Appendix D

Remedial Action Plan

Remedial Action Plan (RAP) The Weir Road, Teralba, NSW

November, 2008

Lake Macquarie City Council

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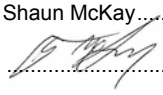
Signed: 

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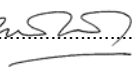
Signed: 

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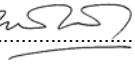
Signed: 

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Executive summary

Lake Macquarie City Council (LMCC) commissioned Parsons Brinckerhoff (PB) to prepare a Remedial Action Plan (RAP) for remediation and validation works for the property located at The Weir Road, Teralba, NSW ('the site'). The RAP has been prepared based on the results and recommendations of PB's previous site investigation: Geotechnical and Environmental Site Assessment at Lots 42-43 and 53-54 DP16062, The Weir Road, Teralba August 2008 (2118857A/PR_0394_RevA).

The purpose of the RAP is to develop a remediation and/or management strategy and to outline the methodology that aims to successfully remediate or manage the identified contamination hotspots at the site, to a level commensurate with the proposed future land use – commercial/industrial. The RAP also provides a framework for the work practices and environmental management techniques to be implemented whilst undertaking the remedial works.

According to LMCC, the proposed future land use is for a concrete recycling facility. The site is currently zoned 9 Natural Resources Zone and requires development consent for 'waste management and/or recycling facilities' under the LMCC LEP 2004.

The previous environmental site assessment identified three individual hotspots with contaminants in excess of the adopted site assessment criteria (NEPM HIL 'F' Commercial/industrial and NSWEPA Service Station) including:

- TP11 – arsenic, copper, lead, manganese and zinc
- TP16 – TPH C_{10}-C_{36}
- TP19 - arsenic, lead, manganese and zinc.

It is estimated that a total of 92 m^3 of heavy metal impacted soil and 108 m^3 of TPH impacted soil present at the site requires onsite management to enable redevelopment of the site for commercial/industrial land use.

Based on the assessment of available remedial technologies, the potential risks to human health and the environment as a result of the site contamination, and considering the cost effectiveness of each remedial technique, the preferred remedial strategy for the site has been assessed to be the cap and contain method. This method employs a risk minimisation approach similar to 'ongoing management', where impacted soils are managed on-site so as not to pose an ongoing risk to the environment or human health. Impacted soils are capped by the placement of capping layer materials or an impermeable barrier to prevent exposure to site occupiers or workers. The base of the 'capping layer material' is clearly marked to indicate that below this depth; workers could potentially be exposed to contamination, which would then trigger additional health, safety and environmental controls.

LMCC has advised that the RAP shall outline procedures that will ensure the redevelopment of the site for commercial/industrial use, within the zoning 9 Natural Resources under the Lake Macquarie City Council Local Environment Plan (LEP). Therefore, the 'commercial/industrial' (HIL F) guideline has been adopted as appropriate environmentally sensitive assessment criteria for validation of the site.

1. Introduction and objectives

1.1 General

Lake Macquarie City Council (LMCC) commissioned Parsons Brinckerhoff (PB) to prepare a Remedial Action Plan (RAP) for remediation and validation works for the property located at The Weir Road, Teralba, NSW ('the site'). The RAP has been prepared based on the results and recommendations of PB's previous investigation:

- Geotechnical and Environmental Site Assessment at Lots 42-43 and 53-54 DP16062, The Weir Road, Teralba (August 2008) - 2118857A/PR_0394_RevA.

The purpose of a RAP is to develop a remediation and/or management strategy and methodology that aims to successfully remediate or manage the identified contamination 'hot spots' at the site to a level commensurate with the proposed commercial/industrial future land use. The RAP also provides a framework for the work practices and environmental management techniques to be implemented whilst undertaking the remedial works.

The RAP has been prepared in accordance with NSW EPA Guidelines for Consultants Reporting on Contaminated Sites (1997), NSW DEC (2006) Guidelines for the NSW Site Auditor Scheme (2nd Edition), NEPC (1999) National Environmental Protection (Assessment of Site Contamination) Measure and DUAP (1998) SEPP 55 – Remediation of Land.

1.2 Remedial objectives

PB understands that the objectives of the RAP are to:

- summarise the available information on the current contamination status of the site
- set remediation or management goals to address the contamination identified on site
- define an appropriate site validation assessment criteria to assess site contamination in relation to potential risks to human health and the environment
- assess the most appropriate remediation methodology/technology for the site
- identify the necessary approvals/licences required by regulatory authorities
- establish a remediation schedule, preliminary site environmental safeguards, health and safety aspects and a framework for consultation for the site remediation works
- outline requirements for the validation report that will detail the remediation works undertaken and assess the contamination status and environmental condition of the site following remediation.

1.3 Scope of work

This RAP includes the following information:

- review of existing information for the site including previous investigation reports
- reassessment of the nature and extent of contamination at the site based on the 2002 and 2008 investigation works
- evaluation and assessment of most practical and cost effective remediation options

- remediation and validation methodology that will enable the site to be remediated to a condition suitable for commercial/industrial use.

The RAP also provides an outline of work practices, environmental management and occupational health and safety (OH&S) procedures to be implemented by contractors/subcontractors whilst undertaking the remedial works. Issues discussed in the RAP include:

- remedial objectives
- background
- site location
- site condition
- site history
- surrounding land uses
- summary of previous environmental investigations
- physical settings of the site
- site characterisation
- validation criteria
- proposed remediation methodology
- site management issues (including site security, emergency response, OH&S etc)
- contact information
- environmental management (including odours, dusts, noise, surface water etc)
- contingency management
- validation monitoring & reporting
- conclusions.

1.4 Data quality objectives

Systematic planning and verification is critical to the successful implementation of contaminated site investigation and remediation projects.

The Data Quality Objective (DQO) process documented by the US EPA (2000a and 2000b) and more recently the NSW DEC Site Auditor Guidelines (NSW DEC, 2006), has been applied to the proposed characterisation sampling activities at the site. The DQO process is a seven-step iterative planning approach to enable the project team to communicate the project goals and decisions, project constraints (time, budget, etc) and an assessment of the project uncertainties and how they are addressed (Steps 1 to 6) and to optimise the project specific sampling and analysis as Step 7. The seven basic steps of the DQO process are provided below in Table 1.1 and document the areas where the steps have been considered.

DQOs, the output of the process is qualitative and quantitative statements developed in the first six steps of the process. They define the purpose of the data collection effort, clarify what the data should represent to satisfy this purpose, and specify the performance requirements for the quality of information to be obtained from the data. The output from the

first six steps is then used in the seventh step to develop the data collection design that meets all performance criteria and other design requirements and constraints.

The data quality objectives for the remediation works are summarised in Table 1-1.

Table 1-1: Seven step data quality process

	Step	Section where addressed
1	Define the problem	Section 1: Introduction, objectives and scope Section 4: Summary of site contamination
2	Identify the problem	Section 2: Background Section 4: Summary of site contamination
3	Identify the inputs to the decision	Section 2: Background Section 3: Physical settings Section 4: Summary of site contamination
4	Define the study boundaries/constraints on data	Table 1-2: Data quality objectives Section 4: Summary of site contamination Section 5: Site remediation/validation criteria
5	Develop a decision rule	Table 1-2: Data quality objectives Section 5: Site remediation/validation criteria
6	Specify limits on decision errors	Table 1-2: Data quality objectives Section 5: Site remediation/validation criteria Section 6: Remediation strategy
7	Optimise the design for obtaining data	Section 6: Remediation strategy Section 8: Site management Issues Section 9: Environmental management

The data quality objectives for the remediation/validation are summarised in Table 1-2.

Table 1-2 Data quality objectives

	Objectives
Project	Remediation and validation for the site located at The Weir Road, Teralba, NSW.
Procedures	Obtaining all necessary Council and Government approvals. Identification of contaminated areas. Placement of high visibility marker layer. Importation and placement of capping layer materials
Priority contaminants of concern	TPH (C_{10}-C_{36}), arsenic, copper, lead, manganese and zinc
Sampling	Sampling of imported fill material for validation purposes as outlined in the RAP. All samples to be collected in accordance with NSW DECC appropriate guidelines. Chain of Custody to be used to ensure the integrity of the samples from collection to receipt by the analytical laboratory.
QA/QC	Sampling to standard procedures – 1 in 10 blind duplicates (intra-laboratory) to the primary laboratory and 1 in 20 blind duplicates (inter-laboratory) to the secondary laboratory. Rinsate blanks for TPH and heavy metals on sampling equipment are also required to be collected during field investigation (1 per day). Field and Laboratory acceptable limits are

	Objectives
	between 30–50% RPD as stated by AS 4482.1 – 2005. Non-compliance to be documented and discussed in remediation and validation report.
Laboratory	Use NATA certified laboratory and methods for the analytes to be determined, appropriate detection limits and check intra-laboratory and inter-laboratory QA.
Laboratory quality control – duplicates, spikes, blanks and surrogates – Acceptable Limits	Vary between analytes and between laboratories. If duplicate results are not satisfactory, non-compliance is to be documented in laboratory reports. Primary laboratory QA/QC acceptance limits were as follows: Surrogates: 70% to 130% recovery Matrix Spikes: 70% to 130% recovery or 80%-120% recovery for inorganics Control Samples: 70% to 130% recovery for soil or 80% to 120% recovery for waters (if applicable). Duplicate Samples: <4PQL - +/- 2PQL, 4-10PQL – 0.-25 or 50%RPD, >10PQL – 0-10 or 30%RPD Method Blanks: zero to <PQL
Reporting	Report presents findings of field and laboratory results, conclusions and recommendations. Report to generally comply with NSW EPA Guidelines for Consultants Reporting on Contaminated Sites, 1997.

1.5 Adopted guidelines and legislative requirements

The methodologies for the assessment, remediation and validation works detailed below have been developed to satisfy the requirements of the following legislation and acts including:

- *Contaminated Land Management Act 1997*
- *Protection of The Environment Operations Act 1997*
- *Occupational Health and Safety Act 2000*
- *Occupational Health and Safety Regulations 2001.*

The works will be also undertaken generally in accordance with the requirements of the following contaminated land documents:

- NSW EPA (1994) Guidelines for Assessing Service Station Sites
- NSW EPA (1995) Sampling Design Guidelines
- NSW EPA (1997) Guidelines for Consultants Reporting on Contaminated Sites
- NSW DEC (2006) Guidelines for the NSW Site Auditor Scheme (2nd Edition)
- NSW EPA (1999) Guidelines on Significant Risk of harm from Contaminated Land and the Duty to Report
- NSW DECC (2008) Waste Classification Guidelines
- NEPC (1999) National Environment Protection (Assessment of Site Contamination) Measure
- ANZECC (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality
- State Environmental Planning Policy 55 Remediation of Land (SEPP 55)

- NSW DECC Protection of the Environment (Waste) Regulation 2005 – General Exemption Under Part 6, Clause 51 and 51A: the recovered aggregate exemption 2008; the excavated natural material exemption 2008, and the recovered fines from construction and demolition waste exemption 2008.

2. Background

The following information has generally been taken from the Geotechnical and Environmental Site Assessment at Lots 42-43 and 53-54 DP16062, The Weir Road, Teralba – 2118857A. PR_0394, August 2008.

2.1 Site legal description and use

The site is located within the Lake Macquarie City Council local government area, at The Weir Road, Teralba, NSW. A locality plan is presented as Figure 1. The site is owned by Lake Macquarie City Council. The legal description of the site is Lots 42-43 and 53-54 DP16062.

The site is zoned 9 Natural Resources under the LMCC Local Environment Plan (LEP).

2.2 Site history

The history of the former Boolaroo Sanitary Depot was presented in PB report 67P144APR_1443 RevC and is summarised below.

- The central portion of the site was initially used for the disposal of toilet pans. Disposal of sanitary pans ceased on 29 June 1993.
- In the recent past the western portion of the site has been used for the disposal of dry sewerage sludge, which was buried in trenches. These activities ceased on 2 November 1999.
- Five maturation ponds were located near the centre of the site which received liquid effluent from domestic and commercial septic tanks for aeration. The ponds were clay lined and there are no known reports of liquid loss.
- The eastern portion of the site has been used for pasture and then left fallow.
- Council commissioned the installation and monitoring of groundwater monitoring wells across the site in August 1997.

This investigation focuses on the southwest part of the site which was used for the disposal of dry sewerage sludge in trenches, which ceased on 2 November 1999.

2.3 Aerial photograph review

An aerial photograph review was undertaken as part of previous investigations and PB's summary of relevant observations is presented below:

- *29 July 1961, Run 10*
  A number of agricultural fields are present in the eastern portion of the site. The centre of the site appears to be cleared and contains a shed. Toilet pan disposal may have been occurring in this area. Sludge disposal looks to have been undertaken in the western portion of the site, evidenced by the presence of a cleared area and open trenches.
- *22 August 1965, Run 10*
  Grazing paddocks are present in the eastern portion of the site. A shed is present in the

centre of the Site, adjacent to an area which appears to have been cleared and filled with coal chitter. This is likely the 'pan disposal area'. The sewage sludge disposal (trenching) has extended further north. Trees have been cleared along the south-western portion of the site, at the sewage sludge disposal area.

- *6 July 1969, Run 13*
  A second pan disposal area is present in the southern central portion of the site, also covered by coal chitter. An effluent treatment pond, located in the southern portion of the site, appears to be filled with water.
- *11 February 1979, Run 11*
  The area of sewage disposal has increased with four additional trenches present. Four evaporation ponds and an extra shed are present in the centre of the site. A road has been constructed around the pan disposal area to the east of the site. The pan disposal area in the southern portion no longer appears to be in use.
- *12 April 1987, Run 11*
  An additional evaporation pond is located in the western portion of the site, adjacent to the existing ponds. The second pan area, north of the road, continues to be active. The paddock in the eastern portion of the site appears to be healthy. Link Road is present along the southern boundary of the site.
- *28 April 1990, Run 4*
  A dwelling is present in the eastern portion of the site. The model aircraft field in the south eastern portion of the Site has been cleared. The track in the northeast portion of the site is overgrown. The northern pan disposal area has been backfilled along its western edge. The southern pan disposal area is partially backfilled. The size of the wetland area located to the south of the site has increased.
- *6 November 1993, Run 4*
  The northern pan disposal area to the east of the site is in disuse and overgrown with weeds, and the southern pan disposal area has been completely backfilled. A north to south aligned trench/drain is present, dividing the southern pan disposal area. A similar drain is also present in the sewage disposal area. The sewage disposal area is mainly overgrown with weeds, but areas still appear to be in use. The wetland to the south of the site is dry. The area surrounding the shed has been surfaced. An aeration/pump is present in one of the evaporation ponds in the centre of the site.
- *25 May 1996, Run 3*
  Worm farm activities have commenced in the central portion of the site. Stockpiles of green waste are present surrounding the southern pan disposal area. The sewage disposal area is mainly overgrown with weeds, but a significant proportion still appears to be in use
- In summary, the aerial photograph review indicated that sewage disposal has occurred since at least 1961.

3. Physical settings

3.1 Site topography and hydrology

The site is 7.2 Ha and includes Lots 42-43 and 53-54 DP16062. The site is rectangular in shape and located on the north side of The Weir Road, approximately 800m west of the Racecourse Road intersection. Topographically, the site is located in an alluvial back swamp approximately 200 m south of Cockle Creek. Wetlands are located immediately to the south of The Weir Road. Small hills are located at distance to the south and south east of the site.

