**15 September 2014**

# ENVIRONMENTAL AUDIT REPORT

# Lot 611 Wadeye Community

**Submitted to:**
Kirstine Cossens - Acting CEO
Thamarrurr Development Corporation
Lot 463, Perdjert Street
WADEYE COMMUNITY, NT 0822

REPORT

**Report Number.** 147663038-003-R-Rev0

**Distribution:**

email: Kirstine Cossens (TDC)

Golder Associates

# Statement of Environmental Audit

This statement provides a summary of the findings of an Environmental Audit of the site referred to as **Lot 611, Wadeye Community, Northern Territory,** in accordance with Part 6 of the *Waste Management and Pollution Control Act (2013)*

| | |
|---|---|
| Auditor | Roger Parker |
| Auditor appointment end date | 21 November 2016 |
| Auditor's appointment category | Contaminated Land |
| Audit Type | Contaminated Land |
| Name of person requesting audit | Kirstine Cossens |
| Relationship of person requesting audit to site | Acting CEO of Thamarrurr Development Corporation (TDC) |
| Date of auditor engagement | 3 June 2014 |
| Completion date of the audit | 12 September 2014 |
| Reason for audit | Condition Precedent 1 of Planning Development Permit DP12/0070:<br>*"Prior to the commencement of works on Lot 611, the applicant must demonstrate to the satisfaction of the Consent Authority, on the advice of NRETAS that the land is suitable for the intended residential use in accordance with the National Environment Protection (Assessment of Site Contamination) Measures 1999."* |
| Environmental Segments | Land and Groundwater |
| Current land use zoning | Residential |
| Municipality | Wadeye Community |
| Dominant Lot on title plan | Lot 611, N.T. Portion 01637 |
| Site/Premises name | Lot 611, Wadeye Community |
| Suburb | Wadeye Community |
| Postcode | 0822 |
| GIS Coordinate of Site centroid: | |
| Latitude (GDA94) | -14.244714° |
| Longitude (GDA94) | 129.522791° |
| Site area (in square metres) | 775 $m^2$ |

**Summary of Findings**

The site is part of the NT Government Subdivision Development and New Airport Apron Project being undertaken by TDC. Following the construction of a new airport terminal, parcels of land comprising the former airport terminal have been assigned to the development of a new 25 lot subdivision (Lots 611 to 635). The site comprises Lot 611 which is one of the last of the lots to be developed and is the only lot requiring audit given that its former use included storage of small quantities of aviation fuel.

An Environmental Site Assessment (ESA) undertaken by Cardno UNG found that all petroleum hydrocarbon and polycyclic aromatic hydrocarbon (PAH) results were below the laboratory limit of reporting (LOR). Cadmium, copper and mercury were below LOR. Arsenic, lead, and zinc had concentrations below assessment criteria. Total chromium concentrations were reported to be in excess of the HIL-A value for chromium VI. Chromium VI was not analysed separately. The ESA discusses the low likelihood of chromium VI to be present given the site's setting and history.

Based on the investigation work presented in the ESA, it is the Auditor's conclusion that subject to the implementation of appropriate management measures during site development, the risk to human health presented by potential unknown contamination at the site and the measured inferred background concentrations is low and acceptable.

The Auditor considers potential risk to onsite ecological receptors presented by potential unknown contamination at the site and the measured inferred background concentrations to be of low significance.

Based on the investigation and assessment presented in the ESA, potential risks to human health and ecological receptors resulting from offsite migration of contamination is limited. Given the low likelihood of residual contamination to remain at the site, the potential for offsite migration of onsite contamination is considered to be low.

Condition 1 of the Development Permit (DP12/0070) is considered to have been met (subject to the implementation of an EMP). A copy of the Development Permit Schedule of Conditions is appended to this document as Appendix A.

The Auditor considers that soil erosion control measures have been employed at the site. Earthworks were in good condition at the time of the site visit on 17 June 2014 and there is little evidence that significant erosion has occurred. As far as is ascertainable from the information provided and the Auditor's site visit, Condition 3 of the appended Development Permit (DP12/0070) is considered to have been met.

**Suitability of the Site**

Based on the reviewed documentation, the Auditor concludes that Lot 611 is suitable for use as a residential dwelling with accessible soil areas, subject to subject to implementation of an Environmental Management Plan as recommended by Cardno UNG.

The Auditor notes that the reviewed documentation did not include an EMP. Cardno UNG state that the EMP should include provision to *"assess and manage any unexpected indicators of contamination during future building works at the site."*

The Auditor considers that the EMP should be a brief document explaining that although no contamination was found to be present at the site, due to potentially contaminating activities having been undertaken at the site in the past, there is the potential for unknown contamination to be present beneath the site's surface.

As such, when carrying out development at the site, a watching brief should be kept for the presence of indicators of potential contamination such as odours, staining, or the presence of free product. If any of these are suspected, then the advice of a suitably qualified environmental professional should be sought and appropriate notification made to the Northern Territory Environment Protection Authority (NT EPA). The Auditor does not consider that there is any need for management measures beyond the period of site development.

It is recommended that the EMP be prepared by a suitably qualified professional and reviewed by an Environmental Auditor prior to commencement of development works.

The limitations outlined in Section 13 of the Environmental Audit Report should be referred to. Figures 1 and 2 of the Environmental Audit Report show the site location and a plan of the site.

DATED: 11 September 2014

SIGNED: 

**ROGER PARKER**

Environmental Auditor (Appointed pursuant to the Victorian Environmental Protection Act 1970) and recognised in the Northern Territory under Part 6 of the *Waste Management and Pollution Control Act 2013*

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**APPENDICES**

# 1.0 INTRODUCTION

Mr Roger Parker of Golder Associates Pty Ltd (Golder) was engaged by Thamarrurr Development Corporation (TDC) to act as Environmental Auditor (the Auditor) in relation to land located at Lot 611, Wadeye Community, Northern Territory (the site). The site location and site plan are shown on Figures 1 and 2.

The Auditor was requested to verify compliance with specific conditions outlined in the Development Permit DP12/0070 which is attached to this document as Appendix A. The specific conditions triggering the request for the Environmental Audit are:

- Condition 1: *"Prior to the commencement of works on Lot 611, the applicant must demonstrate to the satisfaction of the Consent Authority, on the advice of NRETAS that the land is suitable for the intended residential use in accordance with the National Environment Protection (Assessment of Site Contamination) Measures 1999."*
- Condition 3: *"Soil erosion control measures must be employed throughout the construction phase of the development to the satisfaction of the consent authority."*

Contact details for Roger Parker:

Roger Parker – Victorian appointed Environmental Auditor – reappointment due 21 November 2016
Golder Associates Pty Ltd
PO Box 6079
Hawthorn West VIC 3122
Ph: 03 8862 3500
Fax: 03 8862 3501
rparker@golder.com.au

Given Mr Parker is an appointed Victorian Environmental Auditor, he is able to act as an Environmental Auditor in NT under Part 6 of the Waste Management and Pollution Control Act, January 2013. The Act requires an Environmental Audit be conducted by a "Qualified Person" who is accredited under either the New South Wales Site Auditor Scheme or the Victorian Environmental Auditor Scheme.

TDC has engaged Roger Parker to conduct an Environmental Audit (the Audit). It is understood that TDC was formed following local government reform in 2007 and is leasing the site from Daly River / Port Keats Aboriginal Land Trust. The Northern Territory Environment Protection Authority (NT EPA) was advised of the Audit in correspondence to Ryan Wagner (Environmental Officer – Pollution Control) on 13 June 2004. This correspondence is included within Appendix C (Auditor Correspondence).

# 2.0 EXECUTIVE STATEMENT

**The Auditor considers that the site is suitable for the proposed land-use as residential dwellings with garden / accessible soil area <u>subject to a site environmental management plan (EMP) being put in place to assess and manage any unexpected indicators of contamination during future building works at the site</u>, as recommended in the reviewed documentation prepared by Cardno Ullman & Nolan:**

- Cardno Ullman & Nolan (2014) Final Report on Tier 1 Environmental Site Assessment, Lot 611 Wadeye Community, NT (Ref U33277, dated 15 August 2014).

Condition 1 of the Development Permit (DP12/0070) is considered to have been met (subject to the implementation of certain management measures to be outlined in an Environmental Management Plan (EMP)).

The Auditor considers that soil erosion control measures have been employed at the site. Earthworks were in good condition at the time of the site visit on 17 June 2014 and there is little evidence that significant erosion has occurred. As far as is ascertainable from the information provided and the Auditor's site visit, Condition 3 of the appended Development Permit (DP12/0070) is considered to have been met.

## 3.0 SITE IDENTIFICATION

The site is part of the NT Government Subdivision Development and New Airport Apron Project being undertaken by TDC. Following the construction of a new airport terminal, parcels of land comprising the former airport terminal have been assigned to the development of a new 25 lot subdivision (Lots 611 to 635). The site comprises Lot 611 which is one of the last of the lots to be developed and is the only lot requiring audit given that its former use included storage of small quantities of aviation fuel.

The legal description of the site is summarised in the table below.

**Table 1: Legal Identification Lot 611**

| | **Lot 611** |
|---|---|
| Land Description | Lot 611, N.T. Portion 01637 Nemarluk |
| Property Street Address | Lot 611, Wadeye Community, Northern Territory 0822 |
| Current Legal Description | Lot 611, Wadeye Community, N.T. Daly River / Port Keats Aboriginal Land Trust (as detailed on Survey Plan CP 004183, dated October 1978) |

## 4.0 DOCUMENT OVERVIEW

The structure of this report is consistent with the requirements for Environmental Audits in Victoria and the Auditor's expectation of what is required in the Northern Territory. An additional section has been included (Section 6.0 Audit Scope and Methodology) to outline the scope of and the approach to the Audit. Other sections included (Section 7.0 Site Assessment) provide a summary of the assessment presented in each of the reviewed documents (listed in Section 5.0 Audited Documentation), reference to Auditor correspondence and summary of outstanding Auditor comments. This section has been included to provide a basis for the information summarised in Section 8.0 Site Characteristics. Information presented in Sections 7.0 and 8.0 of this report is summarised from the audited documents with Auditor correspondence and outstanding Auditor comments presented in boxed text at the end of each sub section in Section 7.0.

Discussion from the Auditor is subsequently presented as follows:

- Section 9.0 Basis of Adoption of Assessment Criteria
- Section 11.0 Auditor's Assessment
- Section 12.0 Auditor's Conclusions and Recommendations.

Information included with this report:

- Figures 1 and 2 – Golder Site Location Plan and Site Boundary Plan
- Figure 3 – Figure reproduced from audited Cardno UNG documentation (Site Layout and Sampling Location plan)
- Appendix A – Copy of Development Permit Schedule of Conditions (DP12/0070)
- Appendix B – Audited Documentation
- Appendix C – Auditor Correspondence
- Appendix D – Limitations.

## 5.0 AUDITED DOCUMENTATION

A summary of contaminated sites assessment undertaken and reviewed as part of the Audit is summarised in the table below. Copies of these reported are included in Appendix B.

**Table 2: Summary of Contaminated Sites Assessment reviewed as part of Audit**

| Assessment Stage | Date | Description | Document Reference |
|---|---|---|---|
| Stage 1 Environmental Site Assessment | 9 June 2014 | Stage 1 Environmental Site Assessment with preliminary sampling | *Cardno Ullman and Nolan Geotechnic (Cardno UNG, 2014a). Lot 611 Wadeye Community, NT. Final report on Stage One Environmental Site Assessment. Prepared for Thamarrurr Development Corporation. 9 June 2014.* |
| Stage 1 Environmental Site Assessment | 15 August 2014 | Table including summary of auditor comments and Cardno UNG responses to comments | *Cardno Ullman and Nolan Geotechnic (Cardno UNG, 2014b). Summary Table of Auditor Comments and Cardno Responses.* |
| Stage 1 Environmental Site Assessment | 15 August 2014 | Revision of Cardno UNG (2014a) further to Auditor comments | *Cardno Ullman and Nolan Geotechnic (Cardno UNG, 2014c). Lot 611 Wadeye Community, NT. Final Report on Stage One Environmental Site Assessment. Prepared for Thamarrurr Development Corporation. 15 August 2014.* |

## 6.0 AUDIT SCOPE AND METHODOLOGY

The Audit commenced in June 2014 with a walkover of the site by the Auditor on 17 June 2014 and the review of the Environmental Site Assessment undertaken by Cardno UNG, (Cardno UNG 2014a) which included soil investigations. The Audit was completed with the review of Cardno UNG (2014b) (a tabulated response to Auditor comments) and Cardno UNG (2014c) (final report) which were undertaken in response to the Auditor's letter of 18 June 2014 which requested a number of clarifications from Cardno UNG. A copy of the Notification of Request to Issue a Certificate of Environmental Audit for the site and the Auditor's letter following review of Cardno UNG (2014a) are presented in Appendix C of this report. Cardno UNG (2014b) is also provided in Appendix C.

