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Report for Marsden Park
Industrial Precinct
Phase 2 Contamination
Assessment

May 2009



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List of Abbreviations

A list of some common abbreviations used in this report is provided below.

- » ASS – Acid Sulphate Soils
- » BTEX – Benzene, Toluene, Ethyl-benzene and Xylenes
- » DECC – NSW Department of Environment and Climate Change
- » DLWC – Department of Land and Water Conservation
- » EPA – NSW Environment Protection Authority (now incorporated into the DECC)
- » GCC – Growth Centre Commission
- » GDA – Geometric Datum of Australia
- » GWMA – Groundwater Management Area
- » LEP – Local Environment Plan
- » LGA – Local Government Area
- » mAHD – metres Australian Height Datum
- » mBGL – metres below ground level
- » MGA – Map Grid Australia
- » MPIP – Marsden Park Industrial Precinct
- » OCP – Organochlorine Pesticides
- » OPP – Organophosphorous Pesticides
- » PAH – Polycyclic Aromatic Hydrocarbons
- » PCB – Polychlorinated Biphenyls
- » POEO – Protection of the Environment Operations
- » PQL – Practical Quantitation Limit
- » RTA – Roads and Traffic Authority
- » SWL – Standing Water Level
- » TPH – Total Petroleum Hydrocarbon



Executive Summary

Introduction

GHD Pty Ltd (GHD) was commissioned to undertake a Phase 1 and Phase 2 Contamination Assessment at a large area of land off Richmond Road, Marsden Park, NSW. The area, hereafter referred to as the Site, includes the Marsden Park Industrial Precinct (MPIP), which is part of the North West Growth Centre (see **Figure 1, Appendix A**). The Site is earmarked for re-zoning and re-development as industrial/employment land, likely with small areas of public open space and residential land.

A Phase 1 (preliminary) contamination assessment was prepared for the Site by GHD in September 2008. The Phase 1 report contains the results of a preliminary risk ranking exercise for the various parts of the Site, illustrated on a constraints plan and a Sampling Analysis and Quality Plan (SAQP) for the intrusive (Phase 2) investigations.

The preliminary risk ranking exercise identified a number of areas with specific land uses with a potential to generate contamination. Further Phase 2 (intrusive) investigations were recommended in those areas.

Objectives

The objectives of the Phase 2 assessment were to:

- » Define (to the extent practical within the scope of the Phase 2 study) the potential for widespread, gross contamination, including likelihood for off-site migration;
- » Carry out an assessment of the risk posed by any contaminants to the environment and human health; and
- » Assess whether the site appears suitable, from a contamination perspective, (or will be suitable after remediation) for the proposed use.

The results of the Phase 2 investigations were used to update the preliminary risk ranking exercise and constraints plan produced as part of the Phase 1 report.

Scope of Works

The scope of work completed by GHD included the following:

- » Intrusive site investigations in key areas of the Site highlighted in the Phase 1 assessment as having an appreciable potential to be affected by soil and/or groundwater contamination;
- » Collation, analysis and assessment of sampling results and preparation of a Phase 2 contamination assessment report; and
- » Updating the constraints plan for the various parts of the Site to reflect the results of the Phase 2 (intrusive) investigations.



Summary of Sampling Results

GHD's Phase 1 Investigations identified a number of areas that have been subject to potentially contaminative activities.

Phase 2 Investigations have not identified any "gross" widespread contamination that would inhibit the suitability (from a contamination perspective) of the Site for redevelopment, however some contamination was reported on various lots, which will require supplementary assessment, and potentially remedial work. Supplementary investigations are recommended across some other parts of the Site, where the data obtained to date is not considered to provide a comprehensive enough data set upon which to certify the suitability (from a contamination perspective) of those areas for rezoning and redevelopment.

The Marsden Park Landfill was specifically excluded from the Phase 2 study, as it has been (and continues to be) the subject of contamination assessment work by others.

Several areas of the Site were not accessible to GHD and as such, could not be subject to inspection or intrusive (Phase 2) sampling and analytical works.

Further assessment would therefore be required across discrete parts of the Site, prior to redevelopment. Recommendations for further assessment are included in **Table 11** (page 54).

The Updated Risk Ranking scores are illustrated on the Final Contamination Risk Ranking Diagram, presented as **Figure 6, Appendix A**.

Conclusions and Recommendations

The intrusive investigations undertaken by GHD have not identified the presence of any gross, widespread contamination that would otherwise render the investigated areas unsuitable for rezoning and redevelopment.

Nonetheless, some contamination was reported on various lots, which will require supplementary assessment, and potentially remedial work.

Specific areas considered to warrant further (more detailed) assessment (and/or remedial action) include, but may not be limited to:

- » The Marsden Park Landfill and adjacent areas (particularly following closure and capping of the Landfill);
- » The former Council Sanitary Depot (Lots 11&12, DP262886) will require remediation as discussed in previous investigations by URS;
- » The Steggles Chicken Factory (Lot 1, DP747184) and adjacent areas;
- » The Piggery (Lot 31, DP262886) and adjacent areas;
- » The Bells Creek Nursery (Lot 7, DP17048);
- » The machining shop on Lot 21, DP262886;
- » The scrap yard on Lot 4, DP 27536;
- » The Earth Exchange / Blacktown Landscape Supplies (Lot 1 & 2, DP 27536);



- » The RTA owned land in the south east of the Site (Lot 41, DP1100854); and
- » Lots 1 to 7 and 9, 11 and 12, DP193074 and Lots 1, 2 and 3, DP 17048 (none of which could be accessed during the current study).

Potential asbestos containing material was visually spotted atop the surface in some areas. On this basis, it is recommended that a program of confirmatory near-surface soil testing (for asbestos) is carried out on the following areas:

- » Lots 33-38, DP262886 (current agricultural land), potential asbestos containing material was spotted on Lot 38; and
- » Lots 21 and 22, DP584915 (in the vicinity of former buildings, where some scattered potential asbestos containing material was observed).

Indicative Layout Plan

Other than the landfill cells and former Council Sanitary Depot, GHD is not aware of any identified contamination issues which would pose a major constraint to the proposed indicative layout plan. Additional site investigations would however be required in those areas outlined as warranting further assessment and in areas not previously assessed, in particular in areas identified for sensitive end uses (i.e. residential).



1. Introduction and Objectives

1.1 Introduction

GHD Pty Ltd (GHD) was commissioned to undertake a Phase 1 and Phase 2 Contamination Assessment at a large area of land off Richmond Road, Marsden Park, NSW. The area, hereafter referred to as the Site, includes the Marsden Park Industrial Precinct (MPIP), which is part of the North West Growth Centre (see **Figure 1, Appendix A**). The Site is earmarked for re-zoning and re-development as industrial/employment land, likely with small areas of public open space and residential land.

A Phase 1 (preliminary) contamination assessment was prepared for the Site by GHD in September 2008 (GHD ref. 2117717/142931). The Phase 1 report contains the results of a risk ranking exercise for the various parts of the Site, illustrated on a constraints plan and a Sampling Analysis and Quality Plan (SAQP). The Phase 1 report should be read in conjunction with this report.

1.2 Objectives

The objectives of the Phase 2 Contamination Assessment were as follows:

- » Define (to the extent practical within the scope of the Phase 2 study) the potential for widespread, gross contamination, including likelihood for off-site migration;
- » Carry out an assessment of the risk posed by any contaminants to the environment and human health; and
- » Assess whether the site appears suitable, from a contamination perspective, (or will be suitable after remediation) for the proposed use.

The results of the Phase 2 investigations were used to update the preliminary risk ranking exercise and constraints plan produced as part of the Phase 1 report.

1.3 Scope of Work

GHD's scope of work for the Phase 2 investigations, to meet the stated objectives was as follows:

- » Intrusive site investigations in key areas of the Site highlighted in the Phase 1 assessment as having an appreciable potential to be affected by soil and/or groundwater contamination (see **Figures 2 and 3, Appendix A**). Investigations comprised the following:
 - Drilling of ten boreholes using a truck mounted drill rig equipped with solid flight augers;
 - Excavation of 35 test pits using a mechanical excavator;
 - Drilling of 19 shallow boreholes using a hand auger;
 - Collection of soil samples from each sample location (boreholes and test pits) at surface, 0.5m, 1m and at 1m intervals there-on;



- Installation of seven groundwater wells in the deeper (mechanically drilled) boreholes;
 - Collection of one groundwater sample per well;
 - Collection of five surface water samples from selected dams on the Site;
 - Analysis of selected soil and water samples for a range of potential contaminants; and
 - Implementation of a quality assurance/quality control programme through collection and analysis of blind and split duplicate samples.
- » Collation, analysis and assessment of sampling results and preparation of a Phase 2 contamination assessment report;
 - » Updating the constraints plan for the various parts of the Site to reflect the results of the Phase 2 (intrusive) investigations; and
 - » Commenting on the indicative layout plan for the Site.



2. Summary of Phase 1 Information

2.1 Introduction

A Phase 1 desk based assessment was carried out for the Site, this included the following:

- » A site inspection;
- » A desktop review of the local hydrology, soils, topography, geology and hydrogeology;
- » An inspection of historic aerial photographs for the Site;
- » An inspection of registers maintained by the NSW Department of Environment and Climate Change (DECC) under the *Contaminated Land Management Act* and the *Protection of the Environment Operations Act* (POEO); and
- » A review of previous site investigation reports prepared for parts of the Site.

A summary of the main findings from the Phase 1 assessment follows.

2.2 Site Location

The Site is located off Richmond Road, Marsden Park, NSW, approximately 500m north west of the M7 Westlink freeway. The Site forms part of the North West Growth Centre and is proposed to be re-zoned and re-developed. The majority of the Site will be re-developed as industrial/employment land, with a strip of mixed use development along Richmond Road. The strip of land along the northern boundary of the Site is being considered as residential land.

The Site boundary includes the area defined by the Growth Centre Commission (GCC) as Marsden Park Industrial Precinct (MPIP) and land to the north of the Precinct, off South Street. The boundary of the MPIP may be enlarged to incorporate the area adjacent South Street. **Figure 1, Appendix A** shows the Site location, the Site boundary and the MPIP boundary.

The Site is approximately 570 hectares and comprises 65 separate plots of land. The majority of the Site is under one ownership; Ganian Pty Ltd. The remainder of the Site is owned by private landowners, including the Town and Country Caravan Park, Valad Property Group, the Ahmadiyya Muslim Association of Australia, Winten Property Group, the RTA and small businesses along Richmond Road.

For ease of reporting in the Phase 1 assessment, the Site was split into Sections A to J, determined on the basis of known land-uses and location. The layout of the Sections is shown in **Figure 2, Appendix A**.

2.3 Geology

The 1:250 000 Sydney Geological Series Sheet S1 56-5 3rd Ed 1966 indicates the majority of the Site to be underlain by shales with some sandstone beds of the



Bringelly Shales of the Liverpool Sub Group of the Wianamatta Group of the Triassic period.

The area of the site adjacent Bells Creek (Section I) is underlain by alluvium, gravel, sand, silt and clay of Quaternary Age.

The far south east corner of the Site, the area owned by the RTA, (Section J) is underlain by sand, silt, clay and gravel of Tertiary Age.

In the centre of the Site in the approximate area of Section A, there is a small area of Post Triassic igneous intrusion, recorded on the geological sheet as basalt, dolerite, volcanic breccia etc. Basalt and volcanic breccia were extracted from a former quarry in this area.

2.4 Hydrogeology

The 1:2 000 000 Department of Water Resources Groundwater in NSW, Assessment of Pollution Risk map indicates that the Site is likely to be underlain by shales and that the potential for groundwater movement is likely to be low.

Groundwater salinity is mapped $>14\ 000\text{mg/l}$ and therefore unsuitable for stock use.

The direction of the regional groundwater flow is expected to follow the slight slope of the regional topography, towards the north and west.

A search of Department of Infrastructure Planning and Natural Resources (DIPNR) records identified seven existing borehole wells located within an approximate distance of 1 kilometre from the Site. The groundwater wells are all located to the north of the Site in the general location of the closed Grange Avenue landfill site to the north.

The wells are all in private ownership and were installed as monitoring bores; it is assumed that the bores were installed to monitor the closed landfill site.

2.5 Hydrology

In total there were 34 water bodies on the Site, as confirmed by the site inspection. Generally these were man made dams.

A number of creeks were also present on or in close proximity to the Site.

Bells Creek ran south to north along the eastern boundary of the Site. An un-named tributary of Bells Creek crossed the south east corner of the Site (Section H). An un-named creek ran north west from the south west corner of the Site (Section E).

Off-site, Eastern Creek ran south to north approximately 1.5km to the east of the Site and South (also referred to as Wianamatta) Creek ran south to north east approximately 4km to the west of the Site.

2.6 Soils and Landscape

The Soil Conservation Service of NSW, Soil Landscape Series, Sheet 9030 Penrith classified the majority of the Site's soils as Residual of the Blacktown Soil Landscape Group.



The western part of the Site and the area lining Bells Creek (Section I) is underlain by Fluvial soils of the Berkshire Park Soil Landscape Group.

2.7 Acid Sulphate Soils

The Department for Infrastructure, Planning and Natural Resources (DIPNR) Acid Sulphate Soils Risk Mapping (1997) indicates that the Site is not expected to be underlain by acid sulphate soils.

2.8 Potential Contaminant Sources

Some specific land uses with a potential to generate contamination were highlighted by the aerial photograph review and site inspection. These are detailed in **Sections 2.8.1 to 2.8.7** below. The location of each of these 'areas of interest' is depicted on **Figure 4, Appendix A**.

2.8.1 Marsden Park Landfill and Quarry

A former basalt quarry, now a clay and shale quarry and an active landfill site, were present in the centre of the Site (Lot 47 of DP 262886 and Lot 292 of DP 1076555), run by Blacktown Waste Services. Landfilling activities were covered by a POEO license.

Two reports for the landfill site were made available to GHD:

- » Enviro-Managers Pty Ltd, May 1998, Environmental Impact Statement for a proposed Extractive Industry and Landfill at Marsden Park, NSW, for Ganian Pty Ltd (Enviro-Managers, 1998); and
- » Consulting Earth Scientists, February 2008, Annual Environmental Monitoring Report 2007, Marsden Park Landfill, Richmond Road, Marsden Park, for Blacktown Waste Services (CES 2008).

It is apparent from the reports that groundwater in the vicinity of the landfill site was generally of poor quality due to high salinity but apparently not significantly affected by the landfill site. Methane was being produced by the waste, but at the time of the monitoring this did not appear to be migrating to external gas monitoring wells. External gas monitoring wells did however record elevated level of carbon dioxide and associated depleted oxygen up to 100m from the edge of the tipped waste (CES 2008).

2.8.2 Steggle's Chicken Factory

Steggles Chicken processing factory (formerly also an abattoir) was present in the north east of the Site (Lot 1 of DP 747184). Animal product production was covered by a POEO license. The site inspection highlighted the waste water treatment process and infrastructure associated with an underground storage tank (UST) as particular areas of concern.



2.8.3 Former Sanitary Depot

A former Council Sanitary Depot, used for the deposit of nightsoil (night soil is untreated waste material removed from septic tanks and directly from houses which lack sewage infrastructure), was present in the north east of the Site (Lot 11 and 12 of DP262886). The aerial photograph review indicated that the site had been used for disposal activities since approximately 1961. A number of reports relating to the Sanitary Depot were made available to GHD:

- » URS, August 2002, *Review of ESA Report – Sanitary Depot, Marsden Park*, for Blacktown City Council (URS 2002);
- » URS, August 2004, *Environmental Site Assessment – Former Marsden Park Sanitary Depot*, for Blacktown City Council (URS 2004);
- » URS, February 2005, *Phase 3 Environmental Site Assessment – Former Marsden Park Sanitary Depot*, for Blacktown City Council (URS 2005); and
- » Letter report regarding remediation options from URS to Blacktown City Council, February 2005 (URS letter 2005).

It is apparent from the reports that the former sanitary depot is contaminated with elevated levels of heavy metals, Total Petroleum Hydrocarbons (TPH) and Polycyclic Aromatic Hydrocarbons (PAH). Waste materials including nightsoil pans, plastic, glass, metal and rags were also present. In one area of the former depot, a number of 200L drums containing industrial waste had been buried. With respect to remedial options, URS concluded that the area would require remediation, the level of remediation being dependant on the proposed end use of the area.

2.8.4 Possible Further Nightsoil Area

An area believed to have been used for the disposal of nightsoil was present in the south west of the Site adjacent to the current landfill (Lot 26 of DP262886). Anecdotal information provided by Mr. E. Mundy, Blacktown Waste Services Operations Manager indicated that overburden material from the former quarry was deposited in the area (Blacktown Waste Services refer to this area as the 'paddock'). During the tipping of the overburden, some nightsoil pans were noted across the area.

2.8.5 Piggery

A piggery was present in the north west of the Site (Lot 31 of DP262886). Waste water from the main shed was piped to the various dams on the Site.

2.8.6 Commercial Properties along Richmond Road

Various commercial properties were present along Richmond Road including Bells Creek Nursery on Lot 7 of DP17048 (where truck maintenance activities were carried out), a possible Scrap Yard on Lot 4 of DP 27536, two landscaping supply yards on Lots 1 and 2 of DP 27536 (one of the landscaping yards was formerly licensed under the *POEO Act* for waste transport) and a paintballing site on Lot 1 of DP88530.



2.8.7 RTA owned land

The south east corner of the Site (Lot 41 of DP 1100854) was owned by the RTA and anecdotal information suggested that truck maintenance, storage and re-fuelling may have occurred in the area during construction of the adjacent M7 road. The site inspection revealed an area of unauthorized waste tipping close to the north east boundary of this part of the Site.

The locations of the above sites of interest are shown **Figure 4** in **Appendix A**.

2.9 Summary of Risk Ranking Exercise

Given the size of the Site, a method of prioritising areas of the Site or specific Lots was required to assist in identifying areas where contamination may potentially pose a significant constraint to further development. Sites were categorised between (1) and (4), with (1) representative of a 'low risk of significant potential contamination' and (4) being 'high risk of significant potential contamination'.

Potential contamination sources were assessed using a variety of factors, which included the following:

- » Potential source of the contamination;
- » The nature of the potential or known contamination, (e.g. heavy metal contamination from nightsoil disposal);
- » The toxicity of the potential contaminants, (high, moderate and low); and
- » The magnitude of the contamination, for example, one site may have a very high potential to have caused toxic contamination, the extent of which is likely to be limited and as such, may be less likely to impact any proposed development. The media in which the contamination potentially may occur is also considered in this section: soil, groundwater, gas and sediment. The potential magnitude is assessed as: localised, moderate or widespread.