Locally the site is gently undulating, and the ground surface is hummocky and irregular due to the presence of fill on the site. The ground surface contains troughs approximately 1.0 m in depth. Generally the site slopes at <5° to the south.

The site is currently vacant but has previously been used as a night soil dumping ground. Six groundwater wells are present on the site. Five of the wells are located around the site boundaries and 1 well is located in the centre of the site. Figure 3 shows the location of the wells.

Previous investigations indicate that the site has been filled. Fill depths of greater than 2.9 m have been recorded. Filling of the site also includes construction of an unsealed gravel road around the perimeter of the site. The approximate location of the access track is shown on Figure 2. One metre deep, unlined drainage channels have been cut into the fill, which flow east then north toward Cockle Creek. The approximate location of the drainage lines are shown on Figure 2. Water was noted in the drainage channels at the time of the investigation as well as in the numerous troughs located across the site.

A small construction waste stockpile consisting of steel sheeting and other construction waste material is located on the western area of the site in Lot 53. The approximate location of the stockpile is shown on Figure 2.

The site is vegetated by short grasses, short ferns and weeds. Trees up to 5m in height are located along the northern most drainage line. The sites perimeter, including the southern portion of the site (in the No Go Areas) is lined with small to medium sized trees. No trees are present across the proposed entrance to the site.

Surface soils consist of loose sand and clayey sand fill. Trafficability across the site was poor and limited to light vehicles. The gravel access track surrounding the site was suitable for heavier vehicles. Photographs of the site can be found in PB report 2118857A/PR_0394_RevA.

3.2 Geology

3.2.1 Local geology

The Newcastle Coalfield Geology Map indicates that the site is underlain by Quaternary gravel, sand, silt and clay. This is confirmed by the 2008 field investigation results which are summarised below.

Test pits TP1 to TP20 typically encountered uncontrolled fill consisting of soft to stiff clay and very loose to medium dense sand, silt, gravel and clay, to depths greater than 2.9 m. Fill materials were underlain by firm to stiff alluvial sandy clay, and loose to medium dense silty

sand and clayey sand to depths greater than 3.5 m. Test pits TP1, TP2, TP3, TP6 and TP14 encountered very loose to loose silty sand, clayey sand and soft to firm sandy clay topsoil immediately below the fill. The topsoil thickness varied from 0.1 m to 0.5 m.

DCP tests were carried out adjacent to test pits TP1, TP3, TP9, TP13 and TP19 within the fill and natural alluvial soils. Refusal depths were encountered between 1.4 m and 2.7 m. DCP results can be found in PB report 2118857A/PR_0394_RevA.

Boreholes BH1 to BH3 encountered very loose to loose and firm uncontrolled fill to depths of 0.7 m to 1.8 m followed by very loose to medium dense alluvial sand and gravel and firm to stiff clay to depths of 16.5 m to 19 m followed by highly weathered, medium strength sandstone.

3.2.2 Groundwater

Groundwater was encountered within boreholes BH1, BH2 and BH3 at depths of 1.10 m, 0.6 m and 0.7 m respectively. Groundwater was encountered in all test pits except for TP6 and TP8 at depths ranging from 0.6 and 2.8 m.

Groundwater monitoring results are shown in Table 3-1. The table includes results from previous PB investigations (formerly PPK report ref 67P144A.PR_1444) carried out in 2001.

Table 3-1 Groundwater monitoring results

Location	Depth to groundwater (depths in metres)		
	Previous investigation (PPK Oct 2001)	January 2008	May/June 2008
W5	2.60	Unable to locate	1.344
W6	2.10	2.07	0.661
W13	2.00	2.07	0.721
SITE No.3	1.00	2.13	1.690
SITE No.4	1.00	1.72	0.973
SITE No.7	0.40	1.76	0.995
SITE No.8	1.70	1.38	0.365

Fluctuations are due to both seasonal variation and damage to PVC piping allowing surface water to enter the monitoring well.

Water monitoring well depths are shown on Figure 3 and estimated groundwater reduced level contours across the site are shown on Figure 9.

4. Summary of site contamination

PPK conducted previous investigations on the site in 2002. Site plans showing all sample locations from the previous and most recent investigations are provided as Figures 3 and 4. Results tables, detailed laboratory certificates and Chain of Custody (COC) documents are provided in the previous PB report: Geotechnical and Environmental Site Assessment at Lots 42-43 and 53-54 DP16062, The Weir Road, Teralba (August 2008) - 2118857A/PR_0394_RevA.

4.1 Soil contamination

All sampling locations are shown on Figure 2. A summary of soil analytical results is shown on Table 4-1 below. The analytical results are summarised in Tables A1-A6 of PB Report 2118857A/PR_0394_RevA.

Table 4-1 Soil results summary

Analyte	No. of primary samples	Range (mg/kg)	Samples exceeding commercial assessment criteria (mg/kg)
TPH			
C_6-C_9	30	<10	0
C_{10}-C_{36}	30	<250 to 2,030	**1**
Aliphatic TPH Fractions			
C10 - C12	1	<500	NA
C13 - C16	1	<500	NA
C17 - C21	1	<500	0
C22 - C34	1	2,100	
>C35	1	<500	0
Aromatic TPH Fractions			
C10 - C12	1	<50	NA
C13 - C16	1	<50	NA
C17 - C21	1	110	**1**
C22 - C34	1	3,190	
>C35	1	<50	0
BTEX			
Benzene	30	<0.2	0
Toluene	30	<0.5 to 0.5	0
Ethylbenzene	30	<0.5	0
Total Xylene	30	<1.5	0
PAHs			
Benzo(a)pyrene	20	<0.5 to 0.8	0

Analyte	No. of primary samples	Range (mg/kg)	Samples exceeding commercial assessment criteria (mg/kg)
Total PAHs	20	<8 to 9.6	0
Total Phenols	20	<0.1 to 3.4	0
Heavy Metals			
Arsenic	30	<1 to 2,910	**2**
Cadmium	30	<0.1 to 5.4	0
Chromium	30	1 to 53	0
Copper	30	<2 to 6,040	**1**
Nickel	30	<1 to 59	0
Lead	30	2 to 5,110	**3**
Manganese	30	9 to 16,300	**2**
Selenium	30	9 to 28	0
Zinc	30	14 to 65,200	**2**
Mercury	30	<0.05 to 1.24	0
OC/OP/PCBs			
Aldrin & Dieldrin	10	<0.05	0
Chlordane	10	<0.05	0
DDT+DDD+DDE	10	<0.05	0
Heptachlor	10	<0.05	0
Total OPPs	10	<0.5	0
Total PCBs	10	<0.05	0
Nutrients			
Ammonia as N	10	0.1 to 853	NA
Total Kjeldahl Nitrogen (TKN)	10	80 to 2,190	NA
Total Nitrogen (as N)	10	90 to 2,190	NA
Total Organic Carbon	10	0.72 to 3.9	NA
Biosolid Pathogens			
Reoviruses	6	<1	NA
Adenoviruses	6	<1	NA
Enteroviruses	6	<1	NA
Taenia ova	6	<1	NA
Ascaris ova	6	<1	NA

A summary of analytical results is included below:

- TPH C6-C9 concentrations were below the laboratory's Practical Quantitation Limit (PQL).
- TPH C10-C36 concentrations ranged from <250 to 2,030 mg/kg, above the adopted assessment criteria of 1,000 mg/kg TPH C10-C36 was detected in five samples above the PQL but less than the guideline (1,000 mg/kg). Additionally, concentrations from

sample TP16 2.8-2.9 were above the guideline (2,030 mg/kg), however this is not considered to represent concentrations indicative of a hot spot concentration (>2.5 times the guideline). Additional analysis for aromatic and aliphatic TPH fractions indicated that the material is not suitable to remain on site. Results exceeded the HIL 'F' Commercial/Industrial guidelines for Petroleum Hydrocarbon constituents >C16 – C35 Aromatics.

- Aliphatic TPH concentrations ranged from <500 to 2,100 mg/kg, below the adopted assessment criteria of 28,000 mg/kg.
- Aromatic TPH concentrations ranged from <50 to 3,190 mg/kg, above the adopted assessment criteria of 450 mg/kg.
- BTEX concentrations were at or below the PQL.
- Benzo(a)pyrene concentrations ranged from <0.5 to 0.8 mg/kg, below the adopted assessment criteria of 100 mg/kg.
- PAH concentrations ranged from <8 to 9.6 mg/kg, below the adopted assessment criteria of 5 mg/kg.
- Total Phenol concentrations ranged from <0.1 to 3.4 mg/kg, below the adopted assessment criteria of 42,500 mg/kg.
- Arsenic concentrations ranged from <1 to 2,910 mg/kg, above the adopted assessment criteria of 500 mg/kg. Arsenic was detected in each sample above the PQL, with two samples at hot spot concentrations (TP11 0.0-0.1 and TP19 0.0-0.1). Other sample concentrations were below the criterion.
- Cadmium concentrations ranged from <0.1 to 5.4 mg/kg below the adopted assessment criteria of 100 mg/kg.
- Chromium concentrations ranged from 1 to 53 mg/kg, below the adopted assessment criteria of 500 mg/kg.
- Copper concentrations ranged from <2 to 6,040 mg/kg, above the adopted assessment criteria of 5,000 mg/kg. Other results were either below the criterion or below the PQL.
- Nickel concentrations ranged from <1 to 59 mg/kg, below the adopted assessment criteria of 3,000 mg/kg.
- Lead concentrations ranged from 2 to 5,110 mg/kg, above the adopted assessment criteria of 1,500 mg/kg. Results for lead indicated two samples at hot spot concentrations (TP11 0.0-0.1 and TP19 0.0-0.1). Other results were below the criterion. TCLP results (Table A21, PB report PR_0394_RevA) indicate a potential for lead to leach from the soil at TP11.
- Manganese concentrations ranged from 9 to 16,300 mg/kg, above the adopted assessment criteria. Other results were below the criterion.
- Selenium concentrations ranged from 9 to 28 mg/kg, below the adopted assessment criteria.
- Zinc concentrations ranged from 14 to 65,200 mg/kg, above the adopted assessment criteria of 35,000 mg/kg. Other results were below the criterion.
- Mercury concentrations ranged from <0.05 to 1.24 mg/kg, below the adopted assessment criteria of 75 mg/kg.

- OCP/OPP/PCB concentrations were all below laboratory detection limits.
- Ammonia as N concentrations ranged from 0.1 to 85 mg/kg. There are no guidelines for this analyte.
- Total Kjeldahl Nitrogen (TKN) ranged from 80 to 2,190 mg/kg There are no guidelines for this analyte.
- Total Nitrogen (as N) ranged from 90 to 2,190 mg/kg. There are no guidelines for this analyte.
- Total Organic Carbon (TOC) ranged from 0.72 to 3.9 mg/kg. There are no guidelines for this analyte.
- All biosolid pathogen concentrations were below the PQL. There are no guidelines for this analyte.

In summary, elevated concentrations of TPH, arsenic, copper, lead, manganese and zinc indicate significant impacts from previous filling activities at the site.

4.2 Groundwater contamination

A summary of groundwater analytical results is included in Table 4-2. The locations of monitoring wells are shown on Figure 3. The analytical results are summarised in Tables A10-A13, PB Report 2118857A/PR_0394_RevA.

Table 4-2 Groundwater results summary

Number of samples	Analyte	Min. conc. (µg/L)	Max. conc. (µg/L)	Sample locations exceeding investigation levels
TPH				
7	TPH C_6–C_9	<50	<50	Nil
7	TPH C_{10}-C_{36}	80	1,490	Nil
BTEX				
7	Benzene	<1	<1	Nil
7	Toluene	<1	<1	Nil
7	Ethylbenzene	<1	<1	Nil
7	Total xylenes	<3	<3	Nil
PAH				
7	Benzo(a)pyrene	<0.05	<0.05	Nil
7	Naphthalene	<0.1	<0.1	Nil
7	Flouranthene	<0.1	<0.1	Nil
7	Total PAHs	0.1	0.4	Nil
Total Phenolics				
7	Total Phenolics	<10	40	Nil
Heavy Metals				
7	Arsenic	1	16	Nil
7	Cadmium	<0.1	0.3	Nil

Number of samples	Analyte	Min. conc. (µg/L)	Max. conc. (µg/L)	Sample locations exceeding investigation levels
7	Chromium	<0.1	2	Nil
7	Copper	2	18	Six. All except W6
7	Nickel	1	57	One. Site #4
7	Manganese	46	3,870	One. W6
7	Lead	<1	9	Nil
7	Selenium	<5	<5	Nil
7	Zinc	32	2,530	All
7	Mercury	<0.1	0.1	Nil
Nutrients and Faecal Coliforms				
7	Total Organic Carbon (TOC)	11	50	No guideline
7	pH	6.1	7.3	No guideline
7	Total Kjeldahl Nitrogen (TKN)	0.9	132	No guideline
7	Nitrogen	0.9	132	All
7	Ammonia	0.05	134	Four. Site #3, Site #4, W6 and W13.
7	Chemical Oxygen Demand (COD)	22	614	No guideline
7	Biological Oxygen Demand (BOD)	2	47	No guideline
7	Faecal Coliforms	<2	400	No guideline

A summary of analytical results is included below:

- TPH C6-C9 concentrations were below the laboratory's Practical Quantitation Limit (PQL). The highest TPH concentration was located in the offsite well, Site #3. This indicates that there may be impacts in that area of the site, that are unrelated to any on site impacts, considering the relatively low concentrations of TPH in onsite wells.
- TPH C10-C36 concentrations ranged from 80 to 1,490 µg/L.
- BTEX concentrations were below the PQL.
- Naphthalene, Fluoranthene and Benzo(a)pyrene concentrations were below the PQL.
- PAH concentrations ranged from 0.1 to 0.4 µg/L.
- Total Phenolics concentrations ranged from <10 to 40 µg/L, below the adopted assessment criteria of 270 µg/L.
- Arsenic concentrations ranged from 1 to 16 µg/L, below the adopted assessment criteria of 360 µg/L.
- Cadmium concentrations ranged from <0.1 to 0.3 µg/L below the adopted assessment criteria of 0.8 µg/L.
- Chromium concentrations ranged from <0.1 to 2 µg/L, below the adopted assessment criteria of 40 µg/L.

- Copper concentrations ranged from 2 to 18 µg/L, with results from all wells except W6 above the adopted assessment criteria of 2.5 µg/L.
- Nickel concentrations ranged from 1 to 57 µg/L, with results from Site #4 above the adopted assessment criteria of 17 µg/L.
- Lead concentrations ranged from <1 to 9 µg/L, below the adopted assessment criteria of 9.4 mg/kg.
- Zinc concentrations ranged from 32 to 2,530 µg/L, with results from all wells above the adopted assessment criteria of 31 µg/L.
- Mercury concentrations ranged from <0.1 to 0.1 µg/L, below the adopted assessment criteria of 5.4 mg/kg.
- Total Organic Carbon (TOC) ranged from 11 to 500 µg/L. There are no guidelines for TOC.
- pH ranged from 6.1 to 7.3. There are no guidelines for pH.
- Total Kjeldahl Nitrogen (TKN) ranged from 0.9 to 132 µg/L. There are no guidelines for TKN.
- Nitrogen ranged from 0.9 to 132 µg/L, with results from all wells above the adopted assessment criteria of 0.5 µg/L.
- Ammonia concentrations ranged from 0.05 to 134 µg/L, with results from four wells above the adopted assessment criteria of 2 µg/L.
- COD concentrations ranged from 22 to 614 µg/L. There are no guidelines for COD.
- BOD concentrations ranged from 2 to 47 µg/L. There are no guidelines for BOD.
- Faecal coliforms ranged from <2 to 400 coliforms/100 ml. There are no guidelines for faecal coliforms.