The purpose of the Audit was to evaluate whether, in the opinion of the Auditor, the contamination investigations provided in the documentation undertaken by Cardno UNG are complete, accurate, reliable and in accordance with Northern Territory legislation, relevant guidelines and policies. In addition, the purpose of the Audit was to assess whether the work completed by Cardno UNG was sufficiently sound to form a basis for decisions or actions relating to the proposed use of the site as a residential dwellings with garden / accessible soil areas. An assessment was also made on the erosion control measures put in place as part of the construction phase of the development.

The approach taken to the Audit is summarised as follows:

- The site was visited by the Auditor on 17 June 2014, for the purpose of undertaking a site walkover to visually assess the current condition of the site and its immediate surroundings.
- The audited document (Cardno UNG, 2014a) was reviewed by the Auditor and comments provided to TDC and Cardno UNG on 18 June 2014.
- An updated version of the report and the corresponding response to Auditor comments prepared by Cardno UNG (Cardno UNG, 2014b and Cardno UNG, 2014c) were subsequently reviewed. All Auditor comments on the first version of the report were either closed (comment addressed or appropriate explanation provided), noted (explanation provided by Cardno UNG with no further response required from the Auditor) with none being left open to be addressed in subsequent assessment/documentation.
- The NT EPA requires assessment of site contamination to be conducted in accordance with the *National Environment Protection (Assessment of Site Contamination) Measure 1999 (amended 2013)* (the NEPM). Therefore, review of audited documents included assessment against NEPM requirements. This included, but was not necessarily limited to:

- Review of the site description (including current use and site activities), environmental setting (including geology and hydrogeology) and history
- Scope of work against the objectives
- Basis of design of scope of work (including presented data quality objectives (DQOs))
- Basis of selection of assessment criteria
- Field methodologies including sample collection, handling and transport
- Quality Assurance / Quality Control (QA/QC) programs and performance
- Results presented and supporting documentation (such as field notes, test pit logs, chain of custody documentation, laboratory analytical reports etc.)
- Assessment of results including development of the conceptual site model (CSM), risk assessments and discussions
- Conclusions drawn and recommendations made.

# 7.0 SITE ASSESSMENT

The following provides a summary of the main aspects of the Environmental Site Assessment (ESA) prepared by Cardno UNG (2014c).

## 7.1 Objective

The objective as stated in the ESA was to:

- Identify the potential for contamination within the proposed allotment as part of the residential subdivision development.

## 7.2 Scope

The scope of work included:

- Review of the site background information available online or within existing Cardno databases
- Review of the environmental setting of the site
- Review of information pertaining to potential contamination at the site
- A visual inspection of the site to confirm and ground-truth the desktop information
- Interviews with available staff to assess the nature of the activities and land use(s) conducted at the site
- Indicative surface soil sampling within high risk areas
- Development of a preliminary CSM to assist in assessing potential risk to human health and the environment
- Preparation of a Stage 1 Contamination Assessment report.

The Assessment Guidelines section of the ESA lists the selected assessment criteria to include Health Investigation Levels (HILs) and Health Screening Levels (HSLs) as set out in the NEPM.

## 7.3 Site History and Site Inspection Summary

The site history summary stated that potential soil contamination may include petroleum hydrocarbons associated with the presence of an emergency aircraft fuel depot that was present within Lot 611 prior to development. The fuel depot was known to store no more than six drums (totalling about 1,000 litres) and the refuelling of the aircraft occurred within the bitumen apron and was only carried out in emergencies as

aircraft were responsible for carrying sufficient fuels to return back to Darwin without the need to refuel at Wadeye. The Site History interview of Thamarrurr Development Corporation personnel undertaken by Cardno UNG also confirmed that approximately 450m$^3$ of soil was cut from Lot 611 and removed from site and approximately 60m$^3$ of select fill was brought onto site (prior to the soils investigation undertaken by Cardno UNG).

Field observations during the Cardno UNG walkover included that the site comprises near level cleared land devoid of any vegetation. The adjacent allotment to the east (Lot 215) includes the former airport terminal building with semi-mature trees. A preliminary conceptual site model (CSM) was developed following the site history review and site inspection. Potential risks to construction workers and future residential occupants of the site with direct contact with the soil were identified as potentially complete exposure pathways. For this reason, field sampling was proposed to quantify risk to potential receptors.

## 7.4 Fieldwork

Cardno UNG undertook a site inspection and intrusive investigation on 11th December 2013 and made general observations on Lot 611 and the surrounding area such as infrastructure, slopes, drainage and vegetation.

An excavator was used to excavate 4 test pits at the location of the former fuel storage area and samples were taken from each test pit at depths of 0-0.25m 0.25-0.5m and 0.5-0.75m. Fieldwork procedures gave consideration to the NEPM and AS4482 guidelines.

Ground conditions observed by Cardno UNG during the soil sampling comprised silty sandy gravelly fill materials (0.3 m depth) overlying natural clayey sandy gravel. Staining and odours were not reported at any of the four sampling locations.

## 7.5 Sampling Results Summary

All PAH results were below the laboratory limit of reporting (LOR). Cadmium, copper and mercury were below LOR. Arsenic, lead, nickel and zinc had concentrations below assessment criteria. Total chromium concentrations above the EIL for trivalent chromium (Cr III) within each sample, and above HIL-A for hexavalent chromium (Cr IV) within each sample. Speciation of chromium was not undertaken.

The report concluded that the analytes tested were below levels identified as suitable for the proposed land use in relation to the protection of human health. The report also concluded that where residential housing is likely to contain "*extensive horticultural gardens for produce*" further assessment Cr IV concentrations may be justified.

## 7.6 Cardno UNG Conclusion

The ESA (Cardno UNG, 2014c) concludes:

*"The site is considered suitable for the proposed residential land-use, subject to a site environmental management plan being put in place to assess and manage any unexpected indicators of contamination during future building works at the site."*

# 8.0 SITE CHARACTERISTICS

The Stage One Environmental Site Assessment (Cardno UNG (2014c)) presents background information for site description, site history, geology, hydrogeology and CSM. Information from this report and supplementary information from the Auditor's site walkover undertaken on 17 June is summarised in Sections 8.1 to 8.6.

## 8.1 Site Description/History

The site location and plan are presented on Figures 1 and 2. The site is part of the NT Government Subdivision Development and New Airport Apron Project being undertaken by TDC. Following the construction of a new airport terminal, parcels of land comprising the former airport terminal have been assigned to the development of a new 25 lot subdivision (Lots 611 to 635). The site comprises Lot 611 which is one of the last of the lots to be developed. The former terminal building is still in existence and is

located to the north west of Lot 611. The subdivision, including Lot 611 is generally flat although it grades down to gullies either side of the development.

Lot 611 is level and has a gravelly soil surface. There has been some cut to level the block with a cut surface evident on the north west side near the former terminal building (Cardno UNG report that the cut volume was approximately 450m$^3$ ). There may be fill on the other side of the site to form the level platform. It is understood that a veneer of fill has been placed across the surface (Cardno UNG report that the fill volume was approximately 60m$^3$).

To the north of the site lies Wadeye School and to the south is residential subdivision development (Lots 612 to 635) which is either recently constructed or nearing completion. The existing airport terminal and airstrip are located 500 m to the south east of Lot 611.

Prior to the Cardno UNG investigation undertaken in 2013, there are no environmental investigation works known to have taken place. Cardno UNG completed a Geotechnical Site Classification Assessment (April, 2013) within neighbouring Lots 624 – 634 for the purpose of providing geotechnical recommendations for the development.

The site history summary stated that potential soil contamination may include petroleum hydrocarbons associated with the presence of an emergency aircraft fuel depot that was present within Lot 611 prior to development. The fuel depot was known to store no more than six drums (totalling 1,000 litres) and the refuelling of the aircraft occurred within the bitumen apron and was only carried out in emergencies as aircraft were responsible for carrying sufficient fuels to return back to Darwin without the need to refuel at Wadeye. The Auditor site visit included an inspection of the current emergency fuel storage area. The drums were stored on an un-bunded, sealed surface and there was no evidence of spillage, leakage or staining.

The fuel storage was used for approximately 20 years prior to being decommissioned. The land use prior to the development of the airport infrastructure is unknown but is unlikely to have included any commercial or industrial use of the land.

## 8.2 Environmental Setting

Lot 215 to the north west of the site includes the former airport terminal building and semi-mature trees, which are still present. Lot 142 to the north of the site includes Wadeye School and contains single storey classrooms and covered common areas. The Lot contains sporadic semi-mature trees and grasses. Lot 613 to the south east includes a newly constructed residential dwelling with carport. The property is devoid of any vegetation and gradually slopes towards the east.

The site is situated in the Port Keats catchment area. The coastline is approximately 11km to the west and Sandfly Creek is the closest watercourse to the site at approximately 650 m to the west, running south east to North West, then northerly past the township. Cardno (2014) considers that stormwater flow across the Wadeye area is likely to be towards the north and west, into Sandfly Creek.

The southern Wadeye region has been classified as “Extremely Low Probability / Low Confidence” with regards to containing Actual Acid Sulphate Soils (ASS) or Potential Acid Sulphate Soils (PASS).

## 8.3 Geology

The geology of the area is described in the published maps and information from the Northern Territory Geological Survey, 1:250,000 Geological Map Series and explanatory notes of Port Keats (Sheet SD 52-11, 1971). The site is underlain by:

- *Port Keats Group of the Triassic Permian Period (200-300Ma). Consists of micaceous sandy siltstone, siltstone, sandstone, minor limestone and basal conglomerate units.*
- *Recent Tertiary (Cainozoic) alluvial and colluvial deposits of unconsolidated sand and clayey sand occur as a thin cover over the lower Port Keats Group and surrounding areas.*

The geology identified during sampling consisted of silty sandy gravel fill materials (pale brown, fine to coarse grained, angular to sub-rounded, fine to coarse grained sand) to 0.3 m depth, overlying natural clayey sandy gravel (orange-brown, fine to medium grained, sub angular to sub rounded fine to coarse grained sand).

## 8.4 Hydrogeology

The hydrogeology section of Cardno UNG (2014c) includes a list of registered borehole data obtained from a search of the Natural Resource Maps NT and Department of Lands Resource Management Groundwater database. There are over 20 registered groundwater bores within a 5km radius which are associated with rural residential and agricultural properties. Based on the published groundwater bore information, Cardno indicate the groundwater level to be 11 m to 13 m below ground level and that risks to groundwater can be discounted. In order to provide some verification of these statements, Golder sourced topographical information from a published GIS source, referenced as:

> World_Topo_Map - Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), and the GIS User Community)

This reference confirmed that the topographic level at the site is approximately 25 m above sea level and therefore it is considered that the depth to groundwater would not be less than that assumed by Cardno UNG. On this basis and considering the conceptual site model, the Auditor agrees with the Cardno UNG statement that the possibility of risk to groundwater can be discounted.

## 8.5 Extent of Impacts

All petroleum hydrocarbon results were below the laboratory limit of reporting (LOR). Cadmium, copper and mercury were below LOR. Arsenic, lead, and zinc had concentrations below assessment criteria.

Total chromium concentrations were reported to be in excess of the HIL-A value for chromium VI. Chromium VI was not analysed separately. Cardno UNG (2014c) discusses the low likelihood of chromium VI to be present given the site's setting and history. The Auditor agrees with the Cardno UNG statement that the chromium concentration is likely to consist of chromium III, and is also likely to be associated with background concentrations in the area.

The Auditor considers that the EILs presented for chromium III and nickel have not been calculated correctly and should be lower than those presented in Table 1 of Cardno UNG (2014c). This causes the site concentrations to exceed EILs for residential land-use for both chromium III and nickel.

Further to this, as background samples were not taken in order to derive an ambient background concentration, Cardno UNG have conservatively compared the site concentrations directly with the added contaminant limit. This approach is considered to overestimate the risk as in reality, the concentrations reported are likely to be representative of background rather than being representative of any impact from the site.

These results indicate that the site has not been impacted by any of the potential contaminants considered.

## 8.6 Conceptual Site Model

A preliminary CSM was developed for the site as part of the Stage One Environmental Site Assessment and was used to inform the soil sampling strategy. The CSM was not further updated following consideration of the soil results.

