APPENDIX E
Geotechnical Review

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- **Remediation Strategy and Earthfill Platform Requirements – CES (December 2011)**
- **Structural Design Statement – EMS (December 2011)**
- **Geotechnical Review - CES (October 2011)**

CONSULTING EARTH SCIENTISTS

REMEDIATION STRATEGY AND EARTH FILL PLATFORM REQUIREMENTS FOLLOWING GROUND PENETRATING RADAR SURVEY:

RIRP CAMELLIA
1 GRAND AVENUE, CAMELLIA, NSW

PREPARED FOR MS. SUE JUST

CES DOCUMENT REFERENCE: CES110407-NEC-AL

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REMEDIATION STRATEGY AND EARTH FILL PLATFORM REQUIREMENTS FOLLOWING GROUND PENETRATING RADAR SURVEY:

RIRP CAMELLIA

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REMEDIATION STRATEGY AND EARTH FILL PLATFORM REQUIREMENTS FOLLOWING GROUND PENETRATING RADAR SURVEY: RIRP CAMELLIA 1 GRAND AVENUE, CAMELLIA, NSW

CES DOCUMENT REFERENCE: CES110407-NEC-AL

1 INTRODUCTION

Consulting Earth Scientists Pty Ltd (CES) was requested by National Environmental Consulting Services (NEC) to oversee a Ground Penetrating Radar (GPR) Survey at 1 Grand Avenue, Camellia, NSW and provide geotechnical remediation recommendations and preliminary earth fill platform design for the proposed development.

The proposed development comprises a Commercial and Industrial Resource Recovery Facility (CIRRF) and a Source Separated Organic Resource Recovery Facility (SSORRF) and associated weighbridge, internal access road, administration office and car parking (herein collectively referred to as the facility). The proposed facility is to be constructed on a compacted earth fill platform, which will be constructed over existing concrete and bitumen surfaces (capping layer).

CES understand from the Remondis Environmental Assessment (EA) (Section 4 – Proposed Development) that the elevation of the capping layer is approximately RL 5.3m Australian Height Datum (AHD) and that final floor levels for the facility are between RL 6.1mAHD (biofilter basement) and RL 7.2mAHD (main building floor).

The GPR Survey was commissioned in response to the Department of Planning (DoP) second adequacy review of the Environmental Assessment (EA) (DoP reference DOC11/36754), which requested further geotechnical assessment to be conducted in order to provide further information on where voids exist below the concrete cap.

This report presents the findings of a GPR Survey conducted at the facility location. It also provides a remediation strategy based on the results of the survey and a preliminary earth fill platform design.

2 THE SITE

2.1 SITE LOCATION

The site is located at 1 Grand Avenue, Camellia NSW which is situated immediately east of Camellia Train Station, and approximately 18km north-west of Sydney CBD.

The site is shown in Figure 1 and is bounded by the Parramatta River along its northern boundary, while the western boundary is adjacent to railway lines. The southern and eastern boundaries are marked by industrial units. Within the site the area to be surveyed is focused on the proposed facility location. The facility location can be seen in Figure 1.

2.2 SITE HISTORY

The site was previously owned by James Hardies Industries who manufactured fibrous cement products including asbestos cement products up until 1981. Large quantities of fill have been used to level various parts of the site, and have been identified to be contaminated with asbestos cement waste and friable asbestos. Contaminated fill is ‘sealed’ beneath the concrete and bitumen surfaces. The concrete and bitumen ‘cap’ is under the protection of the legally binding Site Management Plan which generally prohibits excavation below the ‘capping’ layer without written approval of the Office for Environment and Heritage (OEH).

2.3 SITE DESCRIPTION

The following description of the facility location is based on observations made during fieldwork that was carried out between 15 November 2011 and 2 December 2011. The facility location is relatively level with approximately 95 percent of the area currently sealed with either concrete or bituminous concrete pavements with the remaining unsealed areas comprising landscaped areas.

For the purpose of undertaking the GPR Survey, the site was split into three areas, the West Area, Centre Area and East Area as shown in Figure 2. At the time of the fieldwork, the West Area was observed to be occupied by stockpiles of soil, construction materials and concrete panels. A large metal container was also observed to be present and ponds of water up to approximately 100mm deep. The East Area was predominantly being used for temporary storage of auction items and the Centre Area was being used for the stockpiling of construction materials and rolls of cable (Refer to Plates 1 to 4).

2.4 SUBSURFACE GROUND CONDITIONS

CES conducted a geotechnical investigation at the site in 2007 (CES document reference CES070901-BIL-01-F dated 30 November 2007). The geotechnical investigation comprised 7 boreholes and 28 Cone Penetration Tests (CPTs). The results of this investigation were used to develop a geotechnical model for the site. A summary of the subsurface ground conditions and an inferred geotechnical model for the proposed facility based on the results of the 2007 investigation and updated to include the GPR survey is provided in Table 1.

3 GROUND PENETRATING RADAR SURVEY

Ground Penetrating Radar (GPR) is a non-intrusive ground investigation technique that provides high resolution reflection profiles of the subsurface. It works by pulsing electro-magnetic energy in the form of radio waves into the subsurface material with a transmitting antenna. This energy propagates through the subsurface material as a function of its electrical properties, which are in turn a function of its physical and chemical properties. Reflection of energy occurs at boundaries between media that have contrasting electrical properties such as concrete, soil and rock. By building a continuous profile of scans along a traverse and analysing the recorded reflections for shape, amplitude, location and two-way travel time, a subsurface profile of the depth and location of buried objects and voids can be produced.

The GPR equipment was fitted to a wheel-mounted frame, which was hand-pushed along transverse survey lines at 1m centres (Plates 5 and 6). The GPR Survey was conducted by GBG Australia Pty Ltd (GBG) in stages as described below.

3.1 TRIAL GPR SURVEY

To assess suitability and applicability of the GPR Survey technique at the site, a trial survey was undertaken. The trial was conducted on the 15 November 2011 in two areas; Trial 1 (East Area) and Trial 2 (West Area), which were approximately 340m^2 and 420m^2 in area respectively. The locations of the trial survey areas are shown in Figure 3.

A key consideration during the trial survey was to ascertain the effective penetration and data quality and resolution of the GPR through the site capping, particularly in concrete capped areas as the presence of reinforcement in concrete is known to effect penetration depth and data quality. Two GPR antennas, a 200MHz and a 400MHz, were chosen for use during the trial survey because of their anticipated effective penetration depths.

3.2 GPR TRIAL SURVEY RESULTS AND RECOMMENDATIONS

The results of the trial GPR survey indicate that the concrete slabs in Trial 1 (East Area) and Trial 2 (West Area) are reinforced with at least two layers of steel reinforcement at a spacing of about 200mm to 250mm. The presence of reinforcement reduced the effective ground penetration depth and resolution of both the 200MHz and 400MHz antennae.

Based on the results of the trial, the GPR subcontractor recommended that any further surveys should use higher frequency 500MHz or 900MHz antennae. The use of higher frequency antennae typically provides greater resolution and data quality; however the effective depth of radar penetration is typically reduced. It was also recommended for the purpose of the main survey, that the facility should be divided into a number of manageable areas.

4 MAIN GPR SURVEY

Due to the presence of surface obstructions and materials stored and stockpiles at the site, it was not possible to undertake the GPR survey over the whole area of the proposed facility in one uninterrupted event. The survey will therefore be carried out in a staged manner to facilitate coverage of the facility. The facility has been divided into nine areas based on size and accessibility (refer to Figure 4), these areas may be further subdivided to facilitate coverage of the facility depending on GPR manageability and presence/absence of surface obstructions.

Stage 1 of the survey comprised areas that were clear and accessible in late November/early December 2011. Stage 1 included the survey of Areas 1 to 6 as shown in Figure 4. The results of the Stage 1 survey are presented in this report. Subsequent stages of the survey will be carried out when surface obstructions have been removed or relocated. The results of subsequent stages of the GPR survey will be provided as separate addenda to this report.

4.1 STAGE 1 SURVEY

The Stage 1 Survey was carried out between 29 November and 2 December 2011 over accessible parts of the site (Parts 1 to 6 (refer to Figure 4)). The survey was carried out using a 900MHz antenna fitted to a wheel-mounted frame at 1m spaced transverse survey lines.

A number of features of interest were identified, these are interpreted by GBG to be underground services, existing piles and voids. The location of these is summarised in Table 2 and graphically illustrated in Figure 5 and 6. The full results of the Stage 1 Survey are enclosed in Appendix A.

Table 1: Summary of Subsurface Conditions and Inferred Geotechnical Model for the Proposed Facility Location

Unit	Description	Depth to Top of Layer (m)	Thickness Range (m)
SURFACE FILL (AREA 2)	Variable fill. Includes fine to coarse gravel, cobble and boulders composed of construction waste (brick, concrete, tiles)	Surface	0.05 to 0.5

Unit	Description	Depth to Top of Layer (m)	Thickness Range (m)
CONCRETE	Heavily reinforced with steel bar at 200mm to 250mm spacing	Surface (excluding Area 2 where it is 0.05 to 0.5)	0.2 to 0.3
EXISTING PILES	Piles are approximately square to rectangular in shape, with each cover a surface area approximately 0.5m^2 to 2m^2.	0.2 to 0.3	>0.65
EXISTING VOIDS	Voids of varying shape are approximately between 1.5m^3 and 25m^3.	0.2 to 0.3	0.15 to >0.65
FILL	Variable fill material with asbestos present in parts. Includes base coarse layers, building rubble, concrete, sand, gravel and clay.	0.2 to 0.7	0.2 to 1.9
ALLUVIAL	Interbedded CLAY, Silty CLAY, sandy CLAY, clayey SILT, SAND, and clayey SAND: red, brown, orange and grey, with some indurated ironstone bands. Stiff consistency or medium dense relative density.	0.2 – 1.9	8.2 – 18.3
BEDROCK	SANDSTONE, medium to coarse grained, light grey and orange-brown, distinctly weathered, low to medium strength. *Becoming…*	9.0 – 18.6	Typically 0.3 – 1.5m
	SANDSTONE, fine to medium grained, light grey, slightly weathered, medium to high strength	--	--

4.2 RESULTS OF THE STAGE 1 SURVEY

The findings of the Stage 1 Survey are summarised in Table 2.

Table 2: Summary of Stage 1 Survey Results

Survey		Approximate Area (m^2)	Approximate Survey Complete	Approximate Extent of Survey Complete (%)	Areas of Interest Identified		
Area		(m^2)			Existing Services	Existing Piles	Existing Voids
West	1	4,950	3,665	75%	4	8	Estimated 17 between $1.5m^3$ and $25m^3$
	2	2,150	1,645	75%	1	5	Estimated 24 between $1.5m^3$ and $7m^3$
	6	1,750	1,120	65%	0	2	Estimated 9 between $1.5m^3$ and $>7m^3$
East	3	1,450	1,185	80%	5	0	Estimated 12 between $1.5m^3$ and $>8m^3$
	4	4,300	3,410	80%	0	3	Estimated 44 between $1.5m^3$ and $>15m^3$
	5	1,150	640	55%	1	0	Estimated 8 between $1.5m^3$ and $>8m^3$
Total		**15,750**	**11,665**	**75%**	**11**	**18**	**As shown in Figure 5 and 6**

NOTE: Areas 7, 8 and 9 (approximately 9,300m^2 (40%)) are still to be surveyed.