5. Site remediation/validation criteria

5.1 Evaluation criteria

To assess the significance of contamination detected across the site following remediation, it is necessary to define the concentrations to be used as the site validation criteria. The validation criteria have been set based on the proposed future land uses of the site – commercial/industrial.

The NSW DECC uses, as its primary soil evaluation criteria for land use a combination of guidelines as follows:

- NSW DEC (2006) Guidelines for the NSW Site Auditor Scheme (2nd Edition).
- NSW EPA (1994) Guidelines for Assessing Service Station Sites.
- National Environmental Protection Measure (NEPC) (1999) – Health Investigation Levels.
- ANZECC (2000) Australian Water Quality Guidelines for Fresh and Marine Waters.
- NSW Protection of the Environment Operations Act.
- NSW DECC (2008) Waste Classification Guidelines.
- NSW DECC Protection of the Environment (Waste) Regulation 2005 – General Exemption Under Part 6, Clause 51 and 51A: the recovered aggregate exemption 2008; the excavated natural material exemption 2008 and; the recovered fines from construction and demolition waste exemption 2008.

Each of the above criteria is discussed in further detail below.

Guidelines for the NSW Site Auditor Scheme

The DEC has outlined soil investigation levels for use by site auditors undertaking site audits in NSW. These guidelines outline Health-Based Investigation Levels and Provisional Phytotoxicity-Based Investigation Levels (for sandy loams, pH 6-8).

Furthermore, the Health-Based Investigation Levels are developed for four categories of development as follows:

- Residential with gardens and accessible soil (home grown produce contributing less than 10 percent fruit and vegetable intake; no poultry), including children's day care centre, preschools and primary school, or town houses or villas.
- Residential with minimal access to soil including high rise apartments and flats.
- Parks, recreational open space, playing fields including secondary schools.
- Commercial or industrial.

NSW EPA Guidelines for assessing service station sites

Threshold concentrations for sensitive land uses are contained within the NSW EPA Guidelines for Assessing Service Station Sites (1994). These levels are for the redevelopment of former service station sites, however can be applied to other former land uses where hydrocarbons have been used. Some of the levels quoted in these guidelines

are derived from work carried out by the Dutch Government, while others are based upon the ANZECC (1992) Investigation Levels.

National Environmental Protection Measure (1999)

The National Environmental Health Forum (NEHF) has been established by directors of Environmental Health from each State and Territory and the Commonwealth.

The NEHF has published a range of monographs to give expert advice and guidance on a variety of environmental health matters. The first monograph in the soil series provides health-based soil investigation levels (HILs) first published by the NEHF in 1996 and revised in 1998 and 1999. The most recent revision (1999) reflects changes made under the development process for the National Environmental Protection (Assessment of Site Contamination) Measure (NEPM) development process.

NEPM states that there are no numeric aesthetic guidelines but the fundamental principal is that soils should not be discoloured, malodorous (including dug over or wet) nor of abnormal consistency. The natural state of the soil should be considered in the assessment. The implications of any such aesthetic issues will then need to be considered and/or addressed as part of the site assessment with regards to the potential future land use of the site.

NSW DECC (2008) Waste Classification Guidelines

The Waste Minimisation and Management Act 1995 (the Waste Act) introduced a State-wide scheme for licensing waste activities. According to this scheme, the wastes that pose the greatest threat to the environment need a licence. The purpose of the licence is to ensure that appropriate controls apply to the handling, storage, treatment and disposal of the waste. There must also be a clear public record of what wastes are going where. Sometimes this is needed even where a licence is not required, so that the community can be confident that waste materials are managed appropriately and correctly.

Under the NSW DECC waste classification guidelines (2008) all non liquid wastes must be classified as General Solid or Restricted Solid waste. In the case of remediation of contaminated sites, the generator will be required to undertake a waste assessment of the materials to be disposed. If the waste stream is of a fairly constant composition a one off assessment to determine the characteristics may be sufficient. If the waste stream is subject to variation ongoing assessment program may be required.

The classification process for non liquid wastes focuses on the potential for wastes to release chemical contaminants into the environment through contact with liquids (leachate). The test used for assessing non liquid waste is the Toxicity Characteristics Leaching procedure (TCLP) whish estimates the potential for the waste to leach chemical contaminants into a leaching liquid. Based on the analysis of the leachable concentrations the guidelines set maximum concentrations for each contaminant in order for the waste to be classified as inert, solid, or industrial. If the contaminants exceed the industrial classification the waste is classified as Hazardous.

The second test used to complete the assessment of waste, the Specific Contaminant Concentration (SCC) test, is one that determines the total concentration of each contaminant in the waste sample. The guidelines set different maximum levels for the total concentration of each contaminant in order for waste to be classified.

While total contaminant concentrations can be used to determine waste classification. TCLP is the preferred method as it gives the leachability potential of the materials, where total

concentrations may exceed certain waste classification concentrations, and can therefore reduce the classifications depending on the levels of total concentrations.

NSW DECC Protection of the Environment (Waste) Regulation 2005 under Part 6, Clause 51 and 51A

The Department of Environment and Climate Change (DECC) encourages the recovery of resources from waste where this is beneficial and does not harm the environment or human health. Many waste-derived materials are not suitable to apply to land or use in thermal applications due to potential contamination to the land or pollution from air emissions.

The resource recovery exemptions provide for the safe reuse of waste materials. DECC is now able to exempt the use of waste or waste-derived materials in certain circumstances where a material is assessed as being fit for its purpose.

General exemptions have been developed by DECC with significant input from industry groups for commonly recovered materials. General exemptions can be used without notifying DECC provided the conditions of the exemption are met. These include exemptions that specifically apply to the site during filling activities, including: the recovered aggregate exemption 2008; the excavated natural material exemption 2008 and; the recovered fines from construction and demolition waste exemption 2008

5.1.1 Selected remediation/validation criteria for soils

LMCC has advised that the RAP shall outline procedures that will enable the redevelopment of the site for commercial/industrial land use, within the zoning 9 Natural Resources under the LMCC LEP 2004.

The focus of soil validation is to facilitate compliance of the remediation which is designed to address unacceptable human health (and/or environment) risks and to protect groundwater from ongoing impacts. To that end, a set of remediation/validation criteria, which defines an appropriate remedial end point, is established in a manner that considers the protection of sensitive receptors.

Investigation levels provided within the state and national guidance documents outlined above are conservative and strict use of them may require more remediation (nature and extent) than would site-specific response levels. However, validation criteria derived within the above guidance are considered adequate to protect the most sensitive receptors at the site and can be adequately supported when impacted land is being remediated for commercial/industrial land use, the redevelopment land use option proposed.

Therefore, it is believed that the ‘Commercial/industrial’ (HIL F) guideline is the most appropriate guideline for the site.

The provisional phytotoxicity based investigation levels for sandy loams pH 6-8 (PBILs) are not generally considered suitable site validation/remediation criteria due to:

- the type of soils at the site
- redevelopment is not proposed to include any agricultural use
- redevelopment of the site will not include any planned vegetated areas
- the site is going to be filled, raising the current surface level by up to 1.5 m.

The soil validation criteria adopted for remediation/validation are listed in Table 5-1 below.

Table 5-1: Adopted assessment criteria - soils

Contaminant	Commercial or industrial (HIL F) (mg/kg)
TPH	
C_6-C_9	65[2]
C_{10}-C_{36}	1000[2]
BTEX	
Benzene	1[2]
Toluene	1.4[2]
Ethyl Benzene	3.1[2]
Total Xylene	14[2]
Heavy Metals	
Arsenic	500[1]
Cadmium	100[1]
Chromium*	60,000[1]
Copper	5,000[1]
Lead	1,500[1]
Mercury	75
Nickel	3,000
Zinc	3,5000[1]
PAH	
Total PAH	100[1,]
Benzo(a)pyrene	5[1,]
Total Phenols	42,500[1]
OC Pesticides	
Aldrin & Dieldrin	50[1, 3]
Chlordane	250[1, 3]
DDT+DDD+DDE	1,000[1, 3]
Heptachlor	50[1, 3]
Total PCBs	50[1, 3]

Sources:

1. DEC (2006) Guidelines for the NSW Site Auditor Scheme
2. NSW EPA (1994) Guidelines for Assessing Service Station Sites – Sensitive Land Use
3. NEPM (1999) Health Investigation Levels

* expected as Cr III

5.1.2 Adopted assessment criteria for groundwater

There are a number of possible sources of assessment criteria available for assessing concentrations of contaminants within groundwater. These include national and state published guidelines:

- ANZECC (2000) Australian Water Quality Guidelines for Fresh and Marine Waters.
- NSW Protection of the Environment Operations Act.
- National Environmental Protection Measure (NEPM) (1999) – Health Investigation Levels.
- NSW EPA (1994) Guidelines for Assessing Service Station Sites.

In order to assess the groundwater quality at the site the ANZECC 2000 Guidelines will be adopted. These guidelines are nationally recognised benchmarks that the NEPM and NSW EPA Guidelines are based upon. The ANZECC 2000 guideline document and guidelines have been updated from previous 1992 published levels. Within these guidelines, assessment criteria are available for a variety of end-uses of groundwater and surface water, including aquatic ecosystems, recreational, drinking, and irrigation.

For the purposes of the application of the ANZECC Guidelines, Cockle Creek is classified as a 'highly disturbed' water system due to its position at the low point of a water catchment, receiving urban and industrial stormwater runoff and historical impacts. Cockle Creek would be expected to be estuarine in nature (mangroves), becoming freshwater upstream. Field parameters from purged groundwater beneath the site indicate that the groundwater is fresh to slightly saline. Therefore, the ANZECC 'protection of freshwater aquatic ecosystem 80%' assessment criteria are adopted for the site.

Where guidelines do not exist for specific analytes, the protection of aquatic ecosystem criteria, within the NSW EPA Guidelines for Assessing Service Station Sites are adopted. The adopted assessment criteria are presented in Table 5-2.

Table 5-2: Adopted assessment criteria for groundwater

Contaminant	Protection of disturbed freshwater aquatic ecosystems (ug/L)
TPH	
C_6-C_{36}	-
C_{10}-C_{36}	-
BTEX	
Benzene	2000[1]
Toluene	
Ethylbenzene	
Total Xylenes	980[1]
PAH	
Total PAH	3[3]

Contaminant	Protection of disturbed freshwater aquatic ecosystems (ug/L)
Naphthalene	85[1]
OC/OP/PCB	
Aldrin	0.01[2]
Azinophos Methyl	0.11[1]
Chlordane	0.27[1]
Chloripyrifos	1.2[1]
Diazinon	2[1]
Dieldrin	0.002[2]
Dimethoate	0.3[1]
DDT	0.04[1]
Endosulfan	1.8[1]
Endrin	0.06[1]
Fenitrothion	0.4[1]
Heptachlor	0.7[1]
Lindane	1.0[1]
Malathion	1.1[1]
Parathion	0.04[1]
Total Phenols	1200[1]
Metals	
Arsenic	360[1]
Cadmium	0.8[1]
Chromium	10[1]
Cobalt	-
Copper	2.5[1]
Lead	9.4[1]
Mercury	5.4[1]
Nickel	17[1]
Zinc	31[1]
Nutrients	
Total Nitrogen	500[1]
Ammonia	20[1]

Sources:

1. ANZECC Guidelines for Protection of Freshwater Aquatic Ecosystems, ANZECC 2000. 80% criteria used for highly disturbed water bodies.

2. NEPM, National Environment Protection Measure Guidelines on Investigations Levels for Soils and Groundwater Protection of Aquatic Ecosystems 1999 (Freshwaters)

5.2 Identified contaminated areas

5.2.1 Soils

Based on the results from the PB (2008) investigation, it has been determined that three areas across the site have been impacted with either TPH or heavy metals (As, Cu, Pb, Mn and/or Zn). These areas have been delineated as shown in Tables 5-3, 5-4 and 5-5 and in Figures 6, 7 and 8.

Test Pit TP11

Heavy metal contamination (arsenic, copper, manganese, zinc and lead) was identified at test pit TP11 at the surface (0.0-0.1 m) and 0.5-0.6 m in the initial investigations, above the groundwater table. Contamination was attributed to Pasminco slag. Delineation samples were collected approximately 4.0m to the north, 2.0 m to the east, 8.0m to the south and 6.0 m to the west of the initial investigation location at 0.0-0.1 m, 0.5-0.6 m and 1.0-1.1 m (refer Figure 6). Results are contained in Table 5-3.

Table 5-3: Delineation sampling results – TP11

Sample ID	Location description	Analyte	Result
TP11 1.0-1.1 m	Vertically delineates contamination at TP11	As, Cd, Cr, Cu, Ni, Mn, Pb, Se, Zn, Hg	Below guideline limits
TP11A 0.0-0.1 m 0.5-0.6 m 1.0-1.1 m	Located 2 m south east of TP11 Delineates contamination to south east	As, Cu, Pb, Mn, Zn	Below guideline limits
TP11B 0.0-0.1 m 0.5-0.6 m 1.0-1.1 m	Located 2 m north east of TP11 Delineates contamination to north east	As, Cu, Pb, Mn, Zn	As and Pb above guideline at 0.0-0.1 m
TP11C 0.0-0.1 m 0.5-0.6 m 1.0-1.1 m	Located 6m north of TP11 Delineates contamination to north	As, Cu, Pb, Mn, Zn	Below guideline limits
TP11D 0.0-0.1 m 0.5-0.6 m 1.0-1.1 m	Located 4m south west of TP11 Delineates contamination to south west	As, Cu, Pb, Mn, Zn	As above guideline at 0.5-0.6m and 1.0-1.1 m
TP11E 0.5-0.6 m 1.0-1.1 m	Located 8m south west of TP11 Delineates contamination to south west of TP11D	As	Below guideline limits
TP11F	Located 4 m north east of TP11	As and Pb	Below guideline limits

Sample ID	Location description	Analyte	Result
0.0-0.1 m	Delineates contamination to north east of TP11B		

Contamination at TP11 has been delineated, with a total volume (assuming a maximum depth of 1.0 m) requiring remediation of 84 m^3. Vertical delineation confirms that contaminated fill material is not impacting the underlying natural material.

Test Pit TP16

TPH C_{10}-C_{36} contamination was identified at test pit TP16 at 2.8-2.9 m in the initial investigations, below the groundwater table. Delineation samples were collected approximately 6.0 m to the north and 3.0 m to the south, east and west of the initial location (refer Figure 7). Results are contained Table 5-4.

