794.004	LB144011	15 Mar 2018	16 Mar 2018	29 Mar 2018	21 Mar 2018	26 Mar 2018	22 Mar 2018
TP2	SE176794.005	LB144011	15 Mar 2018	16 Mar 2018	29 Mar 2018	21 Mar 2018	26 Mar 2018	22 Mar 2018
TP3	SE176794.006	LB144011	15 Mar 2018	16 Mar 2018	29 Mar 2018	21 Mar 2018	26 Mar 2018	22 Mar 2018
TP3	SE176794.007	LB144011	15 Mar 2018	16 Mar 2018	29 Mar 2018	21 Mar 2018	26 Mar 2018	22 Mar 2018
TP4	SE176794.008	LB144011	15 Mar 2018	16 Mar 2018	29 Mar 2018	21 Mar 2018	26 Mar 2018	22 Mar 2018
TP4	SE176794.009	LB144011	15 Mar 2018	16 Mar 2018	29 Mar 2018	21 Mar 2018	26 Mar 2018	22 Mar 2018
TP4	SE176794.010	LB144011	15 Mar 2018	16 Mar 2018	29 Mar 2018	21 Mar 2018	26 Mar 2018	22 Mar 2018
TP5	SE176794.011	LB144011	15 Mar 2018	16 Mar 2018	29 Mar 2018	21 Mar 2018	26 Mar 2018	22 Mar 2018
TP5	SE176794.012	LB144011	15 Mar 2018	16 Mar 2018	29 Mar 2018	21 Mar 2018	26 Mar 2018	22 Mar 2018
TP5	SE176794.013	LB144011	15 Mar 2018	16 Mar 2018	29 Mar 2018	21 Mar 2018	26 Mar 2018	22 Mar 2018
TP6	SE176794.014	LB144011	15 Mar 2018	16 Mar 2018	29 Mar 2018	21 Mar 2018	26 Mar 2018	22 Mar 2018
TP7	SE176794.015	LB144011	15 Mar 2018	16 Mar 2018	29 Mar 2018	21 Mar 2018	26 Mar 2018	22 Mar 2018
TP7	SE176794.016	LB144011	15 Mar 2018	16 Mar 2018	29 Mar 2018	21 Mar 2018	26 Mar 2018	22 Mar 2018
TP8	SE176794.017	LB144011	15 Mar 2018	16 Mar 2018	29 Mar 2018	21 Mar 2018	26 Mar 2018	22 Mar 2018
TP8	SE176794.018	LB144011	15 Mar 2018	16 Mar 2018	29 Mar 2018	21 Mar 2018	26 Mar 2018	22 Mar 2018
TP9	SE176794.019	LB144011	15 Mar 2018	16 Mar 2018	29 Mar 2018	21 Mar 2018	26 Mar 2018	22 Mar 2018
TP9	SE176794.020	LB144011	15 Mar 2018	16 Mar 2018	29 Mar 2018	21 Mar 2018	26 Mar 2018	22 Mar 2018

HOLDING TIME SUMMARY

SE176794 R0

SGS holding time criteria are drawn from current regulations and are highly dependent on sample container preservation as specified in the SGS “Field Sampling Guide for Containers and Holding Time” (ref: GU-(AU)-ENV.001). Soil samples guidelines are derived from NEPM "Schedule B(3) Guideline on Laboratory Analysis of Potentially Contaminated Soils". Water sample guidelines are derived from "AS/NZS 5667.1 : 1998 Water Quality - sampling part 1" and APHA "Standard Methods for the Examination of Water and Wastewater" 21st edition 2005.

Extraction and analysis holding time due dates listed are calculated from the date sampled, although holding times may be extended after laboratory extraction for some analytes. The due dates are the suggested dates that samples may be held before extraction or analysis and still be considered valid.

Extraction and analysis dates are shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria. If the sampled date is not supplied then compliance with criteria cannot be determined. If the received date is after one or both due dates then holding time will fail by default.