5 DISCUSSION AND RECOMMENDATIONS

The interpreted location and approximate depth to the AoI based on the GPR survey results are shown in Figure 5 and 6. Recommendations with regard to remediation and mitigation of the AoI is provided below. A preliminary design for the earth fill platform assuming adequate remediation of the AoI is also provided in this section.

5.1 REMEDIATION STRATEGY

5.1.1 Complete GPR Survey for Remainder of Site

Table 2 shows that an area approximately 13,385m^2 (approximately 40% of the facility location) remains to be surveyed by GPR. This area should be surveyed by GPR with survey lines at 1m centres once surface obstructions have been removed or relocated.

The results of subsequent stages of GPR survey will be submitted as addenda to this report and will include recommendations for the remediation of any further identified AoI. Upon completion of the survey of the whole facility, the earth fill platform design will be reviewed and updated if required.

5.1.2 Localised Grouting of Voids

The Stage 1 Survey has identified several areas of potentially large voids between typically 1.5m^3 and 25m^3 and at a depth of between 0.2m to 0.3m extending down to a depth of 0.4m to greater than 1m, refer to Figure 5 and 6. These voids will require treatment prior to the construction of the earth fill platform by localised grouting by a specialist grouting contractor. A specialist grouting contractor should review this report and provide a detailed method statement for the proposed grouting technique, method, plant and proposed grout type and mix. The method statement should be submitted to CES for review and should also include details of the contractor's environmental controls to prevent or minimise exposure of the materials underlying the site capping. Following completion of grouting, the contractor shall submit a report to CES detailing the grouting works and providing verification that the voids have been adequately grouted.

5.2 PRELIMINARY EARTH FILL PLATFORM DESIGN

The following preliminary earth fill platform design is based on the findings of the geotechnical investigation carried out in 2007 and the Stage 1 GPR Survey. The preliminary design assumes that the remediation strategy described in this report has been adequately completed. The design will be reviewed and finalised following completion of the remediation works.

5.2.1 Engineered Fill Specification

The earth fill platform should be constructed of suitable fill placed in near-horizontal layers of uniform thickness placed systematically across the facility location. The fill should be placed in layers no greater than 250 mm compacted thickness and compacted to a minimum density ratio of 98% based on Standard Compaction within ±2% of Optimum Moisture Content. Fill within pavement subgrade level should be compacted to a minimum of 100% Standard Maximum Dry Density Ratio, within ±2% of Optimum Moisture Content.

Materials considered unsuitable for use as structural fill are stated in "AS3798 - 2007: Guidelines on earthworks for commercial and residential development" and include:

- Organic soils, such as topsoil, severely root-affected subsoils and peat.
- Material not assessed as Virgin Excavated Natural Material (VENM) or Excavated Natural Material (ENM).
- Materials containing substances which can be dissolved or leached out in the presence of moisture, or which undergo volume change or loss of strength when disturbed and exposed to moisture.
- Silts, or materials that have the deleterious engineering properties of silt.
- Fill which contains wood, metal, plastic, boulders or other deleterious material.
- Loose, soft, wet or unstable soil or rock.

And

- Any material deemed unsuitable by the geotechnical practitioner.

Filling operations should be carried out under a Level 1 inspection and testing source as defined in AS3798 – 2007 *Guidelines on Earthworks for Commercial and Residential Developments.*

5.2.2 Geogrid Specification

The Geogrid shall be Tensar Triax 160 Geogrid (or equivalent).

5.2.3 Preliminary Construction Details

Preliminary construction details for the earth fill platform are provided in Figure 7, the finalised platform design will be provided following completion of and based on the results of the verification testing for the remediation strategy.

6 SHALLOW FOOTINGS

Assuming adequate completion of the remediation strategy and construction of the earth fill platform in accordance with the above preliminary recommendations, shallow pad or strip footings could be founded in the engineered fill of the platform. The bearing capacity of a pad or strip footing will be dependent on the geometry of the footing and depth of embedment into the foundation. For preliminary design purposes, an allowable bearing pressure of 125 kPa may be adopted for footing design. Settlement of footings designed using this allowable bearing pressure would be expected to be less than 1% of the footing width.

Strip and pad footings should be cleaned, dewatered and concreted on the same day as excavation or a blinding layer of concrete should be placed. A geotechnical engineer should observe the footings prior to concreting to confirm the bearing stratum is consistent with the design assumptions.

Should bearing pressures greater than the value stated above be required or proposed structures or utilities be intolerant to settlement, piled footings should be considered. The piles should be installed following construction of, and through the earth fill platform using displacement piles or driven pile or similar piling techniques that reduces the amount of spoil produced during construction.

7 CLOSURE

If you have any queries regarding the above or require any clarification, please do not hesitate to contact the undersigned on 8569 2200.

For and on behalf of Consulting Earth Scientists Pty Ltd

Mark Pickett
Engineering Geologist

FIGURES

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Title

Figure 1: Site Location Plan

CES Project ID: CES110407-NEC-AL	Date: 09/12/2011
Prepared By: M. Pickett	Checked By; M. Pickett

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Title	CES Project ID:	Date:
Figure 2: GPR Survey Areas	CES110407-NEC-AL	08/12/2011
	Prepared By: M. Pickett	Checked By; M. Pickett

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Title	CES Project ID:	Date:
Figure 3: Trial GPR Survey Locations	CES110407-NEC-AL	09/12/2011
	Prepared By: M. Pickett	Checked By: M. Pickett

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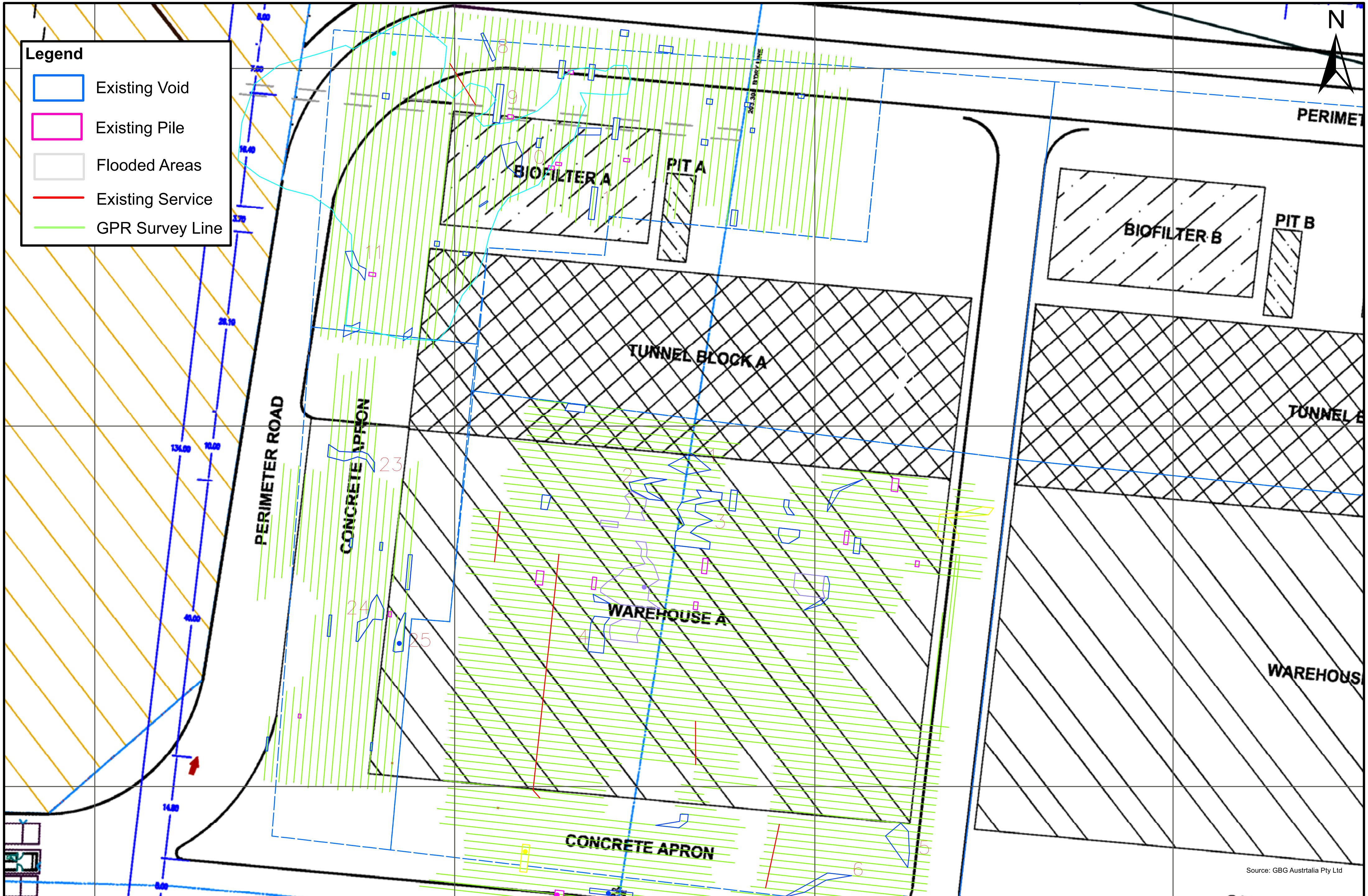
Title	CES Project ID:	Date:
Figure 4: GPR Survey Areas	CES110407-NEC-AL	09/12/2011
	Prepared By: M. Pickett	Checked By; M. Pickett