Table 5-4: Delineation sampling results – TP16

Sample ID	Location description	Analyte	Result
TP16 0.5-0.6	Vertically delineates contamination above TP16 2.8-2.9	TPH C10-C36	Below guideline limits
TP16 3.0-3.1 m	Delineates contamination vertically below TP16 2.8-2.9 m	TPH C10-C36	Below guideline limits
TP16A 0.5-0.6 m 1.0-1.1 m 2.8-2.9 m 3.0-3.1 m	Located 3 m east of TP16 Delineates contamination to east	TPH C10-C36	Below guideline limits
TP16B 0.5-0.6 m 1.0-1.1 m 2.8-2.9 m 3.0-3.1 m	Located 3 m south of TP16 Delineates contamination to south	TPH C10-C36	Below guideline limits
TP16C 0.5-0.6 m 1.0-1.1 m 2.8-2.9 m 3.0-3.1 m	Located 3 m west of TP16 Delineates contamination to west	TPH C10-C36	Below guideline limits
TP16D 0.5-0.6 m 1.0-1.1 m 2.8-2.9 m 3.0-3.1 m	Located 3m north of TP16 Delineates contamination to north	TPH C10-C36	Above guideline limit at TP16D 2.8-2.9 m
TP16E	Located 6 m north	TPH C10-C36	Below guideline limits

Sample ID	Location description	Analyte	Result
2.8-2.9 m	of TP16 Delineates contamination to north of TP16D		

Contamination at TP16 has been delineated, with a total volume (assuming a maximum thickness of contamination of 2.0 m) requiring remediation of 108 m^3. Vertical delineation confirms that contaminated fill material is not impacting the underlying natural material, or the overlying fill material.

Test Pit TP19

Heavy metal contamination (arsenic, manganese, zinc and lead) was identified at test pit TP19 in surface soils (0.0-0.1 m) in the initial investigations, above the groundwater table. Contamination was attributed to Pasminco slag. Delineation samples were collected approximately 2.0 m to the north, east, south and west of the initial investigation location at 0.0-0.1 m (refer Figure 8). Results are contained in Table 5-5.

Table 5-5: Delineation sampling results – TP19

Sample ID	Location description	Analyte	Result
TP19 0.5-0.6 m	Vertically delineates contamination at TP19	As, Cd, Cr, Cu, Ni, Mn, Pb, Se, Zn, Hg	Below guideline limits
TP19A 0.0-0.1 m 0.5-0.6 m	Located 2 m east of TP19 Delineates contamination to east	As, Pb, Mn, Zn	Below guideline limits
TP19B 0.0-0.1 m 0.5-0.6 m	Located 2 m north of TP19 Delineates contamination to north	As, Cu, Pb, Mn, Zn	Below guideline limits
TP19C 0.0-0.1 m 0.5-0.6 m	Located 2 m west of TP19 Delineates contamination to west	As, Cu, Pb, Mn, Zn	Below guideline limits
TP19D 0.0-0.1 m 0.5-0.6 m	Located 2 m south of TP19 Delineates contamination to south	As, Cu, Pb, Mn, Zn	Below guideline limits

Contamination at test pit TP19 has been delineated, with a total volume (assuming a maximum depth of 0.5 m) requiring remediation of 8m^3. Vertical delineation confirms that contaminated fill material is not impacting the underlying natural material. Horizontal delineation confirms that the impacted fill material is not impacting the surrounding soils laterally.

5.2.2 Groundwater

A summary of groundwater analytical results is included in Table 5-6. The locations of monitoring wells are shown on Figure 3. The analytical results are summarised in Tables A10-A13, PB Report 2118857A/PR_0394_RevA.

Table 5-6: Groundwater results summary

Number of samples	Analyte	Min. conc. (µg/L)	Max. conc. (µg /L)	Sample locations exceeding investigation levels
TPH				
7	TPH C_6–C_9	<50	<50	Nil
7	TPH C_{10}-C_{36}	80	1,490	Nil
BTEX				
7	Benzene	<1	<1	Nil
7	Toluene	<1	<1	Nil
7	Ethylbenzene	<1	<1	Nil
7	Total xylenes	<3	<3	Nil
PAH				
7	Benzo(a)pyrene	<0.05	<0.05	Nil
7	Naphthalene	<0.1	<0.1	Nil
7	Flouranthene	<0.1	<0.1	Nil
7	Total PAHs	0.1	0.4	Nil
Total Phenolics				
7	Total Phenolics	<10	40	Nil
Heavy Metals				
7	Arsenic	1	16	Nil
7	Cadmium	<0.1	0.3	Nil
7	Chromium	<0.1	2	Nil
7	Copper	2	18	Six. All except W6
7	Nickel	1	57	One. Site #4
7	Manganese	46	3,870	One. W6
7	Lead	<1	9	Nil
7	Selenium	<5	<5	Nil
7	Zinc	32	2,530	All
7	Mercury	<0.1	0.1	Nil
Nutrients and Faecal Coliforms				
7	Total Organic Carbon (TOC)	11	50	No guideline
7	pH	6.1	7.3	No guideline
7	Total Kjeldahl Nitrogen (TKN)	0.9	132	No guideline
7	Nitrogen	0.9	132	All
7	Ammonia	0.05	134	Four. Site #3, Site #4, W6 and W13.
7	Chemical Oxygen Demand (COD)	22	614	No guideline

Number of samples	Analyte	Min. conc. (µg/L)	Max. conc. (µg /L)	Sample locations exceeding investigation levels
7	Biological Oxygen Demand (BOD)	2	47	No guideline
7	Faecal Coliforms	<2	400	No guideline

A summary of analytical results is included below:

- TPH C6-C9 concentrations were below the laboratory's Practical Quantitation Limit (PQL). The highest TPH concentration was located in the offsite well, Site #3. This indicates that there may be impacts in that area of the site that are unrelated to any on site impacts, considering the relatively low concentrations of TPH in onsite wells.
- TPH C10-C36 concentrations ranged from 80 to 1,490 µg/L.
- BTEX concentrations were below the PQL.
- Naphthalene, Fluoranthene and Benzo(a)pyrene concentrations were below the PQL.
- PAH concentrations ranged from 0.1 to 0.4 µg/L.
- Total Phenolics concentrations ranged from <10 to 40 µg/L, below the adopted assessment criteria of 270 µg/L.
- Arsenic concentrations ranged from 1 to 16 µg/L, below the adopted assessment criteria of 360 µg/L.
- Cadmium concentrations ranged from <0.1 to 0.3 µg/L below the adopted assessment criteria of 0.8 µg/L.
- Chromium concentrations ranged from <0.1 to 2 µg/L, below the adopted assessment criteria of 40 µg/L.
- Copper concentrations ranged from 2 to 18 µg/L, with results from all wells except W6 above the adopted assessment criteria of 2.5 µg/L.
- Nickel concentrations ranged from 1 to 57 µg/L, with results from Site #4 above the adopted assessment criteria of 17 µg/L.
- Lead concentrations ranged from <1 to 9 µg/L, below the adopted assessment criteria of 9.4 mg/kg.
- Zinc concentrations ranged from 32 to 2,530 µg/L, with results from all wells above the adopted assessment criteria of 31 µg/L.
- Mercury concentrations ranged from <0.1 to 0.1 µg/L, below the adopted assessment criteria of 5.4 mg/kg.
- Total Organic Carbon (TOC) ranged from 11 to 500 µg/L. There are no guidelines for TOC.
- pH ranged from 6.1 to 7.3. There are no guidelines for pH.
- Total Kjeldahl Nitrogen (TKN) ranged from 0.9 to 132 µg/L. There are no guidelines for TKN.
- Nitrogen ranged from 0.9 to 132 µg/L, with results from all wells above the adopted assessment criteria of 0.5 µg/L.

- Ammonia concentrations ranged from 0.05 to 134 µg/L, with results from four wells above the adopted assessment criteria of 2 µg/L.
- COD concentrations ranged from 22 to 614 µg/L. There are no guidelines for COD.
- BOD concentrations ranged from 2 to 47 µg/L. There are no guidelines for BOD.
- Faecal coliforms ranged from <2 to 400 coliforms/100 ml. There are no guidelines for faecal coliforms.

In summary, elevated concentrations of contaminants identified above, indicate impacts from previous filling activities at the site. These areas require further investigation by way of additional rounds of groundwater sampling at the site prior to any development proceeding on site and in accordance with Section 6.4.2.

6. Remediation strategy

6.1 General

The preferred order of options for site remediation and management as stated in the NSW DEC (2006) Guidelines for the NSW Site Auditor Scheme (2nd Edition) is:

- on-site treatment of the soil so that the contaminant is either destroyed or the associated hazard is reduced to an acceptable level
- off-site treatment of the soil so that the contaminant is either destroyed or the associated hazard is reduced to an acceptable level, after which the soil is returned to site.

If the above options cannot be implemented, then other options that should be considered include:

- removal of contaminated soil to an approved site or facility, followed, where necessary by replacement with imported fill material
- consolidation and isolation of the soil on-site by containing with an appropriately designed barrier (this could include under road pavements or building foundations to mitigate any exposure).

If remediation is likely to cause a greater adverse effect than would occur were the site left undisturbed, then remediation should not proceed.

6.2 Remediation goals

PB considers that the goals for the remediation of the site are to:

- remediate or manage the identified contamination 'hot spots' at the site to a level commensurate with the proposed future land use, i.e. commercial/industrial
- address the immediate environmental concerns at the site
- validate the site in accordance with NSW DECC requirements.

6.3 Remedial options

To remediate the soils at the site to a level commensurate with the proposed future commercial/industrial land use, there are several methodologies considered to be appropriate, each with a number of advantages and disadvantages. Remediation risk management may comprise implementation of one or a combination of the methodologies.

Any decisions regarding remediation risk management should consider sustainable development. The *CLM Act (1997)* states 'The EPA is to have regard to the principles of ecologically sustainable development in the exercise of its functions under this Act and is to seek the implementation of those principles in the management by other persons of contaminated land'. Therefore in considering sustainable development, the site risks can be mitigated through preventing exposure to the contaminants of concern; this can be achieved by placing the materials in areas of less sensitive land-use or containing the materials under an impervious layer (e.g. concrete building slab). Any mitigation/management measure

would need to be addressed in a site management plan and may need to be recorded on the legal title of the site.

The remedial options are summarised below, with the disadvantages and advantages of each of the options detailed in Table 6-1.

Many remediation methods were not considered for the Teralba site due to the type of contaminants identified, volumes involved and costs. These include vitrification and electrokinetics that have been used for heavy metals as these are restrictive in cost and experience in Australia.

Do nothing

The do nothing option involves no remediation activity prior to redevelopment works. This approach is not in line with current thinking in regards to ecologically sustainable development in terms of intergenerational equity. Intergenerational equity focuses on the idea that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.

The Environmental Site Assessment (ESA) (2118857A/PR_0394_RevA) concluded that levels of heavy metals (As, Cu, Pb, Mn and/or Zn) and TPH C_{10}-C_{36} are higher than commercial/industrial land use and NSWEPA Service Station guidelines respectively. Therefore the 'do nothing' option is not considered to be suitable, as soil contamination within these areas exceeds relevant criteria and may present potential risks to site users.

Ongoing management

'Ongoing management' is considered appropriate for sites where site contamination presents a low or minimal risk to human health and the environment and there is no risk of off-site migration of contaminants.

Commonly, ongoing management involves a monitoring program to assess contaminant conditions at the site and provide assurance that no changes (such as change in the size or orientation of contaminant plumes) are occurring that may impact sensitive receptors. Ongoing management usually also incorporates a remedial contingency plan to be applied should the contaminants present begin to impact receptors. Ongoing management may also include the placement of fencing or barriers to prevent access to the contamination.

The potential redevelopment of the site with the placement of contaminated soils under impermeable structures (roadways, building) reducing the exposure of contaminated soils means that ongoing management of the site is a viable strategy when combined with capping/containment.

Capping and containment

The capping and/or containment method employs a risk minimisation approach similar to 'ongoing management', where impacted soils are managed on-site so as not to pose an ongoing risk to the environment or human health. Impacted soils are capped by the placement of imported fill materials or an impermeable barrier or contained within a specially constructed cell to prevent exposure to site occupiers or workers. The base of the capping layer is clearly marked to indicate that below this depth, workers could potentially be exposed to contamination, which would then trigger additional health, safety and environmental controls.

Prior to the placement of a cap, the soil/fill materials to be capped must be geotechnically sound (capable of supporting the cap) otherwise the cap may degenerate at points of weakness. Compaction of site soil/fill may be required prior to the placement of the cap. Geotechnically unsuitable material may require off site disposal.

As a remediation method, the capping of heavy metal and TPH contaminated materials under an impermeable barrier (such as a concrete slab and/or low permeability clays) is a viable option and will reduce the expense of off site disposal and imported fill (if required).

Excavation and on site treatment

Contaminants that are typically the subject of on site treatment include PAHs and TPHs.

The most widely used treatment method for TPH and PAHs is bioremediation and/or land farming, however this treatment method is more suited for treating lighter fraction TPH (C6-C9) and lighter PAH species. As the TPH contamination is mostly mid to low range, the effectiveness of in-situ or ex-situ bioremediation is reduced at this site potentially resulting in longer remediation time frames and on site storage issues.

Thermal remediation (direct or indirect thermal desorption) of TPH is a proven treatment process, however given the volume of material requiring treatment and the associated costs it is not considered feasible.

Excavation and off-site disposal

This option involves the excavation and transportation of contaminated materials from site for disposal at a suitably (NSW DECC) licensed landfill facility. Excavation of contaminated wastes is a frequently used option, typically used when a rapid site remediation program is required or where significant subsurface contamination exists that is potentially impacting on sensitive off-site receptors.

Following excavation of contamination hot spots and/or fill material, validation sampling is required to confirm that the concentrations of site contaminants following remediation works are acceptable given the proposed land use for the various areas of the site. Details of the remediation works undertaken and validation results would be presented in a validation report.

Excavated and stockpiled wastes must be classified in accordance with the NSW EPA Environmental Guidelines for the Assessment, Classification and Management of Liquid and Non-Liquid Wastes (1999).

The costs associated with disposal of the material to a licensed facility and importing clean fill material to site often restricts this method being used. Further, the disposal of the waste is not in accordance with the NSW EPA waste minimisation policy. Any remedial projects should also consider matters of sustainability that minimise depletion of resources as far as possible. The wholesale excavation and off site disposal of soils is not considered sustainable as:

- the deposition of contaminated materials within landfills is simply transferring the problem elsewhere
- movement of additional trucks off site would generate dust, noise and other environmental issues and would require combustion of fuels (a non-renewable resource)
- additional resources would be required to validate the excavations, adding to the overall costs of the project

- additional imported fill materials would be needed to fill the excavations after validation, increasing the costs associated with excavation and disposal method.

6.4 Preferred remediation/management options

The cap and contain and on-going management of heavy metal and TPH impacted soils is considered to be an appropriate remediation option for this site, given the shallow nature of the contamination and the volumes involved. Each area of contamination is considered an isolated pocket of contaminated fill material that is unlikely to contribute to impacts on the environment or to human health, both on the site and on the surrounding areas. In addition, there are few other remedial treatment technologies available for soils impacted with these contaminants.