The results of the preliminary risk ranking (i.e., based on the Phase 1 outcomes) are provided in **Table 1** and are shown on **Figure 3, Appendix A**.

It should be noted that an updated risk ranking has been carried out based on the results of the intrusive (Phase 2) investigations. This is contained in **Table 9, Section 5**.



Table 1 Risk Ranking of Potential Constraints (From Phase 1 Assessment)

Section Reference	Lot and DP number/area of Site	Potential Source of Contamination	Nature of potential/known contamination	Toxicity of potential/known contaminants High/moderate/low	Potential magnitude of impacts Soil/ sediment/ gas/ surface water/ groundwater Localised/ moderate/ widespread	Overall Ranking Highly likely (4), Likely (3), Potential (2), Unlikely (1)	Comments
A	Part of Lot 47 of DP 262886 and Lot 292 of DP 1076555 - Marsden Park Landfill site	Landfilled waste (in particular, three landfill cells)	TPH, PAH, VOCs, SVOCs, metals and asbestos in landfilled waste materials. TPH, PAH, VOCs, SVOCs, metals, ammonia, BOD, COD, excess nutrients in leachate. Methane, carbon dioxide and trace constituents in soil gas. TPH, BTEX, PAH, metals from maintenance of landfill/quarry vehicles.	High	Moderate soil and gas (limited to the cells), moderate leachate and potential for moderate surface water and groundwater	4	The landfill monitoring report for Dec 06 to Dec 07 indicated that groundwater in the vicinity of the landfill site was generally of poor quality but apparently not significantly affected by the landfill site and that methane was being produced by the waste, but this did not appear to be migrating to external gas monitoring wells.
	Areas of Lot 47 of DP 262886 and Lot 292 of DP 1076555 not currently landfilled	Adjacent landfill cells and quarry activities	TPH, PAH, VOCs, SVOCs, metals and asbestos in surface soils. Carbon dioxide in soil gas. TPH, BTEX, PAH, metals from maintenance of landfill/quarry vehicles.	Moderate/High	Localised soil and moderate gas. Potential for moderate groundwater	3	Landfill and quarry activities are likely to have affected the areas immediately adjacent. Additional investigations of soil quality are required.
	Lot 36 of DP 262886 and part of Lot 35 of DP 262886 – areas referred to as 'paddock'	Potential nightsoil disposal area	TPH, PAH, metals and pathogens from night soil disposal.	Moderate/High	Moderate soil, localised gas and surface water and localised groundwater	4	GHD notes that this area has been used for placement of overburden from the landfill as such physical evidence of nightsoil is not visible. Additional investigations are required.
	Lot 291 of DP 1076555 including proposed Integral Energy site	Agricultural activities and possible localised minor tipping/illegal dumping	OCPs and OPPs from agricultural activities. Possible TPH, PAH, metals and asbestos from any imported fill or in 'farm tips'.	Moderate	Localised soil	1	No further investigations are proposed
B	Lots 11 and 12 of DP 262886 – former Council Sanitary Depot	Nightsoil disposal area	TPH, PAH, metals and pathogens from night soil disposal.	Moderate/High	Moderate soil and localised gas	4	GHD has reviewed the reports provided and notes that remediation of this area would



Section Reference	Lot and DP number/area of Site	Potential Source of Contamination	Nature of potential/known contamination	Toxicity of potential/known contaminants High/moderate/low	Potential magnitude of impacts Soil/ sediment/ gas/ surface water/ groundwater Localised/ moderate/ widespread	Overall Ranking Highly likely (4), Likely (3), Potential (2), Unlikely (1)	Comments
		Workshop	TPH and PAH from use of bitumen and asphalt in workshop. Asbestos from demolished buildings.		Moderate soil and localised groundwater		
		Potential burial of industrial waste	TPH, VOCs from burial of 200l drums of industrial waste.		Moderate soil, localised gas and localised groundwater		
C	Lot 1 of DP 747184 – Steggle's Chicken Factory	Former chicken processing activities and current waste disposal activities	Metals, pathogens, ammonia, chlorine, OCPs, OPPs in waste water/slurry from chicken processing.	Moderate/High	Moderate soil, sediment, surface water and groundwater	4	GHD notes that potential contamination issues exist both from storage of fuels, the treatment plant and the surface waters. Further investigations are required.
		Storage of fuels	TPH, PAH, BTEX from UST.		Moderate soil and groundwater		
D	Lot 25 of DP 262886 – Town and Country Caravan Park	Possible imported fill and/or localised tipping.	Possible metals and asbestos from any imported fill or disposal of locally generated waste materials.	Low/Moderate	Localised soil and surface water	1	Potential contamination issues are considered to be localised and not likely to pose a constraint to development. No further investigations proposed.
		Likely septic tank systems	Possible pathogens and metals from septic tank systems.		Localised soil and surface water		
E	Lot 32 of DP 262886	Overflow from dam on piggery plot	Metals, OCPs, OPPs, pathogens, ammonia, BOD, COD and excess nutrients in overflow waters from piggery plot.	Moderate	Localised soil and surface water	2	Additional investigations may be required to assess the impact to soils and surface waters.
		Agricultural activities and possible localised tipping	OCPs and OPPs from agricultural activities. Possible TPH, PAH, metals and asbestos from any imported fill or in 'farm tips'.		Localised soil		
	Lot 43 and 44 of DP262886	Residential premises	Possible pathogens and metals from septic tank systems. Possible TPH, PAH, metals and asbestos from any imported fill or in 'farm tips'.	Low/Moderate	Localised soil	1	Potential contamination issues are considered to be localised and not likely to pose a constraint to development. No further investigations proposed.
	Lots 33, 34, 37 and 38 and part of lot 35 of DP262886	Agricultural activities and possible localised tipping	OCPs and OPPs from agricultural activities. Possible TPH, PAH, metals and asbestos from any imported fill or in 'farm tips'.	Low/Moderate	Localised soil	1	Potential contamination issues are considered to be localised and not likely to pose a constraint to development. No further investigations proposed.
F	Lot 31 of DP 262886	Piggery	Metals, OCPs, OPPs, pathogens, ammonia, BOD, COD, excess nutrients from piggery activities. Asbestos from buildings.	Moderate	Localised soil, surface waters, sediment and groundwater	3	Additional investigations may be required to assess the impact to soils, surface waters and groundwater.



Section Reference	Lot and DP number/area of Site	Potential Source of Contamination	Nature of potential/known contamination	Toxicity of potential/known contaminants High/moderate/low	Potential magnitude of impacts Soil/ sediment/ gas/ surface water/ groundwater Localised/ moderate/ widespread	Overall Ranking Highly likely (4), Likely (3), Potential (2), Unlikely (1)	Comments
		Localised tipping	Possible TPH, PAH, metals and asbestos from any imported fill or in 'farm tips'.		Localised soil		
		Grange Avenue Landfill site off-site to north	TPH, PAH, VOCs, SVOCs, metals and asbestos in landfilled waste materials. TPH, PAH, VOCs, SVOCs, metals, ammonia, BOD, COD, excess nutrients in leachate. Methane, carbon dioxide and trace constituents in soil gas.		Widespread soil, gas and groundwater (off-site)		
Lot 9 and 10 of DP262886	Potential migration from Steggle's plot or nightsoil disposal plot		Metals, pathogens, ammonia, chlorine, OCPs, OPPs in waste water/slurry from chicken processing. TPH, PAH, metals and pathogens from night soil disposal.	Moderate	Localised soil, surface water and groundwater	2	Limited soil investigations proposed to confirm no migration of contaminants has occurred from neighbouring plots.
	Agricultural activities and possible localised tipping		OCPs and OPPs from agricultural activities. Possible TPH, PAH, metals and asbestos from any imported fill or in 'farm tips'.		Localised soil		
Lots 8 of DP 262886 and Lot 8 of DP 747184	Residential premises including former plant nursery		Possible pathogens and metals from septic tank systems. Possible TPH, PAH, metals and asbestos from any imported fill or in 'farm tips'. Possible OCPs and OPPS from nursery activities.	Moderate	Localised soil	2	Grange Avenue landfill is believed to collect and recycle landfill gas so landfill gas migration issues should be minimised. Gaps in information exist regarding leachate migration from the landfill.
	Grange Avenue landfill site off-site to north		TPH, PAH, VOCs, SVOCs, metals and asbestos in landfilled waste materials. TPH, PAH, VOCs, SVOCs, metals, ammonia, BOD, COD, excess nutrients in leachate. Methane, carbon dioxide and trace constituents in soil gas.		Widespread soil, gas and groundwater (off-site)		



Section Reference	Lot and DP number/area of Site	Potential Source of Contamination	Nature of potential/known contamination	Toxicity of potential/known contaminants High/moderate/low	Potential magnitude of impacts Soil/ sediment/ gas/ surface water/ groundwater Localised/ moderate/ widespread	Overall Ranking Highly likely (4), Likely (3), Potential (2), Unlikely (1)	Comments
	Lot 30 of DP 262886	Agricultural activities and possible localised tipping	OCPs and OPPs from agricultural activities. Possible TPH, PAH, metals and asbestos from any imported fill or in 'farm tips'.	Moderate	Localised soil	1	Potential contamination issues are considered to be localised and not likely to pose a constraint to development. No further investigations proposed.
		Grange Avenue landfill site off-site to north	TPH, PAH, VOCs, SVOCs, metals and asbestos in landfilled waste materials. TPH, PAH, VOCs, SVOCs, metals, ammonia, BOD, COD, excess nutrients in leachate. Methane, carbon dioxide and trace constituents in soil gas.		Widespread soil, gas and groundwater (off-site)		Grange Avenue landfill is believed to collect and recycle landfill gas so landfill gas migration issues should be minimised. Gaps in information exist regarding leachate migration from the landfill.
G	Lot 14 of DP 262886	Residential premises	Possible pathogens and metals from septic tank systems. Possible TPH, PAH, metals and asbestos from any imported fill or in 'farm tips'.	Low/Moderate	Localised soil, surface water and groundwater	1	Potential contamination issues are considered to be localised and not likely to pose a constraint to development. No further investigations proposed.
	Lot 13, 15 and 16 of DP 262886	Potential migration from nightsoil disposal plot	TPH, PAH, metals and pathogens from night soil disposal.	Low/Moderate	Localised soil, surface water and groundwater	1	Potential contamination issues are considered to be localised and not likely to pose a constraint to development. No further investigations proposed.
		Agricultural activities and possible localised tipping	OCPs and OPPs from agricultural activities. Possible TPH, PAH, metals and asbestos from any imported fill or in 'farm tips'.		Localised soil		
H	Lots 26 and 27 of DP 262886	Agricultural activities and possible localised tipping	OCPs and OPPs from agricultural activities. Possible TPH, PAH, metals and asbestos from any imported fill or in 'farm tips'.	Low/Moderate	Localised soil	1	Potential contamination issues are considered to be localised and not likely to pose a constraint to development. No further investigations proposed.
	Lot 21 of DP 262886	Small scale machining business	Possible TPH, PAH, VOCs and metals from solvents and lubricants used during machining.	Low/Moderate	Localised soil and possible localised groundwater	2	Limited soil and possibly groundwater assessments may be required in the vicinity of Lot 21.
	Lots 17, 18, 19, 20, 22, 23 and 24 of DP 262886	Residential premises	Possible pathogens and metals from septic tank systems.	Low/Moderate	Localised soil	1	



Section Reference	Lot and DP number/area of Site	Potential Source of Contamination	Nature of potential/known contamination	Toxicity of potential/known contaminants High/moderate/low	Potential magnitude of impacts Soil/ sediment/ gas/ surface water/ groundwater Localised/ moderate/ widespread	Overall Ranking Highly likely (4), Likely (3), Potential (2), Unlikely (1)	Comments
		Agricultural activities and possible localised tipping	OCPs and OPPs from agricultural activities. Possible TPH, PAH, metals and asbestos from any imported fill, in 'farm tips' or in infilled ponds.		Localised soil		
I	Lots 1 to 7 and 9 to 12 of Section I, DP193074	Residential premises Plant nursery	Possible pathogens and metals from septic tank systems. Possible OCPs and OPPS from nursery activities.	Low/Moderate	Localised soil Localised soil	1	Potential contamination issues are considered to be localised and not likely to pose a constraint to development. No further investigations proposed.
	Lot 8 of Section I, DP193074	Car restoration and storage	TPH, BTEX, PAH, metals associated with possible vehicle maintenance	Moderate	Localised soil and possible localised groundwater	1	Potential contamination issues are considered to be localised and not likely to pose a constraint to development. No further investigations proposed.
	Areas of former buildings on Lots 21 and 22 of DP 584915	Materials remaining from demolition of buildings	Metals and possible asbestos containing materials from demolition of former buildings	Moderate	Localised soil	2	Potential contamination issues are considered to be localised and not likely to pose a constraint to development. No further investigations proposed.
	Areas not subject to former development on Lots 21 and 22 of DP 584915	Agricultural activities and possible localised tipping CSR premises; quarry and also has POEO license for waste disposal activities – off-site to east.	OCPs and OPPs from agricultural activities. Possible TPH, PAH, metals and asbestos from any imported fill, in 'farm tips' or in infilled ponds. Various unknown contaminants possibly including TPH, BTEX, PAH, metals.	Low/Moderate	Localised soil Moderate soil, surface water and groundwater	1	Potential contamination issues are considered to be localised and not likely to pose a constraint to development. No further investigations proposed.
	Lot 1, 2 and 3 of DP 17048	Residential premises	Possible pathogens and metals from septic tank systems. Possible TPH, PAH, metals and asbestos from any imported fill or in 'farm tips'.	Low/Moderate	Localised soil	1	Potential contamination issues are considered to be localised and not likely to pose a constraint to development. No further investigations proposed.
	Lot 4 of DP 17048 – Produce market	Commercial/ residential premises	Various contaminants from storage of materials Possible pathogens and metals from septic tank systems. Possible TPH, PAH, metals and asbestos from any imported fill.	Low/Moderate	Localised Soil	1	Potential contamination issues are considered to be localised and not likely to pose a constraint to development. No further investigations proposed.



Section Reference	Lot and DP number/area of Site	Potential Source of Contamination	Nature of potential/known contamination	Toxicity of potential/known contaminants High/moderate/low	Potential magnitude of impacts Soil/ sediment/ gas/ surface water/ groundwater Localised/ moderate/ widespread	Overall Ranking Highly likely (4), Likely (3), Potential (2), Unlikely (1)	Comments
		Vehicle maintenance	TPH, BTEX, PAH associated with vehicle fuel		Localised soil		
	Lot 5 and 6 of DP 17048	Residential/agricultural activities	Possible pathogens and metals from septic tank systems. OCPs and OPPs from agricultural activities. Possible TPH, PAH, metals and asbestos from any imported fill.	Low/Moderate	Localised soil	1	Potential contamination issues are considered to be localised and not likely to pose a constraint to development. No further investigations proposed.
	Lot 7 of DP 17048 – Bells Creek Nursery	Former Nursery activities	Possible TPH, PAH, metals and asbestos from any imported fill. OCPs and OPPs associated with nursery activities	Moderate	Localised soil	2	Localised soil assessment may be required
		Vehicle storage and maintenance	TPH, BTEX, PAH, metals associated with vehicles		Localised soil		
	Lot 4 of DP 27536 – Scrap Yard	Scrap Yard	Various unknown contaminants possibly including TPH, BTEX, PAH, metals, VOCs, SVOCs, asbestos	Moderate/High	Moderate soil, surface water and groundwater	4	Further soil, surface water and groundwater investigations are likely to be required – access is required to further assess this Lot
	Lot 3 of DP 27536	Residential premises	Possible pathogens and metals from septic tank systems. Possible TPH, PAH, metals and asbestos from any imported fill or in 'farm tips'.	Low/Moderate	Localised Soil	1	Potential contamination issues are considered to be localised and not likely to pose a constraint to development. No further investigations proposed.
	Lot 1 and 2 of DP 27536 – Earth Exchange and Blacktown Landscape Supplies	Storage of various landscaping materials	Various unknown contaminants possibly including TPH, BTEX, PAH, metals and asbestos.	Moderate	Moderate soil, localised surface water and groundwater	3	Further soil, surface water and groundwater investigations are likely to be required – access is required to further assess this Lot
	Lot 1 of DP 397350	Vehicle parking and maintenance	TPH, BTEX, PAH, metals associated with vehicles		Moderate soil		
		Waste disposal activities – former POEO license for waste disposal activities	Various unknown contaminants possibly including TPH, BTEX, PAH, metals,		Moderate soil, localised surface water and groundwater		
		Berkshire Park excavator training centre – off-site to south	TPH, BTEX, PAH, metals associated with vehicle re-fuelling and maintenance		Moderate soil, localised groundwater		
	Lot 1 of DP 88530 – Heartbreak Ridge Paintball	Likely importation of fill materials	Possible TPH, PAH, metals and asbestos	Low/Moderate	Localised soil	2	Limited assessments of imported fill are likely to be required.



Section Reference	Lot and DP number/area of Site	Potential Source of Contamination	Nature of potential/known contamination	Toxicity of potential/known contaminants High/moderate/low	Potential magnitude of impacts Soil/ sediment/ gas/ surface water/ groundwater Localised/ moderate/ widespread	Overall Ranking Highly likely (4), Likely (3), Potential (2), Unlikely (1)	Comments
J	Lot 41 of DP 1100854	Vehicle activities	Possible TPH, BTEX, PAH and metals from vehicle parking and maintenance	Moderate/High	Localised soil Possibly moderate groundwater	3	Targeted assessment of possible vehicle parking areas is required.
	Part of Lot subject to waste disposal	Unauthorised waste disposal	TPH, BTEX, PAH, VOCs, SVOCs, OCPs, OPPs, metals, asbestos	High	Moderate soil and groundwater, localised surface water, possible localised soil gas	4	Further assessment of the waste disposal area is required.

Notes:

A number of plots along Richmond Road have not been accessed, these plots have been assessed from boundaries, however some uncertainties remain concerning the nature and magnitude of impacts, these plots are shown in italics



2.10 Summary

In summary, there are some areas within sections A to J that were identified as having an appreciable potential to be affected by contamination. These include the following:

- » Within Section A, the Marsden Park landfill site and a potential nightsoil disposal area to the south and south west of the landfill site;
- » Within Section B, the former Blacktown Council Sanitary Depot;
- » Within Section C, the Steggles chicken packing and distribution factory;
- » Within Section E, a site adjacent the piggery, allegedly impacted by overflow water from the piggery site;
- » Within Section F, a piggery and a site adjacent the Steggles site and the former Sanitary Depot, possibly affected by contaminant migration;
- » Within Section H, a small area of a plot occupied by a machining works;
- » Within Section I, the former Bells Creek Nursery, a potential scrap yard, Earth Exchange and Blacktown Landscaping Supplies (both landscaping yards), Heartbreak Ridge paintballing site; and
- » Within Section J, the RTA land possibly affected by vehicle activities including re-fuelling and the areas where waste disposal activities have taken place.