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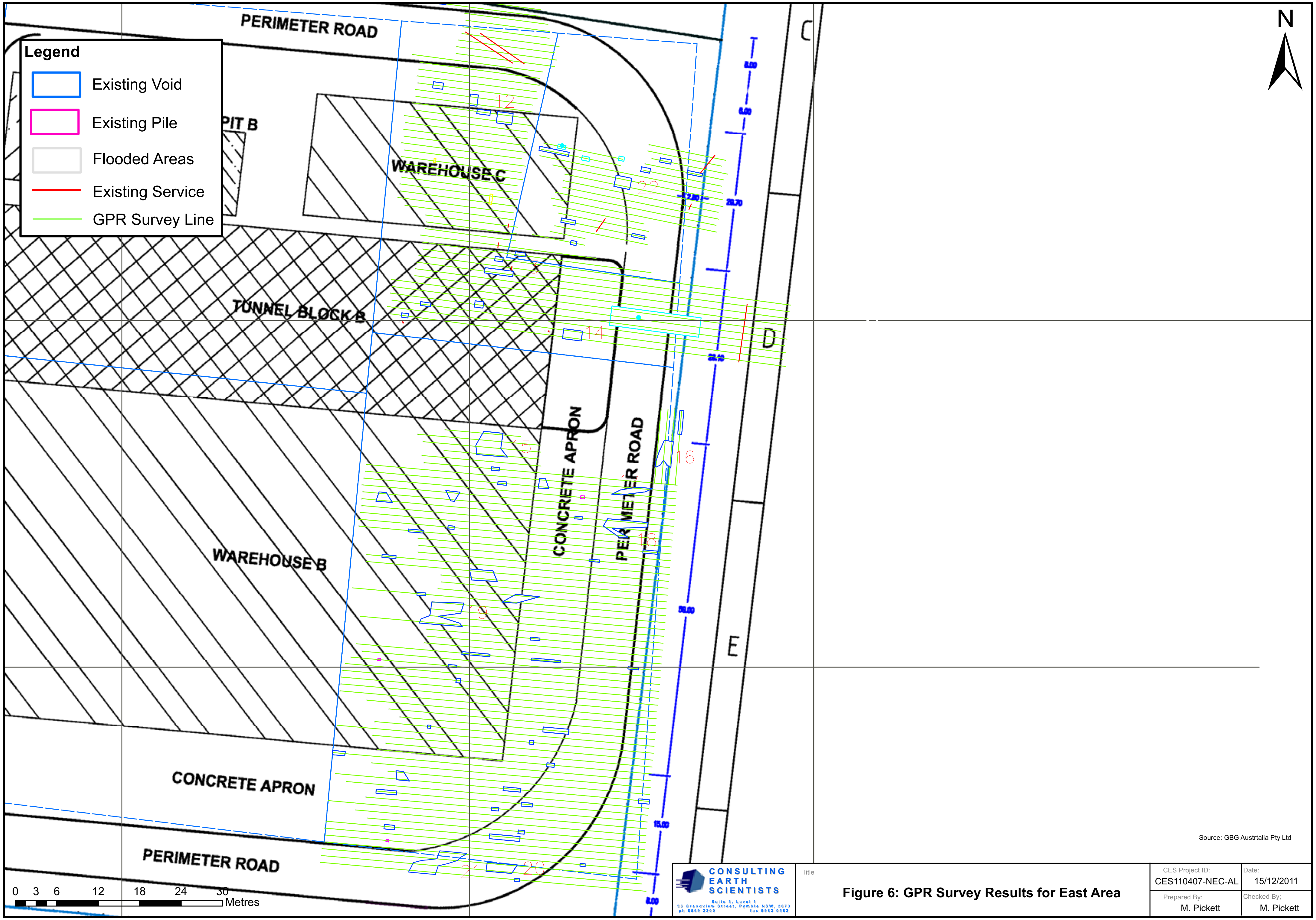
Title	CES Project ID:	Date:
Figure 5: GPR Survey Results for West Area	CES110407-NEC-AL	15/12/2011
	Prepared By: M. Pickett	Checked By: M. Pickett



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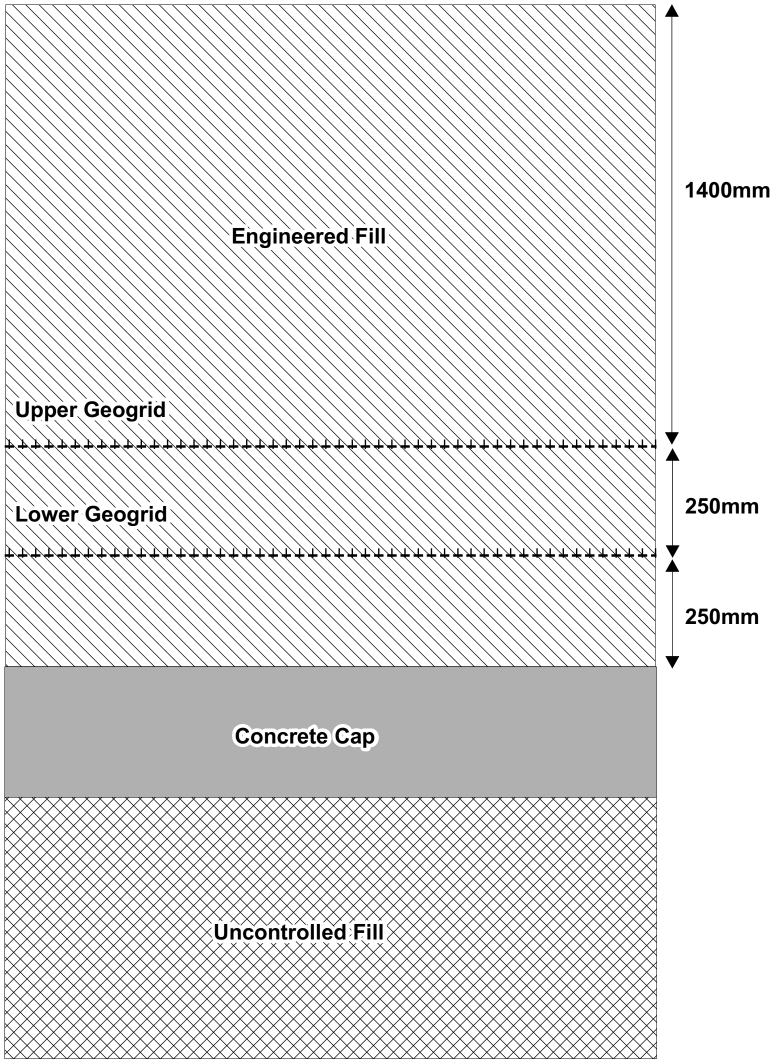
Title	CES Project ID:	Date:
Figure 6: GPR Survey Results for East Area	CES110407-NEC-AL	15/12/2011
	Prepared By: M. Pickett	Checked By: M. Pickett



Notes

Surface Preparation:
Loose material shall be removed prior to placement of engineered fill to the satisfaction of the geotechnical practitioner.

Engineered Fill:
Suitable fill shall be placed in layers no greater than 250 mm compacted thickness and compacted to a minimum density ratio of 98% based on Standard Compaction within ±2% of Optimum Moisture Content. Fill within pavement subgrade level should be compacted to a minimum of 100% Standard Maximum Dry Density Ratio, within ±2% of Optimum Moisture Content.

Suitable fill material shall comply with the requirements of “AS3798 - 2007: Guidelines on earthworks for commercial and residential development”. Unsuitable materials that shall not be used include:
- Organic soils, such as topsoil, severely root-affected subsoils and peat.
- Material not assessed as Virgin Excavated Natural Material (VENM) or Excavated Natural Material (ENM).
- Materials containing substances which can be dissolved or leached out in the presence of moisture, or which undergo volume change or loss of strength when disturbed and exposed to moisture.
- Silts, or materials that have the deleterious engineering properties of silt.
- Fill which contains wood, metal, plastic, boulders or other deleterious material.
- Loose, soft, wet or unstable soil or rock.
- Any material deemed unsuitable by the geotechnical practitioner.

Filling operations should be carried out under a Level 1 inspection and testing source as defined in AS3798 – 2007 Guidelines on Earthworks for Commercial and Residential Developments.

Geogrid:
The Geogrid shall be Tensar TriAx 160 Geogrid (or equivalent). The geogrid shall be placed with a minimum overlap of 300mm. The geogrid shall be permanently secured in place at spacings of no greater than 500mm to prevent separation of the geogrid.   The geogrid shall placed to the satisfaction of the geotechnical practitioner.

The geogrid and engineered fill shall be placed in such a manner that damage to the geogrid does not occur.

PRELIMINARY

PRELIMINARY

PRELIMINARY

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Title	CES Project ID:	Date:
Figure 7: Preliminary Earth Fill Platform Design	CES110407-NEC-AL	15/12/2011
	Prepared By: M. Pickett	Checked By: M. Pickett

PLATES

Plate 1: Construction material stockpiles, concrete blocks and metal containers located in the west survey area.

Plate 2: Concrete panels temporarily stockpiled in the west survey area.

Plate 3: A large puddle of surface water observed in the west survey area.

Plate 4: Rolls of cable temporarily stored in the centre survey area.

Plate 5: GPR Survey equipment attached to wheel-mounted frame.

Plate 6: GPR Survey equipment negotiating obstacles, in this case scrub vegetation.

APPENDIX

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16 December 2011

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SUBJECT: CONCRETE CAPPING SUBSURFACE INVESTIGATION USING GROUND PENETRATING RADAR AT THE INTEGRATED RECYCLING PARK, CAMELLIA, NEW SOUTH WALES.

GBG Australia carried out a non-destructive investigation using Ground Penetrating Radar (GPR) at the Integrated Recycling Park, Camellia New South Wales. The data was collection between the 28th November 2011 to the 2nd December 2011.

The objective of the investigation was to locate possible voiding underneath the slabs and to locate the boundary between the fill materials and underlying alluvial soils, at the above site.

The following report outlines the methodology of the investigation and discusses the results.

BACKGROUND

The property is approximately 3.7 Ha in size and is currently used mainly for storage of industrial good. The site is covered in high strength concrete slabs which caps a layer of industrial fill. The fill is believed to be up to 2m thick in places and overlies alluvial soils (clay, silty clay & sandy clay). Ultimately the property will be used to construct a recycling facility.

INVESTIGATION AREAS

Six (6) areas were designated as investigation areas with a combined area of approximately 15750m². Due to various obstructions on site during the time of collection, actual area scanned is less than the total 3.7 Ha. Figure 1 below is an aerial image of the site outlining the investigation areas.

Figure 1. Outline of areas for the non-destructive subsurface investigation at the Integrated Recycling Park, Camellia NSW. Also listed is the approximate area (m²) for each area. Image courtesy of NearMap.com, Dec. 2011.

The surface of the site consists of heavily reinforced concrete ranging in thickness from 200-300mm, below the slab is believed to be fill material composed of industrial waste (containing asbestos) which is assumed to be stabilised. Certain parts of investigation areas (notably Area 2) were found to contain a layer of fill material composed of mainly gravel building rubble sitting on top of the concrete cap. The thickness of this above ground fill layer ranges from 50mm to a maximum of 500mm. These areas were marked in cyan diagonal hatch on the drawings.

The following is a quick description of the each area and any noticeable surface features:

Areas One

This area is approximately 4950m² and is the largest of all the areas. A number of stockpiles, skip-bins and containers can be found along the northern and eastern edge of the area. Due to heavy rains the previous week, large pools of water were found on site at the time of surveying (Figure 2).

Figure 2. Large puddles of water in Area 1.

Areas Two

This area is approximately 1450m². Large sections of the western section is covered by a layer of gravel and cobble-sized building rubble (Figure 3).

Figure 3. Layer of gravel covering concrete cap in Area 2.

Areas Three

This area is approximately 2150m². The western edge of this area contained a number of skip-bins and containers.

Areas Four

This area is approximately 4300m². Skip-bins and containers as well as heavy vehicles were found along the eastern, western and northern edges of this area (Figure 4).

Figure 4. Obstructions in Area 4.

Areas Five

This area is approximately 1150m² and is the smallest area surveyed. Much of the area could not be surveyed due to the presence of stockpiles, heavy vehicles, skip-bins and containers throughout the area (Figure 5).

Figure 5. Obstructions in Area 5.

Areas Six

This area is approximately 1750m². Skip-bins and containers as well as heavy vehicles were found along the northern edges of this area.

DATA COLLECTION

Subsurface data was collected using Ground Penetrating Radar (GPR). For more information about the GPR method refers to appendix A.

GPR data was collected using a GSSI SIR3000 data collection system with a 900MHz centre frequency antenna (Figure 6). The low frequency antenna was used after considering the required imaging depth and the assumed subsurface conditions at the site.

Data collection involved moving the GPR antenna slowly and steadily along the ground surface. Profiles were collected at 1 m centres in one direction. The location of the collected GPR profiles is shown as a series of green lines in the drawings GBGA1365-01 to GBGA1365-06.

The GPR data was collected at 100 scans per metre along the profile lines with 1024 samples collected for each scan at 16 bit amplitude resolution. The GPR system was set to record a two-way travel time of 82 ns. Chainages along the profiles were logged by a calibrated distance measuring instrument attached to the antenna. On site quality control of the data was achieved in real-time by viewing profiles during acquisition.