Moisture Content (continued)

Method: ME-(AU)-[ENV]AN002

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
TP9	SE176794.021	LB144011	15 Mar 2018	16 Mar 2018	29 Mar 2018	21 Mar 2018	26 Mar 2018	22 Mar 2018
TP10	SE176794.022	LB144011	15 Mar 2018	16 Mar 2018	29 Mar 2018	21 Mar 2018	26 Mar 2018	22 Mar 2018
TP10	SE176794.023	LB144011	15 Mar 2018	16 Mar 2018	29 Mar 2018	21 Mar 2018	26 Mar 2018	22 Mar 2018
TP11	SE176794.024	LB144011	15 Mar 2018	16 Mar 2018	29 Mar 2018	21 Mar 2018	26 Mar 2018	22 Mar 2018
TP11	SE176794.025	LB144011	15 Mar 2018	16 Mar 2018	29 Mar 2018	21 Mar 2018	26 Mar 2018	22 Mar 2018
TP12	SE176794.026	LB144011	15 Mar 2018	16 Mar 2018	29 Mar 2018	21 Mar 2018	26 Mar 2018	22 Mar 2018

pH in soil (1:5)

Method: ME-(AU)-[ENV]AN101

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
TP1	SE176794.001	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	21 Mar 2018	22 Mar 2018†
TP1	SE176794.002	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	21 Mar 2018	22 Mar 2018†
TP2	SE176794.003	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	21 Mar 2018	22 Mar 2018†
TP2	SE176794.004	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	21 Mar 2018	22 Mar 2018†
TP2	SE176794.005	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	21 Mar 2018	22 Mar 2018†
TP3	SE176794.006	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	21 Mar 2018	22 Mar 2018†
TP3	SE176794.007	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	21 Mar 2018	22 Mar 2018†
TP4	SE176794.008	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	21 Mar 2018	22 Mar 2018†
TP4	SE176794.009	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	21 Mar 2018	22 Mar 2018†
TP4	SE176794.010	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	21 Mar 2018	22 Mar 2018†
TP5	SE176794.011	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	21 Mar 2018	22 Mar 2018†
TP5	SE176794.012	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	21 Mar 2018	22 Mar 2018†
TP5	SE176794.013	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	21 Mar 2018	22 Mar 2018†
TP6	SE176794.014	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	21 Mar 2018	22 Mar 2018†
TP7	SE176794.015	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	21 Mar 2018	22 Mar 2018†
TP7	SE176794.016	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	21 Mar 2018	22 Mar 2018†
TP8	SE176794.017	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	21 Mar 2018	22 Mar 2018†
TP8	SE176794.018	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	21 Mar 2018	22 Mar 2018†
TP9	SE176794.019	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	21 Mar 2018	22 Mar 2018†
TP9	SE176794.020	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	21 Mar 2018	22 Mar 2018†
TP9	SE176794.021	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	21 Mar 2018	22 Mar 2018†
TP10	SE176794.022	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	21 Mar 2018	22 Mar 2018†
TP10	SE176794.023	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	21 Mar 2018	22 Mar 2018†
TP11	SE176794.024	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	21 Mar 2018	22 Mar 2018†
TP11	SE176794.025	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	21 Mar 2018	22 Mar 2018†
TP12	SE176794.026	LB143940	15 Mar 2018	16 Mar 2018	22 Mar 2018	20 Mar 2018	21 Mar 2018	22 Mar 2018†

Soluble Anions (1:5) in Soil by Ion Chromatography

Method: ME-(AU)-[ENV]AN245

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
TP1	SE176794.001	LB144081	15 Mar 2018	16 Mar 2018	22 Mar 2018	22 Mar 2018	19 Apr 2018	23 Mar 2018
TP1	SE176794.002	LB144081	15 Mar 2018	16 Mar 2018	22 Mar 2018	22 Mar 2018	19 Apr 2018	23 Mar 2018
TP7	SE176794.015	LB144081	15 Mar 2018	16 Mar 2018	22 Mar 2018	22 Mar 2018	19 Apr 2018	23 Mar 2018
TP7	SE176794.016	LB144081	15 Mar 2018	16 Mar 2018	22 Mar 2018	22 Mar 2018	19 Apr 2018	23 Mar 2018
TP9	SE176794.019	LB144081	15 Mar 2018	16 Mar 2018	22 Mar 2018	22 Mar 2018	19 Apr 2018	23 Mar 2018
TP9	SE176794.020	LB144081	15 Mar 2018	16 Mar 2018	22 Mar 2018	22 Mar 2018	19 Apr 2018	23 Mar 2018
TP9	SE176794.021	LB144081	15 Mar 2018	16 Mar 2018	22 Mar 2018	22 Mar 2018	19 Apr 2018	23 Mar 2018
TP11	SE176794.025	LB144081	15 Mar 2018	16 Mar 2018	22 Mar 2018	22 Mar 2018	19 Apr 2018	23 Mar 2018
TP12	SE176794.026	LB144081	15 Mar 2018	16 Mar 2018	22 Mar 2018	22 Mar 2018	19 Apr 2018	23 Mar 2018