Potential contamination issues may be present on additional sites, but at this stage these have been assessed as likely to be localised and not likely to pose a significant constraint to the planned re-zoning and re-development.

Overall, the potential for gross widespread contamination is considered to be fairly low, however further targeted soil, surface water, groundwater and soil gas investigations were recommended on specific sites. The scope of these investigations is outlined in the Sampling, Analysis and Quality Plan in **Section 3**.



3. Sampling, Analysis and Quality Plan

3.1 Data Quality Objectives

The Data Quality Objective (DQO) Process was applied to the investigation, as described below, to ensure that data collection activities were appropriate and achieved the project objectives.

A process for establishing data quality objectives for an investigation site has been defined by the NSW DEC *Guidelines for the NSW Site Auditor Scheme (2nd ed, 2006)*.

The DQO process involves seven steps as follows:

- » Step 1: State the problem;
- » Step 2: Identify the decision;
- » Step 3: Identify inputs to the decision;
- » Step 4: Define the study boundaries;
- » Step 5: Develop a decision rule;
- » Step 6: Specify limits on decision errors; and
- » Step 7: Optimise the design for obtaining data.

The DQO steps defined above have been addressed as follows.

3.1.1 Step 1: State the Problem

A number of potential sites of concern were identified at the proposed Marsden Park Industrial Precinct (MPIP). The MPIP is part of the North West Growth Centre and is proposed to be re-zoned and re-developed as employment land.

The 'problem' as it stands is that previous and exiting land uses may have given rise to potential soil, surface water, groundwater, sediment and soil gas contamination, which currently have the potential to constraint development.

The project is being undertaken in order to provide data on the status of soil, surface water, groundwater, sediment and soil gas, and make recommendations for remediation where necessary. The information will be used to inform the strategic planning phase of the MPIP.

3.1.2 Step 2: Identify the Decisions

Soil, surface water, groundwater, sediment and soil gas data is required in order to confirm which areas of the Site pose potential constraints to development. The data will be used to update an initial constraints plan that can be used either to inform remediation decisions or facilitate the strategic planning phase of the MPIP.

In particular it will be necessary to decide:

- » Whether remediation is likely to be required, to ensure the suitability of these areas (from a contamination perspective) for the planned development; and



- » Whether further investigations are required to confirm whether remediation is indeed required.

To allow these decisions to be made, it is necessary to consider the following questions:

- » Is contamination present (in soil, sediment, vapour or water) above the applicable guidelines, when analysed in statistically sound manner?
- » Where contamination has occurred, does it have the potential to adversely impact on human health and/or environmental receptors?
- » Is the Site suitable, from a contamination perspective for proposed development?
- » Is further data required before the preceding question can be definitely answered?

3.1.3 Step 3: Identify Inputs to the Decision

Data to be input to the decision making process includes:

- » The information gathered during the Phase 1 assessment, including the initial constraints plan;
- » Quantitative data gained from sampling and analysis of soil via grid-based and targeted soil sampling, sampling and analysis of water samples collected from surface water bodies, and the installation of groundwater monitoring wells; and
- » Comparing the data to nominated investigation levels (as defined in **Section 3.2**) to evaluate the potential for contamination to adversely impact upon human health and/or environmental receptors.

3.1.4 Step 4: Define the Study Boundaries

The lateral boundaries of the study area are the Site boundaries, as depicted on **Figures 1 and 2, Appendix A**.

The vertical boundary will be the depth into the soil and groundwater profile into which contamination may have potentially migrated (the base of Marsden Park landfill site is at approximately 0 mAHD). Surface water investigations will focus on near –surface impacts.

3.1.5 Step 5: Develop a Decision Rule

MPIP is currently at the strategic planning stage and the final end-uses of the different parts of the Site have not been determined. It is proposed that the site will be used for employment end-uses, however, there is the potential that some open spaces may be incorporated into the Precinct design. The area of the Site adjoining South Street may be considered for residential development. As such project analytical data will be compared to appropriate NSW DECC made or endorsed investigation levels considered to be relevant to open space/recreation land uses, commercial/industrial land uses and residential land uses, plus applicable water quality guidelines.



On the basis of this initial comparison, plus an assessment of potential contaminant exposure pathways, a decision will be made as to whether or not any identified contamination may pose a potential risk, warranting management by way of land use planning and/or remediation.

3.1.6 Step 6: Specify Limits on Decision Errors

Two primary decision error-types may occur due to uncertainties or limitations in the project data set:

1. An investigation area may be deemed to pose no unacceptable risk, when in fact it does. This may occur if contamination is 'missed' due to limitations in the sampling plan, or if the project analytical data set is unreliable.
2. An investigation area may be deemed to pose an unacceptable risk, which in fact it does not. This may occur if the project analytical data set is unreliable, due to inappropriate sampling, sample handling, or analytical procedures.

To minimise the potential for decision errors, Data Quality Indicators (DQIs) have been determined, for completeness, comparability, representativeness, precision and accuracy.

The DQIs for sampling techniques and laboratory analysis of collected samples defines the acceptable level of error required for this investigation. The data quality objectives will be assessed by reference to data quality indicators as follows:

- **Data Representativeness** - expresses the degree which sample data accurately and precisely represents a characteristic of a population or an environmental condition. Representativeness is achieved by collecting samples in an appropriate pattern across the site, and by using an adequate number of sample locations to characterise the site. Consistent and repeatable sampling techniques and methods are utilised throughout the sampling.

It should be noted that the sampling program for the whole of the study area does not comply with the "*minimum sampling points required for site characterisation based on detecting circular contaminant hotspots by using a systematic sampling pattern*" (Table A, NSW EPA *Sampling Design Guidelines*). Rather the initial constraints plan has been used to prioritise parts of the Site that have been subject to potentially contaminative land uses.

- **Completeness** - defined as the percentage of measurements made which are judged to be valid measurements. The completeness goal is set at there being sufficient valid data generated during the study. If there is insufficient valid data, then additional data are required to be collected.
- **Comparability** - is a qualitative parameter expressing the confidence with which one data set can be compared with another. This is achieved through maintaining a level of consistency in techniques used to collect samples and ensuring analysing laboratories use consistent analysis techniques and reporting methods.



- **Precision** - measures the reproducibility of measurements under a given set of conditions. The precision of the data is assessed by calculating the Relative Percent Difference (RPD) between duplicate sample pairs.

$$RPD(\%) = \frac{|C_o - C_d|}{C_o + C_d} \times 200$$

Where C_o = Analyte concentration of the original sample
 C_d = Analyte concentration of the duplicate sample

GHD adopts a nominal acceptance criteria of $\pm 30\%$ RPD for field duplicates and splits for inorganics and a nominal acceptance criteria of $\pm 50\%$ RPD for field duplicates and splits for organics, however it is noted that this will not always be achieved, particularly in heterogenous soil or fill materials, or at low analyte concentrations.

- **Accuracy** - measures the bias in a measurement system. Accuracy can be undermined by such factors as field contamination of samples, poor preservation of samples, poor sample preparation techniques and poor selection of analysis techniques by the analysing laboratory. Accuracy is assessed by reference to the analytical results of laboratory control samples, laboratory spikes and analyses against reference standards. Accuracy of field works is assessed by examining the level of contamination detected in equipment blanks.

3.1.7 Step 7: Optimise the Design for Obtaining Data

To optimise the design of the investigations a sampling and analytical program has been prepared. This is outlined in **Section 3.3**.

3.2 Basis for Assessment

3.2.1 Relevant Guidelines

The framework for the contamination assessment made herein, was developed in accordance with guidelines “made or approved”, by the NSW EPA (now the Department of Environment and Climate Change (DECC)), under Section 105 of the *Contaminated Land Management Act, 1997*. These guidelines include, but are not limited to the following:

- » NSW EPA (1994), “Contaminated Sites: Guidelines for Assessing Service Station Sites”.
- » NSW EPA (1995), “Contaminated Sites: Sampling Design Guidelines”.
- » NSW EPA (1997), “Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites”.
- » NSW EPA (1999), “Contaminated Sites: Guidelines on Significant Risk of Harm from Contaminated Land and the Duty to Report”.
- » NEPM (1999), “National Environment Protection (Assessment of Site Contamination) Measure”, National Environment Protection Council (NEPC).



- » ANZECC (2000), "National Water Quality Management Strategy, Paper No. 4, Australian and New Zealand Guidelines for Fresh and Marine Water Quality", October 2000, Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ).
- » NSW DEC (2006), "Contaminated Sites: Guidelines for NSW Site Auditor Scheme (2nd Ed.)".
- » NSW DEC (2007), "Guidelines for the Assessment and Management of Groundwater Contamination".
- » NSW DECC (2008), "Waste Classification Guidelines Part 1: Classifying Waste".

3.2.2 Assessment Criteria (soil)

The assessment criteria (investigation levels) against which the project analytical data is compared have been taken from those guidelines made or approved by the NSW DECC.

Health Based Criteria

Health-based soil Investigation Levels (HILs) are provided for a range of different exposure settings, which are based on the nature of the use(s) for which the land is currently used and/or its approved use(s). Given that the Site is proposed to be used primarily for industrial/employment land with possible open space areas, this assessment is based on exposure setting E (parks, recreational open space, playing fields) from herein referred to (HIL(E)) and on exposure setting F (commercial or industrial), from herein referred as (HIL(F)). Commercial /industrial use includes premises such as shops and offices as well as factories and industrial sites.

The area of the Site that borders South Street may be designated residential and as such the assessment of this part of the Site will be based exposure setting A (residential with gardens and accessible soil) from herein referred as (HIL(A)). Residential use includes children's day care centres, preschools and primary schools, or town houses or villas where home-grown produce contributes less than 10% of fruit and vegetable intake.

These Investigation Levels are published in the NSW DEC (2006) "*Guidelines for the NSW Site Auditor Scheme (2nd Ed.)*".

For some contaminants (including TPH C₆-C₉) for which no HIL is presented in the NSW DEC (2006), "*Guidelines for the NSW Site Auditor Scheme*", reference is made to the sensitive land use threshold provided in the NSW EPA (1994), "*Guidelines for Assessing Service Station Sites*".

The guideline adopted for total coliforms will be the microbiological standard for stabilised grade A product in *Environmental Guidelines: Use and Disposal of Biosolids Products* (EPA 1997). Total coliforms will be compared to the standard for faecal coliforms of <1000 MPN/g (or 100 000cfu/100g). This guideline will be used as a broad screening criteria for total coliforms recorded in Site soils.



Provisional Phytotoxicity Based Investigation Levels

Provisional Phytotoxicity Based Investigation Levels (PBILs) relate to the potential uptake of contaminants that may result in adverse, phytotoxic impacts on sensitive plant species. PBILs are only available for certain metals and for phenol.

The PBILs have significant limitations because phototoxicity depends on soil and species parameters in ways that are not fully understood. They are intended for use as a screening guide only and may be assumed to apply to sand loam soils, or soils of a closely similar texture, for pH 6-8.

Calculated 95% UCL_{avg} Concentration for Comparison to the Guidelines

When comparing specific layers or bodies of material against the HIL criteria, the data set is separated to ensure that only materials of similar composition are included for comparison. For example, when calculating the 95%UCL_{avg} (Upper Confidence Limit of the arithmetic average contaminant concentration) for a particular contaminant concentration in a given volume of material for the purposes of comparison against the relevant site criteria, only the data for the samples collected for that particular material is used in the calculation. This is known as a homogenous sample population.

The guidelines indicate that the calculated 95% UCL_{avg} concentrations for each parameter can be compared to the HIL criteria and represent acceptable concentrations of parameter assuming the following:

- » The calculated 95% UCL_{avg} concentration does not exceed the respective criteria;
- » No single concentration within the data set exceeds 250% of the respective criteria for each parameter; and
- » The standard deviation of the data set must not to exceed 50% of the respective criteria for each parameter.

Table 2 provides a summary of the adopted criteria used to assess soil contamination levels at the site.

Table 2 Adopted Soil Criteria

Parameter	Health-Based Criteria (HIL A ^(b) or TC ^(a) Standard Residential with Garden "A" (mg/kg)	Health-Based Criteria (HIL E ^(c) or TC ^(a)) Parks and recreation Opens Spaces "E" (mg/kg)	Health-Based Criteria (HIL F ^(d) or TC ^(a)) Commercial / Industrial "F" (mg/kg)	PBIL ^(e) mg/kg
Arsenic (total)	100	200	500	20
Cadmium	20	40	100	3
Chromium (III)	12%	24%	60%	400
Chromium (VI)	100	200	500	1
Copper	1000	2,000	5,000	100



Parameter	Health-Based Criteria (HIL A ^(b) or TC ^(a)) Standard Residential with Garden "A" (mg/kg)	Health-Based Criteria (HIL E ^(c) or TC ^(a)) Parks and recreation Opens Spaces "E" (mg/kg)	Health-Based Criteria (HIL F ^(d) or TC ^(a)) Commercial / Industrial "F" (mg/kg)	PBIL ^(e) mg/kg
Lead	300	600	1,500	600
Nickel	600	600	3,000	60
Zinc	7000	14,000	35,000	200
Total Mercury (inorganic)	15	30	75	1
Cyanides (complex)	500	1000	2500	-
Total Petroleum Hydrocarbons (TPH) C ₆ -C ₉ C ₁₀ -C ₃₆	65 ^(a) 1000 ^(a)	65 ^(a) 1,000 ^(a)	65 ^(a) 1,000 ^(a)	-
Benzene	1 ^(a)	1 ^(a)	1 ^(a)	-
Toluene	130 ^(a)	130 ^(a)	130 ^(a)	-
Ethyl Benzene	50 ^(a)	50 ^(a)	50 ^(a)	-
Total Xylenes	25 ^(a)	25 ^(a)	25 ^(a)	-
Polycyclic aromatic hydrocarbons (total) (PAH)	20	40	100	-
Benzo(a)pyrene	1	2	5	-
Polychlorinated Biphenyl's (Total) (PCBs)	10	20	50	-
Phenol	8500	17,000	42,500	70
Organochlorine Pesticides (OCP)	10 Aldrin + Dieldrin 50 Chlordane 200 DDT 10 Heptachlor	20 Aldrin+Dieldrin 100 Chlordane 400 DDT 20 Heptachlor	50 Aldrin+Dieldrin 250 Chlordane 1,000 DDT 50 Heptachlor	-
Total Coliforms	<1000 MPN/g ^(f)	<1000 MPN/g ^(f)	<1000 MPN/g ^(f)	-

a) TC –threshold concentration from Table 3 titled 'Threshold Concentrations for Sensitive Land Use – Soils' in the "Guidelines for Assessing Service Station Sites" (NSW EPA, 1994)

b) Health-based Investigation Levels HIL (A) - standard residential with garden / accessible soil (home grown produce contributing less than 10% of vegetable and fruit intake, no poultry): this



category includes children's day care centres, townhouses and villas, preschools and primary schools. *Guidelines for the NSW Site Auditor Scheme* (NSW DEC, 2006).

- c) Health Based Investigation Levels HIL (E) – Parks, recreational open space and playing fields: includes secondary schools. *Guidelines for the NSW Site Auditor Scheme* (NSW DEC, 2006).
- d) Health-based Investigation Levels HIL (F) – Commercial Industrial: includes premises such as shops and offices as well as factories and industrial sites. *Guidelines for the NSW Site Auditor Scheme* (NSW DEC, 2006).
- e) Provisional Phytotoxicity-based Investigation Levels (PBILs). *Guidelines for the NSW Site Auditor Scheme* (NSW DEC, 2006).
- f) Standard for faecal coliforms to meet Stabilisation Grade A in *Environmental Guidelines: Use and Disposal of Biosolids Products* (EPA 1997) – MPN = Most Probable Number

Waste Classification Guidelines

The NSW DECC (2008), "*Waste Classification Guidelines Part 1: Classifying Waste*" provides criteria for assessing the appropriate waste classification and subsequent disposal location for solid and liquid wastes.

The guidelines provide a six-step guide to the classification of waste:

- » Step 1: establish if the waste should be classified as a special waste.
- » Step 2: If not a special waste, establish whether the waste should be classified as a liquid waste.
- » Step 3: If not special waste or liquid waste, establish whether the waste is of a type that has already been classified. A number of commonly generated wastes have been pre-classified.
- » Step 4: If the waste is not a special waste, liquid or is suitable for pre classification, establish whether it has certain hazardous characteristics and may therefore be classified as hazardous.
- » Step 5: If the waste does not possess hazardous characteristics, it needs to be chemically assessed to determine what class of waste it is.
- » Step 6: if the waste is chemically assessed as general solid waste, a further test is available to determine whether the waste is putrescible or non putrescible.

The classification process for non-liquid wastes focuses on the potential for the waste to release chemical contaminants into the environment through contact with liquids (leachates). The principal test used for assessing non-liquid waste is the Toxicity Characteristic Leaching Procedure (TCLP), which estimates the potential for waste to release chemical contaminants in to a leaching liquid. The guidelines set different maximum levels of the leachable concentration of each contaminant in order for waste to be classified as, general solid, restricted solid. If the level exceeds industrial the waste criteria the material is classified as hazardous waste.

The second test used to complete the assessment of waste, is the Specific Contamination Concentration (SCC) test, which 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 as either inert, solid, industrial waste. If the level exceeds the industrial waste criteria the material must be classified as hazardous waste.

3.2.3 Assessment Criteria (water)

ANZECC Water Quality Guidelines

For the purpose of this assessment, surface and groundwater quality will be compared to the criteria outlined in the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality ANZECC / ARMCANZ 2000 (ANZECC 2000)*. For the site, the receiving freshwater ecosystem is likely to be Bells Creek to the east or South Creek to the west, both of which ultimately join the Hawkesbury River. Local aquatic ecosystems are considered to be “Slightly to Moderately Disturbed” fresh water. Given that there is no local biological effects data, a protection of level of 95% is proposed for the assessment of surface and groundwater contamination.

The ANZECC 2000 guidelines are approved as guidelines under Section 105 of the *Contaminated Land Management Act 1997* as of 6 December 2001.