Figure 6. Collection of data.

DATA PROCESSING

The profiles were recorded digitally for processing analysis and interpretation at our Parramatta office. Due to the high signal to noise ratio and overall quality, minimal processing of the collected data was necessary.

The following processing steps were carried out:

1. X-flip (reverse) the data where it was collected counter chainage so that all the parallel profiles are in the correct direction.

2. Static correction to the first crossing to set the surface reflection interface to zero depth

3. 2D filtering to remove the background signal.

4. Kirchoff migration to reduce hyperbolic reflections to their point of origin

Due to the heavily reinforced nature of the concrete cap, the maximum useful imaging depth obtained with the 400 MHz GPR antenna was approximately 1.0 m.

An example of a processed radar-gram from the Area 4 can be shown in Figure 7. Note the different slabs.

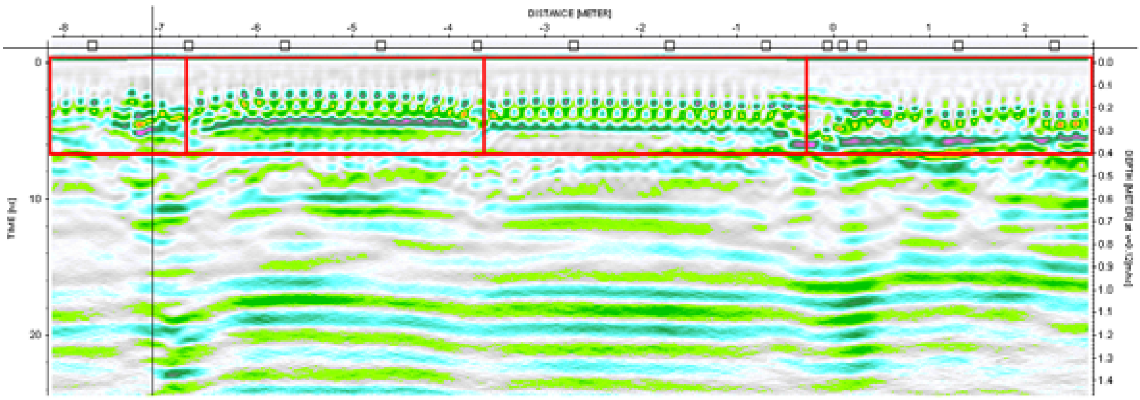


Figure 7. Sample processed radar-gram from Area 4. Highlighted in red are the location of four distinct concrete slabs.

RESULTS

The results of the investigation have been provided in the drawings GBGA1365-01 to GBGA1365-06:

- Drawing GBGA1365-01 gives the results of all areas in plan view overlaid onto a current aerial image of the site, at a scale of 1:100.
- Drawing GBGA1365-02 gives the results of Area 1 in plan view overlaid onto a current aerial image of the site, at a scale of 1:500.
- Drawing GBGA1365-03 gives the results of Area 2 in plan view overlaid onto a current aerial image of the site, at a scale of 1:300.
- Drawing GBGA1365-04 gives the results of Areas 3 & 5 in plan view overlaid onto a current aerial image of the site, at a scale of 1:300.
- Drawing GBGA1365-05 gives the results of all Area 4 in plan view overlaid onto a current aerial image of the site, at a scale of 1:300.
- Drawing GBGA1365-06 gives the results of all Area 6 in plan view overlaid onto a current aerial image of the site, at a scale of 1:300.

A number of features have been identified and are shown as per the legend in the drawing. Three features of particular interest have identified these are:

- Possible Void (blue cross-hatch) – Anomalies which have been identified as possibly caused by voids. A large number of smaller possible voids (<10m²) can be found in all area, a total of 25 larger possible voids (>10m²) have been identified. The characteristics of these larger possible voids will be elaborated on in the discussion section. An example of a possible void can be seen in Figure 8.

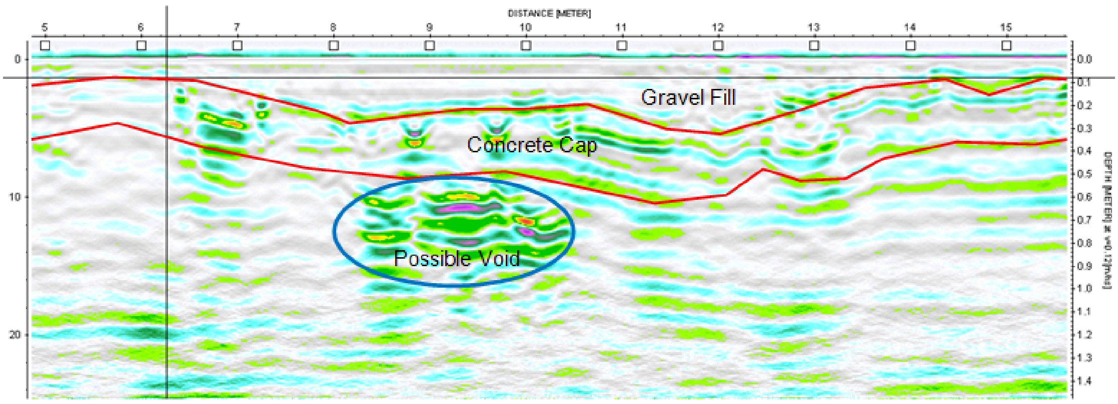


Figure 8. Sample radar-gram of Area 2 showing a possible void (highlighted in blue). Note the gravel fill sitting above the concrete cap (highlighted in red).

- Possible Pile (magenta diagonal hatch) – Location of identified possible piles. These were identified through analysis of reinforcement and adjacent anomalies. An example of a possible pile can be seen in Figure 9.

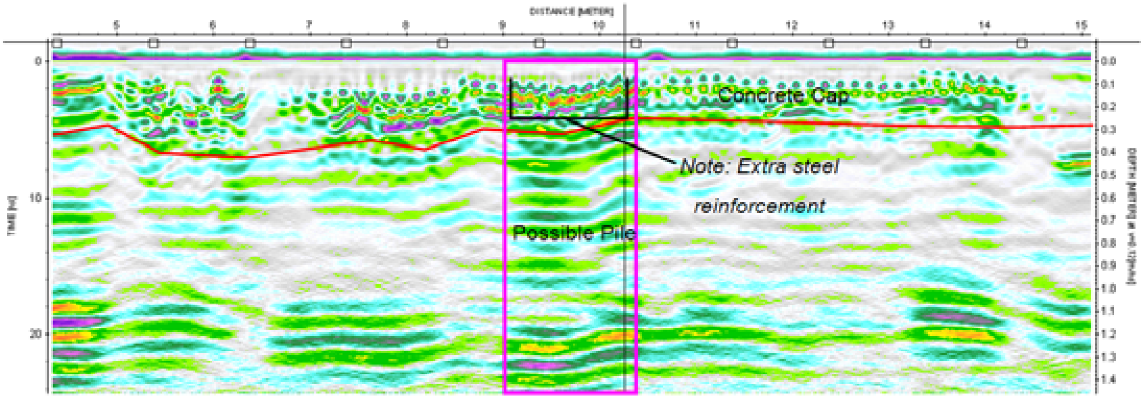


Figure 9. Sample radar-gram from Area 1 showing a possible pile (highlighted in pink). Note the extra steel reinforcement found in the concrete cap relating to the pile.

- Unidentified Anomaly (yellow diagonal hatch) – Anomalies found below the slab that are unlikely to be caused by voiding or by the presence of a pile. Possible explanations include the presence of highly metallic fill, possible concrete block below the slab or degradation of concrete weathering/honey-combing. An example of an unidentified anomaly can be seen in Figure 10.

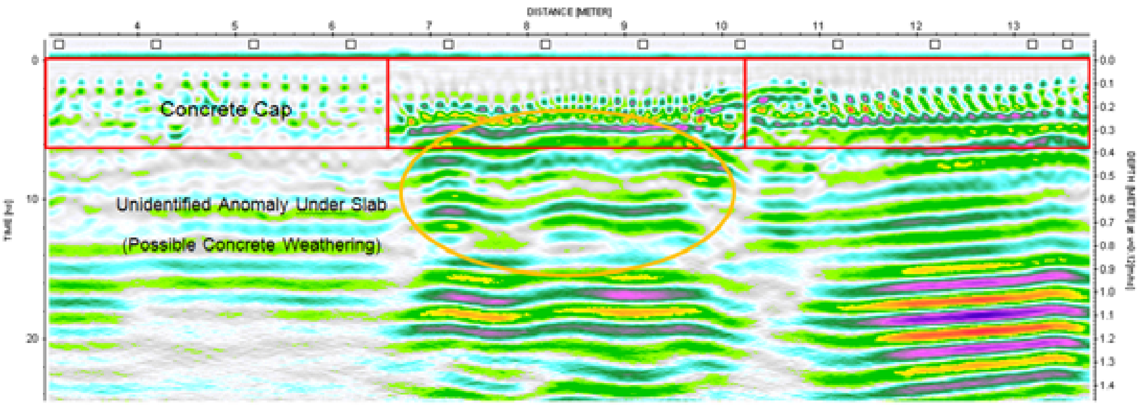


Figure 10. Sample radar-gram from Area 3 showing an unidentified anomaly (highlighted in orange).

DISCUSSION

Below is a table summarising the details of the larger possible voids identified, the ID number corresponds to the possible voids numbered in drawings GBGA1365-01 to GBGA1365-06:

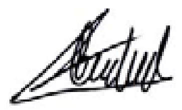
ID	Area	Size (m²)	Depth Range (mm)	ID	Area	Size (m²)	Depth Range (mm)
1	1	18	350-450	14	3	12	450-550
2	1	16.5	250-350	15	4	20	350-450
3	1	48	450-550	16	4	12	>650
4	1	10	250-350	17	4	10	250-350
5	1	18	450-550	18	4	18	550-650
6	1	10	150-250	19	4	24	>650
7	1	16	250-350	20	4	24	350-450
8	2	10	150-250	21	4	10	350-450
9	2	11	250-350	22	5	12	>650
10	2	15	350-450	23	6	14	250-350
11	2	10	350-450	24	6	14	250-350
12	3	12	>650	25	6	10	>650
13	3	10	>650				

Note: the depth range (mm) is the size of the void taken from the bottom of the slab.

The biggest issue with surveying this area has been nature of the concrete cap. As most concrete slabs encountered are heavily reinforced (1-2 layers of steel reinforcement at <200mm centres), a number of problems are caused. One problem is the presence of repeating signals caused by the reinforcement (ringing) often obscures anomalies below the slab. Another problem is the screening of the signal, which limits the depth of penetration of the antenna to no more than approximately 500mm from the bottom of the slab.

I hope that this provides you with the information required. If you require clarification on any points arising from this investigation please contact me.