Surrogate results are evaluated against upper and lower limit criteria established in the SGS QA /QC plan (Ref: MP-(AU)-[ENV]QU-022). At least two of three routine level soil sample surrogate spike recoveries for BTEX/VOC are to be within 70-130% where control charts have not been developed and within the established control limits for charted surrogates. Matrix effects may void this as an acceptance criterion. Water sample surrogate spike recoveries are to be within 40-130%. The presence of emulsions, surfactants and particulates may void this as an acceptance criterion.

Result is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

No surrogates were required for this job.

Blank results are evaluated against the limit of reporting (LOR), for the chosen method and its associated instrumentation, typically 2.5 times the statistically determined method detection limit (MDL).

Result is shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria.

Conductivity and TDS by Calculation - Soil

Method: ME-(AU)-[ENV]AN106

Sample Number	Parameter	Units	LOR	Result
LB143940.001	Conductivity of Extract (1:5 dry sample basis)	µS/cm	1	0

Exchangeable Cations and Cation Exchange Capacity (CEC/ESP/SAR)

Method: ME-(AU)-[ENV]AN122

Sample Number	Parameter	Units	LOR	Result
LB144152.001	Exchangeable Sodium, Na	mg/kg	2	0

Soluble Anions (1:5) in Soil by Ion Chromatography

Method: ME-(AU)-[ENV]AN245

Sample Number	Parameter	Units	LOR	Result
LB144081.001	Sulfate	mg/kg	5	<5.0

Duplicates are calculated as Relative Percentage Difference (RPD) using the formula: RPD = | OriginalResult - ReplicateResult | x 100 / Mean

The RPD is evaluated against the Maximum Allowable Difference (MAD) criteria and can be graphically represented by a curve calculated from the Statistical Detection Limit (SDL) and Limiting Repeatability (LR) using the formula: MAD = 100 x SDL / Mean + LR

Where the Maximum Allowable Difference evaluates to a number larger than 200 it is displayed as 200.

RPD is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

Conductivity and TDS by Calculation - Soil

Method: ME-(AU)-[ENV]AN106

Original	Duplicate	Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE176794.010	LB143940.014	Conductivity of Extract (1:5 dry sample basis)	µS/cm	1	190	82.478022813	31	4
SE176794.020	LB143940.025	Conductivity of Extract (1:5 dry sample basis)	µS/cm	1	350	69.110367063	31	5
SE176794.026	LB143940.035	Conductivity of Extract (1:5 dry sample basis)	µS/cm	1	120	52.523102981	31	27

Moisture Content

Method: ME-(AU)-[ENV]AN002

Original	Duplicate	Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE176794.010	LB144011.011	% Moisture	%w/w	0.5	9.6	9.7	40	1
SE176794.020	LB144011.022	% Moisture	%w/w	0.5	16	15	37	5
SE176878.004	LB144011.033	% Moisture	%w/w	0.5	13	12	38	1
SE176945.003	LB144011.040	% Moisture	%w/w	0.5	9.3	8.8	41	6

pH in soil (1:5)

Method: ME-(AU)-[ENV]AN101

Original	Duplicate	Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE176794.020	LB143940.025	pH	pH Units	0.1	5.1	5.1	32	0
SE176794.026	LB143940.035	pH	pH Units	0.1	5.6	5.6	32	1

Soluble Anions (1:5) in Soil by Ion Chromatography

Method: ME-(AU)-[ENV]AN245

Original	Duplicate	Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE176722A.013	LB144081.014	Sulfate	mg/kg	5	42	41	42	2
SE176794.026	LB144081.027	Sulfate	mg/kg	5	96	80	36	19

Laboratory Control Standard (LCS) results are evaluated against an expected result, typically the concentration of analyte spiked into the control during the sample preparation stage, producing a percentage recovery. The criteria applied to the percentage recovery is established in the SGS QA /QC plan (Ref: MP-(AU)-[ENV]QU-022). For more information refer to the footnotes in the concluding page of this report.