In summary, the CSM considered total recoverable hydrocarbons, benzene, toluene, ethylbenzene, xylenes and polycyclic aromatic hydrocarbons as the potential contaminants of concern with the source being spills and leaks associated with the former fuel depot. Potential contamination pathways via soil, groundwater and surface water are discussed and potential receptors considered are construction workers and future residential occupants of the site.

Overall (taking into account Cardno UNG's response to Auditor comments), the audited documents conclude that reported concentrations are consistent with background conditions and therefore there are no unacceptable risks associated with the site's previous use. The CSM was not subsequently revised however the audited documentation has shown there to be no viable source – pathway – receptor linkages following the intrusive investigation and the provision of the requested clarifications.

# 9.0 BASIS OF ADOPTION FOR ASSESSMENT CRITERIA

## 9.1 Soil Assessment Criteria

The Assessment Guidelines section of the ESA (Cardno UNG, 2014a) lists the selected assessment criteria to include HILs and HSLs as set out in the NEPM specifically:

- HIL-A and HSL-A (residential end use with garden / accessible soil)

Comparisons were also made against the following assessment criteria:

- HIL-B (residential with minimal opportunities for soil access)
- HIL-C (public open space)
- HIL D and HSL-D (commercial / industrial)
- Ecological Investigation Levels (EILs) for the protection of terrestrial ecosystems
- Management Limits (non-health based – e.g. aesthetic considerations)
- Canadian Council of Ministers of the Environment (CCME) Protection of Groundwater for potable and livestock supply
- Landfill acceptance criteria (Vantassel and Hogans Pocket Landfills, Queensland).

Based on the identified receptors and CSM for the site, the Auditor considers HIL-A, HSL-A, EILs and ESLs to be appropriate for use in assessing the site. The remaining assessment criteria listed above are not considered to be relevant to the site.

## 9.2 Groundwater Assessment Criteria

The assessment did not require comparisons with groundwater assessment criteria as the CSM demonstrated that risks to groundwater could be discounted based on the absence of a source of impact. Groundwater was not sampled as part of this assessment.

# 10.0 QUALITY ASSURANCE / QUALITY CONTROL

A review of the QA/QC data presented in the ESA is presented in **Table 3** below.

**Table 3: Review of Quality Assurance and Quality Control**

| QA/QC | Evidence and Evaluation |
|---|---|
| ***FIELD QA/QC*** | |
| Field QC program - verification of field procedures / sampling procedures | The ESA included details on field procedures for the collection of soil samples, storage and handling of samples, sample logging and sample transport to the laboratory. Sampling equipment decontamination procedures were not described however the sample results do not suggest that cross contamination occurred. QA/QC data validation reports were prepared for each laboratory sampling batch. |
| Qualified personnel | The ESA states that the fieldworks were conducted by a suitably qualified and experienced Geotechnician. However, the report did not describe the qualifications of field staff. |
| Calibration of field equipment | No field equipment requiring calibration was used. |
| ***FIELD QA/QC*** | |
| Rinstate blanks and decontamination of equipment | No rinstate blanks (wash blanks) were collected. Decontamination of sampling equipment was not described in the ESA report. As such the potential for cross contamination could not be assessed. |
| Trip blanks and trip spikes volatile loss | Trip spikes and blank analysis was not conducted. As such the potential for cross contamination or loss of volatile contaminants could not be assessed. |
| Chain of custody (COC) and sample receipt notifications (SRN) | The COC and SRN were appended to the ESA. The COC was signed by the receiving laboratory and the SRN confirmed that the samples had been received intact and had been kept chilled at 4.8°C |
| ***FIELD AND LABORATORY QA/QC*** | |
| Field Duplicates | One (1) field duplicate was collected, meeting the assessment criteria of at least one per 20 primary samples.<br>The laboratory relative percentage difference (RPDs) were generally below the upper RPD limit of 30%, with one result for chromium (RPD of 37%) exceeding the upper limit.<br>This exceedance of the RPD control limit was assessed to not be of concern due to overall consistently low RPDs for the other analytes tested. |
| Field Triplicates | No triplicate (inter laboratory) samples were collected during the Cardno UNG soil sampling event, as such the accuracy of the primary laboratory cannot be directly assessed. |
| ***LABORATORY QA/QC*** | |
| Holding times | Samples were received within the recommended holding times for the requested analysis. |
| Laboratory accreditation for analytical methods used | NATA accredited laboratory ALS were engaged to undertake the laboratory analyses. Laboratory QA/QC procedures were followed for all results. |
| Laboratory method detection limit | Laboratory detection limits were less than the adopted screening criteria. |

| QA/QC | Evidence and Evaluation |
|---|---|
| | ***QA/QC DATA EVALUATION*** |
| Data quality objectives (DQOs) | The DQOs for the investigation, were specifically discussed in the ESA, however a Sampling and Analysis Quality Plan (SAQP) was not presented. The Auditor considers that the steps of the DQO process have largely been carried out with the exception of the *"development of the analytical approach or decision rule"* which was not undertaken in accordance with industry standards.<br>This DQO step defines acceptable limits for QA/QC samples (for example rinsate blanks, duplicates etc). As rinsate blanks or inter laboratory split duplicates were not undertaken, the Auditor considers that this DQO step has not been fully met.<br>The Auditor considers however that the data is nevertheless of a sufficient quality on which conclusions can be based, and this deviation from industry practice has not affected the overall conclusions of the report. |
| Completeness of test program | The overall results of the soil sampling are considered sufficient to support the conclusions generated. |

# 11.0 SITE SUITABILITY AND ENVIRONMENTAL MANAGEMENT

## 11.1 The Auditor's Assessment of Risk

Based on review of the documentation provided, the Auditor agrees with Cardno UNG's conclusion (see Section 7.6) and considers that there is a low likelihood that contamination sources remain on the site.

### *Assessment of Human Health Risks*

Based on the investigation work presented in the ESA, it is the Auditor's conclusion that subject to the implementation of appropriate management measures during site development, the risk to human health presented by potential unknown contamination at the site and the measured inferred background concentrations is low and acceptable. This is based on:

- The ESA reported site concentrations to be below the relevant adopted assessment criteria.
- The assumption that the total chromium present is chromium III rather than chromium VI.

The EMP should address potential risks during development ground works within the Lot 611 Audit Area.

### *Assessment of Ecological or Phytotoxic Risks*

The Auditor considers potential risk to onsite ecological receptors presented by potential unknown contamination at the site and the measured inferred background concentrations to be of low significance. This is based on:

- The site is located within a highly modified ecological setting.
- The ESA reported site concentrations that were inferred to be representative of background concentrations.

Given that the measured site concentrations are inferred to be representative of background concentrations, the Auditor considers potential risk to offsite ecological receptors is low and acceptable.

### *Potential for Offsite Migration of Onsite Contamination*

Based on the investigation and assessment presented in the ESA, potential risks to human health and ecological receptors resulting from offsite migration of contamination is limited. Given the low likelihood of residual contamination to remain at the site, the potential for offsite migration of onsite contamination is considered to be low.

## 11.2 Site Suitability and Environmental Management Plan

Based on the reviewed documentation, the Auditor concludes that Lot 611 is suitable for use as a residential dwelling with accessible soil areas, subject to subject to implementation of an EMP as recommended by Cardno UNG.

The Auditor notes that the reviewed documentation did not include an EMP. Cardno UNG state that the EMP should include provision to *"assess and manage any unexpected indicators of contamination during future building works at the site."*

The Auditor considers that the EMP should be a brief document explaining that although no contamination was found to be present at the site, due to potentially contaminating activities having been undertaken at the site in the past, there is the potential for unknown contamination to be present beneath the site's surface.

As such, when carrying out development works, a watching brief should be kept for the presence of indicators of potential contamination such as odours, staining, or the presence of free product. If any of these are suspected, then the advice of a suitably qualified environmental professional should be sought and appropriate notification made to the NT EPA.

It is recommended that the EMP be prepared by a suitably qualified professional and reviewed by an Environmental Auditor prior to commencement of development works.

The Auditor does not consider that there is any need for management measures beyond the period of site development.

# 12.0 CLOSURE

Based on the information within the documentation reviewed the Auditor considers that no unacceptable risks to human health, environment or environmental values are present due to the reported concentrations at the site in its current condition.

The Auditor considers that the site is suitable for the proposed land use as a residential dwelling with accessible soil subject to the implementation of an Environmental Management Plan (EMP) during development works as recommended in the Audited Documentation. The EMP should allow for the identification of any unexpected indicators of contamination during development works at the site, and if identified, the EMP should trigger the appropriate assessment and management of these impacts.

Therefore Condition 1 of the Development Permit (DP12/0070) is considered to have been met (subject to the implementation of an EMP).

In terms of soil erosion, as far as is ascertainable from the information provided and the Auditor's site visit, Condition 3 of the appended Development Permit (DP12/0070) is considered to have been met.

No restrictions are considered to be required by the Auditor, apart from environmental management planning for development works as discussed above.

This Environmental Audit Report and appendices is a discussion of the Auditor's review of available information and forms the basis for the Site Audit Statement for Lot 611, Wadeye Community, Northern Territory, as shown in Figures 1 and 2.

The Statement of Environmental Audit outlines the Auditor's assessment of site suitability as a residential dwelling with accessible soil areas.

A copy of the Statement of Environmental Audit is included at the front of this report. Any changes to the Statement of Environmental Audit must be approved by an appropriately accredited Auditor in conjunction with the Environment Protection Authority.

# 13.0 LIMITATIONS

This report represents a review of certain information relating to the subject site that was obtained from the sources and contacts noted by methods described in this report. Golder and the Contaminated Sites Auditor have used reasonable care to:

- Avoid reliance upon data and information that is inaccurate
- Confirm that the data and information on which the Auditor has relied in forming an opinion regarding the condition of the site constitutes an adequate basis for forming that opinion.

In addition, while this audit report has been undertaken in accordance with EPA Victoria: *Environmental auditor (contaminated land): Guidelines for issue of certificates and statements of environmental audit* (2014) and also current industry practice, there may be some limitations on the meaning and use of this report.

# Report Signature Page

**GOLDER ASSOCIATES PTY LTD**

Roger Parker
Environmental Auditor (appointed pursuant to the Environment Protection Act 1970)

NB/RJP/ae

A.B.N. 64 006 107 857



\\ade1-s-file01\jobs-enviro\env\2014\147663038 - thamarrurr - audit wadeye nt\correspondence out\147663038-003-r\147663038-003-r-reva.docx

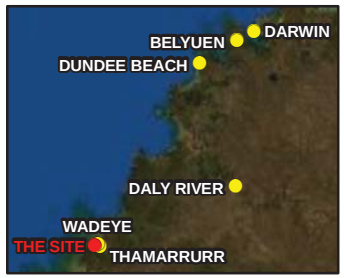
# FIGURE 1

## Site Location Plan


SITE ENVIRONMENTAL AUDIT REPORT
LOT 611, WADEYE COMMUNITY,
WADEYE, NORTHERN TERRITORY

THAMARRURR DEVELOPMENT CORPORATION

## SITE LOCATION PLAN




### LEGEND

Approximate Site Boundary



### COPYRIGHT

World_Imagery - Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community. Aerial image sourced from World Imagery, sourced 123.06.2014.

Township and road data sourced from MapInfo StreetPro.