For and on behalf of
GBG AUSTRALIA PTY LTD



ANDREW BUCHEL

Geophysicist – B.Sc. (Hons)

A-1. GROUND PENETRATING RADAR

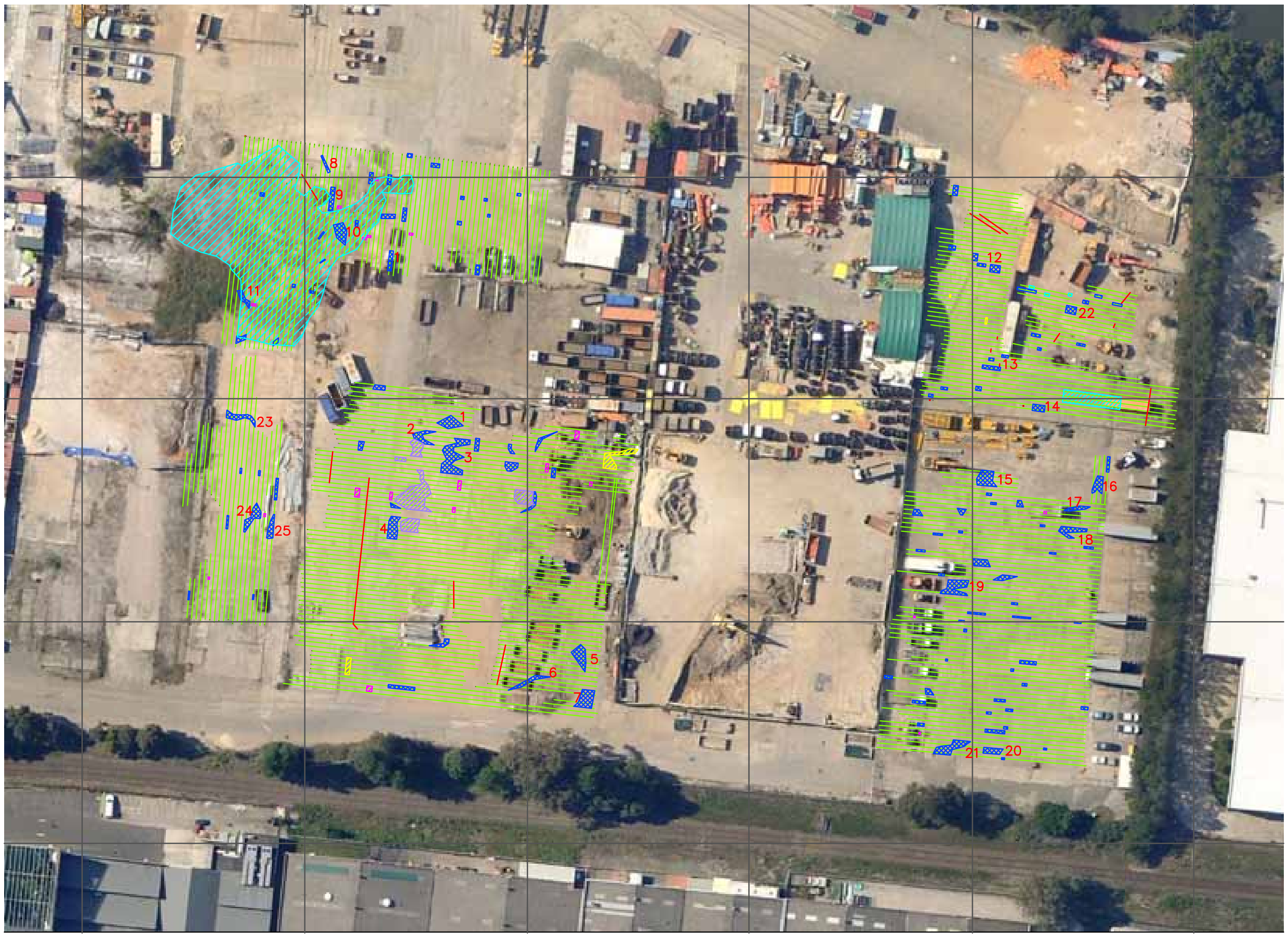
Ground Penetrating Radar (GPR) is a non-destructive and non-invasive geophysical technique for rapidly imaging the shallow subsurface (typically up to 10 m depth) and producing high-resolution colour sections in real time.

In principle, the GPR is a reflection mode imaging technique using high frequency impulses of electromagnetic energy transmitted into the ground. Typically 100,000 impulses per second are transmitted downwards into the subsurface from an antenna placed close to the surface. These impulses are of very short duration (each pulse has a rise time of typically 1-5 nanoseconds) and contain a wide spectrum of frequencies, typically in the range between 100 MHz and 1.5 GHz. For shallow geological, environmental and archaeological applications antenna with a centre frequency of between 400 and 200 MHz are normally used, whilst for high resolution investigations within concrete slabs antenna with centre frequency of up to 2.6 GHz are required.

The transmitted radar signal propagates through the subsurface as a function of the subsurface material's electrical properties, which are in turn dependent on its physical and chemical properties. Reflection of radar energy occurs at boundaries between differing layers or inclusions which have contrasting electrical properties. Conversely, no reflections occur from a homogenous material where there are no internal reflectors. The reflections are detected by the receiving antenna placed adjacent to the transmitter. The depth to the target is proportional to the time (in nanoseconds) taken for the signal to travel from the transmitting antenna at the surface to the target and back to the receiver.

A radar gram profile is built up of continuous scans along selected line path. Each radargram consists of enhanced high frequency radio imaging which provides subsurface information based on the variations in the Dielectric Constants (the electrical conductivity and resistivity) of materials. The recorded reflections can be analysed in terms of shape, phase, travel time and signal amplitude to provide information about a target's size, depth and orientation in relation to the material around it.

NON-INVASIVE GROUND PENETRATING RADAR INVESTIGATION
SITE OVERVIEW



Legend

- GPR LINE
- SERVICE
- POSSIBLE PILE
- POSSIBLE VOID
- WATER PUDDLES DURING TIME OF INVESTIGATION
- UN-IDENTIFIED ANOMALY
- SURFACE FEATURE

Disclaimer:

THIS DRAWING HAS BEEN PREPARED USING EXISTING DRAWINGS OR PRINTS AS SUPPLIED BY CLIENT AND SUPPLEMENTED BY MEASUREMENTS TAKEN ON SITE. PRIOR TO COMMENCING ANY WORK, ALL MEASUREMENT MUST BE CHECKED.

CLIENT: REMONDIS AUSTRALIA PTY LTD		
TITLE: NON-INVASIVE INVESTIGATION OF FILL MATERIAL INTEGRATED RECYCLING PARK, CAMELLIA, NSW		
DRAWN: T.B	PROJECT MANAGER: A.B	CADFILE: GBGA1365
SCALE: 1:100	DATE: 15 DEC 11	DRG No: GBGA1365-01
		REV: A3

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GBG Australia

NON–INVASIVE GROUND PENETRATING RADAR INVESTIGATION

AREA: 1

Legend

- GPR LINE
- SERVICE
- POSSIBLE PILE
- POSSIBLE VOID
- WATER PUDDLES DURING TIME OF INVESTIGATION
- UN–IDENTIFIED ANOMALY
- SURFACE FEATURE

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DRAWN: T.B	PROJECT MANAGER: A.B	CADFILE: GBGA1365	
SCALE: 1:500	DATE: 15 DEC 11	DRG No: GBGA1365–02	
		REV: V2	A3

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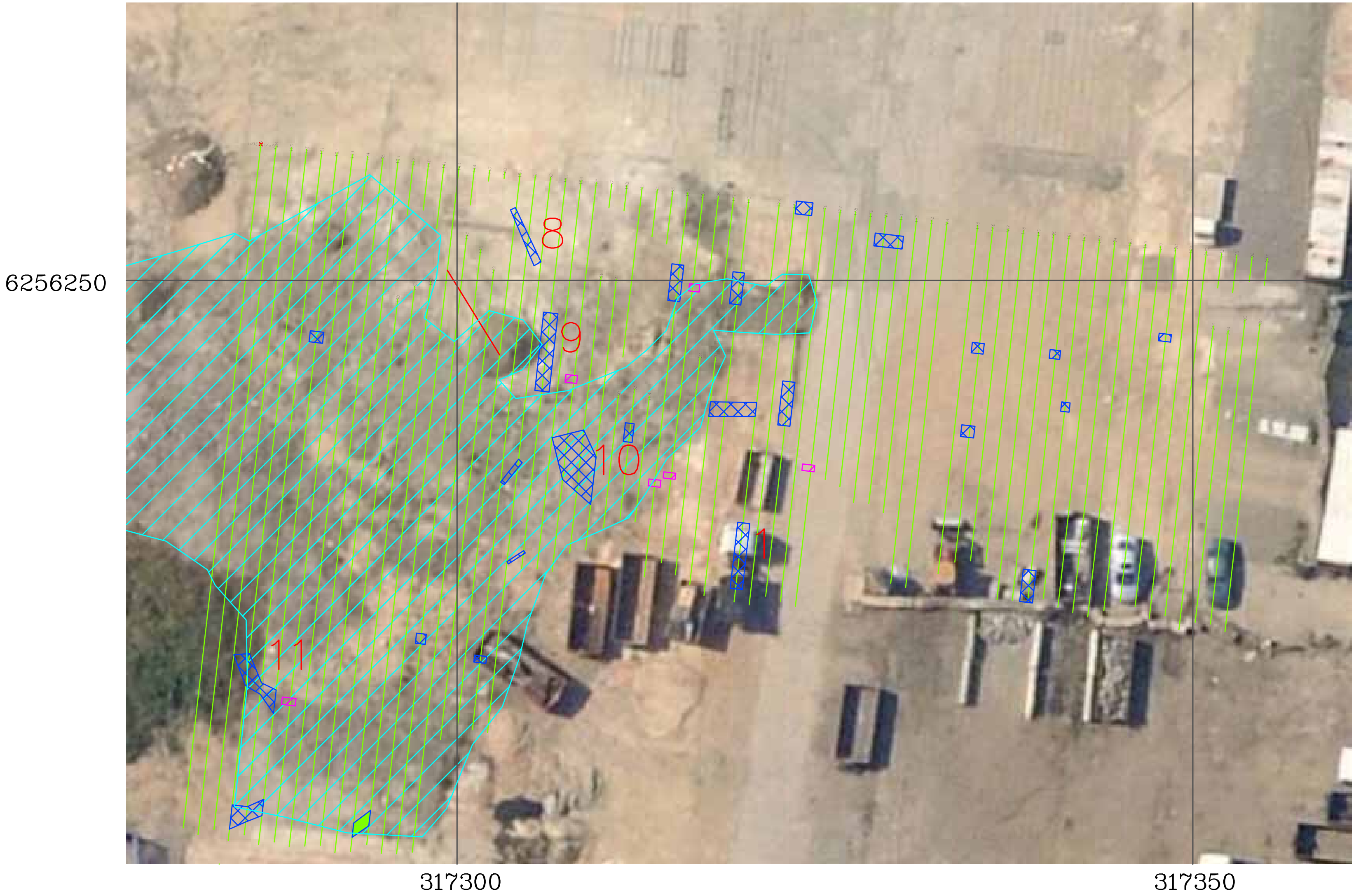
NON-INVASIVE GROUND PENETRATING RADAR INVESTIGATION
AREA: 2



Legend

- GPR LINE
- SERVICE
- POSSIBLE PILE
- POSSIBLE VOID
- WATER PUDDLES DURING TIME OF INVESTIGATION
- UN-IDENTIFIED ANOMALY
- SURFACE FEATURE

Disclaimer:

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TITLE: NON-INVASIVE INVESTIGATION OF FILL MATERIAL INTEGRATED RECYCLING PARK, CAMELLIA, NSW			
DRAWN: T.B	PROJECT MANAGER: A.B	CADFILE: GBGA1365	
SCALE: 1:300	DATE: 15 DEC 11	DRG No: GBGA1365-03	
		REV: V2	A3