Recovery is shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria.

Conductivity and TDS by Calculation - Soil

Method: ME-(AU)-[ENV]AN106

Sample Number	Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB143940.002	Conductivity of Extract (1:5 dry sample basis)	µS/cm	1	NA	303	85 - 115	94

Exchangeable Cations and Cation Exchange Capacity (CEC/ESP/SAR)

Method: ME-(AU)-[ENV]AN122

Sample Number	Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB144152.002	Exchangeable Sodium, Na	mg/kg	2	NA	72.68	80 - 120	101

pH in soil (1:5)

Method: ME-(AU)-[ENV]AN101

Sample Number	Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB143940.003	pH	pH Units	0.1	7.4	7.415	98 - 102	100

Soluble Anions (1:5) in Soil by Ion Chromatography

Method: ME-(AU)-[ENV]AN245

Sample Number	Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB144081.002	Sulfate	mg/kg	5	90	100	70 - 130	90

Matrix Spike (MS) results are evaluated as the percentage recovery of an expected result, typically the concentration of analyte spiked into a field sub -sample during the sample preparation stage. The original sample's result is subtracted from the sub-sample result before determining the percentage recovery. The criteria applied to the percentage recovery is established in the SGS QA/QC plan (ref: MP-(AU)-[ENV]QU-022). For more information refer to the footnotes in the concluding page of this report.

Recovery is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

No matrix spikes were required for this job.

MATRIX SPIKE DUPLICATES

SE176794 R0

Matrix spike duplicates are calculated as Relative Percent Difference (RPD) using the formula: RPD = | OriginalResult - ReplicateResult | x 100 / Mean

The original result is the analyte concentration of the matrix spike. The Duplicate result is the analyte concentration of the matrix spike duplicate.

The RPD is evaluated against the Maximum Allowable Difference (MAD) criteria and can be graphically represented by a curve calculated from the Statistical Detection Limit (SDL) and Limiting Repeatability (LR) using the formula: MAD = 100 x SDL / Mean + LR

Where the Maximum Allowable Difference evaluates to a number larger than 200 it is displayed as 200.

RPD is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

No matrix spike duplicates were required for this job.

Samples analysed as received.

Solid samples expressed on a dry weight basis.

QC criteria are subject to internal review according to the SGS QA/QC plan and may be provided on request or alternatively can be found here: http://www.sgs.com.au/~/media/Local/Australia/Documents/Technical Documents/MP-AU-ENV-QU-022 QA QC Plan.pdf

*	NATA accreditation does not cover the performance of this service.
**	Indicative data, theoretical holding time exceeded.
-	Sample not analysed for this analyte.
IS	Insufficient sample for analysis.
LNR	Sample listed, but not received.
LOR	Limit of reporting.
QFH	QC result is above the upper tolerance.
QFL	QC result is below the lower tolerance.

①	At least 2 of 3 surrogates are within acceptance criteria.
②	RPD failed acceptance criteria due to sample heterogeneity.
③	Results less than 5 times LOR preclude acceptance criteria for RPD.
④	Recovery failed acceptance criteria due to matrix interference.
⑤	Recovery failed acceptance criteria due to the presence of significant concentration of analyte (i.e. the concentration of analyte exceeds the spike level).
⑥	LOR was raised due to sample matrix interference.
⑦	LOR was raised due to dilution of significantly high concentration of analyte in sample.
⑧	Reanalysis of sample in duplicate confirmed sample heterogeneity and inconsistency of results.
⑨	Recovery failed acceptance criteria due to sample heterogeneity.
⑩	LOR was raised due to high conductivity of the sample (required dilution).
†	Refer to Analytical Report comments for further information.