0 50 100 200 300 400 500 metres

**SCALE (at A4)** 1:15,000

DATUM GDA 94, PROJECTION MGA Zone 52

PROJECT: **147663038**
DATE: **13 JUN 2014**
DRAWN: **KB**
CHECKED: **NB**

**FIGURE 1**

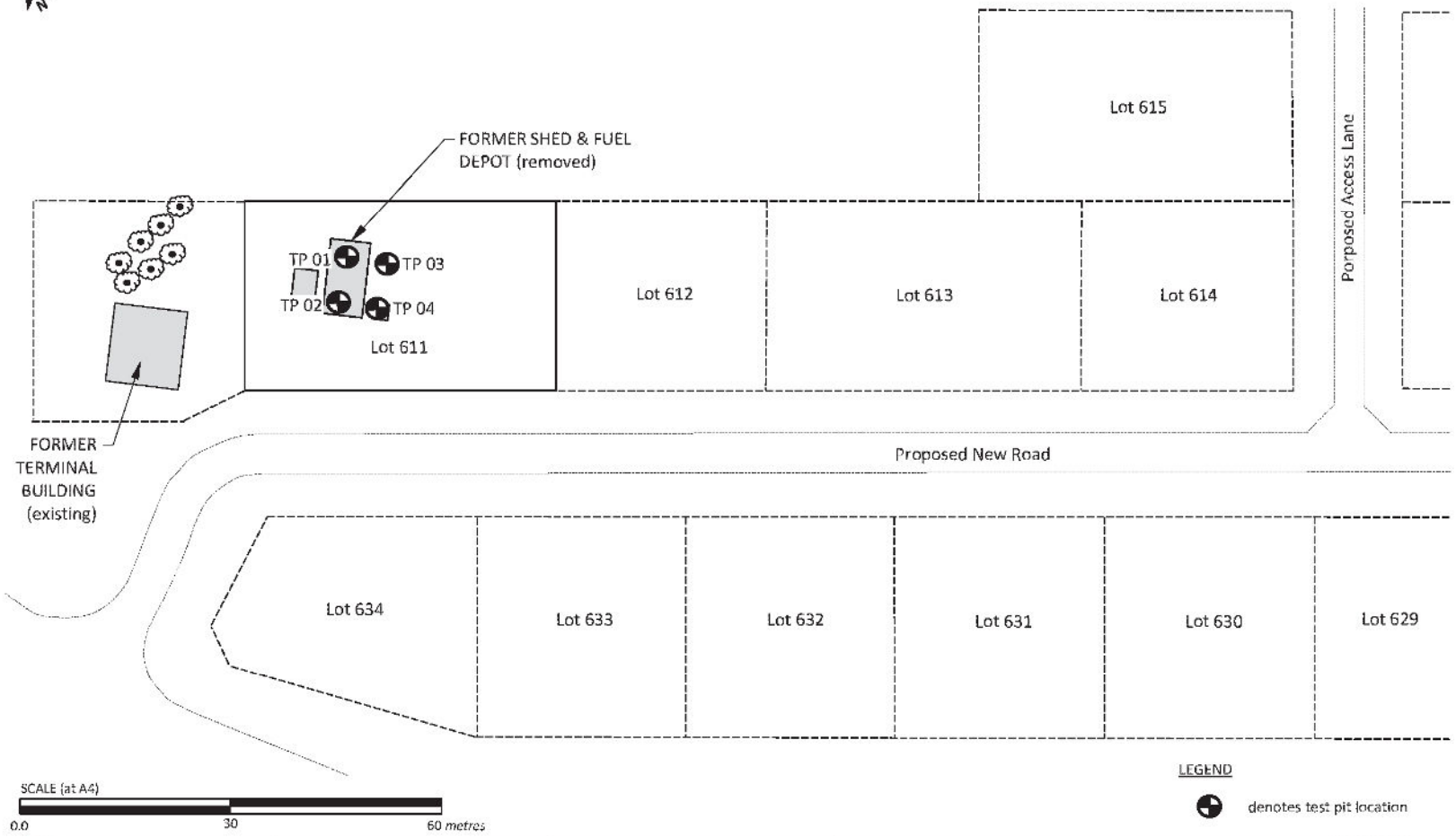
Golder Associates

File Location: \\mel1-s-file01\Jobs\ ...mxd

# FIGURE 2

## Site Plan

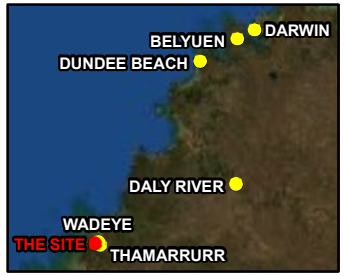
NOTE: This drawing is reproduced from the plans provided by the client.
Locations on site were recorded using hand-held GPS and on-site measurements.




SITE ENVIRONMENTAL AUDIT REPORT
LOT 611, WADEYE COMMUNITY,
WADEYE, NORTHERN TERRITORY

THAMARRURR DEVELOPMENT CORPORATION

## SITE BOUNDARY PLAN






**SCALE (at A4) Not to Scale**

PROJECT: **147663038**
DATE: **12 SEP 2014**
DRAWN: **KB**
CHECKED: **NB**

**FIGURE 2**

Golder Associates

# APPENDIX A

## Copy of Development Permit Schedule of Conditions (DP12/0070)

NORTHERN TERRITORY OF AUSTRALIA

*Planning Act - sections 54 and 55*

# DEVELOPMENT PERMIT

**DP12/0070**

## DESCRIPTION OF LAND THE SUBJECT OF THE PERMIT

N.T. Portion 01637

NEMARLUK

## APPROVED PURPOSE

To use and develop the land (Wadeye) for the purpose of subdivision for leases in excess of 12 years, in accordance with the attached schedule of conditions and the endorsed plans.

## VARIATIONS GRANTED

Clause 11.1.1 (Minimum Lot Sizes and Requirements) of the Northern Territory Planning Scheme

## BASE PERIOD OF THE PERMIT

Subject to the provisions of sections 58, 59 and 59A of the Planning Act, this permit will lapse two years from the date of issue.

**GERRY MCCARTHY**
Minister for Lands and Planning

14 / 3 /2012

# DEVELOPMENT PERMIT

**DP12/0070**

**SCHEDULE OF CONDITIONS**

**CONDITION PRECIDENT**

1. Prior to the commencement of works on Lot 611, the applicant must demonstrate to the satisfaction of the consent authority, on the advice of NRETAS that the land is suitable for the intended residential use in accordance with the National Environment Protection (Assessment of Site Contamination) Measures 1999.

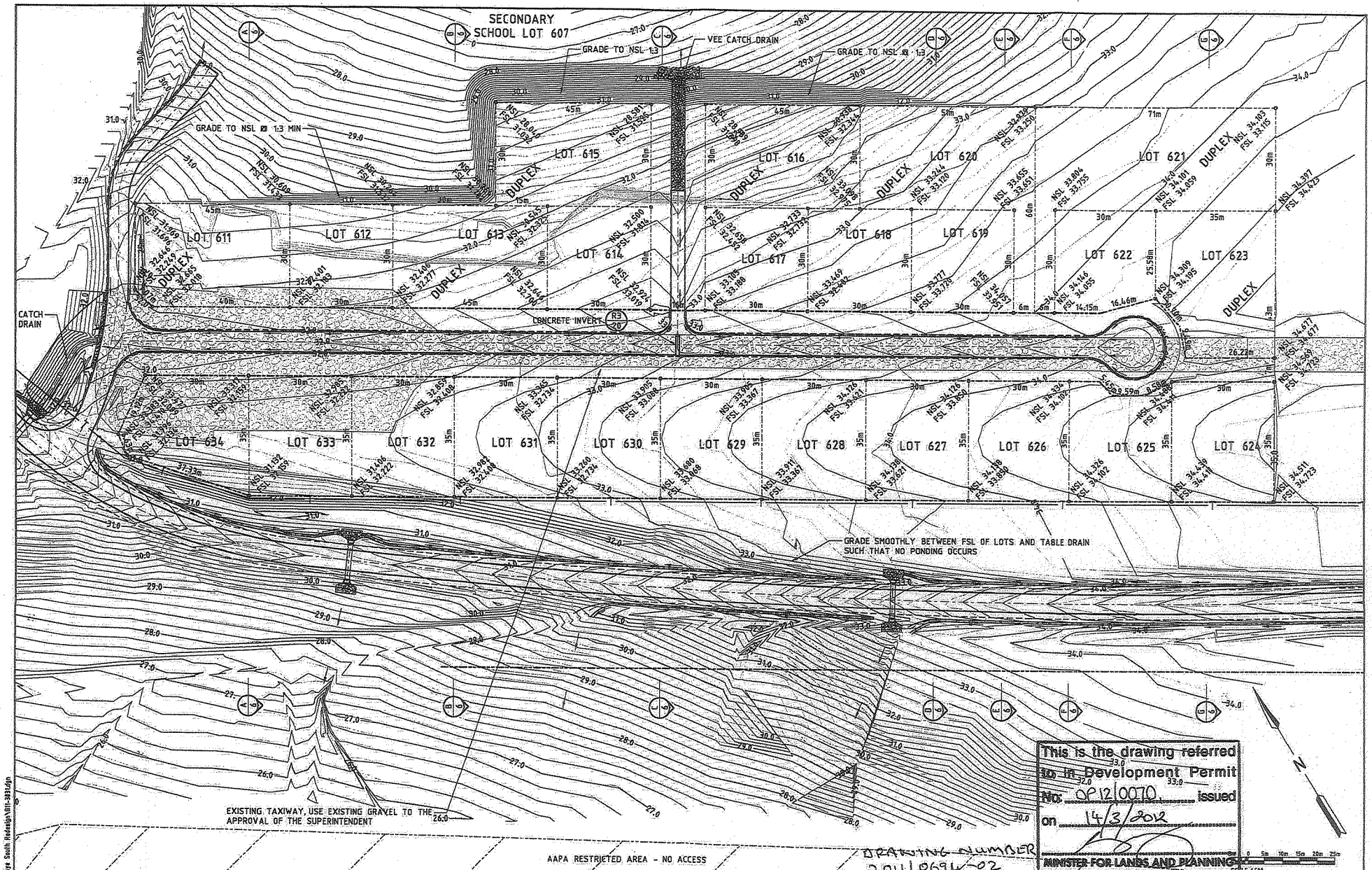
**CONDITIONS**

2. Works carried out under this permit shall be in accordance with drawing numbers 2011/0694-01 to 2011/0694-02 and endorsed as forming part of this permit.

3. Soil erosion control measures must be employed throughout the construction stage of the development to the satisfaction of the consent authority.

4. The owner of the land must enter into agreements with the relevant authorities for the provision of electricity, water, sewerage and telecommunication services to each lot shown on the endorsed plan in accordance with the authorities' requirements and relevant legislation at the time.

5. Engineering design and specification for the affected roads, stormwater drainage and vehicular access, are to be to the technical requirements of the Victoria Daly Shire Council to the satisfaction of the consent authority and all approved works constructed at the owners expense.




This is the drawing referred to in Development Permit No: 09/2/0070 issued on 14/3/2012

MINISTER FOR LANDS AND PLANNING

DRAWING NUMBER 2011/0694-02

| No. | DESCRIPTION | DATE | NAME | DEPT/COMPANY |
|---|---|---|---|---|
| AMENDMENTS | | | | |
| 0 | ISSUED FOR CONSTRUCTION | 01.04.11 | S.K. | DCI - ES - HD |
| C | ISSUED FOR 95% REVIEW | 17.02.11 | S.K. | DCI - ES - HD |
| B | ISSUED FOR 70% REVIEW | 25.10.10 | S.K. | DCI - DSB - HD |
| A | BASED ON 2007 DESIGN BY DA AND BM | 03.05.07 | S.K. | DCI - DSB - HD |

**WARNING**
BEWARE OF UNDERGROUND SERVICES
The locations of underground services are approximate only and their exact position should be proven on site. No guarantee is given that all existing services are shown.

| | | | |
|---|---|---|---|
| DRAWN G.T. | DATE OCT. 2010 | CHECKED S.B. | DATE OCT. 2010 |
| DESIGNED G.T. | DATE OCT. 2010 | CHECKED S.K. | DATE OCT. 2010 |
| DESIGN PROJECT LEADER | DATE | PROJECT OFFICER | DATE |

Northern Territory Government
Department of Construction and Infrastructure

DARWIN - WADEYE SOUTH
PROVISION OF SERVICES TO LOTS 611 TO 635 AND NEW AIRPORT APRON
EARTHWORKS PLAN - FSL CONTOURS

| FILE No. | ASSET No. | SHEET No. | DRAWING No. | AMEND. | SHEET SIZE |
|---|---|---|---|---|---|
| FDS 29282 | | 4 OF 30 | B11-3831 | 0 | A1 |