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NON–INVASIVE GROUND PENETRATING RADAR INVESTIGATION

AREA: 3 & 5

Legend

- GPR LINE
- SERVICE
- POSSIBLE PILE
- POSSIBLE VOID
- WATER PUDDLES DURING TIME OF INVESTIGATION
- UN–IDENTIFIED ANOMALY
- SURFACE FEATURE

Disclaimer:

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CLIENT:	REMONDIS AUSTRALIA PTY LTD		
TITLE:	NON–INVASIVE INVESTIGATION OF FILL MATERIAL INTEGRATED RECYCLING PARK, CAMELLIA, NSW		
DRAWN: T.B	PROJECT MANAGER: A.B	CADFILE: GBGA1365	
SCALE: 1:300	DATE: 15 DEC 11	DRG No: GBGA1365–04	
		REV: V2	A3

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NON-INVASIVE GROUND PENETRATING RADAR INVESTIGATION

AREA: 4

Legend

- GPR LINE
- SERVICE
- POSSIBLE PILE
- POSSIBLE VOID
- WATER PUDDLES DURING TIME OF INVESTIGATION
- UN-IDENTIFIED ANOMALY
- SURFACE FEATURE

Disclaimer:

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TITLE: NON-INVASIVE INVESTIGATION OF FILL MATERIAL INTEGRATED RECYCLING PARK, CAMELLIA, NSW			
DRAWN: T.B	PROJECT MANAGER: A.B	CADFILE: GBGA1365	
SCALE: 1:300	DATE: 15 DEC 11	DRG No: GBGA1365-05	
		REV: V2	A3

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NON-INVASIVE GROUND PENETRATING RADAR INVESTIGATION

AREA: 6

Legend

- GPR LINE
- SERVICE
- POSSIBLE PILE
- POSSIBLE VOID
- WATER PUDDLES DURING TIME OF INVESTIGATION
- UN-IDENTIFIED ANOMALY
- SURFACE FEATURE

Disclaimer:

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CLIENT: REMONDIS AUSTRALIA PTY LTD		
TITLE: NON-INVASIVE INVESTIGATION OF FILL MATERIAL INTEGRATED RECYCLING PARK, CAMELLIA, NSW		
DRAWN: T.B	PROJECT MANAGER: A.B	CADFILE: GBGA1365
SCALE: 1:300	DATE: 15 DEC 11	DRG No: GBGA1365-06
		REV: V2 / A3

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ENGINEERING AND MANAGEMENT SERVICES (EMS) PTY LTD
ABN 62 105 407 752

17 December 2011

REMONDIS AUSTRALIA PTY LTD
PO BOX 885,
MASCOT, NSW 1460

Attention Mr. Mohan Selvaraj
National Technical Manager Australia & New Zealand

Dear Sir,

RE: REOMONDIS RECYCLING PLANT AT 1B GRAND AVE, CAMELLIA SUBSTRUCTURE (CONCEPT) STRUCTURAL DESIGN STATEMENT

Further to our discussions and correspondence to date, we hereby provide a statement over the structural design for the proposed building substructure taking into account the project and site specific restrictions and criteria. This statement is limited to the evaluation over the impact of the substructure, in the form of reinforced concrete shallow footings, on the cap.

A number of documents supplied to EMS form the basis of this statement. A schedule of the salient documents is provided below.

In brief, we note the following:

1. The development will be constructed over a compacted earth filled fill platform constructed over the existing cap. Construction of the platform is to be all in accordance with the CES report CES110407-NEC-AL.

2. Remediation work is recommended by CES in CES110407-NEC-AL to fill voids identified under the cap. With the remediation work complete, CES nominates a maximum allowable bearing pressure of 125KPa.

3. Based on preliminary calculations, the maximum design bearing pressure exerted by the shallow footings is found in the Green/Food Wastes Tunnel Composting building. Reasonably proportioned shallow footings in this area will result in a maximum design pressure of less than 100KPa, which is less than the CES recommended maximum allowable bearing pressure, after remediation, of 125KPa. Shallow footings in other areas of the development, such as the Source

Separated Organic Resource Recovery Facility and the Commercial & Industrial Resource Recovery Facility buildings exert significant reduced design bearing pressure.

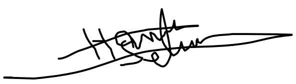
4. Where, and if, necessary, shallow footings in any part of the development can be sized to further reduce the design bearing pressure.

5. Based on our preliminary analysis and the detailed comments contained within Item 6 – Shallow Footings of the CES Report CES110407-NEC-AL with respect to settlement less than 1% of the footing width, the anticipated settlement in the highest loaded areas would be minimal and does not pose as a risk over the cap or the structural elements of the buildings.

6. Other non-building areas, i.e. roads, landscape, external pavement, the imposed stresses to the supporting platform/cap will be of no structural significance.

In conclusion, it is our opinion that Shallow Footing concept is a valid substructure option which, in the highly loaded areas, will result in Design Bearing Pressure lower than the maximum allowable bearing pressure of 125KPa, nominated by CES in their report CES110407-NEC-AL. In other areas, where the building loads are reduced, i.e. Biofilter, Office areas, the design bearing pressures will be much lower than the maximum allowable bearing pressure of 125KPa.

Yours Faithfully,
Engineering and Management Services (EMS) Pty Ltd



Hani Selim
B.Sc.(Eng.), M.Sc.(Eng.), MIEAust CPEng, NPER
Accredited Certifier – Building Professional Board (BPB) – Category C

Engineering and Management Services (EMS) Pty. Ltd. PO Box 4611, North Rocks NSW 2151.
Fax : (02) 9871 3948 Mobile: 0401 695 627 Email: ems1@tpg.com.au

Documents Reviewed:

1. Algory Zappia & Associates architectural drawings, A01 Rev E, A02 Rev C, A03 Rev A and A04 Rev B.
2. Consulting Earth Scientists (CES) Geotechnical Investigation Report dated 30 November 2007, Report ID CES070901-BIL-01-F.
3. Consulting Earth Scientists (CES) Geotechnical letter dated 16 May 2011, document reference CES 110407-NEC-AB.
4. Consulting Earth Scientists (CES) Remediation Strategy and Earth Fill Platform – Requirements Following Ground Penetrating Radar Survey 16 December 2011, CES110407-NEL-AL.

Engineering and Management Services (EMS) Pty. Ltd. PO Box 4611, North Rocks NSW 2151.
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CONSULTING EARTH SCIENTISTS

National Environmental Consulting Services
PO Box 271
Camperdown
NSW 1450
Email: sue@necs.com.au

For the attention of Ms Sue Just

6 October 2011

RE: RIRP Camellia - Review of Previous Information and Geotechnical Advice.
CES Document Reference: CES110407-NEC-AI

Dear Sue,

1. INTRODUCTION

Consulting Earth Scientists Pty Ltd (CES) was commissioned by National Environmental Consulting Services (NEC), to undertake a review of the geotechnical report carried out in 2007 (CES document CES11070901-BIL-01-F dated 30 November 2007 (herein referred to as the geotechnical report)). The review was initiated to assess the applicability and suitability or otherwise of the geotechnical report in consideration of the current proposed development at 1 Grand Avenue, Camellia NSW (herein referred to as the site).

2. DOCUMENTS REVIEWED

CES completed a review of the following documents:

- Sydney Water document entitled 'Site Management Plan: Eastern Portion Former James Hardie Site, Grand Avenue Camellia' dated 17 March 2004.
- URS document entitled 'Phase II Environmental Site Assessment, Sydney Water Camellia Eastern Site, 1 Grand Avenue Camellia NSW' dated 31 October 2006.
- CES document reference CES070901-BIL-01-F entitled 'Geotechnical Investigation Report: Proposed Industrial Development, 1 Grand Avenue Camellia, NSW' dated 30 November 2007.
- 'Section 4 – Project Description REMONDIS EA – Camellia' supplied by NEC via email 20 April 2011.

- Billbergia document entitled 'Site Work Plan for Extension of Utility Services to the Lease Area No. 1 Grand Avenue, Camellia', Project Number 3262 dated 25 June 2010.
- Billbergia document entitled 'Site Work Plan for Extension of Utility Services to the Lease Area No. 1 Grand Avenue, Camellia', Project Number 3263 dated May 2011.
- Algory Zappia & Associates drawing entitled 'Figure 4.1: RIRP Layout', version 6, 2010.
- Algory Zappia & Associates drawing entitled 'Figure 4.2: RIRP Layout on Site', version 6, 2010.
- Algory Zappia & Associates drawing entitled 'Figure 4.3: Extent of Excavation Works - Construction', version 1.
- Algory Zappia & Associates drawing entitled 'Figure 4.4: Elevations', version 3, 2010.

3. BACKGROUND

The site was previously owned by James Hardies Industries who manufactured fibrous cement products including asbestos cement products up until 1981. Large quantities of fill have been used to level various parts of the site, and have been identified to be contaminated with asbestos cement waste and friable asbestos. The site consisted of mainly warehouse buildings which have been demolished down to concrete slab level.

Sydney Water acquired the site in July 1996 and it is understood that they did not develop or occupy the site. As a result the site remains largely covered with hard surfaces, mostly concrete and bitumen.

The Site Management Plan (SMP (Sydney Water, 2004)) was developed, in part, to '*ensure an adequate seal is maintained over the areas of fill known to contain asbestos waste to ensure physical isolation of the waste from casual human contact, restrict infiltration of rainwater, and prevent erosion or movement of the waste'*. As a result the concrete 'cap' is under the protection of the legally binding SMP, and generally prohibits excavation below the 'capping' layer without written approval of Office of Environment and Heritage (OE&H (incorporating DECCW)).

4. PROPOSED DEVELOPMENT

The proposed development at the site is to comprise a Commercial and Industrial Resource Recovery Facility (CIRRF) and a Source Separated Organic Resource Recovery Facility (SSORRF) and associated weighbridge, internal access road, administration office and car parking (herein collectively be referred to as the facility) as shown in Figure 1.

CES understand that the proposed facility is to be constructed on a compacted earth fill platform. The site capping is currently at an elevation of approximately RL 5.3mAHD. The earth platform will be constructed over a total area of 3.2 ha to a height between RL 7.0mAHD and RL7.2mAHD. The platform is expected to comprise between 45,000m^3 and 50,000m^3 (between 90,000 to 100,000 tonnes) of fill material.

CES further understands that as part of the installation of services, including stormwater, approximately 550m of trenching will be excavated to depths of between 1m and 3.7m below existing ground level. It is expected that this will generate approximately 1,200m^3 of spoil that will be removed from site and disposed of at an approved landfill.

5. GEOTECHNICAL MODEL

As part of the geotechnical report, CES developed two separate soil profile models for the site. One model is for the eastern portion of the site and one for the western portion, the two portions of site are roughly separated by a former railway spur (Figure 1). At the time of the geotechnical investigation approximately 95 percent of the site was observed to be sealed with either concrete or bituminous concrete pavements with the remaining unsealed areas comprising landscaped areas and embankments. The following geotechnical models were provided for the site.