E-MAILED
16/3/18 @ 9.54am

GEOTECHNIQUE PTY LTD

Laboratory Test Request / Chain of Custody Record

Lemko Place
PENRITH NSW 2750

P O Box 880
PENRITH NSW 2751

Tel: (02) 4722 2700
Fax: (02) 4722 6161
email: info@geotech.com.au

Page

TO:	SGS ENVIRONMENTAL SERVICES UNIT 16 33 MADDOX STREET ALEXANDRIA NSW 2015			Sampling By:	JH
				Job No:	14160/1
				Project:	ProposedCemetery Extension
PH:	02 8594 0400	FAX:	02 8594 0499	Project Manager:	IJ
ATTN:	Ms Emily Yin			Location:	St Bartholomew Place, Prospect

Sampling details				Results required by:									
	Location	Depth	Soil	Water	EC (1:5)	pH	SO4	ESP					Notes	Keep Sample
1	TP1	0.2-0.4	DSP		✓	✓	✓	✓						✓
2	TP1	0.5-0.7	DSP		✓	✓	✓	✓					ESP=Exchangeable Sodium Percentage	✓
3	TP2	0.4-0.6	DSP		✓									✓
4	TP2	1.0-1.2	DSP		✓									✓
5	TP2	1.4-1.5	DSP		✓									✓
6	TP3	0.6-0.8	DSP		✓									✓
7	TP3	1.2-1.4	DSP		✓									✓
8	TP4	0.2-0.4	DSP		✓									✓
9	TP4	0.8-1.0	DSP		✓									✓
10	TP4	1.4-1.6	DSP		✓									✓
11	TP5	0.4-0.6	DSP		✓									✓
12	TP5	1.3-1.5	DSP		✓									✓
13	TP5	2.3-2.5	DSP		✓									✓
14	TP6	1.6-1.8	DSP		✓									✓
15	TP7	0.3-0.5	DSP		✓	✓	✓	✓						✓
16	TP7	1.1-1.3	DSP		✓	✓	✓	✓						✓
17	TP8	0.5-0.7	DSP		✓									✓
18	TP8	1.0-1.7	DSP		✓									✓
19	TP9	0.4-0.6	DSP		✓	✓	✓	✓						✓
20	TP9	1.3-1.5	DSP		✓	✓	✓	✓						✓
21	TP9	1.6-1.7	DSP		✓	✓	✓	✓						✓

SGS EHS Alexandria Laboratory
SE176794 COC
Received: 16 – Mar – 2018

Name	Signature	Date	Received by Name	Received by Signature
Indra Jworchan		25/01/2017		16/3/18 02:00

Legend:

WG	USG	Undisturbed soil sample (glass	DSP	Disturbed soil sample (small plastic bag)	* Purge & Trap
WP	DSG	Disturbed soil sample (glass ja	✓	Test required	# Geotechnique Screen

GEOTECHNIQUE PTY LTD

Laboratory Test Request / Chain of Custody Record

Lemko Place
PENRITH NSW 2750

P O Box 880
PENRITH NSW 2751

Tel: (02) 4722 2700
Fax: (02) 4722 6161
email: info@geotech.com.au

TO:	SGS ENVIRONMENTAL SERVICES UNIT 16 33 MADDOX STREET ALEXANDRIA NSW 2015	Sampling By: JH	Job No: 14160/1 Project: ProposedCemetery Extension
PH: 02 8594 0400	FAX: 02 8594 0499	Project Manager: IJ	Location: St Bartholomew Place, Prospect
ATTN: Ms Emily Yin			

Sampling details

Results required by:

	Location	Depth	Soil	Water	EC (1:5)	pH	SO4	ESP					Notes	Keep Sample
22	TP10	0.2-0.4	DSP		✓									✓
23	TP10	1.8-2.0	DSP		✓								ESP=Exchangeable Sodium Percentag	✓
24	TP11	0.5-0.7	DSP		✓									✓
25	TP11	1.8-2.0	DSP		✓	✓	✓	✓						✓
26	TP12	0.4-0.6	DSP		✓	✓	✓	✓						✓

Relinquished by			Received by		
Name	Signature	Date	Name	Signature	
Indra Jworchan		25/01/2017			16/3/18 EC: EC

Legend:

WG	USG	Undisturbed soil sample (glass	DSP	Disturbed soil sample (small plastic bag)	* Purge & Trap
WP	DSG	Disturbed soil sample (glass ja	✓	Test required	# Geotechnique Screen

SAMPLE RECEIPT ADVICE

SE176794

CLIENT DETAILS

Contact	Indra Jworchan
Client	Geotechnique
Address	P.O. Box 880 NSW 2751
Telephone	02 4722 2700
Facsimile	02 4722 6161
Email	indra.jworchan@geotech.com.au
Project	**14160-1 St Bartholomew Place, Prospect**
Order Number	(Not specified)
Samples	26