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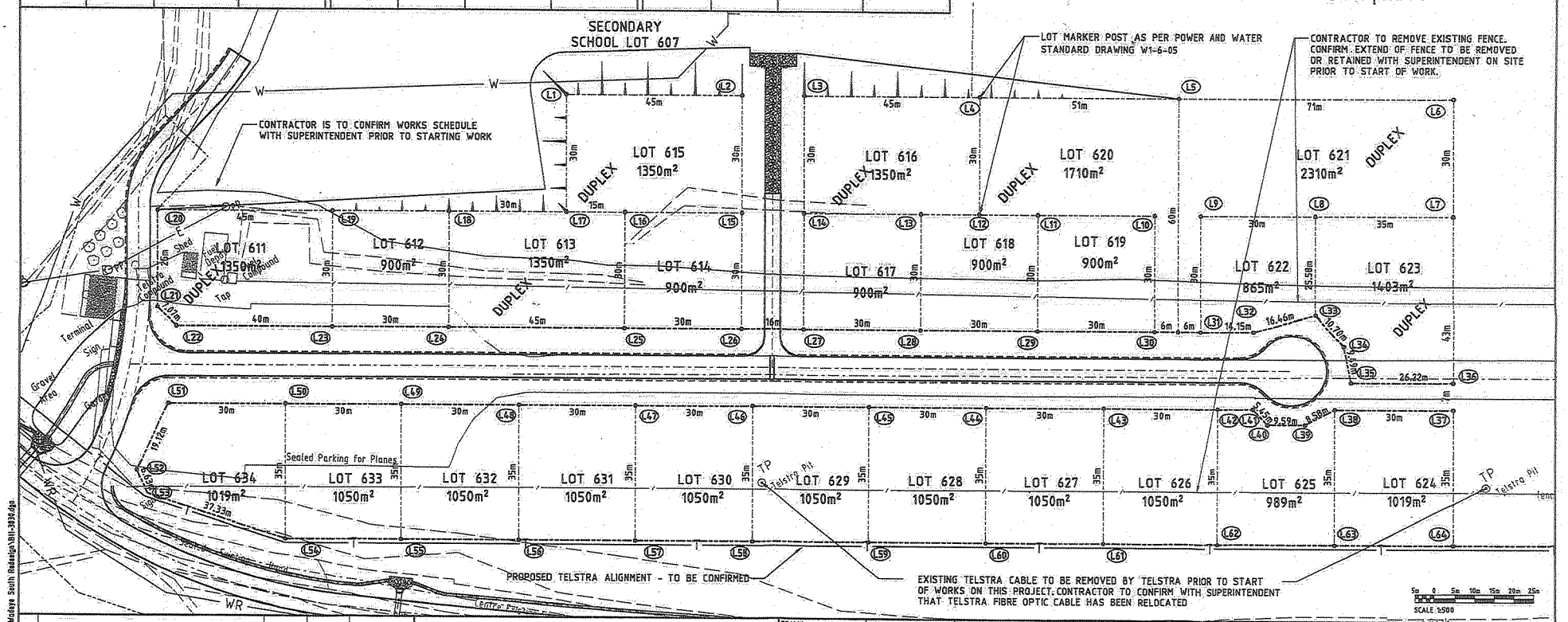
## LOT SET-OUT COORDINATES TABLE

| POINT No. | FSL | EASTING | NORTHING | POINT No. | FSL | EASTING | NORTHING | POINT No. | FSL | EASTING | NORTHING |
|---|---|---|---|---|---|---|---|---|---|---|---|
| L1 | 31.032 | 556497.54 | 8425149.72 | L26 | 33.019 | 556505.18 | 8425075.11 | L51 | 32.099 | 556368.90 | 8425133.72 |
| L2 | 31.525 | 556536.10 | 8425126.53 | L27 | 33.188 | 556518.89 | 8425066.86 | L52 | 34.410 | 556348.87 | 8425120.28 |
| L3 | 31.698 | 556549.81 | 8425118.28 | L28 | 32.482 | 556544.60 | 8425051.40 | L53 | 32.134 | 556352.14 | 8425116.50 |
| L4 | 32.344 | 556588.38 | 8425095.09 | L29 | 33.720 | 556570.31 | 8425035.94 | L54 | 32.159 | 556376.57 | 8425088.27 |
| L5 | 33.250 | 556632.08 | 8425068.81 | L30 | 33.951 | 556596.02 | 8425020.48 | L55 | 32.222 | 556402.28 | 8425072.81 |
| L6 | 33.115 | 556692.93 | 8425032.22 | L31 | 34.055 | 556606.30 | 8425014.30 | L56 | 32.408 | 556427.99 | 8425057.35 |
| L7 | 34.423 | 556677.47 | 8425006.51 | L32 | N/A | 556618.43 | 8425007.01 | L57 | 32.734 | 556453.70 | 8425041.89 |
| L8 | 34.059 | 556677.47 | 8425024.55 | L33 | 34.195 | 556634.29 | 8425002.63 | L58 | 33.068 | 556479.41 | 8425026.43 |
| L9 | 33.755 | 556621.76 | 8425040.01 | L34 | N/A | 556636.10 | 842499.08 | L59 | 33.367 | 556505.12 | 8425010.97 |
| L10 | 33.651 | 556611.48 | 8425046.19 | L35 | N/A | 556632.84 | 8424983.17 | L60 | 33.621 | 556530.83 | 8424995.51 |
| L11 | 33.120 | 556585.77 | 8425061.65 | L36 | 34.677 | 556655.31 | 8424969.66 | L61 | 33.850 | 556556.54 | 8424980.05 |
| L12 | 32.975 | 556572.92 | 8425069.38 | L37 | 34.723 | 556651.70 | 8424963.66 | L62 | 34.102 | 556582.24 | 8424964.59 |
| L13 | 32.732 | 556560.06 | 8425077.11 | L38 | 34.411 | 556625.99 | 8424979.12 | L63 | 34.411 | 556607.95 | 8424949.13 |
| L14 | 32.452 | 556534.35 | 8425092.57 | L39 | N/A | 556617.42 | 8424979.61 | L64 | 34.723 | 556633.66 | 8424933.67 |
| L15 | 31.814 | 556520.64 | 8425100.82 | L40 | N/A | 556609.21 | 8424984.55 | | | | |
| L16 | 32.325 | 556494.93 | 8425116.28 | L41 | N/A | 556608.10 | 8424989.88 | | | | |
| L17 | 31.782 | 556482.08 | 8425124.01 | L42 | 34.102 | 556600.28 | 8424994.58 | | | | |
| L18 | 31.532 | 556456.37 | 8425139.47 | L43 | 33.850 | 556574.57 | 8425010.04 | | | | |
| L19 | 31.433 | 556430.66 | 8425154.93 | L44 | 33.621 | 556548.86 | 8425025.50 | | | | |
| L20 | 31.696 | 556392.09 | 8425178.12 | L45 | 33.367 | 556523.15 | 8425040.96 | | | | |
| L21 | 32.249 | 556379.21 | 8425156.69 | L46 | 33.068 | 556497.44 | 8425056.42 | | | | |
| L22 | 32.018 | 556380.92 | 8425149.83 | L47 | 32.734 | 556471.73 | 8425071.88 | | | | |
| L23 | 32.183 | 556415.20 | 8425129.22 | L48 | 32.408 | 556446.02 | 8425087.34 | | | | |
| L24 | 32.277 | 556440.91 | 8425113.76 | L49 | 32.222 | 556420.32 | 8425102.80 | | | | |
| L25 | 32.700 | 556479.47 | 8425090.57 | L50 | 32.159 | 556394.61 | 8425118.26 | | | | |

This is the drawing referred to in Development Permit No: DP12/0070 issued on 14/3/2012
MINISTER FOR LANDS AND PLANNING

DRAWING NUMBER 2011/0694-01

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AMENDMENTS

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| | | | |
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| DRAWN G.T. | DATE OCT. 2010 | CHECKED S.B. | DATE OCT. 2010 |
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Northern Territory Government
Department of Construction and Infrastructure

DARWIN - WADEYE SOUTH
PROVISION OF SERVICES TO LOTS 611 TO 635 AND NEW AIRPORT APRON
WADEYE SOUTH LOT SETTING OUT PLAN

| FILE No. | ASSET No. | SHEET No. | DRAWING No. | AMEND. | SHEET SIZE |
|---|---|---|---|---|---|
| | FOS 29282 | 3 OF 30 | B11-3830 | 0 | A1 |

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# APPENDIX B

## Audited Documentation

**Cardno Ullman & Nolan, Final Report on Stage One Environmental Site Assessment, Lot 611 Wadeye Community, NT (Ref: U33277, dated 15 August 2014)**

# FINAL REPORT ON TIER 1 ENVIRONMENTAL SITE ASSESSMENT

## LOT 611 WADEYE COMMUNITY NT

U33277

Prepared for
Thamarrurr Development Corporation

15 August 2014

Cardno Ullman& Nolan
Shaping the Future

# Contact Information

**Cardno Ullman and Nolan Geotechnic (NT)**
ABN 78 078 713 934

76 Benison Road
Winnellie NT 0820 Australia

P.O. Box 39623
Winnellie NT 0821 Australia

Telephone: 08 8984 4983
Facsimile: 08 8984 4659

darwinlabs@cardno.com.au
www.cardno.com.au

# Document Information

| | |
|---|---|
| Prepared for | Thamarrurr Development Corporation |
| Project Name | Final Report on Tier 1 Environmental Site Assessment |
| Project Location | Lot 611 Wadeye Community NT |
| Job Reference | U33277 |
| Date | 15 August 2014 |

# Document Control

| Version | Date | Author | Author Initials | Reviewer | Reviewer Initials |
|---|---|---|---|---|---|
| 1 | 10/1/2014 | Robert Taylor | RT | Karen Gates | KEG |
| 2 | 28/1/2014 | Robert Taylor | RT | Karla Penn | KP |
| 3 | 4/2/2014 | Matt Thorogood | MT | Karla Penn | KP |
| 4 | 7/2/2014 | Matt Thorogood | MT | Robert Taylor | RT |
| 5 | 9/6/2014 | Robert Taylor | RT | Matt Thorogood | MT |
| 6 | 15/8/2014 | Lynn Morrissey | LM | Robert Taylor | RT |
| | | | | | |
| | | | | | |
| | | | | | |

# Letter of Transmittal

Thamarrurr Development Corporation
c/- Wadeye Post Office
WADEYE NT 0822

15 August 2014

Attention: Kirstine Cossens

Dear Kristine,

It is understood that the site of an old airport terminal has been proposed for redevelopment for residential purposes. Referred to as the old airport terminal, the site is identified as Lot 611 Wadeye Community, NT.

The investigation undertaken by Cardno comprised a Preliminary Tier 1 Environmental Site Assessment with sampling as part of a contaminated land investigation to establish the current condition of the proposed residential allotment within South Wadeye. Work undertaken included a desktop study and field investigation with laboratory testing conducted by ALS Laboratory Group. Development of the site conceptual model to identify potential sources, pathways and receptors for contamination and analysis of the laboratory results was undertaken by a senior environmental scientist from Cardno.

The scope of works was proposed and undertaken by Cardno to meet the needs of the client and appropriate guidelines. The results and analysis of the fieldwork and laboratory testing completed are reported herein.

With regard to contaminants of concern being present on the site, none of the contaminants encountered were identified at a level considered by guidance as being at a level that may be detrimental to the health of people as the receptor in the current or proposed development environment.

We trust this report meets your requirements and should you have any queries please do not hesitate to contact the undersigned.

Yours faithfully,

*Robert Taylor*
*Branch Manager / Geotechnical Engineer*
*For **Cardno Ullman & Nolan Geotechnic (NT)***

*Business Unit Manager*
*CPEng, MIEAust, BEng, MEng, MSEnv.Mgmt*
*For **Cardno Ullman & Nolan Geotechnic***

# LIST OF ABBREVIATIONS AND UNITS

## Chemical Names

| | |
|---|---|
| BTEX | Benzene, Toluene, Ethylbenzene and Xylenes (subset of MAH) |
| CHC | Chlorinated Hydrocarbons |
| MAH | Monocyclic Aromatic Hydrocarbons |
| OCP | Organochlorine Pesticides |
| OPP | Organophosphate Pesticides |
| PAHs | Polycyclic Aromatic Hydrocarbons |
| PCBs | Polychlorinated Biphenyls |
| SVOC | Semi-Volatile Organic Compounds |
| TDS | Total Dissolved Solids (salinity of water) |
| TOC | Total Organic Carbon |
| TPH | Total Petroleum Hydrocarbons |
| TRH | Total Recoverable Hydrocarbons (= TPH) |
| VOC | Volatile Organic Compounds |

## Technical Terms

| | |
|---|---|
| AHD | Australian Height Datum |
| AMG | Australian Map Grid |
| ANZECC | Australian and New Zealand Environment and Conservation Council |
| AST | Aboveground Storage Tank |
| BDL | Below Detection Limit |
| COC | Chain of Custody |
| CoEA | Certificate of Environmental Audit |
| CoPC | Chemicals of Potential Concern |
| DNAPL | Dense Non-Aqueous Phase Liquid |
| DO | Dissolved Oxygen |
| EC | Electrical Conductivity |
| EILs | Environmental Investigation Levels |
| ESA | Environmental Site Assessment |
| GCMS | Gas Chromatograph - Mass Spectrometer |
| GDB | Groundwater Database (Department of Natural Resources and Environment) |
| GME | Groundwater Monitoring Event |
| HILs | Health Investigation Levels |
| LNAPL | Light Non-Aqueous Phase Liquid |
| LOR | Limit of Reporting |
| N/A | Not Applicable |
| NAPL | Non-Aqueous Phase Liquid |
| NEPM | National Environmental Protection Measure |
| NT EPA | Northern Territory Environmental Protection Authority |

| | |
|---|---|
| PID | Photo-ionisation detector (measures in ppm) |
| PQL | Practical Quantitation Limit |
| PSH | Phase Separated Hydrocarbon |
| QA | Quality Assurance |
| QC | Quality Control |
| RL | Reduced Level |
| RPD | Relative Percentage Difference |
| SoEA | Statement of Environmental Audit |
| UCL | Upper confidence Limit ("95% UCL of the mean" is a value for the mean concentration from sampling which has only a 5% chance of being greater than the true mean value.) |
| UST | Underground Storage Tank |

# Units

| | |
|---|---|
| Ha | Hectares |
| mBGS | Metres Below Ground Surface |
| mg/kg | Milligram per Kilogram (approximately equivalent to ppm) |
| mg/L | Milligram per Litre |
| mTOC | Metres below Top of Casing |
| ppb | Part per Billion |
| ppm | Parts per Million |
| µg/kg | Microgram per Kilogram (approximately equivalent to ppb) |
| µg/L | Microgram per Litre |
| µS/cm | Micro Siemens per Centimetre (Electrical Conductivity - Water) |

# TABLE OF CONTENTS

# Appendices



# Tables



# Figures

# 1 INTRODUCTION

Cardno Ullman and Nolan Geotechnic Pty Ltd (Cardno) has been commissioned by Thamarrurr Development Corporation to undertake a Preliminary Tier 1 Environmental Site Assessment (ESA), with sampling required as part of a contaminated land investigation to establish the current environmental condition of Lot 611 Wadeye Community, Northern Territory.