ANZECC 2000 outlines the principles, objectives and philosophical basis underpinning the development and application of the guidelines. It also outlines the management framework recommended for applying the water quality guidelines to the natural and semi-natural marine and freshwater resources in Australia and New Zealand. The guidelines provide a risk-based decision framework where possible, to help refine trigger values for application at local and/or regional scales. The *Guidelines for the Assessment and Management of Groundwater* should be used in conjunction with other relevant guidelines approved by the DECC, the guidelines outline the best practice framework for assessing and managing contaminated groundwater in NSW.

The NSW DECC recommends that when assessing contamination of groundwater, consideration needs to be given to the impact of any contaminants to the beneficial uses or resources of the groundwater. The beneficial uses of groundwater may include providing recharge to rivers, lakes, and bays, being a source of water for drinking, irrigation and industrial uses.

Concentrations of total coliforms in surface water and groundwater will be compared to the trigger value for thermotolerant coliforms in irrigation waters used for pasture and fodder for dairy animals or grazing animals in the ANZECC 2000 Guidelines. This land use scenario is more applicable to current land/water uses as opposed to the proposed land use and as such this value will be used as a general screening value only.

Drinking Water Guidelines

The Australian Drinking Water Guidelines (ADWG) are intended to provide a framework for good/safe drinking water supplies that, if implemented will assure safety at point of use. They are designed to provide authoritative reference on what defines safe, good water quality.



They are not mandatory standards and are concerned with both safety from a health point of view and with aesthetic quality. The *Drinking Water Guidelines* are not endorsed by the NSW DECC.

Table 3 provides a summary of the adopted water investigation levels used to compare the recorded surface and groundwater chemical concentrations.

Table 3 Adopted Groundwater Criteria

Parameter	Trigger Values 95% Fresh water ^(a) (µg/L)	Drinking Water Guidelines Health ^(b) (mg/L)
Arsenic (As III / As V)	24 / 13	0.007
Ammonia	900	-
Nitrate	700	50
Cadmium	0.2 [©]	0.002
Chromium (VI)	1.0	0.05
Copper	1.4	2
Lead	3.4	0.01
Mercury (inorganic)	0.6	0.001
Nickel	11	0.02
Zinc	8.0	-
Total Petroleum Hydrocarbons (TPH)		
C ₁₀ -C ₃₆	325 ^(e)	-
Benzene	950	0.001
Toluene	180 ^(d)	0.8
Ethylbenzene	80	0.3
Organochlorine Pesticides		
Chlordane	-	-
DDE	0.08	-
DDT	0.01	-
Endosulfan	0.2	-
Endrin	0.02	-
Heptachlor	0.09	-
Lindane	0.2	-
o-xylene	350	-



Parameter	Trigger Values 95% Fresh water ^(a) (µg/L)	Drinking Water Guidelines Health ^(b) (mg/L)
<i>m</i> -xylene	7	-
<i>p</i> -xylene	200	-
Polycyclic Aromatic Hydrocarbons		
Naphthalene	16	-
Benzo(a)pyrene	0.2 ^(d)	0.00001
Total Polycyclic Biphenyls (PCBs)		
	-	-
Phenol	320	-
Total Coliforms	<1000 cfu/100ml ^(f)	<1000 cfu/ml ^(f)

- a) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC /ARMCANZ, 2000), 95% Protection Level for Fresh Water.*
- b) *Australian Drinking Water Guidelines (National Health and Medical Research Council, Agricultural and Resources Management Council of Australia and New Zealand) 2004*
- c) Actual concentration depends on water hardness
- d) These values are low reliability trigger values (ANZECC/ARMCANZ, 2000).
- e) There is no criterion for TPH C₁₀ – C₃₆ that has been endorsed by the NSW DECC. A screening level has therefore been derived based on average of target value (50 µg/L) and intervention value (600 µg/L) for mineral oil in groundwater, from “Environmental Quality Objectives in the Netherlands”, MHSPE 1994 (to be applied to TPH C10 – C36 detected above the PQL). This is comparable to levels of TPH that have been found to cause taste issues in drinking water.
- f) Trigger value for thermotolerant coliforms in irrigation waters used for pasture and fodder for dairy animals or grazing animals from *ANZECC 2000*.

3.3 Sampling and Analytical Program

Intrusive sampling and analytical work was undertaken on those areas identified as being subject to potentially contaminative activities (as determined by the Phase 1 study outcomes). Specific areas of the Site subject to Phase 2 investigations are shown on **Figure 4, Appendix A**.

3.3.1 Introduction

The sampling and analytical work undertaken comprised the following elements:

- » A program of soil sampling and analysis, to evaluate the contamination status of soils in the identified areas of concern (**Section 3.3.2**);



- » A program of surface water sampling and analysis to evaluate the contamination status of surface water bodies on and surrounding the areas of concern (**Section 3.3.3**);
- » A program of groundwater well installation, sampling and analysis to define groundwater profiles, aquifer characteristics and impacts to groundwater quality in the areas of concern (**Section 3.3.4**);

A summary of the sampling and analytical program is contained in **Table 4**.

There is the potential for some areas of the Site to be affected by elevated levels of soil gas (methane, carbon dioxide and trace gases), however no soil gas testing was proposed for the following reasons:

- » No soil gas testing was proposed at the former night soil disposal area as GHD assumes that this area will be subject to remediation prior to development. In addition soil gas testing was not proposed at the 'paddock' area, as the extent of the nightsoil is at present unclear;
- » No soil gas testing was proposed adjacent to Marsden Park landfill site; GHD considers the soil gas monitoring exercise currently carried out by CES around and over the landfill to be sufficient; and
- » Similarly no soil gas testing was proposed adjacent Grange Avenue closed landfill to the north. GHD considers that the existing gas collection system and gas engine on the landfill and the distance between the landfill site and the Site boundary (approximately 300m) to be sufficient to most likely negate any risk to the Site from gas migration from this landfill.

There is also the potential for some of the dams on the Site to contain contaminated sediments. Contaminated sediments are only likely to be a constraint if dams are proposed to be drained and the sediment removed. GHD does not consider it necessary to sample the sediment in all dams on the Site at this stage, rather it is proposed that this may be undertaken when the proposals for each dam have been finalised.

The scope of works originally proposed (Table 10 in the Phase 1 report) altered slightly for the following reasons:

- » A number of landowners did not grant permission for intrusive works on their land, these were the Scrap Yard and the two landscaping supply yards off Richmond Road and the RTA owned land in the south east of the Site;
- » A decision was made to make some minor modifications to the scope of work whilst on-site due to the ground conditions encountered; and
- » The suite of analysis for the samples collected from some sites was altered slightly due to observations made whilst on-site.

The scope of intrusive works carried out is detailed in **Table 4**. Actual sampling locations are depicted on **Figures 5a to 5j, Appendix A**.



3.3.2 Soil Sampling and Analytical Program

In total, 87 soil sampling locations were completed, targeting the areas of concern highlighted in the Phase 1 assessment. A combination of boreholes, test pits and hand augers were undertaken depending on current site uses and site access.

- » In general test pits were excavated to a depth of 3m, until natural materials were encountered or to refusal. In each pit, samples were collected:
 - At the surface (i.e., the topsoil horizon);
 - From within each defined fill horizon, to the maximum depth of investigation; and
 - From the uppermost residual soil horizon (if encountered).

Samples were collected directly from backhoe bucket returns, using a gloved hand or clean (decontaminated) stainless steel trowel.

One to two samples per test pit (including the topsoil sample from each pit, a sample of the underlying fill, plus quality control samples, as set out in **Section 3.4**) were submitted to a NATA certified testing laboratory, to be analysed for the determinants set out in **Table 4**.

- » Boreholes were used on sites with significant hardstanding or where sampling at depths of greater than 3m was required. Boreholes were drilled using a truck-mounted drill rig, equipped with hollow flight augers. Boreholes were drilled to an approximate depth of 10m, or to refusal at bedrock, whichever was shallower. A minimum of three samples were collected at each borehole location, using a split spoon sampler. Samples were collected at the following intervals:
 - At the surface;
 - From 0.3-0.5m;
 - From 0.8-1.0m; and
 - At 1m intervals then on.

Samples, including quality control samples as set out in **Section 3.4**, were submitted to a NATA certified testing laboratory to be analysed for the determinants set out in **Table 4**.

- » Hand augers were used to take samples from sites with restricted access, where contamination is only expected close to surface. Two or three samples were collected from each sample location at the following intervals:
 - At the surface;
 - From 0.3-0.5m; and
 - At base of hole.

Samples, including quality control samples as set out in **Section 3.4**, were submitted to a NATA certified testing laboratory to be analysed for the determinants set out in **Table 4**.



3.3.3 Surface Water Sampling and Analytical Program

Five surface water samples were taken from dams in areas of concern highlighted in the Phase 1 report. No samples were taken from Bells Creek.

Grab samples were collected using a disposable bailer from 20-30 cm below the water surface.

Field parameters were measured after sample collection to avoid disturbing any sediment. Parameters measured were temperature, pH, conductivity, dissolved oxygen and redox potential.

Water samples were submitted to a NATA certified testing laboratory to be analysed for the determinants set out in **Table 4**.

3.3.4 Groundwater Sampling and Analytical Program

A total of seven groundwater wells were installed across the Site, the areas subject to groundwater investigations are shown on **Figure 4, Appendix A**.

Groundwater wells were installed via a truck mounted drill rig, equipped with hollow flight augers. The maximum depth of groundwater wells was 10m below ground level. Groundwater wells were constructed using Class 18 PVC casing, a gravel pack around the screened zone, a bentonite "plug" to preclude the downward percolation of water from the overlying fill horizons, and a soil / cement grout to the surface. Wells were completed using a gatic cover. Following construction, wells were developed to remove drilling materials, well construction materials and fines.

Prior to sampling wells were purged to remove 'stagnant' water from the well. Field parameters were measured during purging, including temperature, pH, conductivity, dissolved oxygen and redox potential. Bores were purged until field parameters stabilised. Stainless steel bailers were used for purging and a disposable bailer was used for sample collection.

Groundwater samples were filtered by the analytical laboratory in order to analyse dissolved metal concentrations.

Groundwater samples will be submitted to a NATA certified testing laboratory to be analysed for the determinants set out in **Table 4**.



Table 4 Scope of Intrusive Work

Section Reference	Lot and DP number/area of Site	Soil sampling and analysis	Surface water sampling and analysis	Groundwater sampling and analysis
A	Parts of Lot 47 of DP 262886 and Lot 292 of DP 1076555 not subject to landfilling (See Figure 5a).	9 test pits and 3 boreholes in areas outside landfill cells, targeted at disturbed or developed areas. 15 soil samples collected from test pits and boreholes plus 2 QC samples analysed for metals, TPH, BTEX, PAH, OCPs, OPPs and asbestos	N/A	N/A
	Lot 36 of DP 262886 and part of Lot 35 of DP 262886 – areas referred to as 'paddock" (See Figure 5b).	14 grid based test pits 11 soil samples collected from test pits plus 2 QC samples analysed for metals, TPH, PAH and total coliforms	N/A	N/A
B	Lots 11 and 12 of DP 262886 – former Council Sanitary Depot (See Figure 5c).	Soil samples collected from the borehole drilled for well installation but no analysis is proposed at present due to data available from URS site investigations (see Section 3.3.2 to 3.3.5 in Phase 1 report)	N/A	1 groundwater well in south west corner of area 1 groundwater sample analysed for dissolved metals, TPH, PAH, BTEX and VOCs



Section Reference	Lot and DP number/area of Site	Soil sampling and analysis	Surface water sampling and analysis	Groundwater sampling and analysis
C	Lot 1 of DP 747184 – Steggles Chicken Factory (See Figure 5d).	<p>4 hand auger locations along drain between water treatment unit and dam and between dams</p> <p>12 soil samples (from hand augers and wells) plus 1 QC sample analysed for metals, TPH, BTEX, PAH, OCPs, OPPs, total coliforms, ammonia and asbestos</p>	<p>2 sampling locations, 1 at each dam in the south east corner of plot</p> <p>2 water samples plus 1 QC sample analysed for total metals, TPH, PAH, BTEX, OCPs, OPPs, total coliforms, ammonia, major cations and anions, BOD and COD</p>	<p>4 groundwater wells; 1 targeting the water treatment area, 1 targeting the sump and 2 targeting the UST</p> <p>4 groundwater samples analysed for dissolved metals, TPH, PAH, BTEX, OCPs, OPPs, total coliforms, ammonia, major cations and anions, BOD and COD</p>
E	Lot 32 of DP 262886 – Lot adjacent piggery (See Figure 5e).	<p>4 hand auger locations</p> <p>4 soil samples from hand auger holes analysed for metals, OCPs, OPPs, total coliforms and ammonia</p>	N/A	N/A
F	Lot 31 of DP 262886 – piggery (See Figure 5f).	<p>5 targeted hand auger locations</p> <p>5 soil samples from hand auger holes plus 1 QC sample analysed for metals, TPH, BTEX, PAH, OCPs, OPPs, total coliforms, ammonia and asbestos</p>	<p>3 sampling locations, each at separate dams on plot</p> <p>3 water samples plus 1 QC sample analysed for total metals, TPH, PAH, BTEX, OCPs, OPPs, total coliforms, ammonia, major cations and anions, BOD and COD</p>	N/A



Section Reference	Lot and DP number/area of Site	Soil sampling and analysis	Surface water sampling and analysis	Groundwater sampling and analysis
	Lot 9 and 10 of DP262886 – plots adjacent Steggles and nightsoil disposal area (See Figure 5g).	8 test pits targeting the boundaries with sites with contaminative uses 8 soil samples from test pits plus 2 QC samples analysed for metals, TPH, PAH, OCPs, OPPs, total coliforms, ammonia and asbestos	N/A	N/A
H	Lots 21 of DP 262886 – machining business (See Figure 5h).	No specific soil sampling locations 4 soils samples plus 1 QC sample taken from well locations, samples analysed for metals, TPH, BTEX, PAH and VOCs		2 groundwater wells targeting machining shed 2 groundwater samples analysed for dissolved metals, TPH, BTEX, PAH and VOCs
I	Lot 7 of DP 17048 – Bells Creek Nursery (See Figure 5j).	4 test pits targeting potential sources of contamination 4 soil samples from test pits analysed for metals, TPH, BTEX, PAH, OCPs, OPPs total coliforms and asbestos	N/A	N/A
	Lot 1 of DP 88530 – Heartbreak Ridge Paintball (See Figure 5i).	5 hand augers targeting imported fill mounds 5 soil samples from hand auger holes analysed for metals, TPH, BTEX, PAH, OCPs, OPPs and asbestos	N/A	N/A



Section Reference	Lot and DP number/area of Site	Soil sampling and analysis	Surface water sampling and analysis	Groundwater sampling and analysis
		3 borehole locations 35 test pit locations 18 hand auger locations Total of 68 soils samples analysed (including 6 blind duplicates and 3 split duplicates)	5 surface sampling locations, 5 surface water and 2 QC samples analysed	7 groundwater wells, 7 groundwater and 1 QC samples analysed



3.4 Quality Assurance and Quality Control (QA/QC)

3.4.1 Field Program

All fieldwork was conducted in general accordance with GHD's Standard Field Operating Procedures (SFOP), which are aimed at ensuring that all environmental samples are collected by a set of uniform and systematic methods, as required by GHD's Quality Assurance system. Key requirements of these procedures are as follows:

- » Decontamination procedures - including the use of new disposable gloves for the collection of each sample, decontamination of the sampling equipment between each sampling location (using DECON 90¹) and the use of dedicated sampling containers provided by the laboratory;
- » Trained, experienced GHD personnel conducted the sampling program using GHD's Standard Field Operating Procedures;
- » Logging procedures - all soil samples are logged using a recognised system;
- » Calibration procedures - all field monitoring equipment is appropriately calibrated;
- » Sample identification procedures - collected samples were immediately transferred to sample containers of appropriate composition and preservation for the required laboratory analysis. All sample containers were clearly labelled with a sample number, sample location, sample depth, sample date and sampler's initials. The sample containers were then be transferred to a "chilled" esky for sample preservation prior to and during shipment to the testing laboratory; and
- » Chain of custody information requirements - a chain-of-custody form was completed and forwarded to the testing laboratory.

Field Quality Control Samples

Field quality control samples collected and/or analysed during the project comprised the collection and analysis of the following:

Blind duplicates: Comprise a single sample that is divided into two separate sampling containers. Both samples are sent anonymously to the project laboratory. Blind duplicates provide an indication of the analytical precision of the laboratory, but are inherently influenced by other factors such as sampling techniques and sample media heterogeneity.

Blind duplicates (soil, water and sediment) were collected and analysed at a rate of approximately 1 per 20 samples (i.e. 5%).

Split duplicates: Identical to a blind duplicate, except that the primary sample is sent to the project laboratory and the duplicate is sent to the check laboratory.

¹ Non dedicated equipment only.



Split duplicates (soil, water and sediment) were collected and analysed at a rate of approximately 1 per 20 samples (i.e. 5%).

In total, blind and split duplicate samples were collected and analysed at a rate of 10% (i.e. 1 duplicate per 10 primary samples).

3.4.2 Laboratory Program

The project laboratories will adopt their internal procedures and NATA accredited methods in accordance with their quality assurance system.

Laboratory Quality Control

Laboratory quality control samples collected and analysed during the project were:

Laboratory duplicate samples: The analytical laboratory collects duplicate sub samples from one sample submitted for analytical testing at a rate equivalent to one in twenty 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 the analytical precision and reproducibility of the test result.

Spiked Samples: An authentic 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. Spiked samples will be analysed for each batch where samples are analysed for organic chemicals of concern.

Certified Reference Standards: A reference standard of known (certified) concentration is analysed along with a batch of samples. The Certified Reference Standard (CRS) or Laboratory Control Spike provides an indication of the analytical accuracy and the precision of the test method and is used for inorganic analyses.

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. Surrogate Standard/Spikes provide a means of checking that no gross errors have occurred during any stage of the test method leading to significant analyte loss.

Method Blank: Usually an organic or aqueous solution that is as free as possible of analytes of interest to which is added all the reagents, in the same volume, as used in the preparation and subsequent analysis 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.



The laboratory will be required to provide this information to GHD. The individual testing laboratories shall conduct an assessment of the laboratory QC program, internally however, the results will also independently reviewed and assessed by GHD.

Laboratory duplicate samples should return RPDs within the NEPM acceptance criteria of $\pm 30\%$. Percent recovery is used to assess spiked samples and surrogate standards. Percent recovery, although dependent on the type of analyte tested, the concentrations of analytes, and the sample matrix; should normally range from about 70-130%. Method (laboratory) blanks should return analyte concentrations as 'below PQL.