Table 1: Summary of Subsurface Conditions and Inferred Geotechnical Model for the Eastern Portion of the Site

Unit	Description	Depth to Top of Layer (m)	Thickness Range (m)
FILL	Variable fill material with asbestos present in parts. Includes pavement and base coarse layers, building rubble, concrete, sand, gravel and clay.	Surface	0.2 – 1.9
ALLUVIAL	Interbedded CLAY, Silty CLAY, sandy CLAY, clayey SILT, SAND, and clayey SAND: red, brown, orange and grey, with some indurated ironstone bands. Stiff consistency or medium dense relative density.	0.2 – 1.9	8.2 – 18.3

Unit	Description	Depth to Top of Layer (m)	Thickness Range (m)
BEDROCK	SANDSTONE, medium to coarse grained, light grey and orange-brown, distinctly weathered, low to medium strength. *Becoming…*	9.0 – 18.6	Typically 0.3 – 1.5m
	SANDSTONE, fine to medium grained, light grey, slightly weathered, medium to high strength	--	--

Table 2: Summary of Subsurface Conditions and Inferred Geotechnical Model for the Western Portion of the Site

Unit	Description	Depth to Top of Layer (m)	Thickness Range (m)
FILL	Variable fill material including pavement and base coarse layers, and asbestos fibrous cement sheeting and asbestos pulp. Other fill materials encountered included silt, sand and gravel.	Surface	1.6 – 5.4
ALLUVIAL	Interbedded CLAY, Silty CLAY, sandy CLAY, clayey SILT, SAND, and clayey SAND: red, brown, orange and grey, with some indurated ironstone bands. Some dark grey to black SILT to sandy SILT mangrove muds present. Very loose to loose relative density or very soft to firm consistency.	1.6 – 5.4	2.6 – 14.2
BEDROCK	SANDSTONE, medium to coarse grained, light grey and orange-brown, distinctly weathered, low to medium strength. *Becoming…*	7.9 – 17.2	Typically 0.3 – 1.5m
	SANDSTONE, fine to medium grained, light grey, slightly weathered, medium to high strength	--	--

6. DISCUSSIONS AND RECOMMENDATIONS

6.1 EARTHWORKS AND SITE PREPARATION

The earth fill platform on which the facility is to be constructed should be constructed of suitable fill placed in near-horizontal layers of uniform thickness placed systematically across the fill area. The fill should be placed in layers no greater than 250 mm compacted thickness and compacted to a minimum density ratio of 98% based on Standard Compaction within ±2% of Optimum Moisture Content. Fill within pavement subgrade level should be compacted to a minimum of 100% Standard Maximum Dry Density Ratio, within ±2% of Optimum Moisture Content.

Materials considered unsuitable for use as structural fill are stated in “AS3798 - 2007: Guidelines on earthworks for commercial and residential development” and include:

- Organic soils, such as topsoil, severely root-affected subsoils and peat.

- Material not assessed as Virgin Excavated Natural Material (VENM) or Excavated Natural Material (ENM).
- Materials containing substances which can be dissolved or leached out in the presence of moisture, or which undergo volume change or loss of strength when disturbed and exposed to moisture.
- Silts, or materials that have the deleterious engineering properties of silt.
- Fill which contains wood, metal, plastic, boulders or other deleterious material.
- Loose, soft, wet or unstable soil or rock.

And

- Any material deemed unsuitable by the geotechnical practitioner.

Filling operations should be carried out under a Level 1 inspection and testing source as defined in AS3798 – 2007 *Guidelines on Earthworks for Commercial and Residential Developments.*

Prior to placement of fill, any unsuitable materials such as materials containing deleterious matter and vegetation should be removed to the satisfaction of the geotechnical practitioner.

The risk of differential settlement caused by variable fill materials across the site should be reduced by placing a geotextile such as a geogrid to assist with the spreading of future loads. Detailed design with respect to the type and position of the geotextile should be undertaken once the presence (or absence) of voids and remnant piles has been ascertained.

Piles that may have been left in place following demolition of former buildings at the site have the potential to provide unwanted support beneath proposed buildings resulting in differential settlement. It is also possible that voids may have formed beneath the cap due to settlement of the underling fill. Upon loading with the fill platform, the cap could subside into the voids resulting in differential settlement of the fill platform. CES understands that that the Developer has committed to undertaking a Ground Penetrating Radar (GPR) Survey to explore the absence or presence of piles or voids below the existing cap, prior to the placement of the fill platform.

Erosion and sediment controls should be implemented during earthworks in accordance with the requirements of the Landcom publication “Managing Urban Stormwater: Soils and Construction”.

6.2 EXCAVATION CONDITIONS

It is understood by CES that service trenches will require to be excavated across the eastern and western portions of the site to depths between 1m and 3.7m below existing ground level. The excavation of service trenches will encounter fill and alluvial soils (refer to Tables 1 and 2). The fill is variably contaminated with asbestos and will require responsible management during excavation.

Groundwater levels in the vicinity of the proposed service trench locations indicated water levels at the time of the 2007 geotechnical investigation of between 4.3mbgl and 4.7mbgl. Based on the 2007 monitoring results, it is unlikely that significant volumes of groundwater will be encountered during excavation of the service trenches. Perched water may be encountered in the fill, and should be controllable by pumping from excavated sumps and by controlled progressive excavation and restoration of the service trenches. It is recommended that groundwater monitoring of the installed wells is carried out prior to commencement of excavation to assess and confirm current groundwater levels.

6.2.1 Excavatability

CES understands that the service trenches will be excavated through concrete pavements by saw cutting to suit the width of the trench, thereby reducing the amount of fill material disturbed. It is further understood that where practicable, progressive restoration of the trenches will be carried out to reduce the amount of material exposed.

It is envisaged that the fill and alluvial soils will be excavatable using conventional plant such as hydraulic excavators and backhoes. Contractors should be required to examine the borehole logs to make their own assessment of excavation plant and production rates.

The fill material is variably contaminated with asbestos. Excavations in asbestos impacted fill will require responsible management during excavation and if applicable, removal and disposal at a suitable licensed landfill facility permitted to accept asbestos soils. A suitably qualified and experienced AS1 registered asbestos contractor should be engaged to supervise excavation and soil removal from site and ensure the methodologies adopted are consistent with requirements of the WorkCover NSW 2008 Guide *Working With Asbestos*.

6.2.2 Excavation Support

Due to the need to reduce the amount of disturbance to the existing ground, battering back of excavation sidewalls is not recommended. Temporary shoring should be installed during the proposed excavation works to provide adequate support to excavation side walls.

Table 3 below presents recommended design parameters that may be adopted for shoring design. Analyses will need to consider surcharges and hydrostatic pressure. Surcharge loads should be kept well clear of the crest of excavations.

Table 3: Design Parameters for Retaining Wall Design

Geotechnical Unit	Bulk Density γ (kN/m^3)	c' (kPa)	Φ' (degrees)	Active Earth Pressure (Ka)	Passive Earth Pressure (Kp)
Fill	20	0	25	0.4	2.5

6.3 FOUNDATIONS

It is expected that suitable foundations for the proposed industrial buildings will comprise shallow pad or strip footings founded on engineered fill, or alternatively piles to sandstone bedrock. CES recommends that footings for any proposed structure be founded on a consistent medium to reduce the potential for differential settlements.

6.3.1 Shallow Foundations

Eastern Portion of the Site

The bearing capacity of a pad or strip footings is dependent on the geometry of the footing and depth of embedment into the foundation. Assuming that the foundation for pad or strip footings on the eastern portion of the site would be the earth fill platform constructed in accordance with Section 6.1 of this report, an allowable bearing pressure of 150 kPa may be adopted for preliminary footing design. Settlement of footings designed using this allowable bearing pressure is expected to be less than 1% of the footing width.

Strip and pad footings should be cleaned, dewatered and concreted on the same day as excavation or a blinding layer of concrete should be placed. A geotechnical engineer should observe the footings prior to concreting to confirm the bearing stratum is consistent with the design assumptions.

Western Portion of the Site

The western portion of the site is underlain by uncontrolled asbestos impacted fill of variable depth, compaction and composition. This fill is underlain by very soft to soft and very loose to loose alluvial soil. These materials are considered unsuitable as a bearing stratum for shallow foundations.

6.3.2 Deep Foundations (Piles)

If the proposed buildings and associated utilities and structures are intolerant to settlement or piles are chosen as a mitigation measure for voids identified below the site capping, consideration should be given to the use of piles founded in sandstone bedrock. Should piles be the chosen option, they should be installed following construction of and through the earth fill platform using displacement piles or driven pile or similar piling techniques that reduces to a minimum the amount of spoil produced during construction.

The advantage of using displacement piles or driven piles is little spoil would be produced during construction of the piles. As a result, the risk of asbestos contaminated material being brought to surface is reduced. Piling through the earth fill platform would also reduce the amount of disturbance to the existing site cap, provide a “clean” working platform on which the works could be undertaken and provide additional capping to the site which would further reduce the risk of asbestos contaminated material being disturbed, exposed or brought to the surface.

Driven piles may comprise steel, timber or pre-cast concrete. Pre-drilling may be required as fill contains some subsurface obstructions, particularly across the western portion of the site. Any pre-drilling should also be carried out through the earth fill platform to reduce the risk of asbestos contaminated material being exposed or brought to the surface.

To decide on the most appropriate pile system, CES recommends that the structural engineer discuss the various options with a piling contractor. Selection will also need to consider uplift loads required and management of asbestos contamination that could be disturbed and brought to the surface during piling operations.

For piles founded in bedrock, the shaft adhesion (in compression) provided by the fill and alluvial soil layers would be negligible and should be ignored for design purposes. For uplift capacity the shaft adhesion of the sandstone should be multiplied by 0.5. If the piles have only a minimal socket into bedrock, the uplift capacity will be governed by adhesion of the stiff and medium dense alluvial soils. At this stage CES recommends an allowable shaft adhesion in uplift of 15 kPa for the stiff and medium dense alluvial soils.

A summary of the relevant design parameters for deep foundations across the site is provided below.

Table 4: Pile Design Parameters

Layer / Unit	**Allowable End Bearing Pressure (kPa)**	**Allowable Shaft Adhesion (compression) (kPa)**	**Allowable Shaft Adhesion (uplift) (kPa)**
Alluvial Soils (Stiff/Medium dense or better)	N/A	N/A	15
Distinctly Weathered Sandstone	1000	100	50
Slightly Weathered Sandstone	3500	350	175

Settlements for individual pile footings on rock are anticipated to be less than about 1% of the pile diameter. As described in Section 6.6 below, groundwater would likely be encountered should piles be the preferred footing system. The use of temporary casing would reduce the risk of sidewall instability due to groundwater inflow.

6.4 PAVEMENTS

Soaked CBR values for samples of alluvial soil beneath the existing pavements across the eastern portion of the site was assessed to be 5% to 7% assuming the material is compacted to the equivalent of 100% standard compaction. Detailed design of pavements by a qualified engineer will be required.

6.5 SLAB ON-GROUND CONSTRUCTION

Reference should be made to Cement and Concrete Associations "*Industrial Floors and Pavements*" (Report No. T48, 2nd Edition dated May 1999). Furthermore, any pavement should be underlined by a minimum 200 mm layer of granular sub-base meeting the requirements of DGS 20 as defined in RTA Specification 3051. The purpose of this layer is to provide a stable base for construction equipment, a uniform bearing surface, and reduces potential deflections at joints and facilitates load transfer across construction joints. In accordance with AS3798-2007, this layer should be compacted to a minimum density ratio of 98% modified.

Assuming construction of the earth fill platform in accordance with Section 6.1 of this report, a Young's Modulus of 20 MPa is recommended for design purposes.