This preliminary investigation will assess the potential for residual contamination to be present within the property boundaries as a result of historical and/or current land use(s). An area of possible contamination within the allotment has also been targeted for soil sampling and testing, with the results discussed within this report.

The intention of the report is to form the basis of a preliminary assessment of site suitability for residential development.

## 1.1 OBJECTIVES AND SCOPE OF WORKS

The primary objective of this ESA is to identify the potential for contamination to be present within the Lot 611 Wadeye which is to form as part of a residential subdivision development. The investigation of Lot 611 is required due to the presence of a former fuel storage activity associated with an airstrip terminal.

The purpose of the investigation is to enable an evaluation of the suitability of Lot 611 Wadeye for the proposed residential use, given the historical usage of the site.

The scope of works completed in order to achieve the objectives and purpose of the investigation is detailed in the scope of works section below:

### 1.1.1 Scope of Works

The following scope of works was conducted:

- Review of the site background information available online or within existing Cardno databases, including:
  - A review of historical aerial photographs for the site to ascertain previous land use and determine a timeline for past land use; and
  - Review of the historical and current land titles for the property.
- Review of the environmental setting of the site, including (but not limited to):
  - Geological, hydrological and hydrogeological setting;
  - Vegetation;
  - Site landforms, topography and morphology (including land filling and earthmoving works); and
  - Acid Sulfate Soils (ASS) risk mapping.
- Review of information pertaining to potential contamination at the site including:
  - Chemical storage and potential for leaks, spills and discharges;
  - Identification of potential onsite sources of contamination, including diffuse and point sources; and
  - Identification of the potential chemicals of concern and description of their characteristics, including migration and persistence within the environment.
- A visual inspection of the site to confirm and ground-truth the desktop information.
- Interviews with available site staff to determine the nature of the activities and land use(s) conducted at the site.
- Indicative surface soil sampling within high risk areas where contaminants of concern would likely concentrate.
- Development of a preliminary Conceptual Site Model (CSM) risk assessment to assist in determining potential risk to human health and the environment.

- Preparation of a Tier 1 Contamination Assessment report identifying potential constraints associated with contamination issues and provision of recommendations, if required.
- To assess the need for further investigation (if any) and if not make a recommendation on the suitability or otherwise of the site for residential use.
- In the instance that the site is deemed unsuitable for the proposed residential use, the actions required to be taken in order to make the site suitable for such usage will be outlined.

## 1.2 LIMITATIONS OF THE ESA REPORT

It is the reader's responsibility to verify the correct interpretation and intention of the recommendations presented herein. Cardno UNG assumes no responsibility for misunderstandings or improper interpretations that result in unsatisfactory or unsafe work products. It is the reader's further responsibility to acquire copies of any supplemental reports, addenda or responses to public agency reviews that may supersede recommendations in this report.

The findings presented in this report have been based on the investigation described herein, which was undertaken in general accordance with Australian Standard 4482.1-2005 sampling series and NEPM 2013 guideline. This investigation is preliminary in nature and does not constitute a Stage 2 investigation.

As such, the investigation report only includes a limited amount of subsurface (intrusive) sampling of the site, targeting the most at-risk areas based on the professional judgement of the investigating Environmental Scientist.

It is understood that this report is required in order to satisfy conditions outlined in the projects' development conditions as required by the development consent authority. The report is provided for this purpose and no other purpose.

This investigation is designed in order to provide an assessment of on-site contamination conditions at locations representative of likely environmental risks. Environmental studies identify actual sub-surface conditions only at those points where samples are taken, when they are taken. Actual conditions between sampling locations may differ from those inferred because no professional, no matter how qualified, and no sub-surface exploration program, no matter how comprehensive, can reveal what is hidden below the ground surface. The actual interface between materials may be far more gradual or abrupt than an assessment indicates. Actual conditions in areas not sampled may differ from that predicted.

### 1.2.1 Authorised Agents for Report Use

This report has been specifically prepared for use by Thamarrurr Development Corporation (the client), and the regulatory assessing agencies of Northern Territory Environmental Protection Authority (NT EPA) subject to:

- This Stage One report has been prepared for Thamarrurr Development Corporation for use by themselves and appointed consultants to meet required obligations and enable project progression;
- The use of the reports by any related parties is subject to the same terms of agreement formed between Cardno UNG and Thamarrurr Development Corporation; and
- Any users of the reports acknowledge the limitations section stated in Section 1.2 and Section 12. No other users or parties (other than described above) are authorised to use this report without prior written approval of Cardno UNG.

# 2 SITE DESCRIPTION

In accordance with the development plans provided by the client, the study site (Lot 611) is part of the NT Government Subdivision Development and New Airport Apron Project being undertaken by Thamarrurr Development Corporation within the Wadeye Community. Thamarrurr Development Corporation was formed following the Local Government reform in 2007, when the Thamarrurr Regional Council was subsumed by the Victoria Daly Shire Council. As part of this amalgamation, non-core Shire Council functions in Wadeye were transferred to Thamarrurr Development Corporation.

Following the construction of a new Port Keats (Wadeye) Airport Terminal, parcels of land have been assigned to the development of a new 25-lot subdivision (Lots 611 to 635) within the southern area of Wadeye.

Several of the newly developed allotments have already had residential housing constructed on site, with Lot 611 one of the final allotments to receive construction.

A site location plan is presented in Figure 1 with site photographs presented in Appendix A.

The area of land earmarked for residential development includes:

- **Lot 611 on NT Portion 1637** – This vacant allotment is situated on near-level topography and contains little to no vegetation.

The former terminal building is still situated to the north-west of the study site. To the north of the site contains the Wadeye School, and to the south is the recently constructed (or near completion) residential subdivision development (Lots 612 to 635).

The existing airport terminal and airstrip is situated 500m towards the south east.

## 2.1 GEOLOGY

The regional geology of the area is described in the published maps and information from the Northern Territory Geological Survey (NTGS), 1:250,000 Geological Map Series and Explanatory Notes of PORT KEATS (Sheet SD 52-11, 1971).

The site is underlain by the Port Keats Group of the Triassic and Permian period (200-300Ma). The Port Keats Group consists of micaceous sandy siltstone, siltstone, sandstone, minor limestone and basal conglomerate units.

Recent Tertiary (Cainozoic) alluvial and colluvial deposits of unconsolidated sand and clayey sand occur as a thin cover over the lower Port Keats Group and surrounding areas. This description is consistent with the geology observed during the site investigation.

The soils and geologies described are consistent with descriptions of low to moderate soil permeability.

## 2.2 ACID SULFATE SOILS

In accordance with the Australian Soil Resources Information System (ASRIS) Acid Sulfate Soil (ASS) Overlay Map June 2013, the Southern Wadeye region has been classified as Extremely Low Probability/Low Confidence with regards to containing ASS/PASS soils.

ASS occurrence is considered unlikely to be a confounding factor relating to this assessment.

## 2.3 HYDROGEOLOGY

A search of the Natural Resource Maps NT and Department of Lands Resource Management Groundwater Database was conducted. The search indicated over 20 registered groundwater bores exist within a 5km radius of the site and are associated with rural residential and agricultural properties.

From review of the NT water bore database the flowing bores were interrogated. The standing water level in registered groundwater bores seems reasonably consistent with some localised variation; however it was not possible to confirm the RL for the boreholes and standing water level, though dates were also an issue when ascertaining how seasonal rainfall may have impacted on recorded readings. Therefore the indicative depth to groundwater at the site is assessed as 11-13 meters below ground level. Based on the borehole data inferred direction of groundwater movement at the site is likely to be in a (state direction to RN007274, RN007273).

**Table 2-1 REGISTERED WATERBORE BOREHOLE DATA**

| Bore reference | Date of installation (completion) | Depth of bore (m) | Standing Water Level (m) |
|---|---|---|---|
| **RN27146** | 03/09/1990 | 50.00 | - |
| **RN009265** | 05/04/1978 | 48.30 | 11.84 |
| **RN009262** | 26/03/1978 | 38.00 | 11.00 |
| **RN005612** | 28/09/1966 | 10.40 | 13.70 |
| **RN005613** | 29/09/1966 | 16.10 | 5.20 |
| **RN007275** | 03/10/1970 | 38.10 | 13.41 |
| **RN007274** | <1981 | 38.40 | 13.40 |
| **RN007273** | 1970 | 32.00 | 13.40 |
| **RN007276** | 1970 | 22.80 | 1.52 |
| **RN027143** | 30/08/1990 | 32.60 | - |

## 2.4 HYDROLOGY

The study site is situated within the Port Keats catchment area. The coast line is located 11km to the west and Sandfly Creek approximately 650m to the west, running south-east to north-west, then north past the township. Sandfly Creek is the closest water course to site, at approximately 8.0km north of Wadeye the local water courses reach the sea passing to the east of Dorcherty Island flowing to the Timor Sea.

It is anticipated based on the site topography that stormwater at site would drain either direct to ground, to the road, or into the vacant low-lying land to the east. The general stormwater flow across the Wadeye catchment is likely to be towards the north and west, into the neighbouring Sandfly Creek.

## 2.5 SENSITIVE RECEPTORS AND RECEIVING ENVIRONMENTS

Based on the site condition assessment, sensitive potential off-site receiving environments and receptors are considered to be:

- Groundwater flowing beneath the site;
- Road reserve stormwater catchment and table drains;
- Neighbouring residential allotments and schools; and
- Sandfly Creek as well as other local tributaries and watercourses from stormwater flow from the general Wadeye area.

Sensitive potential on-site receptors are considered to be

- Site soils and subsoils
- Current site users
- Future site users including construction workers and inhabitants of future residences

# 3 SITE HISTORY

The site history investigation has been prepared with consideration of the NEPM Site Contamination Measure 1999 (as amended 2013) - NEPM 2013 guidelines and AS4482. The objective of the site history investigation is to complete an investigation to determine the probable locations and spatial extent of contaminant use, storage and disposal across the site; as well as identifying potential contamination from past and present land use.

Sources of site historical detail include:

- Darwin Land and Planning Services (Department of Lands Planning and the Environment) for aerial information;
- Darwin Environment Protection Authority;
- NT Department of Land Resource Management ;
- Site History interviews with relevant TDC personnel; and
- Site inspections of entire site for ground-truthing and identification of information that may not have been identified from the collation of the above information.

Cardno UNG completed a Geotechnical Site Classification Assessment, dated April 2013, within the neighbouring allotments (Lots 624 – 634) for the purpose of providing geotechnical recommendations for residential development. A desktop study of this report was completed as part of the Preliminary Environmental Site Assessment; however the previous geotechnical assessment did not reveal any additional historical detail regarding the site and is therefore not considered relevant to the assessment.

The relevant site history information which was obtained during the review is presented below.

## 3.1 HISTORICAL AND CURRENT TITLE INFORMATION

The study site (Lot 611) is part of the property NT Por 1637 for the Township of Wadeye, with the Owner Category as Aboriginal Land (Scheduled under ALRA) along with the greater Thamarrurr Region. Historical title information indicated the Property Name is Daly River/Port Keats Aboriginal Land Trust, as detailed on Survey Plan CP 004183, dated October 1978.