4. Results

This section presents the results of all soil, surface water and groundwater investigations undertaken by GHD during October 2008. Sampling locations are shown on **Figures 5a to 5j, Appendix A**.

The soil analytical results are presented in **Table A**, surface water analytical results are presented in **Table B** and groundwater analytical results are presented in **Table C, Appendix B**.

Copies of laboratory certificates and chain of custody documentation are provided in **Appendix C**, borehole and groundwater construction logs are provided in **Appendix D** and equipment calibration certificates are presented in **Appendix E**.

4.1 Field Observations

Fill materials or disturbed ground were encountered in the near surface at the majority of sampling locations, generally extending to depths of approximately 0.5m (deeper fill was present at some sampling locations around the periphery of the landfill cells, on the 'paddock' site, on the former Sanitary Depot and at Steggles Chicken factory).

Fill materials generally comprised brown sandy clay or clayey sand with various gravels and cobbles. Shale quarry spoil was encountered at some sampling locations at the landfill site and on the "Paddock" site. Imported sandstone cobbles were encountered at Bells Creek Nursery and at the Paintballing site.

Evidence of waste materials (glass, brick, plastic, wood, metal and rags) was noted within fill materials at a limited number of sampling locations including a skip store at the landfill site, a few locations at the "Paddock", the former Sanitary Depot, the piggery, one location adjacent to the former Sanitary Depot and at Bells Creek Nursery.

Grey clays with red/orange mottling and grey, tan or red weathered shales were encountered underlying fill materials or re-worked materials.

On-site PID readings taken from the sampled soils returned results of generally less than 10ppm, not indicative of any volatile hydrocarbon vapours in the soil gas.

Limited fragments of potentially asbestos containing materials were noted during site inspections at the following plots:

- Lot 292 of DP1076555 (skip store at landfill site)
- Lot 7 of DP17048 (Bells Creek Nursery);
- Lot 38 of DP262886 (agricultural plot);
- Lot 21 of DP584915 (site of demolished building); and

Lot 22 of DP584915 (site of demolished building).

Soils encountered across the Site are described in **Table 5**.



Table 5 Encountered Ground Conditions

Site Name/reference	Summary of ground conditions	
	Fill materials	Residual materials
<p>Landfill site, Figure 5a; TP15 to TP23 and BH1 to BH3</p>	<p>Fill materials encountered generally comprised light brown to dark brown sandy clay fill and light brown clayey sand fill. Mixed gravels and occasional cobbles were present</p> <p>Test pits 17 and 18, which were located in the present day crushing area, encountered grey gravelly fill material. TP17 encountered water and possible pond base sediments at 1.0m depth</p> <p>Test pit 23, which was located in the skip store area encountered grey sandy gravel. Significant waste materials were encountered in TP22 and 23 in this area, including glass, plastic, brick, tile, wood and fragments of possible asbestos containing cement sheet.</p>	<p>Residual materials were encountered in all test pits with the exception of TP18, which met refusal at 2.1m depth in hard rock boulders (fill/quarry spoil). Residual materials were encountered at a minimum depth of 0.6m in TP15 and at a maximum depth of greater than 2.1m in TP18.</p> <p>Residual materials comprised grey clay/weathered shale. Clays had orange and red mottling and were sandy in some locations. Fragments of grey weathered shale were common.</p>
<p>Paddock, Figure 5b; TP1 to TP14</p>	<p>Fill materials encountered comprised brown sandy clay underlain by grey clay with red or orange/tan mottling. Various gravels and occasional boulders and cobbles were noted.</p> <p>In test pits 7, 8, 9, 10, 12, 13 and 14, topsoil was underlain by a grey sandy clay fill with significant gravels, cobbles and occasional boulders –likely spoil from the former quarry adjacent.</p> <p>A relic soil layer (the former topsoil layer that would have been present prior to filling activities) was noted in most test pits at approximately 1m depth, occasionally waste materials including plastic, glass and metal were noted associated with this layer. There were no obvious indications of nightsoil deposits.</p>	<p>Residual materials were encountered in the majority of test pits with the exception of TP9 and 14 which met refusal in cobbles and boulders at 2.6m depth. Residual materials were encountered at a minimum depth of 0.9m in TP6.</p> <p>Residual materials comprised firm-stiff grey clays with red or orange/tan mottling with the exception of TP6 where a hard red rock was encountered at 1.0m depth.</p>



Site Name/reference	Summary of ground conditions	
	Fill materials	Residual materials
<p>Former Sanitary Depot, Figure 5c; MW7</p>	<p>Brown clayey sand with a layer of brown/black fibrous organic matter (likely nightsoil) was noted at surface. An organic odour was noted and pieces of plastic were present. Fill materials extended to 1.0m.</p> <p>Re-worked natural materials comprising grey clay with orange and red mottling was present underlying the fill materials to depths of approximately 2.0m.</p>	<p>Residual materials comprised grey clay with red and brown highly weathered shale fragments.</p>
<p>Steggles Chicken Factory Figure 5d; HA11 to HA14 and MW1 to MW4</p>	<p>HA11 to HA14 were located in grassed areas, MW1 to MW4 were located in concrete or gravel road areas.</p> <p>Fill materials generally comprised brown sandy clays with various gravels, including road base gravels in MW 1, 3 and 4.</p> <p>HA13 was located in a drain area and encountered moist, grey drain sediments with high organic matter.</p> <p>No significant waste materials, odours or staining that might indicate contamination were noted.</p> <p>Some re-worked natural materials were encountered; these generally comprised grey and red or orange stiff clays.</p>	<p>Residual materials were encountered in HA 13 and MW1 to MW4 commencing at a minimum depth of 0.3m in HA 13 and at a maximum depth of 2.0m in MW3 and MW4.</p> <p>Residual materials generally comprised grey clays with red or orange/tan mottling, grading to weathered brown, tan or grey shales. Shale fragments in drill returns tended to be brittle and weak, however hard drilling was encountered in shale materials.</p>
<p>Piggery, Figure 5f; HA6 to HA 10</p>	<p>Surface soils at the piggery site were fill generally comprising brown and light brown sandy clay with various gravels including ironstone. Soils were generally dry to moist. Waste materials were encountered at HA7, 8 and 10, HA8 in particular encountered plastic, bricks, rags, metal and animal bones.</p>	<p>Residual materials comprised grey brown silty clay and red orange clays with occasional weathered shale fragments.</p>
<p>Site adjacent piggery, Figure 5e;</p>	<p>Surface soils were noted to be brown sandy clays - likely re-worked natural materials.</p>	<p>The depth of residual materials was difficult to judge due to the disturbed nature of hand auger returns, residual</p>



Site Name/reference	Summary of ground conditions	
	Fill materials	Residual materials
HA15 to HA18	No odours or staining that might be indicative of contamination were noted.	materials comprised grey clays and sandy clays with brown, orange and tan mottling.
Site adjacent Steggles and former Sanitary Depot, Figure 5g; TP24 to TP31	Light grey to brown and brown clayey sand and sandy clays were encountered at surface. Surface soils generally appeared to be re-worked natural materials with the exception of TP27, on the boundary of the former Sanitary Depot, close to the workshop. Old bottles, brick, wood and tar covered rock were noted at this location. With the exception of TP27, no odours or staining that might be indicative of contamination were noted.	Residual materials were encountered in all test pits, commencing at a minimum depth of 0.4m and a maximum depth of 1.1m. Residual materials were typically grey clays, generally with red, orange or yellow mottling. Red or brown weathered shale fragments were common, generally increasing with depth. A band of shaley material was present at approximately 1.5m depth in TP24 and TP31.
Machining business, Figure 5h; MW5 to MW6	Brown sandy clay fill with mixed gravels up to 60mm in size was encountered at surface to 1m depth. Re-worked natural material underlying the fill comprised yellow brown sandy clay with minor gravels.	Residual materials were encountered at approximately 2.5m in MW5 and at 1.5m in MW6. Residual materials comprised light brown clay/weathered shale with major shale fragments.
Bells Creek nursery, Figure 5i; TP32 to TP35	Light brown and yellow gravelly sand fill with minor clay content was noted at surface. Gravels were generally sandstone imported onto site or shales. Brick, plaster and possible asbestos containing materials were noted in TP32, wood and a small area of a tar like substance were noted in TP34. TP35 encountered a dark brown sandy clay high in organic material.	Residual materials were encountered in all test pits commencing at a minimum depth of 0.7m and a maximum depth of 1.1m Residual materials comprised grey clay with red or orange mottling. Red shale fragments were present increasing with depth.
Paintballing site, Figure 5j; HA1 to HA5	Paintballing mounds comprised gravelly sand fill at surface underlain by yellow and brown sandy clay fill and red/orange clay fill. Occasional brick fragments were noted; otherwise no odours or staining that might indicate contamination were noted.	Residual materials were not encountered on this site due to hand auger refusal in gravelly materials.



4.2 Soil Analysis Results

Soil analytical results are summarised in **Table A (Appendix B)**.

Concentrations of analytes in soils were generally below the adopted site assessment criteria (**Section 3.2.2**), with the following exceptions:

- » Arsenic was detected at or above the PBILs in soil sampled from Steggles Chicken Factory and the site adjacent Steggles and the former Sanitary Depot. A sample of fill material from MW1 at 0-0.1m depth and a sample of re-worked material from TP28 at 0-0.1m reported concentrations of 52mg/kg and 20mg/kg respectively compared to the PBIL of 20mg/kg.
- » Copper was detected at or above the PBILs in soil sampled from Steggles Chicken Factory and the Piggery. Sample of fill material from MW3 at 0-0.1m depth and from HA10 at 0-0.1m depth reported concentrations of 240mg/kg and 140mg/kg respectively. These exceed the PBIL for copper of 100mg/kg.
- » Nickel was detected at or above the PBILs in 14 soil samples, taken from the landfill site, the paddock and Steggles Chicken Factory. Concentrations of nickel ranged from 2mg/kg to 170mg/kg compared to the PBIL of 60mg/kg.
- » Zinc was detected at or above the PBILs in 12 soil samples, taken from the landfill site, the paddock, Steggles Chicken Factory and the Piggery. Concentrations ranged from 8mg/kg to 1200mg/kg, compared to the PBIL of 200mg/kg.
- » TPH in the fraction C₁₀-C₃₆ was detected at or above the Threshold Concentrations in two soil samples from Steggles Chicken Factory. Samples of fill material from MW1 at 0-0.1m depth and MW3 at 0-0.1m depth reported concentrations of 2300mg/kg and 1430 mg/kg respectively. These exceed the adopted site assessment criteria of 1000mg/kg (Threshold Concentration, NSW EPA 1994); and
- » Benzo (a) Pyrene was detected at the HIL (A) in soil sampled from Steggles Chicken Factory at one location. A sample of fill material from MW4 at 0-0.1m depth reported a concentration of 1mg/kg which equals the HIL(A) (1mg/kg).

Soils in several areas of the Site were analysed for ammonia and total coliforms. There are no specific guideline values for these substances in soil however high concentrations were recorded on some areas of the Site:

- » Concentrations of total coliforms were generally recorded in the range 500 to 5000cfu/100g, however samples from HA16, adjacent the piggery site and HA8, on the piggery site were recorded at concentrations of 35000 cfu/100g and 1 600 000 cfu/100g respectively. The site assessment criteria for total coliforms is 100 000 cfu/100g, based on *Environmental Guidelines, Use and Disposal of Biosolids Products* (NSW EPA 1997) (see **Section 6.2** in the Phase 1 assessment). The concentration of total coliforms in HA8 on the piggery site exceeds this value.
- » Concentrations of ammonia were generally recorded in the range 0.7mg/kg to 18mg/kg, however samples taken from the majority of locations on the Steggles site recorded much higher concentrations of ammonia, in the range 30mg/kg to 92mg/kg.



No asbestos was identified in soils by the testing laboratories, and no asbestos fibres were recorded, despite potentially asbestos containing materials being identified in a number of areas.

4.3 Surface Water Analysis Results

Surface waters were collected from five of the dams on the Site on 1 October 2008. The five dams were located at the piggery site (**Figure 5f**) and at Steggles Chicken Factory (**Figure 5c**).

Field parameters were recorded after sample collection to avoid disturbing sediments. **Table 6** summarises the field parameters from the surface waters.

Table 6 Surface Water Field Parameters

Location	Temp (°C)	Conductivity (uS/cm)	pH	DO (mg/L)	Redox (mV)
SW1	20.5	811	6.21	7.0	81
SW2	20.7	682	8.72	8.77	73
SW3	25.7	623	9.19	12.99	71
SW4	25.4	1014	7.35	5.81	-12
SW5	24.2	646	9.39	9.26	73

Surface water parameters were fairly consistent with the exception of SW4, on the Steggles site. This dam is the first dam to receive wastewater from the Site; it also contains an aerator.

4.3.1 Surface water analytical results

Organics – Concentrations of TPH, BTEX, PAH, OPPs and OCPs were reported below the adopted site assessment criteria for water namely the ANZECC Guidelines for Freshwater Ecosystems and the Australian Drinking Water Guidelines.

It should be noted that the PQLs used by the analytical laboratories for Benzo(a)pyrene, OCPs and OPPs were higher than the applicable ANZECC (2000) trigger values. These substances were not recorded at high concentrations in Site soils so surface waters are not expected to have concentrations of B(a)P, OCPs and OPPs in excess of the guidelines, but it is not possible to confirm this.

Metals – Concentrations of some metals in surface water exceeded the site assessment criteria as follows:

- » Total lead was reported at SW1, SW3 and SW4 at concentrations of 43ug/L, 4.3ug/L and 3.5ug/L respectively, exceeding the ANZECC criteria of 3.4ug/L;
- » Total cadmium was reported at SW2 at a concentration of 0.2ug/L, this is equal to the ANZECC criteria;



- » Total copper was reported at concentrations ranging from 7.1ug/L to 62ug/L (SW1), exceeding the ANZECC criteria of 14ug/L;
- » Total nickel was reported at SW1 at a concentration of 22ug/L, exceeding the ANZECC criteria of 11ug/L;
- » Total zinc was reported at all locations at concentrations ranging from 8.5ug/L to 100ug/L (SW1), exceeding the ANZECC criteria of 8ug/L; and
- » Total arsenic was reported at SW1, SW3 and SW5 at concentrations of 16ug/L, 11ug/L and 8.3ug/L, exceeding the Drinking Water Guideline of 7ug/L.

Other Inorganics – Concentrations of total ammonia exceeded the Drinking Water Guideline of 0.5mg/L in three locations, SW1 (0.7mg/L), SW3 (2.8mg/L) and SW4 (1.9mg/L). Concentrations of ammonia in SW3 and SW4 also exceeded the ANZECC guideline of 0.9mg/L.

BOD and COD - Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) are measures of the demand on the amount of dissolved oxygen in a system from chemicals and nutrients. There are no specific guidelines for BOD and COD, however the ANZECC Guidelines recommend that BOD should not exceed 15mg/L and COD not exceed 40mg/L for waters being considered for aquaculture.

BOD ranged from less than the laboratory PQL to 51mg/L, COD ranged from 80mg/L to 400mg/L.

Total Coliforms – Concentrations of total coliforms ranged from 30cfu/100ml in SW5 to 3 900 000cfu/100ml in SW4. The ANZECC guideline value for faecal coliforms in water used for pasture and fodder for dairy animals and other grazing animals is 1000cfu/100ml, two surface water samples exceeded this value at SW1 (15000cfu/100ml) and SW4.

4.4 Groundwater Analysis Results

Seven groundwater wells were installed across the Site. Wells were installed on

- » The Former Council Sanitary Depot (Figure 5c);
- » Steggle's Chicken Factory (Figure 5d); and
- » The machining business (Figure 5h).

Groundwater samples were collected from these wells on the 29 and 30 October 2008.

Field parameters were monitored prior to sample collection, **Table 7** summarises the groundwater parameters.

Observations made during groundwater purging indicated that groundwater was initially slightly turbid, becoming more turbid. Groundwater wells generally had slow recharge.

Field parameters were relatively consistent across the Site as a whole, conductivity ranged from 9.94 mS/cm to 35.8 mS/cm indicating saline groundwater. pH ranged from 5.95 to 7.44, generally indicating mildly acidic to mildly alkaline conditions.



Table 7 Groundwater Field Parameters

Location	SWL (m TOC)	Temp (°C)	Conductivity (mS/cm)	pH	DO (mg/L)	Redox (m/V)
MW1	1.51	21.0	35.8	6.67	2.56	120
MW2	1.22	19.4	16.45	6.16	2.94	149
MW3	2.11	18.8	17.17	5.95	6.05	60
MW4	2.05	19.4	32.0	6.30	3.11	67
MW5	5.9	18.5	9.94	7.44	7.84	97
MW6	6.15	18.6	22.79	7.36	6.50	95
MW7	4.34	18.4	27.1	6.85	6.37	143

Note: The water quality meter recorded conductivity in mS/cm due to the high conductivity of the groundwater, 1mS/cm = 1000uS/cm.

4.4.1 Groundwater analytical results

Organics – Concentrations of TPH, BTEX, PAH, OPPs and OCPs were reported below the adopted site assessment criteria for water namely the ANZECC Guidelines for Freshwater Ecosystems and the Australian Drinking Water Guidelines.

It should be noted that the PQLs used by the analytical laboratories for Benzo(a)pyrene, OCPs and OPPs were higher than the applicable ANZECC (2000) trigger values. These substances were not recorded at high concentrations in Site soils so ground water is not expected to have concentrations of B(a)P, OCPs and OPPs in excess of the guidelines, but it is not possible to confirm this.

Metals – Concentrations of some metals in groundwater exceeded the site assessment criteria as follows:

- » Concentrations of dissolved cadmium were reported at or marginally above the ANZECC criteria of 0.2ug/L at all locations apart from MW5. Concentrations ranged from 0.2ug/L at MW7 to 0.8ug/L at MW4;
- » Concentrations of dissolved copper were reported marginally above the ANZECC criteria of 1.4ug/L at all locations. Concentrations ranged from 1.9ug/L at MW2 to 6.6ug/L at MW4;
- » Concentrations of dissolved nickel were reported above the ANZECC criteria of 11ug/L at three locations, MW2; 37ug/L, MW3; 240ug/L and MW4; 130 ug/L;
- » Concentrations of dissolved zinc were reported above the ANZECC criteria of 8ug/L in all locations. Concentrations ranged from 8.7ug/L at MW6 to 230ug/L at MW3.