The preferred remediation strategy was selected for the following reasons:

- Placement under an impermeable barrier will immediately remove the risk to human health of site occupants.
- The potential for further impact to the surrounding environment as a result of the remediation process (for example, contaminated surface waters/sediment) is minimised.
- On site capping and management is the most reliable remediation strategy for removing exposure pathways for heavy metal and TPH contamination.
- Filling of the site will be undertaken as part of the proposed site works for the recycling facility; therefore, capping of the contaminated areas will be the most cost-effective solution.

Table 6-1: Remediation methodologies

Remediation Methodology	Description	Advantages	Disadvantages	Suitable
Do Nothing	No further works	Low Cost	Unacceptable as contamination would still be present at levels in excess of the soil criteria creating future environmental liabilities, especially if land is to be divested. Exposure pathways remain complete.	No
On-Going Management	Institutional controls such as preventing use of the garden areas, fencing off of affected areas	Low cost, quick method	Would cause potential problems with site occupiers and a potential future environmental liability with any change in land use, especially if land is to be divested. Likely to impose restrictions on proposed land use and leave exposure pathways complete.	Yes. In conjunction with capping/ containment
Capping	Risk minimisation approach where impacted soils are managed on-site by capping the ground surface with a clean, impermeable layer of fill material.	Relatively fast method. Effectively removes risks to human health by eliminating exposure pathway.	Importation of capping material. Groundwater protection is achieved only if leachable materials are removed, stabilised or contained. May require notification of contamination on land titles. Restricted development options.	Yes. In conjunction with on-going management
Containment	Risk minimisation approach similar to capping except that impacted soils are excavated and placed within an impervious lined cell and contained.	Reduced disposal costs. Removes contamination from affected areas to allow development to proceed.	Potentially expensive design of containment cell in suitable area of redevelopment. May require notification of contamination on land titles. Restricted development options.	Possible
Soil Treatment (land farming, bioremediation, thermal desorption methods) – onsite/offsite	Soils can be excavated and transported off site for treatment or excavated, stored and treated on site.	Eliminates impacted materials Soil can be re-used on site so a reduction in imported fill costs Removes future environmental liability from the site.	Slower remediation times. Expensive technology (thermal desorption, bioremediation etc). Some methods not suitable for some contaminants. Potential storage and treatment problems. Management and transport issues.	Possible (for TPH, on site treatment only)

Remediation Methodology	Description	Advantages	Disadvantages	Suitable
Off-site Disposal	Excavate impacted material. Transport directly to licensed landfill facility. Re-instate site with clean fill material.	Fast – impacted material removed immediately, no potential for further impact. No storage or treatment problems. Minimal design and management costs. Removes all future environmental liability from the site.	Expensive to dispose as waste classification required for landfill disposal. Costs associated with the importation of clean fill. May require on-site treatment of highly impacted material to enable classification as solid waste prior to disposal. Not in accordance with the NSW EPA waste minimisation policy.	Yes

6.5 Contamination Management Plan

Section 2.1.13 of the Lake Macquarie Development Control Plan (DCP) 2008 requires a Contamination Management Plan (CMP) to be developed for any contaminants to remain on the site stating how the contaminants will be monitored. Sections 6.5.1 and 6.5.2 discuss the strategies that should be implemented to remediate and monitor the soil and groundwater contamination identified on the site.

6.5.1 Soil

Based upon the assessment of remedial technologies, the potential risks to human health and the environment, and considering the cost effectiveness of each remedial technique, the preferred remedial strategy for the site is to cap and contain the site. The entire site is to be raised by up to 1.5 m above current levels with imported fill materials. The contaminated areas should be covered by at least one metre of capping layer materials with an impermeable hardstand material at the surface. The base of the imported fill should be marked with a high visibility geotextile marker layer. Current surface levels should be surveyed prior to commencement of site filling to ensure that a one metre capping layer is established.

For future reference, the presence of contaminated fill below the capping layer should be recorded on the Section 149 certificate for the site.

6.5.2 Groundwater

Ongoing groundwater monitoring is to be implemented to assess for impacts in groundwater associated with the onsite soil impacts and the potential for off-site migration of associated contaminants in groundwater. Additional groundwater monitoring is required to be undertaken to assess for trends in groundwater contaminants detected in the most recent groundwater monitoring event (PB report 2118857A/PR_0394_RevA). It should be noted that there are no registered groundwater wells in the vicinity of the site, other than those registered as ‘investigation’ under the previous environmental investigations; therefore, off-site groundwater impacts may only be detected in the receiving water body, which should also be sampled as part of the ongoing groundwater monitoring.

In addition to the above, natural attenuation parameters should be analysed for in all future groundwater monitoring events to assess for the TPH contamination to naturally attenuate. This may involve the installation of a groundwater well in the vicinity of TP16 to facilitate both natural attenuation parameters and migration.

In the event that monitoring wells are unable to be preserved during the capping process, replacement wells will be installed at completion of the works to allow for the proposed ongoing groundwater monitoring.

A groundwater monitoring plan should be developed and implemented prior to remediation/development commencing.

7. Remediation methodology

7.1 Preliminaries

Prior to commencement of remedial works at the site, the following activities need to be completed:

- obtain any statutory/regulatory approvals and/or licences (refer Section 9.2) and notifying Lake Macquarie City Council of the works
- preparation of a waste management plan including provisions for source sites for imported fill
- preparation of an OH&S plan and an EMP to ensure that all site personnel are aware of the health and safety and environmental management requirements for the project
- provide adequate on site safety equipment (for example, adequate fencing, barrier boards, barricades and warning signage) to secure the work area and minimise the danger to contractors and the public for the duration of the site works
- preparation of a project timeline for the proposed site works
- establishment of on site worker facilities, preparation for all inductions, and installation of environmental control measures and establish stockpile areas.

7.2 Remediation work implementation

7.2.1 Site establishment

During site establishment process, the following is required:

- the site boundaries, stockpiling and remediation areas be clearly defined
- the area for the works compound should be clearly defined including any decontamination/washing areas etc.
- preliminary environmental controls should be laid out for erosion and run-off control.

7.2.2 Cap and containment

The remedial approach involves a general plan to import fill material and placement across the site, raising the current surface level of the entire site by up to 1.5 m. The cap will provide a physical barrier to prevent future site users from accessing contaminated soils. The cap would be in accordance with ANZECC (1999) Guidelines for the assessment of on site containment of contaminated soil. Specific cap requirements would be determined following concept design of the site.

A marker mesh (woven geotextile) should be placed over the impacted material prior to filling with imported fill material.

The cap above the impacted material should be at least 1 m thick.

7.3 Remedial contingencies

At this stage it is anticipated that the proposed remedial technologies should be effective in dealing with the contamination present, however remedial contingencies may be required should the scenarios detailed in Table 7-1 arise.

Table 7-1: Remedial contingencies

Scenario	Remedial contingencies/actions required
Highly contaminated soils encountered not identified during previous investigation.	Work to be suspended until environmental consultant can further assess impacted soils/materials and associated risks.
Changes in proposed future land uses at the site.	Review of the remediation works completed for the site.
Contaminated material to be transported offsite	Refer to Waste Classification letter in PB report PR_0394_RevA
Increasing trends in groundwater contaminant concentrations at the site boundaries	Assess offsite groundwater impacts and at the receiving water body. Consider groundwater remediation strategies.

7.4 Validation sampling – imported capping material

It is understood that all imported capping material to be used as the site capping layer is to be sourced from LMCC works. This material should be certified VENM or ENM. Sampling rates and analytical suites will be in accordance with DECC Protection of the Environment (Waste) Regulation 2005 – General Exemption Under Part 6, Clause 51 and 51A: the recovered aggregate exemption 2008; the excavated natural material exemption 2008 and; the recovered fines from construction and demolition waste exemption 2008.

An accurate log of all volumes of imported capping materials will be kept on site and reported in a validation report at completion of the works. This will include the volume of materials, number of trucks used for transportation and the capacity of the trucks.

7.5 Laboratory analysis

Samples collected from imported fill materials will be sent by courier under suitable 'chain of custody' (COC) documentation to a laboratory certified by NATA for the required analysis. A nominated check laboratory will also be utilised for analysis of quality control samples.

The nominated laboratories may send samples interstate to obtain particular detection limits or use particular methodology or analytical instruments. These samples would be transported under the laboratories QA/QC programs with appropriate (COC) documentation.

All laboratories used will meet compliances under the respective AS/NZS ISO 9001:1994 quality assurance programs, be certified by NATA for analyses to be performed and complete their own internal QA/QC programs.

7.6 Field and laboratory QA/QC

Quality Assurance/Quality Control (QA/QC) practices will be applied to all stages of data gathering and subsequent sample handling procedures. These are designed to provide control over both field and laboratory operations.

Quality control – field sampling

All fieldwork will be undertaken by experienced professionals in accordance with documented Field Operating Procedures, a copy of which can be provided on request. Field QC samples collected for this project should comprise the following:

- one in 10 intra laboratory duplicates
- one in 20 inter laboratory duplicates
- one equipment rinsate per day.

Trip spikes are not proposed to be used as light fraction TPH and BTEX contaminants are not a concern on this site.

Quality control – laboratory

Laboratory quality control procedures should be generally undertaken with each batch of samples or every 10 or 20 samples as required by NATA. This includes analysis of laboratory duplicate samples, spiked samples, certified reference standards, surrogate standard/spikes and laboratory blanks.

Laboratory duplicate samples: The analytical laboratory sub-samples from one sample submitted for analytical testing at a rate equivalent to one in 20 samples per analytical batch, or one sample per batch if less than twenty samples are analysed in a batch. A laboratory duplicate provides data on analytical batch and the analytical precision (repeatability) of the test result.

Spiked samples: An original field sample is spiked by adding an aliquot of known concentration of the target analyte(s) prior to sample extraction and analysis. A spike documents the effect of the sample matrix on the extraction and analytical techniques.

Certified Reference Standards: A reference standard of known (certified) concentration is analysed along with a batch of samples. The Certified Reference Standard provides an indication of the analytical accuracy of the test method.

Surrogate Standard/Spikes: These are organic compounds which are similar to the analyte of interest in terms of chemical composition, extractability, and chromatographic conditions (retention time), but which are not normally found in environmental samples. These surrogate compounds are spiked into blanks, standards and samples submitted for organic analyses by gas-chromatographic techniques prior to sample extraction. They provide a means of checking that no gross errors have occurred during any stage of the test method leading to significant analyte loss.

Laboratory Blank: Usually an aqueous solution that is as free as possible of the analyte of interest to which is added all the reagents, in the same volume, as used in the processing of the samples. The reagent blank is carried through the complete sample preparation procedure and contains the same reagent concentrations in the final solution as in the sample solution used for analysis. The reagent blank is used to correct for possible contamination resulting from the preparation or processing of the sample.

7.7 Reporting and closure

Following achievement of the remediation objectives, it is recommended that a remediation/validation report be prepared to include all fieldwork, chemical analysis,

discussions, conclusions and recommendations. The validation report should be prepared in general accordance with the NSW EPA (1997) Guidelines for Consultants Reporting on Contaminated Sites.

The validation report will detail the extent and nature of the remedial works undertaken, characterisation and disposal of contaminated soils (if undertaken), the validation of imported capping material and will consider the overall status of the site, demonstrating that the contaminated areas have been dealt with appropriately.

The report should include:

- executive summary
- scope of works
- site identification
- summary of site history
- summary of site conditions and surrounding environment
- summary of geology and hydrogeology
- summary of previous investigation results
- summary of the remedial action plan
- basis for assessment criteria
- comment on the extent and nature of the remediation undertaken
- results of any waste classification, compared to the relevant guidelines
- sampling and analysis plan and sampling methodology
- field and laboratory QA/QC
- results/interpretation and discussion of QA/QC results
- results of the sampling of any imported fill materials, compared to relevant guidelines
- results of any validation sampling, compared to relevant guidelines
- contractor supplied information, including drawings, waste disposal dockets and documentation for imported materials
- discussion of the suitability the remediated areas for intended land use
- recommendations for long term management of the site (if required) including ongoing site monitoring requirements
- conclusions.

8. Site management issues

8.1 Occupational health and safety

The appointed contractor will be required to prepare an Occupational Health and Safety Plan (OHS Plan) or similar given they will be in control of the site during remediation/validation works.

All work associated with the remediation of the site should conform to the requirements of the Occupational Health and Safety Act (2000) and Occupational Health and Safety Regulation.

Typically the OHS Plan (or similar) should address the following issues:

- regulatory requirements
- responsibilities
- hazard identification and control
- management of asbestos contaminated soils (if encountered)
- OHS monitoring (e.g. air monitoring and action levels during excavation, if necessary)
- manual handling procedures
- personal protective equipment (PPE)
- work zones
- requirement for protection officers for work near railway lines (if necessary)
- material safety data sheets (MSDS)
- decontamination procedures
- emergency response plans
- contingency plans
- incident/accident reporting.

All personnel involved in site works should be familiar with the requirements of the contractors Job Safety Analysis (JSA) or Safe Work Method Statement (SWMS) and have completed a site induction.

8.2 Plant and machinery

It is the responsibility of the remediation contractor to ensure that all plant and machinery used on the site is properly maintained, in good working order and used safely.

8.3 Site security

The site shall be secured (as far as practicable) and appropriate safety/warning signs posted in accordance with the Occupational Health and Safety Act 2000, Occupational Health and Safety Regulation 2001 as well as NSW WorkCover Codes of Practice and Guidelines.

8.4 Contact information

The following contact details are required to be displayed in a prominent location at the site (such as at site entry/exit points and within any site sheds). Should any incidents of concern occur they should be initially reported to the Site Supervisor, who will prepare an incident report for the Project Manager.

Client Representation: TBA

Remediation Contractor: TBA

Environmental Consultant: TBA

8.5 Approvals

With respect to the State Environmental Planning Policy (SEPP) No. 55 – *Remediation of Land*, the remedial works undertaken are considered to be "Category 2 remediation work: work not needing consent" as defined in Clause 14 of SEPP No. 55 for the following reasons:

- the works do not constitute a designated development
- the remediation works are considered to be minor
- the remediation works to occur will have minimal interference to native flora and fauna
- mine subsidence and flood plans should be reviewed prior to commencement of development works.

Clause 16(2)a of SEPP 55 requires that 30 days notice be given to the relevant council before the commencement of Category 2 Remediation work. Clause 17(3) requires that notice be given to Council of completion of work within 30 days.

The actual redevelopment of the site itself, separate from the remediation, may be classified as a Major Project by the Department of Planning in accordance with the Major Projects SEPP & Part 3A of the EP&A Act. The redevelopment works would then require approval from the Minister.

Relevant Lake Macquarie City Council publications include the Lake Macquarie Local Environment Plan (LEP) 2004 and Lake Macquarie Development Control Plan (DCP) 2008. The proposed remediation works comply with the Lake Macquarie DCP. Section 60 of the LEP relates to development on land adjoining Zones 5, 7 (1), 7 (4) and 8 and states:

> Consent must not be granted to development on land adjoining or adjacent to land within Zone 7 (1) unless the consent authority is satisfied that the proposed development is consistent with the effective conservation of the land within Zone 7 (1) and its protection from adverse impacts, including stormwater run-off, erosion and sedimentation, pollution, weed infestation, feral or domestic animals, chemicals, nutrients and the like.

The proposed development should comply with the statements in Section 60 of the LEP.

Appropriate OH&S notifications should be provided by the contractor to NSW WorkCover prior to the commencement of remedial works.