In the western portion of the site, the fill is highly variable in depth, compaction and composition and the Young's Modulus of the material will vary significantly. The existing pavement will assist with negating the impact of the variable fill, however it is recommend that a geogrid is also used beneath any floor slab on the western side of the site to spread loads and reduce the risk of differential settlement. The size and strength of the geogrid will need to be designed.

6.6 GROUNDWATER

Eleven groundwater monitoring wells were installed as part of the geotechnical investigation to supplement those previously installed by URS. At the time of the 2007 geotechnical investigation, the groundwater levels in the wells was recorded to be at depths between 1.67 mbgl and 4.93 mbgl (RL 0.4 mAHD and RL 1.35 mAHD). The results of a minitroll pressure transducer indicate that the groundwater level is influenced by tidal fluctuations in the Parramatta River. Tidal fluctuations in the order of 200 mm and 300 mm were assessed.

In consideration of the above, groundwater would likely be encountered if piles are the preferred footing system. The use of temporary casing would reduce the risk of sidewall instability due to groundwater inflow. As described in Section 6.2, groundwater levels in the vicinity of the proposed service trench locations indicated water levels at the time of the 2007 geotechnical investigation of between 4.3mbgl and 4.7mbgl. Based on the 2007 monitoring results, it unlikely that significant volumes of groundwater will be encountered during excavation of the service trenches. Perched water may be encountered in the fill, this should be controllable by pumping from excavated sumps and by controlled progressive excavation and restoration of the service trenches.

It is recommended that groundwater monitoring of the wells is carried out prior to commencement of excavation to assess current groundwater levels.

Measures should be included as part of the development to ensure that adequate drainage is in place to facilitate the controlled and environmentally responsible removal of surface and groundwater.

6.7 EARTHQUAKE SITE FACTOR

Structural design for earthquake loads should be carried out in accordance with the relevant provisions in AS1170.4–1993 '*Minimum Design Loads on Structures, Part 4: Earthquake Loads*'.

Based on the encountered subsurface soils, and with reference to Table 2.4(a) of AS1170.4–1993, CES suggests a nominal site factor (S) for earthquake design loading to be 1.0. In addition, from Table 2.3 of AS1170.4–1996, an acceleration coefficient (α) of 0.08 for Sydney should be used.

6.8 GEOTECHNICAL CONSTRAINTS

Based on the results of the geotechnical investigation, the following geotechnical constraints are assessed:

- The site is largely covered with hard surfaces, mostly concrete and bitumen, which have been placed over variable fill contaminated with asbestos material. As a result, the concrete and bitumen 'cap' is under the protection of a legally binding SMP, which generally prohibits excavation below the 'cap' layer without prior written approval from OE&H (incorporating DECCW).
- Groundwater may be encountered during excavation works within fill and alluvial soils but manageable with local pumps and sumps. Bored piles are not considered suitable due to the presence of groundwater leading to the likelihood of sidewall collapse and difficulty achieving adequate cleanliness at pile base.
- Former piles may exist which may provide unwanted support beneath proposed buildings and voids may be present below the cap due to fill settlement. This could result in differential settlement of the fill platform. The variable fill in the western portion of the site may also result in differential settlement.

If proposed buildings are intolerant to settlement, it is recommended that further investigation be carried out using techniques such as geophysical Ground Penetrating Radar (GPR) to the confirm the presence of piles or voids below the existing cap. A geotextile such as a geogrid should also be placed as part of the construction of the earth fill platform which will assist with spreading future loads and reduce the risk of differential settlement.

7. CLOSURE

If you have any queries regarding the above or require any clarification, please do not hesitate to contact the undersigned on 8569 2200.

For and on behalf of Consulting Earth Scientists Pty Ltd

Mark Pickett
Engineering Geologist

Attachments: Figure 1 – Site Plan with Proposed Development
Annexure A: Generic Subsidence Management Plan

FIGURES

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Figure 1: Site Plan with Proposed Development

CES Project ID:	Date:
CES110407-NEC	11/05/2011
Prepared By: M.Howden	Checked By; M.Pickett

CONSULTING EARTH SCIENTISTS

APPENDIX A

Generic Subsidence Management Plan

CONSULTING EARTH SCIENTISTS

GENERIC SUBSIDENCE MANAGEMENT PLAN:

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GENERIC SUBSIDENCE MANAGEMENT PLAN:

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CES DOCUMENT REFERENCE: CES110407-NEC-AJ

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GENERIC SUBSIDENCE MANAGEMENT PLAN:
RIRP CAMELLIA
1 GRAND AVENUE, CAMELLIA, NSW

CES DOCUMENT REFERENCE: CES110407-NEC-AJ

1 INTRODUCTION

Consulting Earth Scientists Pty Ltd (CES) was requested by National Environmental Consulting Services (NEC) to provide a Generic Subsidence Management Plan (herein referred to as the GSMP) for the proposed development at 1 Grand Avenue, Camellia, NSW.

The GSMP provides a generic management plan to reduce the risk, mitigate against, monitor and rehabilitate subsidence affected areas of the site in the event that subsidence occurs.

2 BACKGROUND

2.1 THE SITE

The site is located at 1 Grand Avenue, Camellia NSW (herein referred to as the site) which is situated immediately east of Camellia Train Station, and approximately 18km north-west of Sydney CBD.

The site is bounded by the Parramatta River along its northern boundary, while the western boundary is adjacent to railway lines. The southern and eastern boundaries are marked by industrial units. Approximately 95 percent of the site is currently sealed with either concrete or bituminous concrete pavements with the remaining unsealed areas comprising landscaped areas, and embankments. The site is currently used for container storage by A & J Container Sales and Services.

The site was previously owned by James Hardies Industries who manufactured fibrous cement products including asbestos cement products up until 1981. Large quantities of fill have been used to level various parts of the site, and have been identified to be contaminated with asbestos cement waste and friable asbestos. Contaminated fill is ‘sealed’ beneath the concrete and bitumen surfaces. The concrete and bitumen ‘cap’ is under the protection of the legally binding Site Management Plan which generally prohibits excavation below the ‘capping’ layer without written approval of the Office for Environment and Heritage (OEH).

2.2 PROPOSED DEVELOPMENT

The proposed development comprises a Commercial and Industrial Resource Recovery Facility (CIRRF) and a Source Separated Organic Resource Recovery Facility (SSORRF) and associated weighbridge, internal access road, administration office and car parking (herein collectively referred to as the facility). The proposed facility is to be constructed on a compacted earth fill platform. The compacted earth fill platform will be constructed over existing concrete and bitumen surfaces.

3 SUBSIDENCE MANAGEMENT STRATEGIES

This GSMP follows three management strategies:

- Subsidence Risk Reduction and Mitigation
- Monitoring
- Rehabilitation

3.1 SUBSIDENCE RISK REDUCTION AND MITIGATION

3.1.1 Geophysical Survey

To reduce the risk of subsidence at the site, the first stage of this plan is to identify and locate voids and areas that are potentially susceptible to ground subsidence. This will be done by undertaking a Ground Penetrating Radar (GPR) Survey of the proposed facility. CES understands that the Developer has committed to undertaking a GPR survey following receipt of approval for the development.

GPR Survey is a non-intrusive ground investigation technique that provides high resolution reflection profiles of the subsurface, including identification of potential voids. GPR works by pulsing electro-magnetic energy in the form of radio waves into the subsurface material with a transmitting antenna. This energy propagates through the subsurface material as a function of its electrical properties which are in turn a function of its physical properties. Reflection of energy occurs at boundaries between media which have contrasting electrical properties such as between soil and concrete. By building a continuous profile of scans along a traverse and analysing the recorded reflections for shape, amplitude, location and two-way travel time, a subsurface profile of the depth and location of buried objects and voids can be produced.

3.1.2 Ground Treatment Options

Upon completion of the GPR survey, the presence (or absence), frequency and size of the voids and remnant piles will be better understood. This will allow targeted treatment of potential areas of concern. Preferred treatment options will consider the requirement to reduce to a minimum disturbance to the existing site capping. For the purpose of this generic plan, it is anticipated that localised grouting of voids will be a viable treatment option for identified voids, this assumption is subject to the results of the GPR survey.

Grouting would involve drilling a small diameter hole(s) (typically <50mm) into the void and injecting liquid grout. The grout is pumped into the void until the void is filled and the grout allowed to harden. Grouts used for such an application are typically cement based or polysynthetic grouts. Targeted grouting will allow contaminated fill to remain insitu and minimise disturbance to the site capping. The hardened grout may also act to immobilise contamination and asbestos impacted material.

A site specific work method statement will be developed should targeted grouting be carried out. The method statement would address *inter alia* health and safety issues, environmental management and construction quality.

3.1.3 Design Considerations

The facility and earth fill platform could be designed to accommodate and withstand subsidence. Such design considerations typically include:

- Providing a geogrid(s) to reinforce the earth fill platform. The geogrid acts to stiffen the earth raft which facilitates bridging of the platform over areas of subsidence and also should ground movement occur, the geogrid acts to make the earth platform move more uniformly, which results in less differential movement. The type and grade of the geogrid can be designed and adopted to suit the proposed structures, loadings and ground conditions identified during the GPR survey.
- Proposed buildings and associated utilities and structures that are intolerant to settlement could be founded using piles to bedrock. The piles could be installed following construction of, and through the earth fill platform using displacement piles or driven pile or similar piling techniques that reduces the amount of spoil produced during construction.
- In areas where significant voids are identified, a geogrid reinforced piled earth platform could be constructed. Piles founded on bedrock provide support to the earth platform reducing the amount of settlement of the platform while also reducing the load placed on the existing site capping, this would further reduce the risk of subsidence.

3.2 SUBSIDENCE MONITORING PROGRAM

If considered necessary based on the results of the GPR survey, the site could also be subject to a Subsidence Monitoring Program. The purpose of the Subsidence Monitoring Plan is to regularly monitor movements of the earth platform and structures constructed at the site. This monitoring would facilitate identification of areas of the fill platform and structures undergoing excessive ground movement. Geotechnical monitoring could include the installation and monitoring of settlement plates, inclinometers, extensometers, tell tales and survey monitoring markers.

3.2.1 Subsidence Action Plan

Following implementation of the above measures, CES considers it unlikely that significant amounts of subsidence would occur. However, if subsidence is observed or monitored, a Plan of Action would be formulated, this would typically include the following:

- Secure affected areas and make safe. The response will be dependent on the amount of subsidence observed/monitored. It may require simple signage to make employees and visitors aware of a trip hazard or potentially require the area to be physically cordoned off and access restricted.
- The frequency of subsidence monitoring increased and if considered necessary, the installation of additional geotechnical monitoring instrumentation.
- Undertake further geophysical survey to identify the cause and extent of the subsidence.
- Remediate the subsidence e.g. by localised grouting.
- Undertake repair of the earth fill platform.

4 NOTES

This document provides a generic plan for the prevention, mitigation, monitoring and rehabilitation of the site in regards to potential subsidence hazard, while taking into account constraints at the site by contaminated fill and the requirement to minimise disturbance of the existing site capping.

This Generic SMP will be reviewed and updated as and when more detailed information become available following the GPR survey and considering the detailed design of the structures and utilities to be constructed at the site.

5 CLOSURE

If you have any queries regarding the above or require any clarification, please do not hesitate to contact the undersigned on 8569 2200.

For and on behalf of Consulting Earth Scientists Pty Ltd

Mark Pickett
Engineering Geologist