Other Inorganics – High levels of chloride, sodium and sulphate were reported in groundwater samples. Chloride ranged from 4600mg/L to 12000mg/L, sodium ranged from 3200mg/L to 6000mg/L and sulphate ranged from 1300mg/L to 1900mg/L. As a comparison, the ANZECC guidelines report damages to crops where chloride levels



exceed 700mg/L and sodium levels exceed 460mg/L. The Australian Drinking Water Guideline for sulphate is 500mg/L.

Concentrations of ammonia in groundwater were reported to range from 0.5mg/L to 0.7mg/L. These are within the ANZECC Guidelines but exceed the Australian Drinking Water guideline of 0.5mg/L.

BOD and COD – BOD and COD were recorded in groundwater samples taken from the Steggles site. COD ranged from 600mg/L to 2400mg/L whilst BOD was below the laboratory PQL.

Total Coliforms – concentrations of total coliforms ranged from 80cfu/100ml in MW4 to 32000cfu/ml in MW2, both on the Steggles Chicken Factory site. The ANZECC guideline value for faecal coliforms in water used for pasture and fodder for dairy animals and other grazing animals is 1000cfu/100ml, the level of total coliforms in the groundwater sample from MW2 exceeds this value.

4.5 Assessment of Quality Control Results

Blind and split duplicate quality samples were collected during the soil, surface water and groundwater sampling programmes. Analytical data for the quality samples is contained in **Tables D** (soil), **E** (surface water) and **F** (groundwater) in **Appendix B**.

The collection of field duplicate frequency is summarised in **Table 8**.

Table 8 Quality Sample Frequency

	Soils	Surface water	Groundwater
Primary samples analysed	68	5	7
Blind duplicate samples analysed	6	1	1
Split duplicate samples analysed	3	1	0
Total duplicate frequency	13%	40%	14%

4.5.1 Soils Quality Control Summary

RPD were calculated between the primary sample and quality control sample results, these are contained in **Table D** in **Appendix B**, RPDs were not calculated for BTEX, TPH, OCPs, OPPs and VOCs as the results reported below the laboratory PQL for these contaminants.

The nominal acceptance criteria used for the assessment of RPDs are $\pm 30\%$ for inorganic parameters and $\pm 50\%$ for organic parameters as provided in Australian Standard AS4482.1 (1997). Variations from these RPD criteria can be expected in heterogenous material or where low concentrations of analytes are detected.



The majority of RPDs fell within the appropriate criteria, however a small number of RPDs did fall outside the criteria, as summarised in **Table 9** below.

Table 9 RPD Exceedences - Soil

Duplicate pair	Analyte	RPD (%)	Comments
Blind Duplicate Pairs			
HA7 and QC1	Copper	30	Fill
TP2 and QC3	Benz(a)anthracene	67	Fill (overburden from adjacent quarry/landfill)
	Benzo(a)pyrene	67	
	Chrysene	67	
	Fluoranthene	67	
	Pyrene	67	
TP10 and QC5	Nickel	50	Fill (overburden from adjacent quarry/landfill)
	Benz(a)anthracene	100	
	Benzo(a)pyrene	100	
	Benzo(b) & (k) fluoranthene	67	
	Benzo(g,h,i)perylene	67	
	Chrysene	120	
	Fluoranthene	120	
	Indeno (1,2,3-c,d)pyrene	67	
	Phenanthrene	67	
	Pyrene	143	
TP26 and QC5	No exceedences		Re-worked natural materials
TP29 and QC9	Ammonia	74	Re-worked natural materials
MW5 and QC10	Benz(a)anthracene	67	Fill
	Benzo(a)pyrene	67	
	Benzo(b) & (k) fluoranthene	67	
	Benzo(g,h,i)perylene	67	
	Chrysene	67	
	Indeno (1,2,3-c,d)pyrene	67	
	Phenanthrene	100	
Split Duplicate Pairs			
HA12 and QC2	Arsenic	67	Fill
	Cadmium	133	



Duplicate pair	Analyte	RPD (%)	Comments
Blind Duplicate Pairs			
	Zinc	60	
TP16 and QC6	Lead	61	Fill
	Copper	37	
	Phenanthrene	86	
TP21 and QC7	Lead	32	Fill
	Chromium	33	

Elevated RPD were reported in duplicate samples taken from fill material, the RPD exceedences are therefore likely due to the inherent heterogeneity of the sample matrix. With respect to the PAH RPD exceedences, reported concentrations of PAHs in the duplicate sample pairs were low; generally either the primary or the duplicate sample was reported a result below the laboratory PQL. Such a small difference in concentration between the primary and duplicate pair gives rise to a high RPD value.

The RPD results for the soil samples do not cast doubt on the quality of the analytical data.

4.5.2 Surface Water Quality Control Summary

RPD exceedences in the surface water data set are summarised in **Table 10**.

Table 10 RPD Exceedences – Surface Water

Duplicate Pair	Analyte	RPD (%)	Comments
SW1 and QA1	Ionic Balance	120	Ionic balance is a calculation carried out using a number of other analytical results; the RPD result is therefore not relevant.
SW5 and QA2	Ammonia	67	Samples reported low concentrations meaning that a small variation in concentration gives rise to a relatively large RPD value.
	Lead	44	
	Chromium	70	
	Copper	38	
	Nickel	53	

The RPD results for the surface water samples do not cast doubt on the quality of the analytical data.

4.5.3 Groundwater Quality Control Summary

There were no RPD exceedences between the groundwater duplicate pairs (MW5 and QA3).



4.5.4 Laboratory Quality Control Programme

The NATA certified laboratories (Envirolab and Labmark) used for sample analysis undertook their own internal quality assurance and quality control procedures.

GHD has reviewed the internal laboratory control data (provided within laboratory results reports, **Appendix C**).

Laboratory duplicates, laboratory blanks, surrogate spikes, laboratory control samples and matrix spikes were used by Envirolab, method blanks, surrogate spikes, laboratory control samples and certified reference materials were used by Labmark.

Soil and water samples were generally analysed within the holding times as recommended by the testing laboratories, based on holding times set out in Schedule B(3) of the NEPM (1999), with the following exceptions:

- » Quality sample QA2, sampled on the 1 October 2008, was analysed for total coliforms on the 7 October 2008 – the laboratory recommended holding time for total coliforms is 24 hours; and
- » Quality Sample QA2, sampled on the 1 October 2008, was analysed for BOD on the 8 October 2008 – the recommended laboratory holding time for BOD is 2 days.

Laboratory duplicate RPDs returned results within the laboratory criteria of 0-50%, laboratory or method blanks returned results of less than the PQL, surrogate spike recovery was within the laboratory criteria of 60-140%, laboratory control sample and certified reference material recovery was within the laboratory criteria of 70-130%.

These results indicate that the laboratory preparation of samples and methods used were precise, accurate, reliable and reproducible for the sample matrix.

4.5.5 Summary of Quality Control Results

Overall, the assessment of the quality control results from the field and laboratory programmes indicated that the precision of the data is of an acceptable quality upon which to draw conclusions regarding the environmental condition of the Site at the time of the investigation.



5. Discussion

Table 11 (over page) provides a summary of the inferred contamination status of each individual lot within the Site, based on the data obtained to date via the GHD Phase 1 and Phase 2 investigations.

Table 11 also provides an updated “risk ranking” for each individual lot, based on the outcomes of the investigations documented herein.

In general:

- » GHD’s Phase 1 Investigations had identified a number of areas that have been subject to potentially contaminative activities.
- » Phase 2 Investigations have not identified any “gross” widespread contamination that would inhibit the suitability (from a contamination perspective) of the Site for redevelopment.

Nonetheless, some contamination was reported on various lots, which will require supplementary assessment, and potentially remedial work. Furthermore, some supplementary investigation is recommended across some other parts of the Site, where the data obtained to date is not considered to provide a comprehensive enough data set upon which to certify the suitability (from a contamination perspective) of those areas for rezoning and redevelopment.

The Marsden Park Landfill was specifically excluded from the Phase 2 study – as it has (and continues to be) the subject of contamination assessment work by others.

Furthermore, several areas of the Site were not accessible to GHD and as such, could not be subject to intrusive (Phase 2) sampling and analytical works.

Some further (more detailed) assessment will therefore be required across discrete parts of the Site, prior to redevelopment. Recommendations for further assessment are included in **Table 11**.

The Updated Risk Ranking scores are illustrated on the Final Contamination Risk Ranking Diagram, presented as **Figure 6, Appendix A**.



Table 11 Conclusions and Recommendations for Specific Areas of the Site

Lot and DP number/area of Site	Issues highlighted during Phase 1 assessment	Contamination issues identified (GHD intrusive investigations, October 2008)	Conclusions regarding suitability for use (with respect to soil and water contamination)	Updated Risk Ranking
Part of Lot 47 of DP 262886 and Lot 292 of DP 1076555 - Marsden Park Landfill site	The landfill monitoring report for Dec 06 to Dec 07 indicated that groundwater in the vicinity of the landfill site was generally of poor quality but apparently not significantly affected by the landfill site and that methane was being produced by the waste, but this did not appear to be migrating to external gas monitoring wells.	Area not subject to intrusive investigations	The soil, water and gas contamination status of the landfill site may alter as it nears completion. In particular the gassing regime is likely to alter when the landfill site is capped. Soil, water and gas contamination issues will require consideration prior to development in the area.	4
Areas of Lot 47 of DP 262886 and Lot 292 of DP 1076555 not currently landfilled – area referred to as landfill site	Landfill and quarry activities were believed likely to have affected the areas adjacent the landfill cells.	Additional soil investigations undertaken around the periphery of the landfill cells indicated fill material to a maximum depth of greater than 2.1m. Glass, wood, metal and possible asbestos containing materials were noted in TP22 and TP23. Levels of contamination were below the applicable HIL(F) values. Some exceedence of the PBILs were noted.	The suitability (or otherwise) of this area for redevelopment will require some further assessment, including after the capping of the adjacent landfill. In particular: » Some remedial work may be required to remove potential asbestos containing materials; » The capping of the landfill site may encourage lateral migration of landfill gas, this will need further consideration; and » Any open space areas may require “capping” to preclude potential exposure to fill containing building rubble.	3
Lot 36 of DP 262886 and part of Lot 35 of DP 262886 – area referred to as “Paddock”	The ‘paddock’ area was believed to have been used for the disposal of nightsoil materials. Overburden from the landfill site had also been deposited across the area.	Soil investigations indicated fill material across the site to maximum depths of greater than 2.6m. Fill material was generally re-worked clay material or shale spoil from quarrying activities. No evidence of nightsoil was noted. Occasional plastic and metal was noted in fill material. Levels of contamination were below the applicable HIL(F) values. Some exceedence of the PBILs were noted.	The paddock area appears suitable (from a contamination perspective) for industrial/commercial development.	2
Lot 291 of DP 1076555 including proposed Integral Energy site	Phase 1 contamination assessment reported under separate cover (GHD report ref. 2117717/143416, August 2008)	Area investigated and reported under separate cover (GHD report ref. 2117717/145262, November 2008)	The area appears suitable for commercial /industrial development.	1
Lots 11 and 12 of DP 262886 – former Council Sanitary Depot	Previous site investigation reports by URS (2002 to 2005) indicated that the area will require remediation to enable development. Further groundwater monitoring was recommended (by GHD) to update the existing data.	A groundwater monitoring well was installed in the south west corner of the area where industrial waste had been deposited. Concentrations of heavy metals in groundwater were reported slightly in excess of the ANZECC guidelines. Concentrations of TPH, BTEX, PAH and VOCs were below the laboratory PQL.	Groundwater contamination should not constrain industrial/commercial development of the area. Recommendations made by URS regarding remediation of soil contamination are still relevant.	4
Lot 1 of DP 747184 – Steggles Chicken Factory	Potential contamination issues were highlighted associated with the storage of fuels, the water treatment plant and surface waters.	Soil, surface water and groundwater investigations were undertaken. Fill materials were noted to maximum depths of 2.0m, fill materials were generally road base materials or re-worked natural materials. Concentrations of TPH C ₁₀ -C ₃₆ in MW1 and MW3 were elevated over the site assessment criteria, concentrations of B(a)P in MW4 were equal to the HIL(A).	It is apparent that soil, surface water and groundwater on the Steggles site is subject to some (limited) impact, most notably by ammonia and/or biological contaminants. The Steggles site is considered likely to be able to be made suitable for commercial or industrial development, subject to the following recommendations: » Further consideration should be given to the water quality in SW4, water quality treatment may be required if the dam is to be drained to another site or incorporated into	3



Lot and DP number/area of Site	Issues highlighted during Phase 1 assessment	Contamination issues identified (GHD intrusive investigations, October 2008)	Conclusions regarding suitability for use (with respect to soil and water contamination)	Updated Risk Ranking
		<p>Some exceedence of the PBILs were noted.</p> <p>Surface water sampling indicated levels of some heavy metals, ammonia and total coliforms above the applicable site assessment criteria.</p> <p>Groundwater sampling indicated levels of some heavy metals (in particular nickel and zinc), sulphate, ammonia and total coliforms above the applicable site assessment criteria.</p>	<p>the surface water network of the precinct;</p> <ul style="list-style-type: none"> » Sediment quality in SW4 is likely to have been affected. If this dam is to be drained and dredged, sediment quality may need further consideration; and » A minimum of one further groundwater monitoring round is recommended to confirm the first set of results. » More detailed soil, surface water and groundwater investigations are likely to be required to further characterise this area. <p>It must be noted that the section of the Site adjacent South Street may be considered for residential development – this area will require more comprehensive testing, given the more sensitive nature of the proposed land use.</p>	
Lot 25 of DP 262886 – Town and Country Caravan Park	Potential contamination issues were considered to be localised and not likely to pose a significant constraint to development.	Area not subject to intrusive investigations	Potential contamination issues are considered to be localised and not likely to pose a significant constraint to development.	1
Lot 32 of DP 262886 – adjacent to piggery	Additional investigations were recommended to assess the impact to soils and surface waters.	Soil investigations indicated re-worked natural materials at surface. Concentrations of metals were below the applicable HIL(F). Concentrations of total coliforms in one soil sample were higher than concentrations across the remainder of the Site, however did not exceed the site assessment criteria of 1 000 000 cfu/100g.	Some supplementary soil investigations are recommended, to confirm that impact by coliforms and/or nutrients are not widespread.	2
Lot 43 and 44 of DP262886 - residential plots	Potential contamination issues were considered to be localised and not likely to pose a significant constraint to development.	Area not subject to intrusive investigations	Potential contamination issues are considered to be localised and not likely to pose a significant constraint to development.	1
Lots 33, 34, 37 and 38 and part of lot 35 of DP262886 – agricultural land	Potential contamination issues were considered to be localised and not likely to pose a significant constraint to development – some isolated potentially asbestos containing materials noted on Lot 38.	Area not subject to intrusive investigations	Potential contamination issues are considered to be localised and not likely to pose a significant constraint to development, however some confirmatory testing of near surface soils recommended on Lot 38 to establish nature and extent of any asbestos-bearing material.	Mostly 1, one area ranked 2, see Figure 6
Lot 31 of DP 262886 - piggery	Additional investigations were recommended to assess the impact to soils and surface waters.	<p>Soil investigations indicated fill and re-worked natural materials in the areas investigated. Concentrations of metals were below the applicable HIL(F). Some exceedence of the PBILs were noted. Concentrations of total coliforms exceeded the site assessment criteria of 1 000 000 cfu/100g.</p> <p>Surface water sampling indicated levels of some heavy metals, ammonia and total coliforms above the applicable site assessment criteria in the three dams on site. It should be noted that SW3 appeared to be a non-permanent feature.</p>	<p>It is apparent that soil and surface water on the piggery site is subject to some (limited) impact, most notably by ammonia and/or biological contaminants.</p> <p>The piggery site is considered likely to be able to be made suitable for commercial or industrial development, subject to the following recommendations:</p> <ul style="list-style-type: none"> » Risks associated with high levels of soil-borne coliforms will require more detailed assessment, as will the reported ammonia levels; and » Surface water quality will require further assessment; and » Groundwater assessment of the piggery site is recommended, to assess the potential impact from soil-borne ammonia and coliform levels. <p>It must be noted that the section of the Site adjacent South Street may be considered for residential development – this</p>	3



Lot and DP number/area of Site	Issues highlighted during Phase 1 assessment	Contamination issues identified (GHD intrusive investigations, October 2008)	Conclusions regarding suitability for use (with respect to soil and water contamination)	Updated Risk Ranking
			area will require more comprehensive testing, given the more sensitive nature of the proposed land use.	
Lot 9 and 10 of DP262886 – adjacent Steggles and former sanitary depot	Soil investigations were recommended to confirm no migration of contaminants had occurred from neighbouring plots.	Soil investigations generally indicated re-worked natural materials with the exception of TP27 on the boundary with the former Sanitary depot, close to the former workshop, old bottles, brick, wood and a tar covered rock were noted. Concentrations of all analytes were below the site assessment criteria.	Potential contamination issues are considered to be localised and not likely to pose a significant constraint to development, however some confirmatory testing of near surface soils is recommended prior to development.	1
Lots 8 of DP 262886 and Lot 8 of DP 747184 – residential plots	Soil investigations were recommended adjacent the boundary of Steggles and in the area of the former nursery.	Area not subject to intrusive investigations. During site investigations contact was made with the former owner of the nursery, the nursery did not use or store on site commercial pesticides/chemicals.	Potential contamination issues are not considered likely to pose a significant constraint to development, however some confirmatory testing of near surface soils is recommended prior to development.	1
Lot 30 of DP 262886 – agricultural land	Potential contamination issues in these areas are considered to be localised and not likely to pose a constraint to development. No further investigations proposed.	These area were not subject to intrusive investigations	Potential contamination issues are considered to be localised and not likely to pose a constraint to development in these areas.	1
Lot 14 of DP 262886 – residential plot				
Lot 13, 15 and 16 of DP 262886 – agricultural land				
Lots 26 and 27 of DP 262886 – agricultural land				
Lot 21 of DP 262886 – machining shop	Limited soil and groundwater assessments were recommended in the vicinity of Lot 21.	Two groundwater wells were installed in this area. Fill materials were present at surface comprising sandy clays and mixed gravels. Concentrations of all analytes in soil were below the site assessment criteria. Concentrations of some heavy metals were slightly in excess of the ANZECC (2000) criteria.	Potential contamination issues are considered to be localised and not likely to pose a significant constraint to development, however some confirmatory testing of near surface soils is recommended prior to development.	2
Lots 17, 18, 19, 20, 22, 23 and 24 of DP 262886 – residential plots	Potential contamination issues in these areas are considered to be localised and not likely to pose a constraint to development. No further investigations proposed.	These area were not subject to intrusive investigations	Potential contamination issues are considered to be localised and not likely to pose a constraint to development in these areas. Some further consideration of potential asbestos containing materials in the areas of former buildings on Lots 21 and 22 of DP 584915 may be required. It should be noted that access was not granted to Lots 1 to 7 and 9, 11 and 12 of Section I, DP193074 and Lots 1, 2 and 3 of DP 17048 and as such these Lots have not been fully assessed. Supplementary assessment of these lots is recommended prior to development.	Mostly 1, some areas ranked 2, see Figure 6
Lots 1 to 7 and 9 to 12 of Section I, DP193074 – residential plots				
Lot 8 of Section I, DP193074 – 155 South Street				
Lots 21 and 22 of DP 584915 – vacant land, formerly residential/commercial plots				
Lot 1, 2 and 3 of DP 17048 – residential plots				
Lot 4 of DP 17048 – Produce market				