The historical title search did not reveal any additional information regarding the historic site usage.

## 3.2 HISTORICAL AERIAL PHOTOGRAPHY

Due to the geographic location of the site, and the isolation from the larger regional centres, historical aerial photographs covering the region, prior to 2005, are of a very large coverage area with low resolution.

Therefore, the site location and surface features are unable to be distinguished for the study region and surrounding areas.

The historical aerial photograph review did not reveal any additional factual information regarding the site history or historical land use and therefore cannot be relied upon as evidence for the assessment.

## 3.3 SITE HISTORY INTERVIEW

Prior to the investigation, a site interview was conducted with a member of Thamarrurr Development Corporation. The interview was undertaken via a phone conversation. The following information was provided during the site history interview:

- Lot 611 is situated in the southern region of Wadeye aboriginal community and is currently being developed for residential housing by Thamarrurr Development Corporation;

- The site is being developed for residential use following the relocation of the Port Keats Airport Apron and Terminal Building;
- The original terminal building is still present to the north-west of Lot 611, however the site of the former fuel depot is within the boundaries of Lot 611;
- The fuel stored on site within the former fuel depot contained no more than 6 drums (approximately 1,000 litres) of aviation fuel, and was for emergency purposes only;
- The refuelling of aircraft occurred within the bitumen apron and was only carried out in emergencies, as aircraft were responsible for carrying enough fuel to get them back to Darwin from Wadeye without the need to re-fuel at Wadeye.
- The fuel storage was used for approximately 20 years prior to decommission;
- The fuel storage area was on gravel and was within security fencing. The fuel storage area was not bunded and there were no drains or first flush containment systems surrounding the area. When the fuel storage area was removed the gravel beneath the area was removed and disposed at an industrial dump.
- The land use prior to development of the airport infrastructure is unknown, however based on the history of the Wadeye community it is considered unlikely that an industrial activity with the potential to create contamination impacts was undertaken at the site.
- During the recent subdivision development, approximately 450m$^3$ of soil was cut from Lot 611 and removed from site. Approximately 60m$^3$ of select fill was brought onto site. Earthworks were completed prior to this contamination assessment. This fill material was sourced from a local gravel pit outside 7 km Wadeye for the provision of clean fill and therefore is unlikely to contain contamination (pers comm Kristine Cossens).

## 3.4 SITE INSPECTION

A site inspection was undertaken on 11th December 2013 by a suitably qualified and experienced Geotechnician. The site inspection was focussed on Lot 611, however Cardno did also visually inspect the neighbouring lots for potential stormwater/contaminants flow paths.

This section contains a summary of the observations carried out on site. Refer to Figure 1 for the site layout plan and Appendix A for site photographs.

### 3.4.1 GENERAL OBSERVATIONS

| LOT AND PLAN | FIELD OBSERVATIONS |
|---|---|
| **Lot 611 on NT Portion 1637** | The site comprised of near-level cleared land, devoid of any vegetation. All evidence of the fuel storage and airport apron had been removed prior to the inspection. No staining or indication (odours etc) of contamination within fill or natural materials beneath during the investigation. |
| **Lot 215 on NT Portion 1637 (Neighbouring allotment)** | Site infrastructure visible and remaining onsite which was observed was the former airport terminal building (existing) within semi-mature tress to the north. |
| **Lot 613 on NT Portion 1637 (Neighbouring allotment)** | Lot 613 to the south included a newly constructed residential dwelling and carport. The property was devoid of any vegetation, and gradually slopes towards the east. |
| **Lot 142 on NT Portion 1637 (Neighbouring allotment)** | Lot 142 to the north included the Wadeye School infrastructure, and contains single-storey classrooms and covered common areas. The site was observed to contain sporadic semi-mature trees and grasses. |

### 3.4.2 CONTAMINANTS OF POTENTIAL CONCERN

Using the information obtained during the site inspection and desktop study data, potential contaminants of concern were identified as contaminants associated with historic storage of aviation fuel.

The most significant area of concern is the site of the original emergency fuel storage depot, situated within the boundaries of Lot 611. Although the fuel storage has been decommissioned, historical fuel leaks and spills from fuel storage containers may have occurred, the evidence for which was not visually apparent on the day of inspection.

## 3.5 SITE HISTORY INTEGRITY ASSESSMENT

Information gathered from the site history investigation indicates that potential soil contamination may include petroleum hydrocarbons associated with the presence of an emergency aircraft fuel storage depot that was present within Lot 611 prior to the recent subdivision development.

The following data gaps are present in the site history:

- Prior to the airport infrastructure, little information is known about the previous land use of Lot 611 and surrounding allotments. Given the history of the community, however, the prior land use is considered unlikely to be of an industrial nature.

- The aerial photography of the site is unclear making interpretation of historical aerials difficult.

- Precise operational management details for the history of the fuel storage and complaints history are unclear due to the length of storage.

Given the above information gaps from the site history assessment a sampling programme was devised in order to confirm site soil conditions beneath the former fuel storage areas.

# 4 PRELIMINARY CONCEPTUAL SITE MODEL

## 4.1 AREAS OF ENVIRONMENTAL CONCERN

Based on the site history review a conceptual site model has been prepared. The Areas of Environmental Concern (AEC) for the site, outlined in Table 4-1 below, have been identified based from the previously discussed historical aerial review, discussions with relevant staff and from the site investigation.

**Table 4-1 AREAS OF POTENTIAL CONCERN AND POTENTIAL CONTAMINANT SOURCES IDENTIFIED ON THE SITE**

| SOURCE/ ISSUE | POTENTIAL CONTAMINANTS OF CONCERN | RISK ISSUES AND RISK RANKING | LOCATION OF ACTIVITY |
|---|---|---|---|
| Spills and leaks associated with former fuel storage area | Total Recoverable Hydrocarbons (TRH); Benzene, Toluene, Ethylbenzene and Xylenes (BTEX); and Polycyclic Aromatic Hydrocarbons (PAH). | **Low to Medium Risk**– Fuel storage was minor storage and on gravel and substrate which has been since removed. Notwithstanding contamination status of this area is unclear as no previous environmental assessments conducted at site. | Within the location of the former airport apron the fuel storage area and any associated informal drainage lines, This area was situated directly south-east of the airport terminal. |
| Groundwater flowing beneath the site | Total Recoverable Hydrocarbons (TRH); Benzene, Toluene, Ethylbenzene and Xylenes (BTEX); and Polycyclic Aromatic Hydrocarbons (PAH). | **Low risk** - No significant history of spills and leaks apparent from recent site history. Depth of overburden to groundwater is greater than 10m. Geology of clayey sand and gravel only is indicative of low to moderate soil permeability with reference to conceptual site model | Beneath immediate area of fuel storage. |
| Historical Fill from off-site sources | Total Recoverable Hydrocarbons (TRH); Benzene, Toluene, Ethylbenzene and Xylenes (BTEX); and Polycyclic Aromatic Hydrocarbons (PAH), Heavy Metals | **Low risk** – Fill has been sourced from known site and has been approved for use on the site | Across the site. |

## 4.2 PRELIMINARY CONCEPTUAL SITE MODEL

A preliminary Conceptual Site Model (CSM) is a tool used in the determination of the potential risk to human health and/or the environment as a result of soil and/or groundwater conditions. An assessment is undertaken to identify the likely presence or absence of the following elements:

- Source - a substance that is capable of causing an unacceptable risk to human and/or environmental health;
- Pathway - a mode or route by which the substance/source can migrate to a receptor; and
- Receptor - someone and/or something that could be adversely affected by the substance/source.

For instance where one or more of these elements are absent, there cannot be unacceptable risk to human and/or environmental health. Where all of these elements are present, a complete or potentially complete pathway for contamination exists and there is a potential risk to human and/or environmental health that will require further investigation and possible remediation and/or management. The magnitude of the risk is primarily a function of the concentration, mobility and physico-chemical properties of the source, the sensitivity of the receptor and the nature of the migration pathway.

### 4.2.1 Potential Contamination Sources

Section 4.1 has presented the likelihood of contaminant sources being present at the site based on the findings of the site inspection. It is noted that contaminant concentrations in soils at the site from the majority of identified sources is generally expected to be low. The expected low concentrations is based on the likelihood/risk of occurrence and the likelihood of exceedances of health based guidelines for contaminants in soils based on the limited land use in the past.

Based on the assessment of the areas of environmental concern the residual risk of significance requiring further investigation was considered to be the area of the former fuel storage area.

It is understood that during the recent subdivision development, 450m$^3$ of soil was removed from the surface of the site, and backfilled with 60m$^3$ of select from a known source of fill, therefore this is not considered to be a potential source of contamination.

### 4.2.2 Potential Contamination Pathways

| | |
|---|---|
| **SOIL** | The entire allotment is currently unsealed and comprises near-level bare land; therefore, potential for direct soil contamination from onsite activities is possible. The majority of Lot 611 was previously sealed with bitumen under airstrip apron prior to the subdivision development, therefore this migration pathway is not considered to be a potentially problematic contamination pathway. |
| **GROUNDWATER** | Groundwater is likely to fluctuate seasonally in the general area as a result of heavy rains during the wet season followed by long dry periods with minimal rain. There is potential for leaks/spills to reach groundwater, particularly when the water table is near the ground surface, however would be heavily dependent on the subsurface geology. The desktop review indicates that the soils present are of medium to low permeability which would indicate a generally low risk of migration to groundwater from surface soils and spills. |
| **SURFACE WATER** | Stormwater from the allotment will likely discharge to the neighbouring road reserve.<br>The nearest natural surface water body is Sandfly Creek (approximately 650m to the west) however is considered unlikely that stormwater from the site will directly flow into the Creek, unless there is a substantial rain event/flooding. Surface water and stormwater is unlikely to constitute a potential contamination pathway of travel to adjacent properties unless sampling of aviation area and preferential stormwater flow paths demonstrate surface and sub-surface soils are historically impacted by aviation fuel |

### 4.2.3 Receptors

Given the new allotment is part of a residential sub-division, direct human contact with soil is expected to be feasible, especially site construction works and eventual site occupancy.

- There may be a residual risk to construction workers as potential receptors during soil handling for future the construction of foundations.
- The proposed residential land use, makes future residential users of the site a potential receptor mainly via the pathway of soil contact and gardening.
- Of lesser concern, based on the conceptual site model, is the potential for off-site receptors at the adjacent educational facilities.

For this reason, further quantification of contamination within the fuel depot area (field sampling) is justified to assess the likelihood of human contact with contaminants and possible completion of the source-pathway-receptor relationships within the CSM.

## 4.3 SUMMARY

For a risk to the environment or human health to exist there must a contaminant source and a pathway to the receptor. Possible risk to construction workers and current and future residential occupants of the site with direct contact to the soil has been identified; therefore further investigation through intrusive chemical analysis (field sampling) is justified to quantify risk to the potential receptors. The progress and findings of the aforementioned sampling is discussed in the sections which follow.

# 5 DATA QUALITY OBJECTIVES

The Data Quality Objective (DQO) process has been adopted for this assessment to provide a solid framework to help ensure that sufficient data of high quality is collected to meet the end objectives. DQOs are qualitative and quantitative statements developed using the DQO process that clarifies objectives of the investigation.

The DQO process consists of the following seven (7) steps described in Table 5-1.