8.6 Community consultation

Community Consultation should be taken into consideration and if required will inform the community of the proposed works, likely impacts and controls. Community consultation may be required at various stages including design, remediation and redevelopment.

8.7 Emergency response procedures

Emergency response procedures are to be presented in the OHS Plan (or similar) prepared by the appointed contractor as they will be in control of the remediation work site. These procedures should cover the required actions and responsibilities should a major accident (for example fire, industrial accident or large scale spill) occurs on or off site.

9. Environmental management

The remediation contractor will be required to prepare an Environmental Management Plan (EMP) or similar, given they will be in control of the site so as to ensure that the on site and off site environment is not adversely impacted by remedial works. The EMP should address and take into consideration the following matters:

9.1 Noise

Increased noise levels may result from the use of mechanical equipment on the site during the course of the project.

To mitigate any noise which may arise as a result of site works, all works should be carried out during standard working hours acceptable to LMCC and in accordance with Part 5.5 of the POEO Act 1997 and the NSW EPA Environmental Noise Control Manual. In addition, all plant and equipment shall be in good operational condition with respect to noise generation.

All practical measures will be taken to minimise generation of noise, and contact information for enquires or complaints will be posted on the site entrance gate.

9.2 Odour and vapour

Due to the nature of the identified contamination, it is unlikely that organic vapours and odours are to be generated during the excavation of contaminated soils. However, if the ambient air concentration of VOCs is greater than 5ppm (as measured by a PID) for a sustained period, work should cease until levels drop. Odour control measures may be required which include:

- fitting workers with appropriate vapour masks or respirators
- application of odour suppressants
- covering of excavated materials by the use of tarpaulin or plastic sheeting.

9.3 Dust and vehicle traffic

During the earthworks, dust will be visually monitored and assessed for excessive generation. If visible dust is being generated, dust levels will be monitored using a high volume sampler and NSW DECC endorsed air quality criteria. Areas of earthworks will be sprayed with water to reduce dust levels. Material to be stockpiled should be covered or wetted down to minimise dust generation.

During transport of material onto the site, trucks will travel by designated routes only and trucks should be clean prior to leaving site to prevent potentially contaminated soil from being transported onto local roads. Truck drivers will be required to cover their loads and site personnel will sweep up any spilt soil/fill material surrounding the truck(s) prior to their departure.

9.4 Equipment and cleaning operations

Throughout the site remediation project, controls will be placed on the operation and movement of equipment. General procedures that will be implemented include the following:

- excavation equipment will be washed in an environmentally sound manner prior to leaving the site
- effective truck wheel-washing facilities will be provided to ensure that contaminated material is not tracked off-site
- no trucks or equipment carrying contaminated materials should be allowed to move across unsealed ground surfaces, except across designated transport corridors.

9.5 Disposal of contaminated soil material

In the event that contaminated soil requires off-site disposal, all contaminated soil/fill material will be sampled at a rate of 1/25m^3. Based on the analytical results, a waste classification will be undertaken, prior to the material being transported by a certified waste contractor to a suitable licensed waste facility. A waste tracking log will be kept of all materials brought to site and taken off site by the environmental scientist supervising the works. This will include waste certificates, tip dockets and imported fill classifications (VENM).

All transport trucks loaded with contaminated material for off-site disposal should be sealed and securely covered to prevent wind blown emissions or spillages and covers should be maintained until unloading. All truck tailgates should be securely fixed prior to loading and immediately after unloading materials and all vehicles are to be operated in a manner so as to prevent loss of materials during loading, transport and unloading activities.

9.6 Water and sediment management

9.6.1 Surface water

Soil stockpiled during excavation works should be suitably contained to prevent run-off of sediment to the surrounding environment. Control measures should be established to prevent surface water run-off entering and leaving stockpile areas. Control measures may include:

- temporary bunding or diversion drains
- silt fences/hay bales to surround stockpiles and excavations
- protection of existing drainage lines with silt fencing/hay bales.

These mitigation measures should be regularly inspected to ensure that they are in good condition and if necessary upgraded where their performance is deteriorating.

No ponded water should be released from site unless it has been sampled, analysed and found not to be contaminated. Any discharges should comply with all regulatory requirements.

9.7 Contingency management

Contingency plans for anticipated problems that may arise on-site during the course of the remediation work are presented in the Table 9-1.

Table 9-1 Contingency management plans

Anticipated Problems	Corrective Actions
Unearthing unexpected materials, fill or waste	Stop activities, contact appropriate team members. Work to remain suspended until further assessment of impacted soils/materials and associated risks. Prepare a management plan to address the issue.
Asbestos Waste Encountered	Work to be suspended and asbestos material removed by a suitably qualified contactor, in accordance with WorkCover regulations.
Changes in proposed land use	Review of remediation works completed for the site.
Excessive Dust	Securely cover loads exiting site, use water sprays to suppress the dust or reduce/stop site activities generating the dust until it abates. If dust is generated from stockpiled areas consider covering with plastic sheeting. Dust monitoring and sampling to be carried out if complaints received or if directed by Council.
Excessive Noise	Identify the source, isolate the source if possible, modify the actions of the source or erect temporary noise barriers if required. Noisy work to be scheduled for middle of day onwards rather than at the start/finish of the day.
Odours/Vapours	If excessive odours/vapours are being generated, stop works and monitor ambient air across site for organic vapours with a PID and odours at site boundaries. Implement control measures.
Excessive rainfall	Ensure sediment and surface water controls are operating correctly. If possible divert surface water away from active work areas or excavations.
Leaking machinery or equipment	Stop the identified leak (if possible). Clean up the spill with absorbent material. Stockpile the impacted material in a secure location, sample and determine the appropriate disposal/treatment option.
Failure of erosion or sedimentation control measures	Regularly inspect control measures during site work activities (especially during periods of rainfall). If failed, stop work and repair any failed control measures immediately.
Uncovering of potential heritage items	Stop activities, contact appropriate team member. Prepare a management plan to address the issue.
Equipment failures	Ensure plant and equipment is inspected daily and before use. Ensure failed equipment can be repaired on site or replaced in a timely manner.
Complaint Management	Notify appropriate teams members following complaint as per management procedures. Implement control measures to address reason of complaint (if possible).

10. RAP conclusions

Based upon the assessment of remedial technologies, the potential risks to human health and the environment, and considering the cost effectiveness of each remedial technique, the preferred remedial strategy for the site is to cap and contain the site. The entire site is to be raised by up to 1.5 m above current levels with imported fill materials. The contaminated areas should be covered by at least one metre of capping layer materials with an impermeable hardstand material at the surface. The base of the imported fill should be marked with a high visibility geotextile marker layer. Current surface levels should be surveyed prior to commencement of site filling to ensure that a one metre capping layer is established.

An ongoing groundwater monitoring program is to be developed in consultation with LMCC to determine trends in groundwater contaminants and to assess for any impacts associated with contaminants in soil.

Based on the proposed remedial works, PB concludes that following establishment of a cap/hardstand, the contamination on the site can be successfully managed to a level suitable for the proposed commercial/industrial land use.

11. References

- Geotechnical and Environmental Site Assessment at Lots 42-43 and 53-54 DP16062, The Weir Road, Teralba (August 2008). PB, 2008 (Ref: PR_0394_RevA).
- Teralba Sanitary Depot Site Investigation. PB report 67P144A/PR_1443 RevC.
- NEPC (1999), the National Environmental Protection Measure for the Assessment of Site Contamination, National Environment Protection Council.
- NSW DEC (2006), Guidelines for the NSW Site Auditor Scheme (2nd Edition), Department of Environment and conservation NSW.
- NSW DECC (2008) Waste Classification Guidelines, Department of Environment and Climate Change.
- NSW EPA (1994), Guidelines for Assessing Service Station Sites, New South Wales Environment Protection Authority.
- NSW EPA (1995), Sampling Design Guidelines, New South Wales Environment Protection Authority.
- NSW EPA (1997), Guidelines for Consultants Reporting on Contaminated Sites, New South Wales Environment Protection Authority.
- New South Wales Environment Protection Authority (NSW EPA 1999). Guidelines for the Assessment, Classification and Management of Liquid and Non-liquid Wastes.
- New South Wales Environment Protection Authority (NSW EPA 1999). Contaminated Sites: Guidelines on Significant Risk of Harm from Contaminated Land and the Duty to Report.
- Department of Urban Affairs and Planning (1998) State Environmental Protection Policy No. 55 (SEPP 55) – Remediation of Land.
- Australian Standard, Guide to the Sampling and Investigation of Potentially Contaminated Soil, AS4482.1, 2005.
- DECC Protection of the Environment (Waste) Regulation 2005 – General Exemption Under Part 6, Clause 51 and 51A: the recovered aggregate exemption 2008; the excavated natural material exemption 2008 and; the recovered fines from construction and demolition waste exemption 2008.

12. Statement of limitations

12.1 Scope of services and reliance of data

This environmental impact study (the study) has been prepared in accordance with the scope of work/services set out in the contract, or as otherwise agreed, between PB and the client. In preparing this environmental impact study, PB has relied upon data, surveys, analyses, designs, plans and other information provided by the client and other individuals and organisations, most of which are referred to in the environmental impact study (the data). Except as otherwise stated in the environmental impact study, PB has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in this environmental impact study (conclusions) are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. PB will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to PB.

12.2 Study for benefit of client

This environmental impact study has been prepared for the exclusive benefit of the client and no other party. PB assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with in this environmental impact study, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in this environmental impact study (including without limitation matters arising from any negligent act or omission of PB or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in this environmental impact study). Other parties should not rely upon the environmental impact study or the accuracy or completeness of any conclusions and should make their own inquiries and obtain independent advice in relation to such matters.

12.3 Other limitations

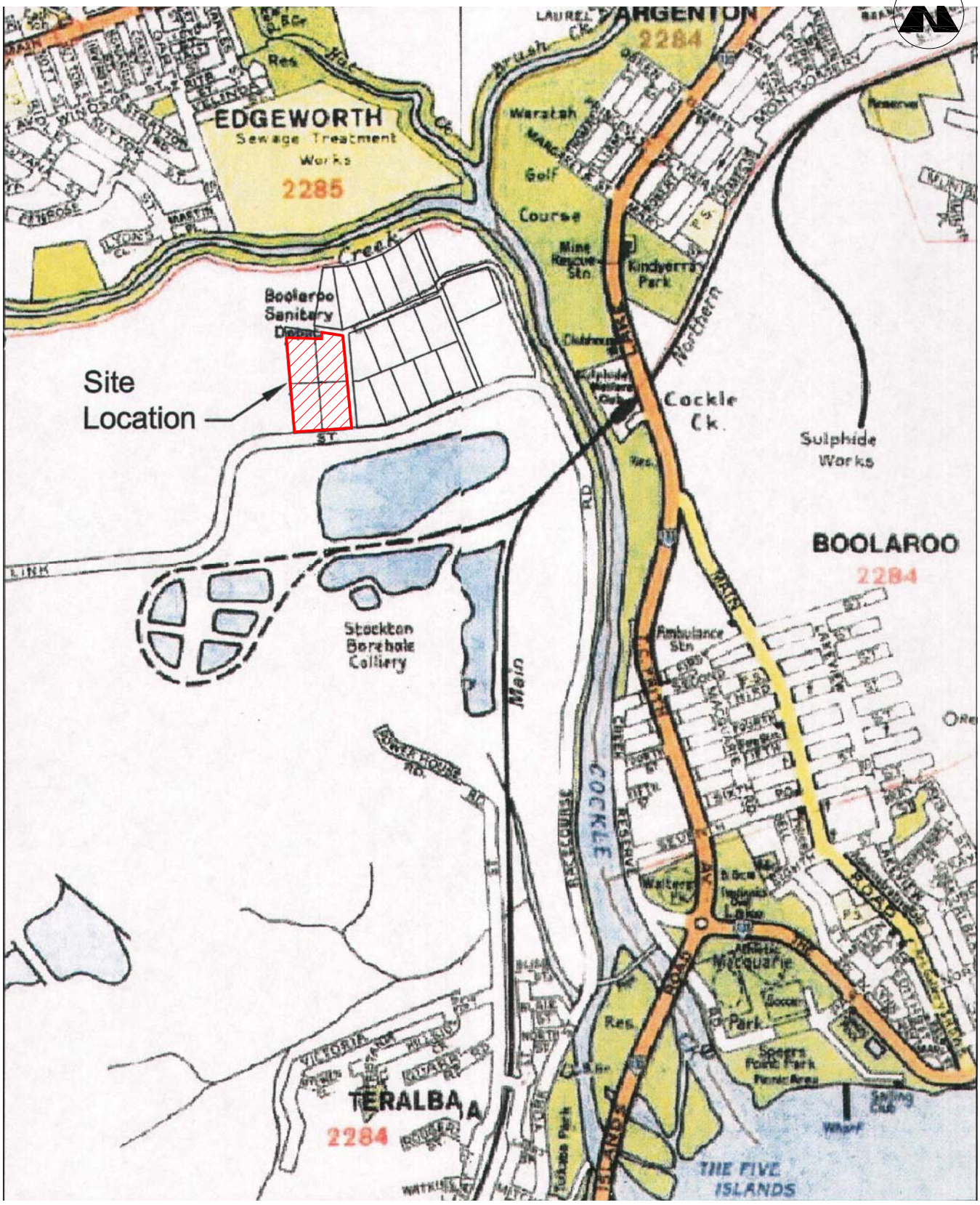
To the best of PB's knowledge, the proposal presented and the facts and matters described in this environmental impact study reasonably represent the client's intentions at the time of printing of the environmental impact study. However, the passage of time, the manifestation of latent conditions or the impact of future events (including a change in applicable law) may have resulted in a variation of the Proposal and of its possible environmental impact.

PB will not be liable to update or revise the environmental impact study to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the environmental impact study.

Figures

Client: LMCC
Project: Proposed Concrete Recycling Facility
Location: The Weir Road
Teralba

PB PARSONS BRINCKERHOFF



Locality Plan
Figure 1

Plot Date: 09/07/08 - 15:59 Cad File: J:\VA237 - HUNYPROJ\2118857A___CLMGEO_LMCC_TEV09_CADD\DRAWINGS\2118857A-GEO-F001.dwg

Client: LMCC
Project: Proposed Concrete Recycling Facility
Location: The Weir Road
Teralba

PB PARSONS BRINCKERHOFF

LEGEND
- APPROX TEST PIT LOCATION (DEPTH TO EXISTING FILL)
- APPROX BORE HOLE LOCATION (DEPTH TO EXISTING FILL)
- APPROX LOCATION OF PREVIOUS TEST LOCATIONS (PB REPORT 67P144\PR_1444)
- APPROX DRAINAGE LINE
- APPROX EXISTING CULVERT
- APPROX LOCATION OF EXISTING ACCESS TRACK
- APPROX EXTENT OF FILL
- APPROX LOCATION OF CONSTRUCTION WASTE STOCKPILE

THE WEIR ROAD

55 54 53 41 42 43

5m BUNDING AROUND PERIMETER 1.5m HIGH

PROPOSED WATER STORAGE PONDS PENDING GEOTECHNICAL AND HYDROLOGICAL STUDIES

WATER STORAGE POND

WATER STORAGE POND

PRODUCT STORAGE BINS

NO GO AREA

ACCESS TO PUBLIC PICKUP AREA

PUBLIC PICKUP AREA

ELECTRICITY

ELECTRICITY

END PRODUCT STOCKPILES

(EXCESS STORMWATER RETENTION)

APPROXIMATE LOCATION OF CONSTRUCTION WASTE STOCKPILE

D.P. 16062

D.P. 16062

CRUSHER SCREENERS PUGMIL

OFFICE CAR PARK

GATEHOUSE AND TWO-WAY WEIGHBRIDGE

SITE OFFICE

BULK HAULAGE

ACCESS

NO GO AREA

PLANT STORAGE

EASEMENT

EASEMENT

FEEDSTOCK CONCRETE STOCKPILES

FEED STOCKPILES

TANKS

ELECTRICITY TOWER

CULVERT?