Lot and DP number/area of Site	Issues highlighted during Phase 1 assessment	Contamination issues identified (GHD intrusive investigations, October 2008)	Conclusions regarding suitability for use (with respect to soil and water contamination)	Updated Risk Ranking
Lot 5 and 6 of DP 17048 – vacant land/commercial property				
Lot 7 of DP 17048 – Bells Creek Nursery	Localised soil assessments were recommended	Soil investigations generally encountered fill materials at surface comprising gravely sands. Brick, plaster, wood, a tar like substance and possible asbestos containing materials were noted in the fill matrix. Concentrations of all analytes in soil were below the site assessment criteria.	Potential contamination issues are considered to be localised and not likely to pose a significant constraint to development, however some confirmatory testing of near surface soils is recommended prior to development. Some remediation or management may be required to address the possibility that asbestos-bearing fibro exists in the fill matrix.	2
Lot 4 of DP 27536 – Scrap Yard	Further soil, surface water and groundwater investigations are likely to be required – access is required to further assess this Lot	Access not granted to area	Given the nature of the current land use, soil, surface water and groundwater contamination is possible. Further investigations of the area will be required prior to any re-development.	3
Lot 3 of DP 27536 – residential plot	Potential contamination issues are considered to be localised and not likely to pose a constraint to development. No further investigations proposed.	Area not subject to intrusive investigations	Potential contamination issues are considered to be localised and not likely to pose a constraint to development.	1
Lot 1 and 2 of DP 27536 – Earth Exchange and Blacktown Landscape Supplies	Further soil, surface water and groundwater investigations are likely to be required – access is required to further assess this Lot	Access not granted to area	Given the nature of the current land use, soil, surface water and groundwater contamination is possible. Further investigations of the area will be required prior to any re-development.	3
Lot 1 of DP 88530 – Heartbreak Ridge Paintball	Limited assessments of imported fill were recommended.	Soil investigations concentrated on mounds of material on site, these comprised fill material, generally gravely sands. Concentrations of all analytes in soil were below the site assessment criteria.	The area appears suitable for commercial /industrial development.	1
Lot 1 of DP 397350 – part of Berkshire Park	Potential contamination issues are considered to be localised and not likely to pose a constraint to development. No further investigations proposed.	Area not subject to intrusive investigations	Potential contamination issues are considered to be localised and not likely to pose a constraint to development.	1
Lot 41 of DP 1100854 – RTA land	Targeted assessment of possible vehicle parking areas was recommended.	Although this site was subject to a site inspection, access not granted for intrusive investigations	Some localised soil contamination is possible in this area associated with the RTA's former use of the area to park vehicles. Further investigations are recommended.	2
Part of Lot subject to waste disposal	Further assessment of the waste disposal area was recommended.		Soil, surface water and groundwater contamination are possible in the area used as an unauthorised waste tip. Further investigations of this area of the site are recommended and remediation of the area should be expected, regardless of the intended use of this part of the Site.	3

Notes:

- 4 - Risk associated with contamination **Highly likely** to pose constraint;
- 3 - Risk associated with contamination **Likely** to pose constraint;
- 2 - Risk associated with contamination **Potential** to pose constraint; and
- 1 - Risk associated with contamination **Unlikely** to pose constraint.



6. Conclusions & Recommendations

GHD Pty Ltd (GHD) was commissioned by Marsden Park Developments Pty Ltd to undertake a Phase 1 and Phase 2 Contamination Assessment at a large area of land off Richmond Road, Marsden Park, NSW. The Site includes the Marsden Park Industrial Precinct.

A Phase 1 Contamination Assessment and a risk ranking of possible constraints was previously undertaken by GHD (GHD report ref. 2117717/142931). The Phase 2 Contamination Assessment focused on the areas of the Site ranked as having a substantial risk of being subject to contamination that may pose a constraint on the planned development (based on the outcomes of the Phase 1 Assessment).

Those areas of the Site ranked via the Phase 1 Assessment as having a low risk of being subject to contamination that would pose a constraint to the planned rezoning and redevelopment were not subject to intrusive (Phase 2) Investigations.

It must be noted that the Phase 2 study undertaken by GHD was targeted at specific “higher risk” portions on the overall Site (as identified via the Phase 1 study), and does not serve to characterise the entire Site for contamination in accordance with NSW DECC guidelines.

It should also be noted that the Marsden Park Landfill in the centre of the Site has not been investigated by GHD. The landfill is subject to a POEO license, under the conditions of which regular soil, water and gas monitoring is carried out by Consulting Earth Scientists. Soil, water and gas contamination issues are likely to be associated with the landfill site and these will require consideration prior to development in that area.

Access was not granted to all areas of the Site and as such some areas where contamination was suspected have not been investigated. These areas will require consideration prior to development of those parts of the Site

The intrusive investigations undertaken by GHD have not identified the presence of any gross, widespread contamination that would otherwise render the investigated areas unsuitable for rezoning and redevelopment, however some contamination was reported on various lots, which will require supplementary assessment, and potentially remedial work. In addition, some supplementary investigation is recommended across some other parts of the Site, where the quantitative information obtained to date is not considered to provide a comprehensive enough data set upon which to certify the suitability (from a contamination perspective) of those areas for rezoning and redevelopment.

Specific areas considered to warrant further (more detailed) assessment (and/or remedial action) include but are not limited to:

- » The Marsden Park Landfill and adjacent areas (particularly following closure and capping of the Landfill);



- » The former Council Sanitary Depot (Lots 11&12, DP262886) will require remediation as discussed in previous investigations by URS;
- » The Steggles Chicken Factory (Lot 1, DP747184) and adjacent areas;
- » The Piggery (Lot 31, DP262886) and adjacent areas;
- » The Bells Creek Nursery (Lot 7, DP17048);
- » The machining shop on Lot 21, DP262886;
- » The scrap yard on Lot 4, DP 27536;
- » The Earth Exchange / Blacktown Landscape Supplies (Lot 1 & 2, DP 27536);
- » The RTA owned land in the south east of the Site (Lot 41, DP1100854); and
- » Lots 1 to 7 and 9, 11 and 12, DP193074 and Lots 1, 2 and 3, DP 17048 (none of which could be accessed during the current study).

Furthermore, it is apparent that substantial portions of the remaining Site areas have been seemingly subject to some topographic modification (which may have included fill placement), or demolition of former fibro structures. Both of these activities could potentially introduce asbestos to the soil profile.

Potential asbestos containing material was visually spotted atop the surface in some areas. On this basis, it is recommended that a program of confirmatory near-surface soil testing (for asbestos) is carried out on the following areas:

- » Lots 33-38, DP262886 (current agricultural land), which may have been filled, and fibro was spotted on Lot 38; and
- » Lots 21 and 22, DP584915 (in the vicinity of former fibro-clad buildings, where some scattered fibro was observed).



7. Indicative Layout Plan Assessment

An indicative layout for the MPIP has been drafted by the Master Planners for the project; *Marsden Park Industrial Precinct – Draft Indicative Layout Plan - 27 April 2009*, (included in **Appendix A**).

Based on the evidence obtained in the Phase 1 and Phase 2 assessments for the Site, the following comments are made with respect to contamination issues and the indicative layout:

- » Although intrusive investigations undertaken by GHD did not identify the presence of any gross, widespread contamination that would present a major constraint to the Master Planning process, the following two areas require further consideration during the process:
 - Landfill site - Soil, water and gas contamination issues are likely to be associated with the landfill site. Development over the landfill cells presents particular problems with subsidence due to the degradation of waste materials and the generation of landfill gases. These issues require further assessment to demonstrate that development over the landfill cells is in fact feasible during the life of the MPIP project; and
 - Former Council Sanitary Depot (nightsoil disposal area) - Previous site investigation reports by URS (2002 to 2005) indicated that the area will require remediation to enable development.
- » Although not likely to present a major constraint to the Master Planning process, confirmatory testing of near surface soils is recommended prior to development of individual areas of the MPIP. In particular, more detailed investigation and/or remedial action are recommended at the following properties:
 - The Steggle's Chicken Factory (Lot 1, DP747184);
 - The Piggery (Lot 31, DP262886);
 - The Bells Creek Nursery (Lot 7, DP17048);
 - Lots 33-38, DP262886 (current agricultural land), where potential asbestos containing material was observed;
 - Lots 21 and 22, DP584915 (in the vicinity of former fibro-clad buildings) where potential asbestos containing material was observed; and
 - All other areas designated for residential development (in the master plan).
- » GHD notes that access was not granted to all areas of the Site and as such some areas where contamination was suspected have not been investigated. Again these areas are not envisaged to present a major constraint to the Master Planning process, however prior to development these areas should be assessed. Areas not inspected include but are not limited to:
 - The scrap yard on Lot 4, DP 27536;
 - The Earth Exchange / Blacktown Landscape Supplies (Lot 1 & 2, DP 27536);



- The RTA owned land in the south east of the Site (Lot 41, DP1100854); and
- Lots 1 to 7 and 9, 11 and 12, DP193074 and Lots 1, 2 and 3, DP 17048.

In summary, other than those areas previously identified (i.e. landfill cells and former Council Sanitary Depot), GHD is not aware of any identified contamination issues which would pose a major constraint to the proposed indicative layout plan. Additional site investigations would however be required in those areas outlined as warranting further assessment and in areas not previously assessed, in particular in areas identified for sensitive end uses (i.e. residential).



8. Limitations

This report is confidential and:

- (i) has been prepared by GHD for Marsden Park Developments Pty Ltd;
- (ii) may only be used and relied upon by the client;
- (iii) must not be copied to, used by or relied upon by any person other than the client;
- (iv) may only be used for the purpose of identifying the contamination constraints to development of the Marsden Park Industrial Precinct (and must not be used for any other purpose).

All results, conclusions and recommendations presented should be reviewed by a competent person, with experience in environmental investigations, before being used for any other purpose.

GHD accepts no liability for use of, interpretation of or reliance upon this report by any person or body other than the client. Third parties must make their own independent inquiries.

This report should not be altered amended or abbreviated, issued in part or issued incomplete without prior checking and approval by GHD. GHD accepts no liability that may arise from the alteration, amendment, abbreviation or part-issue or incomplete issue of this report. To the maximum extent permitted by law, all implied warranties and conditions in relation to the services provided by GHD and this report are expressly excluded (save as agreed otherwise with the client).

The extent of sampling of soils, surface water and groundwater and subsequent analysis, has been necessarily limited, and has been targeted towards areas where contamination is considered to be most likely (based on the results of a Phase 1 contamination assessment). This approach maximises the probability of identifying contaminants; however, it may not identify contamination that occurs in unexpected locations or from unexpected sources.

Soil and groundwater contamination is often highly variable, and it is possible that the contamination data used for the assessment may not reflect the conditions that may be encountered elsewhere on-site.

Site Conditions may change after the date of this Report. GHD shall bear no liability in relation to: (i) any change to site conditions after the date of this report; and/or (ii) any failure to update this report to account for any such change.

Further, soil, rock and aquifer conditions are often variable, resulting in non-homogenous contaminant distributions across a site. Contaminant concentrations have been identified at chosen sample locations; however, conditions between sample locations can only be inferred on the basis of the estimated geological and hydrogeological conditions and the nature and extent of identified contamination. Boundaries between zones of variable contamination are often indistinct, and have



been interpreted based on available information and the application of professional judgement. The accuracy with which the sub-surface conditions have been characterised depends on the frequency and methods of sampling and the uniformity of sub-surface conditions and is therefore limited by the scope of works undertaken.

The information contained herein is based partly on third party information and data, for which GHD provides no assurances.



Appendix A

Figures

Figure 1

Figure 2

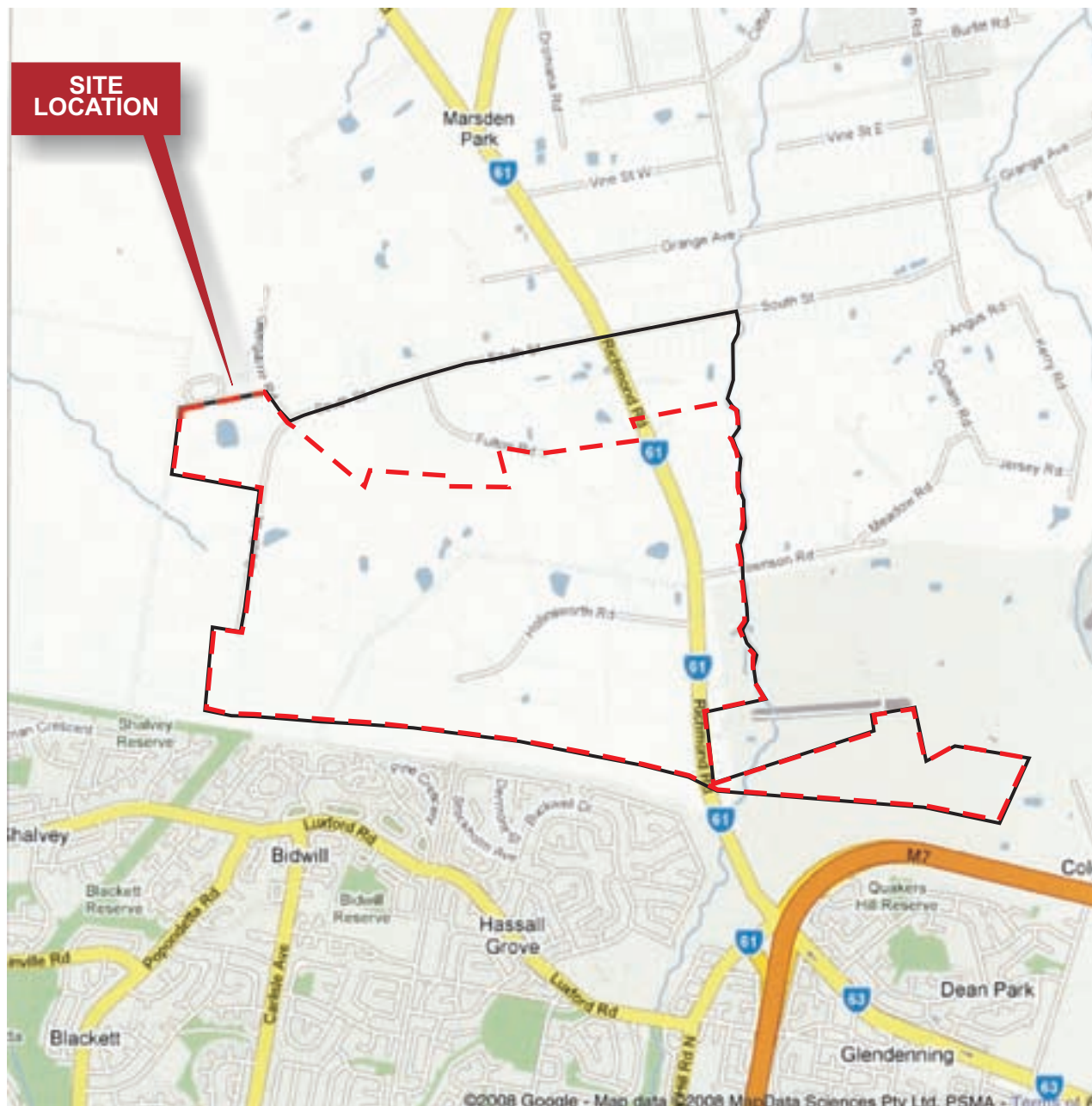
Figure 3

Figure 4



Figures 5 a to 5j

Figure 6

Indicative Layout Plan (dated 2 January 2009)