LABORATORY DETAILS

Manager	Huong Crawford
Laboratory	SGS Alexandria Environmental
Address	Unit 16, 33 Maddox St Alexandria NSW 2015
Telephone	+61 2 8594 0400
Facsimile	+61 2 8594 0499
Email	au.environmental.sydney@sgs.com
Samples Received	Fri 16/3/2018
Report Due	Fri 23/3/2018
SGS Reference	**SE176794**

SUBMISSION DETAILS

This is to confirm that 26 samples were received on Friday 16/3/2018. Results are expected to be ready by COB Friday 23/3/2018. Please quote SGS reference SE176794 when making enquiries. Refer below for details relating to sample integrity upon receipt.

Samples clearly labelled	Yes	Complete documentation received	Yes
Sample container provider	Client	Sample cooling method	None
Samples received in correct containers	Yes	Sample counts by matrix	26 Soil
Date documentation received	15/3/18@9:54am	Type of documentation received	COC
Samples received in good order	Yes	Samples received without headspace	Yes
Sample temperature upon receipt	22.0°C	Sufficient sample for analysis	Yes
Turnaround time requested	Standard		

Unless otherwise instructed, water and bulk samples will be held for one month from date of report, and soil samples will be held for two months.

COMMENTS

SAMPLE RECEIPT ADVICE

SE176794

CLIENT DETAILS

Client Geotechnique

Project 14160-1 St Bartholomew Place, Prospect

SUMMARY OF ANALYSIS

No.	Sample ID	Conductivity and TDS by Calculation - Soil	Exchangeable Cations and Cation Exchange Capacity	Moisture Content	pH in soil (1:5)	Soluble Anions (1:5) in Soil by Ion Chromatography
001	TP1 0.2-0.4	1	3	1	1	1
002	TP1 0.5-0.7	1	3	1	1	1
003	TP2 0.4-0.6	1	-	1	-	-
004	TP2 1.0-1.2	1	-	1	-	-
005	TP2 1.4-1.5	1	-	1	-	-
006	TP3 0.6-0.8	1	-	1	-	-
007	TP3 1.2-1.4	1	-	1	-	-
008	TP4 0.2-0.4	1	-	1	-	-
009	TP4 0.8-1.0	1	-	1	-	-
010	TP4 1.4-1.6	1	-	1	-	-
011	TP5 0.4-0.6	1	-	1	-	-
012	TP5 1.3-1.5	1	-	1	-	-
013	TP5 2.3-2.5	1	-	1	-	-
014	TP6 1.6-1.8	1	-	1	-	-
015	TP7 0.3-0.5	1	3	1	1	1
016	TP7 1.1-1.3	1	3	1	1	1
017	TP8 0.5-0.7	1	-	1	-	-
018	TP8 1.0-1.7	1	-	1	-	-
019	TP9 0.4-0.6	1	3	1	1	1
020	TP9 1.3-1.5	1	3	1	1	1
021	TP9 1.6-1.7	1	3	1	1	1
022	TP10 0.2-0.4	1	-	1	-	-
023	TP10 1.8-2.0	1	-	1	-	-
024	TP11 0.5-0.7	1	-	1	-	-

CONTINUED OVERLEAF

The above table represents SGS' interpretation of the client-supplied Chain Of Custody document.
The numbers shown in the table indicate the number of results requested in each package.
Please indicate as soon as possible should your request differ from these details .
Testing as per this table shall commence immediately unless the client intervenes with a correction .

SAMPLE RECEIPT ADVICE

SE176794

CLIENT DETAILS

Client Geotechnique

Project 14160-1 St Bartholomew Place, Prospect

SUMMARY OF ANALYSIS

No.	Sample ID	Conductivity and TDS by Calculation - Soil	Exchangeable Cations and Cation Exchange Capacity	Moisture Content	pH in soil (1:5)	Soluble Anions (1:5) in Soil by Ion Chromatography
025	TP11 1.8-2.0	1	3	1	1	1
026	TP12 0.4-0.6	1	3	1	1	1

The above table represents SGS' interpretation of the client-supplied Chain Of Custody document.
The numbers shown in the table indicate the number of results requested in each package.
Please indicate as soon as possible should your request differ from these details .
Testing as per this table shall commence immediately unless the client intervenes with a correction .