CULVERT ~300mm CONCRETE PIPE

CULVERT?

TP14 (0.7m)
TP10 (1.2m)
TP15 (1.8m)
TP16 (>2.9m)
TP16A TP16B TP16C TP16D
TP13 (0.7m)
TP9 (1.2m)
TP11 (1.0m)
TP11A TP11B TP11C TP11D
TP7 (2.6m)
TP8 (1.8m)
TP17 (>2.8m)
TP12 (0.9m)
BH1 (1.1m)
BH2 (1.8m)
TP20 (0.6m)
TP19 (0.8m)
TP19A TP19B TP19C TP19D
TP6 (0.6m)
BH3 (0.7m)
TP18 (0.8m)
TP1 (0.7m)
TP2 (0.5m)
TP3 (0.6m)
TP5 (0.6m)
TP4 (1.3m)

A1 A2 A3 A4 A5 A6 A7 A8 A9 A10 A11 A12 A13 A14 A15 A16 A17 A18 A19 A20

5° 5-10° 0-5°

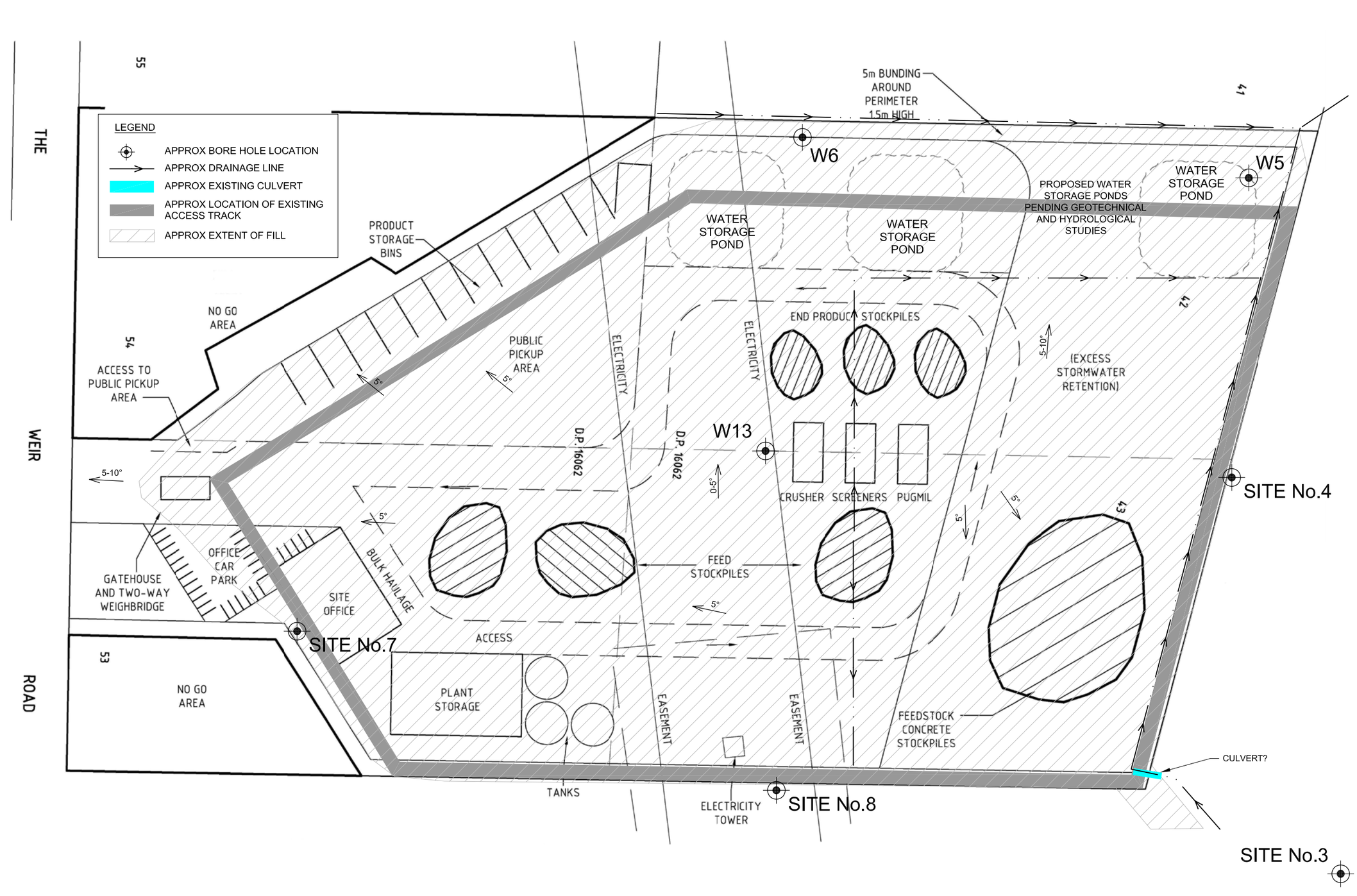
0 25 50 m
Scale 1: 1000

Borehole and Testpit Location Plan

Figure 2

Client: LMCC
Project: Proposed Concrete Recycling Facility
Location: The Weir Road
Teralba

PB PARSONS BRINCKERHOFF



Site Well Location Plan

Figure 3

Client: LMCC
Project: Proposed Concrete Recycling Facility
Location: The Weir Road
Teralba

PB PARSONS BRINCKERHOFF

TP11	ARSENIC	COPPER	LEAD	MANGANESE	ZINC
0.0-0.1	2450	6040	5110	16300	65200
0.5-0.6	299	1470	1730	6130	24300
1.0-1.1	2	42	4	43	93
(ALL RESULTS IN mg/kg)					

LEGEND
- APPROX TEST PIT LOCATION
- APPROX BORE HOLE LOCATION
- APPROX LOCATION OF PREVIOUS TEST LOCATIONS (PB REPORT 67P144\PR_1444)
- APPROX DRAINAGE LINE
- APPROX EXISTING CULVERT
- APPROX LOCATION OF EXISTING ACCESS TRACK
- APPROX EXTENT OF FILL

THE WEIR ROAD

55 54 53 41 42 43

TP14 TP10 TP15 TP16 TP11 TP9 TP13 TP7 TP17 TP20 TP12 TP8 TP6 TP19 TP1 TP2 TP3 TP5 TP4 TP18

A1 A2 A3 A4 A5 A6 A7 A8 A9 A10 A11 A12 A13 A14 A15 A16 A17 A18 A19 A20

BH1 BH2 BH3

PROPOSED WATER STORAGE PONDS PENDING GEOTECHNICAL AND HYDROLOGICAL STUDIES

WATER STORAGE POND

WATER STORAGE POND

WATER STORAGE POND

CULVERT? CULVERT ~300mm CONCRETE PIPE CULVERT?

PRODUCT STORAGE BINS

NO GO AREA

NO GO AREA

ACCESS TO PUBLIC PICKUP AREA

PUBLIC PICKUP AREA

ELECTRICITY ELECTRICITY

END PRODUCT STOCKPILES

(EXCESS STORMWATER RETENTION)

D.P. 16062 D.P. 16062

CRUSHER SCREENERS PUGMIL

FEED STOCKPILES

BULK HAULAGE

OFFICE CAR PARK

GATEHOUSE AND TWO-WAY WEIGHBRIDGE

SITE OFFICE

ACCESS

PLANT STORAGE

EASEMENT EASEMENT

FEEDSTOCK CONCRETE STOCKPILES

TANKS

ELECTRICITY TOWER

5° 5-10° 0-5°

TP19	ARSENIC	LEAD	MANGANESE	ZINC
0.0-0.1	2910	4240	14600	63900
(ALL RESTULTS IN mg/kg)				

Soil Contamination Plan

Figure 4

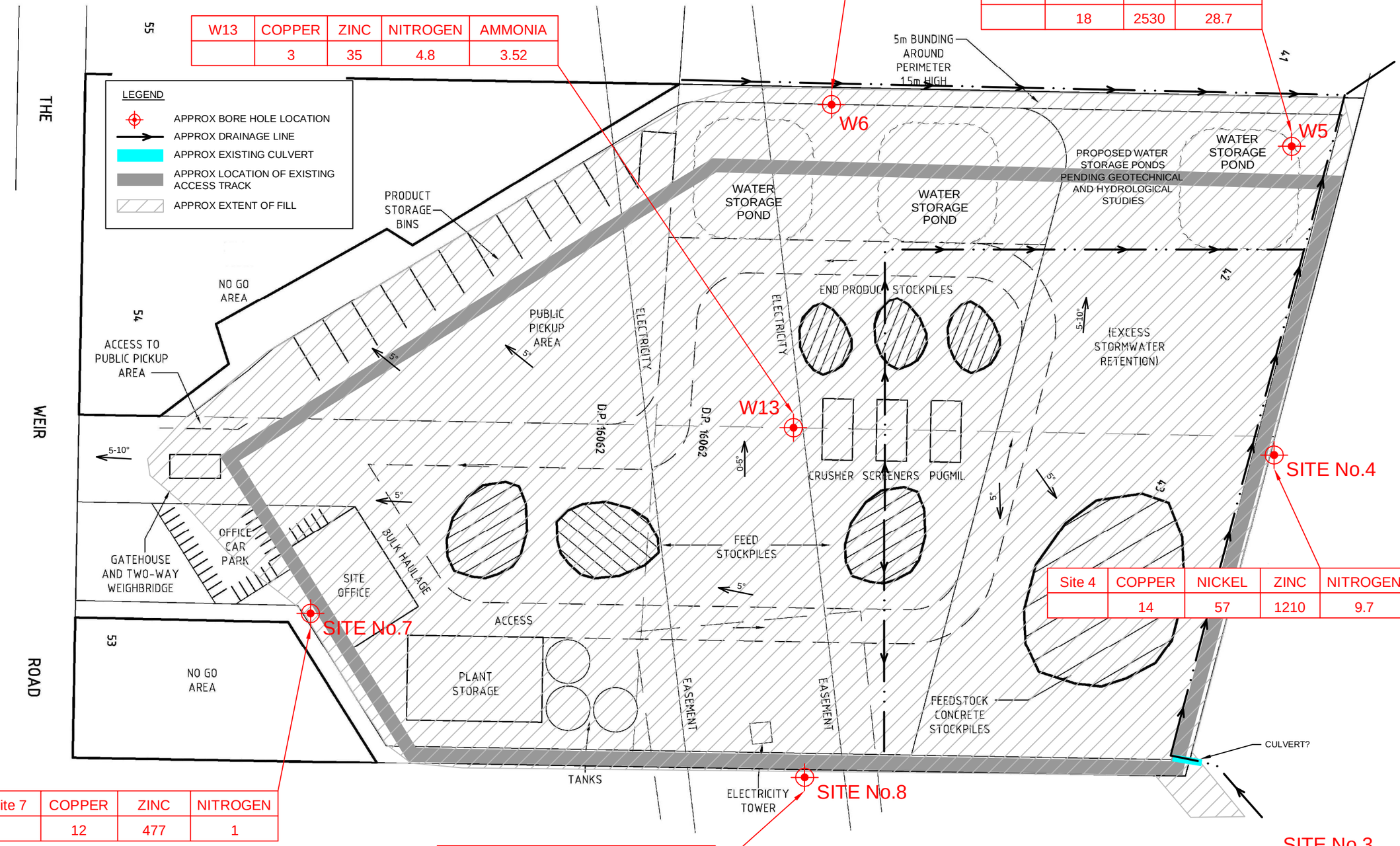
Client: LMCC
Project: Proposed Concrete Recycling Facility
Location: The Weir Road
Teralba

PB PARSONS BRINCKERHOFF

W6	MANGANESE	ZINC	NITROGEN	AMMONIA
	3870	32	132	134

W5	COPPER	ZINC	NITROGEN
	18	2530	28.7

W13	COPPER	ZINC	NITROGEN	AMMONIA
	3	35	4.8	3.52



SITE No.4

Site 4	COPPER	NICKEL	ZINC	NITROGEN	AMMONIA
	14	57	1210	9.7	3.86

SITE No.7

Site 7	COPPER	ZINC	NITROGEN
	12	477	1

SITE No.8

Site 8	COPPER	ZINC	NITROGEN
	8	90	2.3

SITE No.3

Site 3	COPPER	ZINC	NITROGEN	AMMONIA
	10	47	12.7	5.35

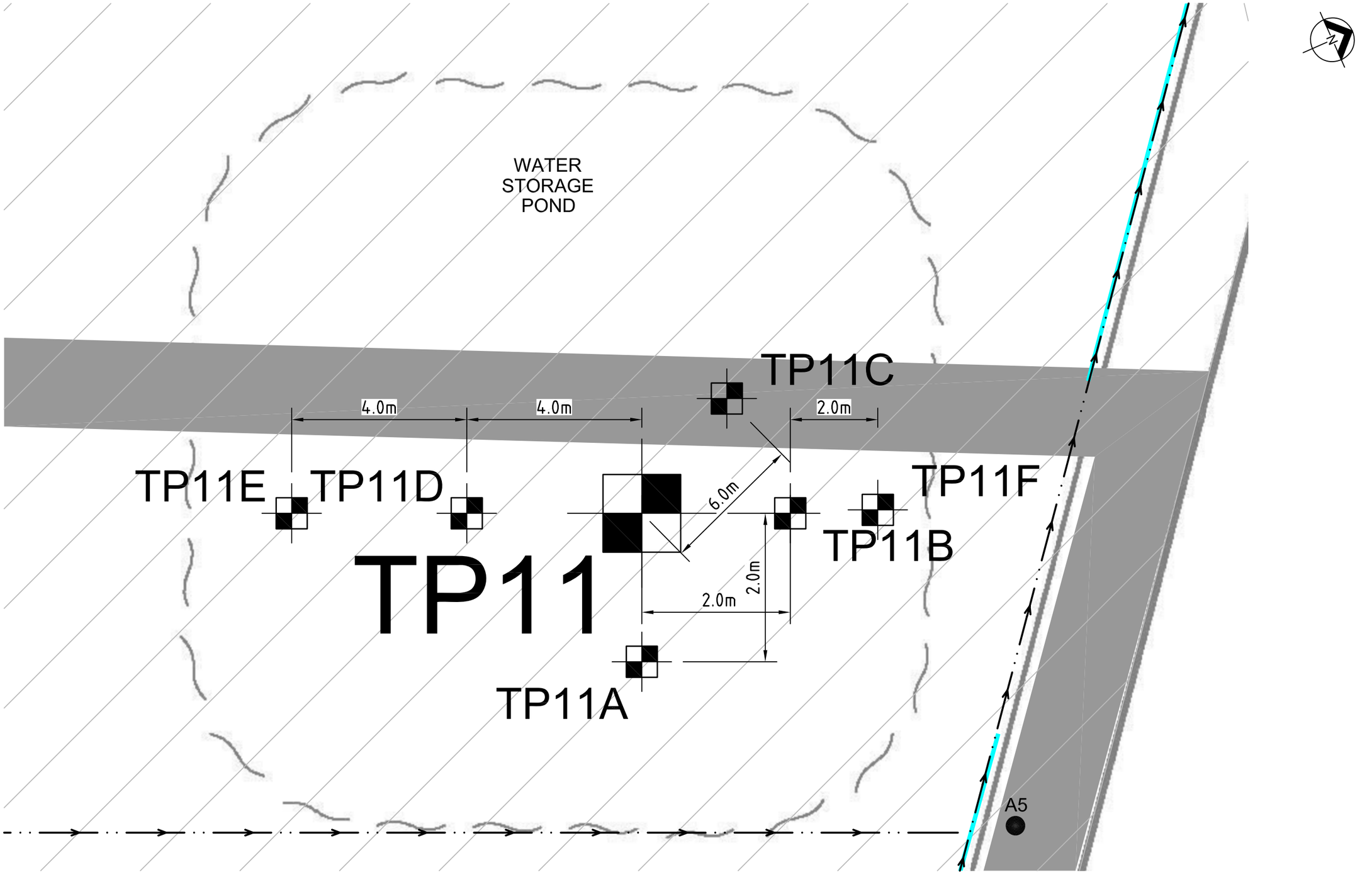
Groundwater Contamination Plan

Figure 5

Plot Date: 10/11/08 - 12:25 Cad File: J:\A237 - HUNTPROJ\21188857A___CLMGEO_LMCC_TEK09_CADD\DRAWINGS\21188857A-GE0-F005.dwg