Legend

-  Site Boundary
-  Marsden Park Industrial Precinct Boundary

Source: Google Maps, accessed August 2008



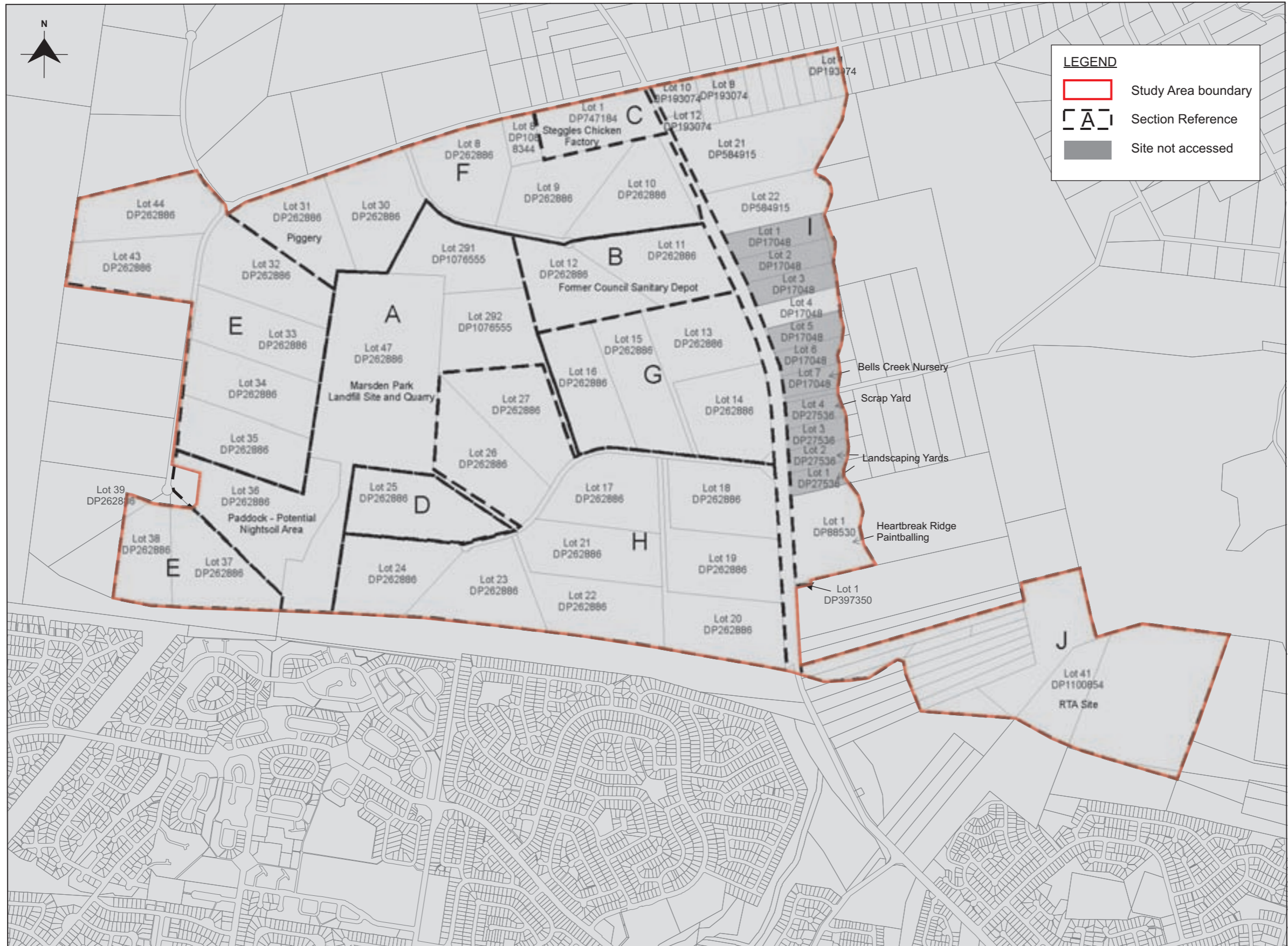
Phase 2 Contamination Assessment
Marsden Park Industrial Precinct
Marsden Park Developments Pty Ltd

job no | 21-17717
file ref | 21-17717 - P2Fig1.cdr

Site Location

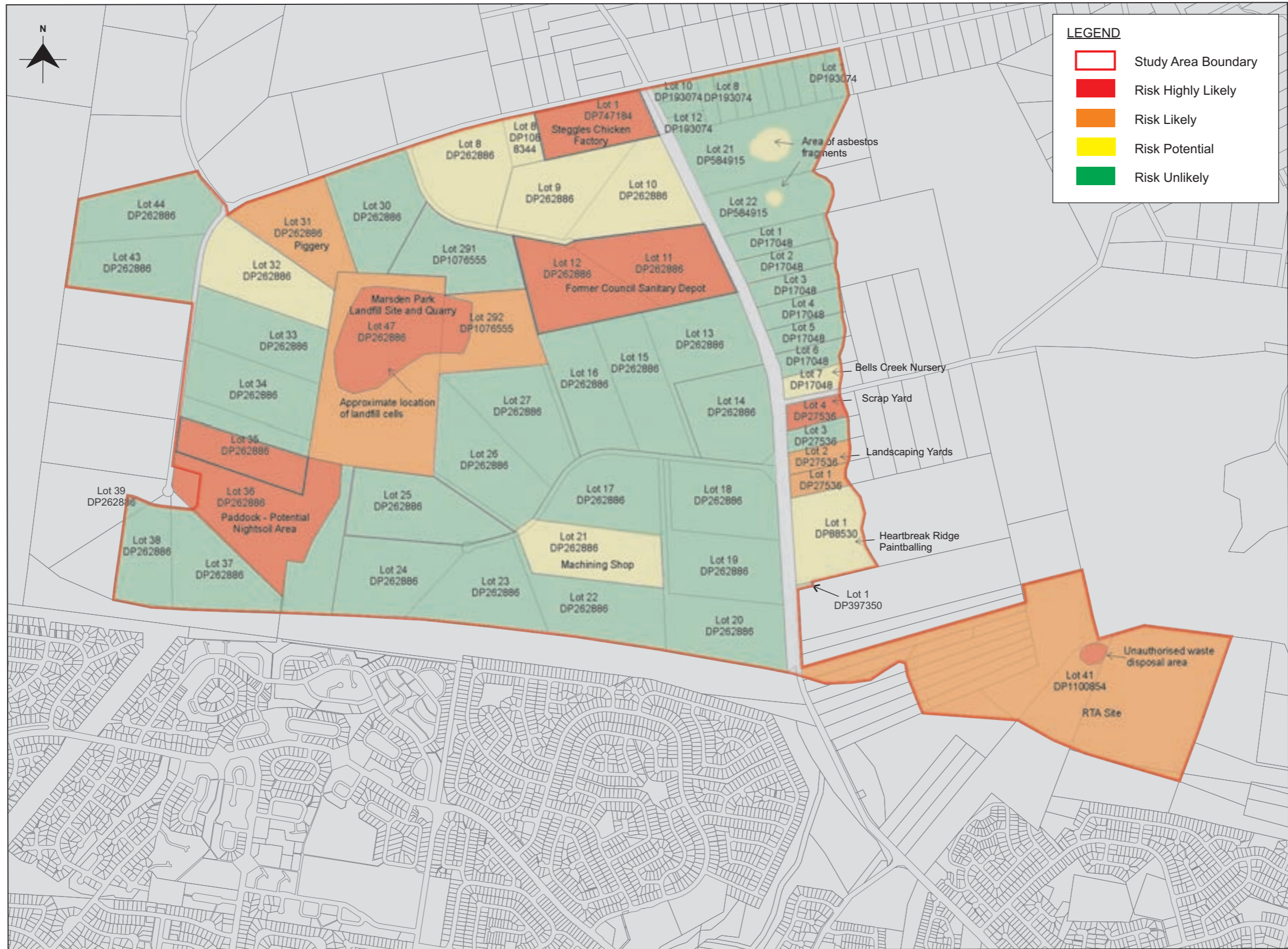
date | November 2008

Figure 1



Source: Growth Centres Commission

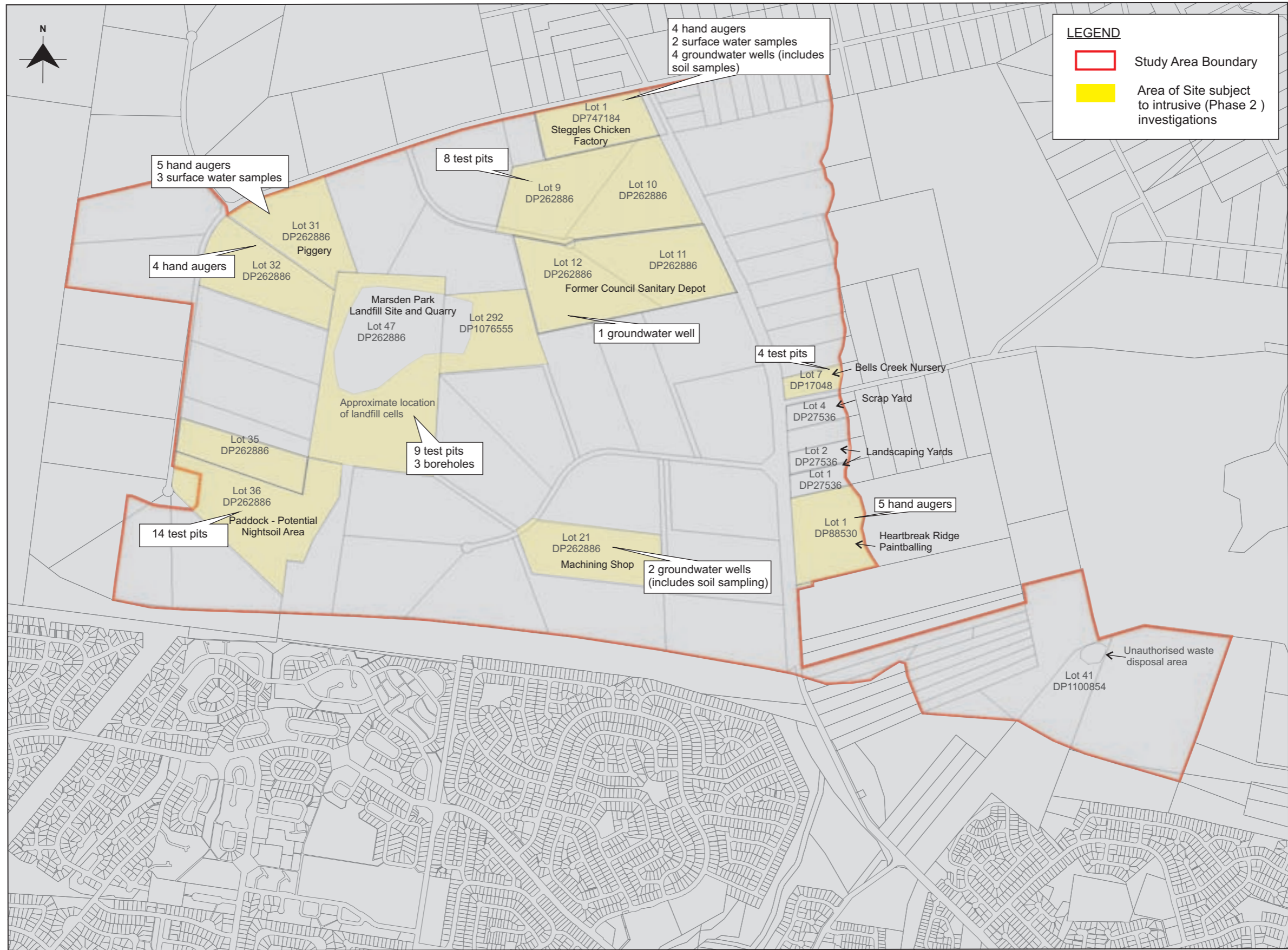
0 0.2 0.4
Scale Kilometres



GHD Note: Not all areas of the Site have been accessed therefore some risk rankings may be subject to change

Source: Growth Centres Commission








Source: Growth Centres Commission



Sampling Plan



Legend

-  Borehole Location
-  Test Pit Location
-  Sub-area Boundary



Source: Department of Lands Six Viewer, accessed October 2008



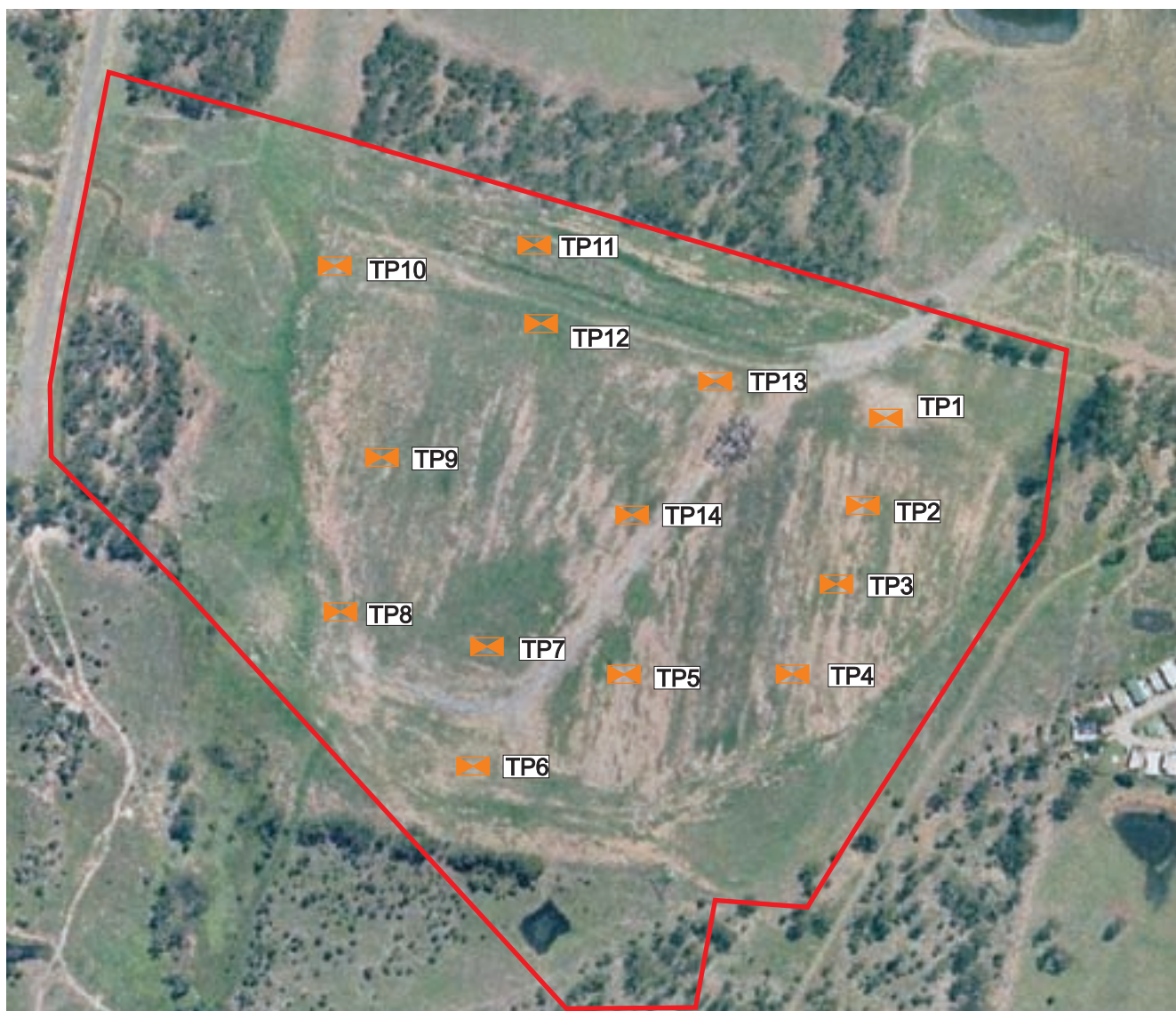
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Marsden Park Developments Pty Ltd

job no | 21-17717
file ref | 21-17717P2 - 5a.cdr



Sampling Locations - Landfill Site

date | November 2008

Figure 5a



Legend

-  Test Pit Location
-  Sub-area Boundary



Source: Department of Lands Six Viewer, accessed October 2008



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job no | 21-17717
file ref | 21-17717P2 - 5b.cdr



Sampling Locations - Paddock

date | November 2008

Figure 5b



Legend

-  Monitoring Well Location
-  Sub-area Boundary



Source: Department of Lands Six Viewer, accessed October 2008



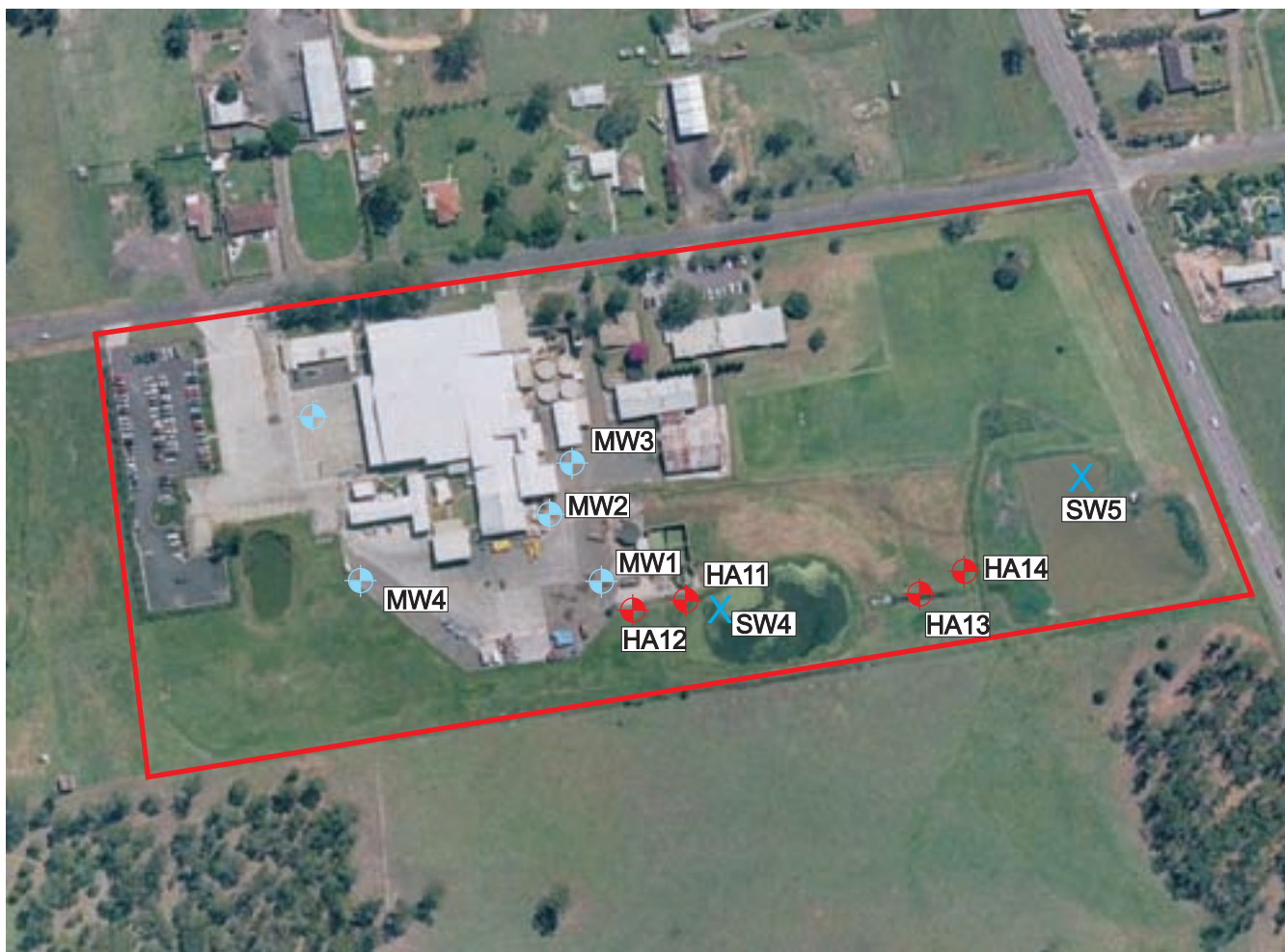
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file ref | 21-17717P2 - 5c.cdr





Sampling Locations - Council Depot

date | November 2008

Figure 5c



Legend

-  Hand Auger Location
-  Monitoring Well Location
-  Surface water sampling location
-  Sub-area Boundary



Source: Department of Lands Six Viewer, accessed October 2008



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file ref | 21-17717P2 - 5d.cdr

Sampling Locations - Steggles Chickens

date | November 2008

Figure 5d