Client: LMCC
Project: Proposed Concrete Recycling Facility
Location: The Weir Road
Teralba

PB PARSONS BRINCKERHOFF

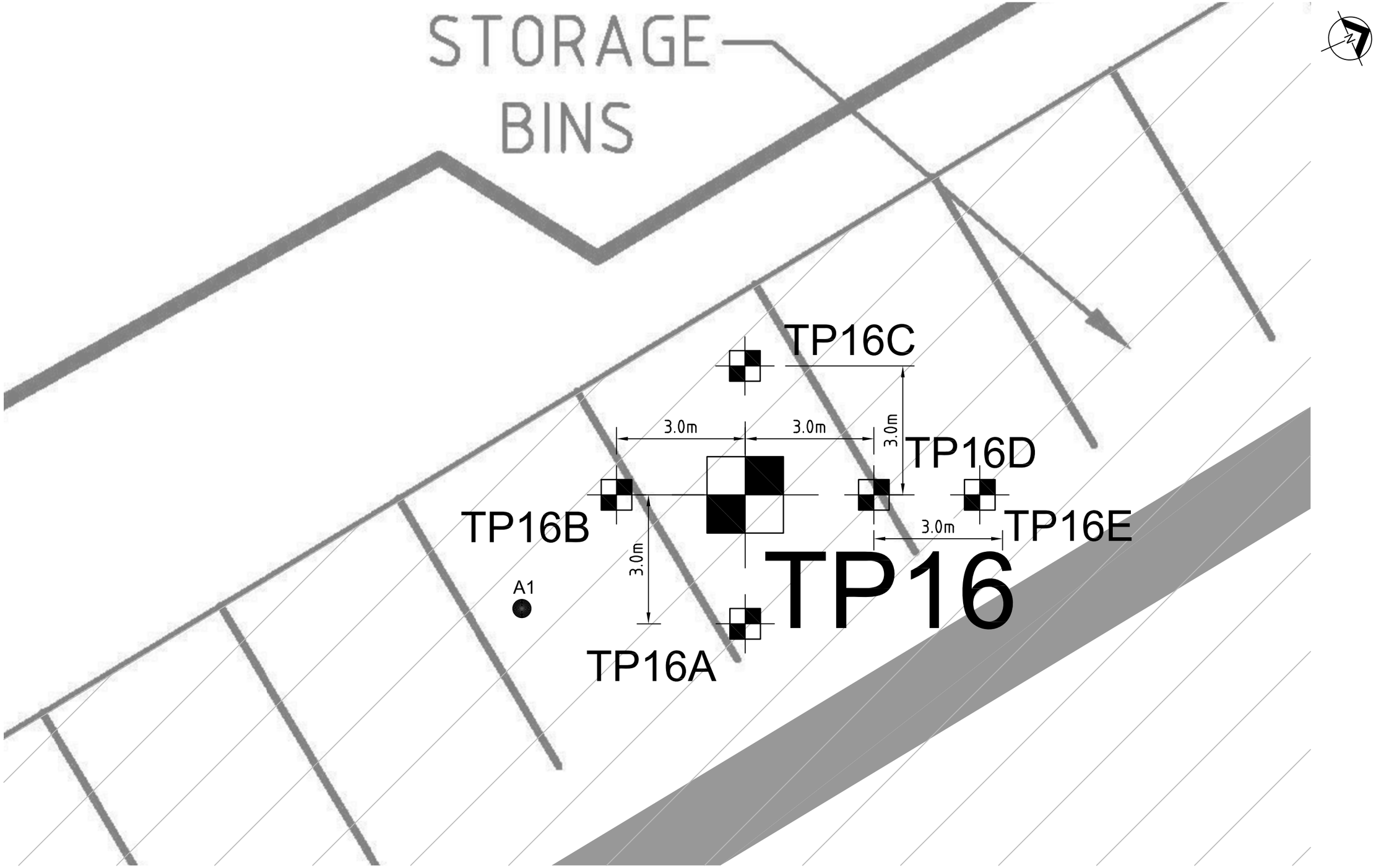


Delineation Sampling - TP 11 (Heavy Metals)

Figure 6

Client: LMCC
Project: Proposed Concrete Recycling Facility
Location: The Weir Road
Teralba

PARSONS BRINCKERHOFF

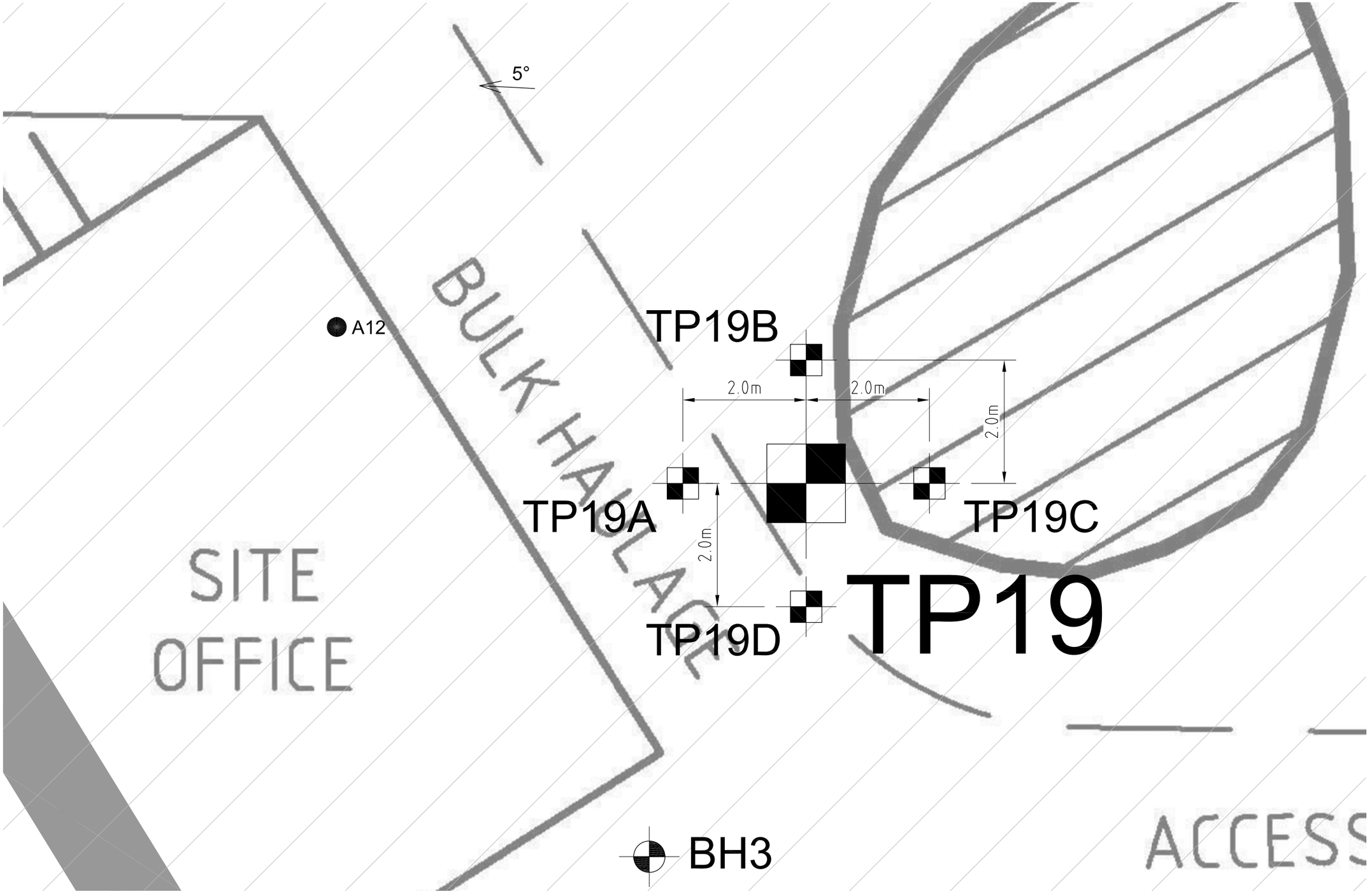


Delineation Sampling - TP 16 (TPH C10-C36)

Figure 7

Client: LMCC
Project: Proposed Concrete Recycling Facility
Location: The Weir Road
Teralba

PB PARSONS BRINCKERHOFF

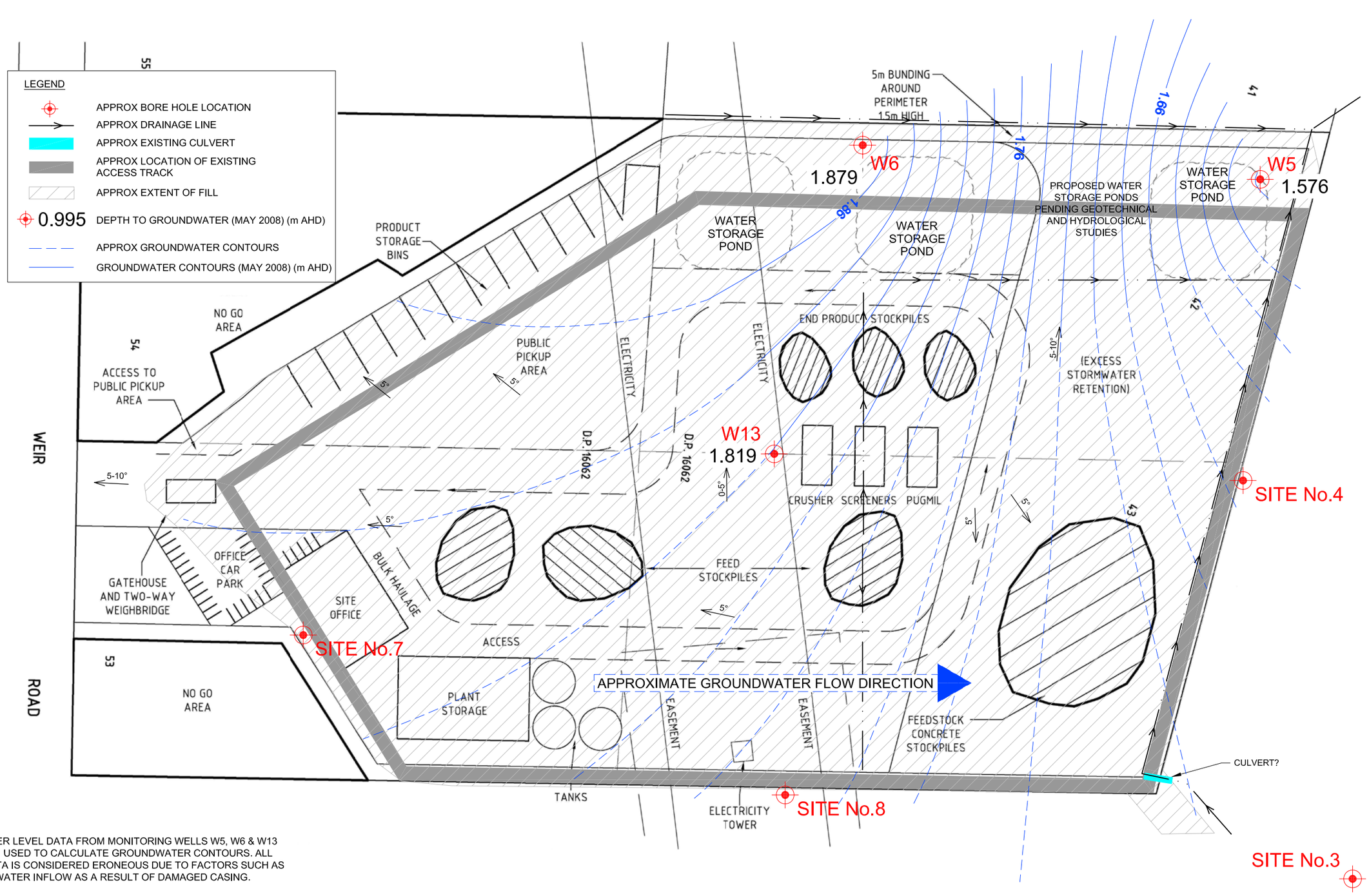


Delineation Sampling - TP 19 (Heavy Metals)

Figure 8

Client: LMCC
Project: Proposed Concrete Recycling Facility
Location: The Weir Road
Teralba

PB PARSONS BRINCKERHOFF



N.B.
ONLY WATER LEVEL DATA FROM MONITORING WELLS W5, W6 & W13 HAVE BEEN USED TO CALCULATE GROUNDWATER CONTOURS. ALL OTHER DATA IS CONSIDERED ERONEOUS DUE TO FACTORS SUCH AS SURFACE WATER INFLOW AS A RESULT OF DAMAGED CASING.

Approximate Groundwater Contours

Figure 9

Client: LMCC
Project: Proposed Concrete Recycling Facility
Location: The Weir Road
Teralba

0 50 100 150 m
Scale

PARSONS BRINCKERHOFF

LEGEND

- Previous Sludge Disposal Area (Area A)
- Previous Pan Disposal Area (Area B)
- Area C
- Existing SEPP 14 Wetland
- Existing Vegetated Areas

Site Plan

Figure 10

Plot Date: 25/08/08 - 16:37 Cad File: J:\A237 - HUN\PROJ\2118857A___CLMGEO_LMCC_TE\09_CADD\DRAWINGS\2118857A-GEO-F010.dwg