**Table 5-1 DATA QUALITY OBJECTIVES PROCESS**

| STEPS | DATA QUALITY OBJECTIVE (DQO) |
|---|---|
| **State The Problem** | Part of the property has been earmarked for residential development as part of a Northern Territory Government Department of Construction and Infrastructure subdivision development and new airport apron project. Since part of the property was previously associated with the airport terminal and minor fuel storage area prior to development, an assessment of possible contamination for the site is required. |
| **Identify the Decision** | A Preliminary ESA with soil sampling is required to identify human and ecological health risks associated with potential onsite contamination relative to proposed land use, and particularly fuel storage activity. The ESA will be limited to the investigation of relevant media (either: soil; groundwater; air; and noise etc.) based on desktop study information. |
| **Identify Inputs to the Decision** | Comprehensive historical data, site information and chemical soil data is required to determine health risks for onsite and offsite receptors due to a data gap identified during the site history review. The required ESA analytical information will be gathered via refinement of the conclusions of the desktop study and targeted intrusive surface soil investigation at the site. Laboratory analysis of soil samples collected onsite were screened against adopted investigation levels as discussed in Section 6 based on the proposed site usage to determine the contamination risk to identified receptors. |
| **Define the Study Boundaries** | General desktop study data of potentially contaminating activity occurring on the lots to identify areas of environmental concern will also be investigated. Chemical soil data is required to be collected within the proposed development area. Samples to be collected from within areas associated with potentially contaminating activities, targeting locations where chemicals are likely to have migrated to/from. |
| **Develop the Analytical Approach** | Provide evidence that onsite contamination is acceptable for current and potential future land use setting. Confirm data reliability and QA/QC processes. |
| **Specify Performance or Acceptance Criteria** | The use of statistical performance parameters and data validation by in-house review. Calculation of relative percentage differences (RPD) for error identification in sampling laboratory processes (30-50% achievement). Review of QA/QC processes and results relative to recommended legislative criteria. |
| **Optimise the Design for Obtaining Data** | The investigation has been designed in a manner to best satisfy project requirements, timeframes, budgets and data quality. Desktop study data, historical information and the intrusive site investigation have been carried out in a sequential and logical manner to maximise resource efficiency. Sampling areas have been chosen complementary to identified desktop information. |

# 6 ASSESSMENT GUIDELINES

## 6.1 SAMPLING GUIDELINES AND STANDARDS

In the absence of state specific contamination guidelines, the site assessment criteria for this assessment have been taken from the following documents:

- National Environment Protection (Assessment of Site Contamination) Measure (NEPM) 1999 (as amended 2013) (NEPM 2013);
- Australian Standard AS 4482.1-2005 Guide to the Investigation and Sampling of Sites with Potentially Contaminated Soil, Part 1: Non-Volatile and Semi-Volatile Compounds;
- Australian Standard AS 4482.2-1999 Guide to the Sampling and Investigation of Potentially Contaminated Soil – Volatile Substances;
- Environmental Protection Act 1994;
- Northern Territory Environment Protection Authority Act 2012;
- Health screening levels for Petroleum Hydrocarbons in Soil and Groundwater (CRC CARE Health Screening Levels 2011);
- Canada wide standard for petroleum hydrocarbons in soil (CCME 2008); and
- Australian Standard AS 1726-1993 Geotechnical Site Investigations.

## 6.2 SOIL ASSESSMENT CRITERIA

Assessment of soil contamination in Northern Territory is based on the National Environment Protection Measure guidelines (herein referred to as NEPM 2013). The soil assessment criteria used in this assessment include the Health Investigation Limits (HIL “A”) for standard residential land uses and Health Screening Levels (HSL’s) for direct soil contact at residential premises.

Investigation levels are applicable to terrestrial ecosystems and depend on specific soil physiochemical properties and land use scenarios. They generally apply to the top 2m of soil. These guidelines apply when assessing the site contamination status; and detail acceptable levels of inorganic and organic contaminants within soil and water. In this assessment results are compared against NEPM 2013 HILs and HSLs.

Given, the intended land use, the soil results have also been compared to ESLs and EILs for urban residential and public open space usage. Possible background concentrations of contaminants of concern in soil have been adopted from Olzowy et al where necessary. Site specific ESLs and EILs were assessed using the aged Added Contaminant Limits set out in NEPM 2013 toolbox, relative to literature values for Cation Exchange Capacity and pH expected for soils encountered at the site.

The investigation levels presented in this report are not necessarily clean up or response levels nor are they desirable soil quality criteria, but rather are to be used for assessment of residual contamination only to prompt site specific risk assessment (Tier 2 assessment) where requried.

## 6.3 BASIS FOR ASSESSMENT CRITERIA

The analysis has been undertaken against the following guidelines:

- National Environment Protection (Assessment of Site Contamination) Measure (NEPM) 2013; and
- Health screening levels for petroleum hydrocarbons in soil and groundwater (CRC Care 2011).

The assessment criteria for contamination currently used in the Northern Territory for the analysis of soil contamination levels is NEPM (2013). The guideline values adopted for this assessment are listed below:

- Health Investigation Levels for residential land-uses (HIL A); and
- Soil Health Screening Levels for Low Density Residential Housing (HSL A) for direct contact.
- Soil Health Screening Levels for Commercial Industrial (HSLD) for direct contact to assess construction and soil handling exposure risk
- Ecological Investigation levels for urban residential and public open spaces (EIL Areas of Ecological Significance, Urban Residential and Public Open Space)
- Ecological Screening Levels for commercial industrial usage (ESLs Commercial Industrial Use)

Comparison against these criteria was used to determine risk to the future occupants of the property and the suitability of the redeveloped site for the proposed end use.

In the instance that the conceptual site model and subsequent soil investigation appears to indicate a risk to groundwater, HSLs relating to groundwater assessment and vapour intrusion will also be considered.

# 7 PRELIMINARY SOIL SAMPLING METHODOLOGY

## 7.1 SAMPLING RATIONALE

The sampling rationale for the Tier 1 intrusive investigation which was applied was a targeted judgemental approach to the assessment of the former fuel storage area.

The sampling rationale and extent of sampling was based on the extent of the preliminary CSM and the observations of the historic fuel storage area from the site inspection.

Four (4) Soil samples were considered an appropriate density based on the size of the area (>20m$^2$) and were collected from the locations assessed to have been most likely exposed to contamination from site activities. These locations included two (2) locations in the immediate area and two (2) locations in the general direction of stormwater migration.

Samples were collected from surface and subsurface materials from the location at depths of 0-0.25m 0.25-0.5m and 0.5-0.75m. Provision was made in the sampling methodology to vary the depths in the event that contaminant markers were encountered.

## 7.2 SOILS SAMPLING METHODOLOGY

Soil samples were collected from four testing locations at the depths previously identified and situated within the fuel storage area in order to delineate potential contamination impacts. Selected samples across all three sampling depths were analysed for potential contaminants, including the recently placed fill at the surface.

The following procedures were implemented with consideration of the NEPM 2013 and AS4482 guideline series:

- Collection of soil samples (including quality assurance samples, consisting of duplicate samples only), filled to zero headspace, labelled accordingly and immediately placed on ice;
- Geotechnical logging of the soil profile (with reference to AS1726) and visual assessment of any contamination markers;
- Sample handling undertaken using Nitrile gloves to avoid cross contamination and replaced between each test location;
- Sample collection occurred directly from the excavated spoil from the centre of the excavator bucket without touching soils which had come in contact with the bucket;
- The bucket was inspected and cleaned prior to the commencement of sampling; and
- Samples were transported to ALS Environmental for chemical analysis (refer below for laboratory analysis).

Cardno maintained a Quality Assurance/Quality Control (QA/QC) standard protocol for the works. QA/QC samples and procedures comprised:

- Field duplicate soil sample collection at a rate of 1/10 samples (10%) for blind submission to primary laboratory; Split samples were not collected and analysed interlab as a lab integrity check due to the limited scope of the sampling and the degree of confidence in the primary laboratory internal QA/QC procedures based on regularity of use.

QA/QC has been further discussed in Section 8.

Soil samples were analysed for potential contaminants of concern as identified in the preliminary conceptual site model as follows:

- TRH, BTEX and PAH; and
- Eight metals including arsenic, cadmium, copper, chromium, lead, nickel, zinc and mercury.

# 8 QUALITY ASSURANCE DETAIL

Data quality objectives are established to control the sources of errors and quantify the errors whenever possible. Quality control (QC) procedures are designed to both increase sample data quality and help interpret discrepancies in results.

Overall the QA/QC results obtained are considered satisfactory and confirm that concentrations of chemicals in the samples provided to the laboratory are indicative of the soil environment on site. No error, cross contamination or inconsistency between the concentrations detected in the primary and secondary laboratory is suggested. Please see below sections for a detailed assessment of QA/QC.

## 8.1 FIELD AND SPLIT DUPLICATES

As part of the Quality Assurance and Quality Control (QA/QC) program, one duplicate sample was collected during the field investigation. The relative percentage differences (RPD) between the primary and duplicate samples have been summarised within Table 9-1. This is calculated using the following equation as per *AS 4482.1:2005*:

$$\text{RPD (\%)} = \frac{\text{Result No. 1} - \text{Result No. 2}}{\text{Mean Result}} \times 100$$

The RPD is defined as the difference between the duplicate samples as a percentage of the mean. The RPD is not calculated when one or both of the duplicate results are below the laboratory LOR.

The duplicate samples were used to assess the natural variability associated with the sampling area, as well as the accuracy of sample handling procedures. The QA/QC duplicate samples are assigned a unique identification without disclosing the identification of the parent sample to the laboratories. The same tests are then conducted on each sample and results are compared for any variation in concentrations.

For the purpose of this report RPDs greater than 50% for metals have been considered significant. Since the results for TRH/BTEX were below the laboratory LOR, hydrocarbons have been omitted from RPD calculations. This result indicates an RPD of 0% for petroleum hydrocarbon which is considered acceptable.

Table 8-1 below shows the RPD value between the primary and duplicate sample collected during the field investigation.

**Table 8-1 DUPLICATE RESULTS**

| CONTAMINANT | ORIGINAL SAMPLE | DUPLICATE SAMPLE | RPD % |
|---|---|---|---|
| **Arsenic** | 37 | 30 | 21.21 |
| **Cadmium** | <1 | <1 | - |
| **Chromium** | 218 | 301 | 37.28 |
| **Copper** | 5 | <5 | - |
| **Lead** | 17 | 19 | 10.91 |
| **Nickel** | 11 | 10 | 9.78 |
| **Zinc** | 12 | 12 | 0.00 |
| **Mercury** | <0.1 | <0.1 | - |

The analyte concentrations identified in the duplicate have been compared to metal concentrations. Where RPD values are present, the value determined is of relatively low magnitude and below 40%. The overall consistency of the metal and TRH/BTEX concentrations for both the parent and duplicate

sample suggests that laboratory or sampling error has not occurred and that the sampling methodology has been undertaken competently.

## 8.2 DATA VALIDATION

All incoming analytical data has been reviewed by appropriately qualified environmental personnel. All data has been independently assessed against the predetermined Data Quality Objectives (DQOs) and data quality indicators (completeness, comparability, representativeness, precision and accuracy) for all field and laboratory procedures and results received.

Following review of all supplied laboratory reports and review of field sampling procedures, the following comments can be made.

- No method blank outliers occurred.
- Sample integrity and container requirements were documented as acceptable.
- Laboratory surrogate recovery was considered acceptable indicating the laboratory accuracy was acceptable.
- Duplicate analysis is deemed acceptable and compliant to required NEPM 2013 and AS Standards sampling procedures.
- All field sheets, field log books and calibration sheets were reviewed for completeness by the onsite Environmental Engineer before dismantling the sampling equipment at each sample location with all documentation reviewed at the conclusion of the field sampling day.
- All scientific meters used throughout the sampling investigation were calibrated according to manufacturer's specifications.
- All sample holding times have been met.
- All samples received were adequately chilled during transport to the nominated laboratories with the correct preservations used for the specified target analyte. All samples were received in good working order.
- All requested test analyses are NATA certified with all laboratory test requests in compliance. All certificates of analysis received have been authorised by a NATA signatory laboratory prior to release. All reports have been reviewed by appropriately qualified chemical personnel.
- Upon receipt of quality control reports from the laboratory, it was noted that acceptable metal surrogate recoveries were reported. The results indicate good repeatability for the majority of analysis, below the acceptable limit of 30-50% variability.

# 9 SAMPLING RESULTS AND DISCUSSION

The results are summarised in Appendix E. The full laboratory reports and chain of custody (COC) documentation are presented in Appendix F.

## 9.1 ANALYTICAL RESULTS

### 9.1.1 Petroleum Hydrocarbons and Polycyclic Aromatic Hydrocarbons

All petroleum hydrocarbon and PAH results were below the LOR for the methods used, and hence well within protection of human health guidelines. There is no indication of human health or environmental risk in the samples tested.

### 9.1.2 Heavy Metals

Cadmium, copper and mercury are below the limits of reporting (LOR). The remaining five heavy metals tested had low concentrations or are within levels consistent with background ranges for naturally occurring soils in the Northern Territory.

From the laboratory results, the soils appear to have elevated chromium content, however are within levels consistent with background ranges for chromium in naturally occurring soils. At the levels detected for each of the eight samples analysed, the HIL-A value for chromium VI was exceeded, however were below the limits for HIL-D. HiL-D has been adopted to screen for possible risk from limited exposure during soil handling or construction works through direct contact.

Chromium VI is quickly oxidised and is rarely present in the environment unless a source is present. Possible prior land use that can contribute to high hexavalent chromium content include the use of certain historic phosphate fertilisers, tanning activities or the presence of treated timber or timber treating agents, however these activities are not deemed to have occurred at the site based on the site history investigation.

As there are no sources apparent for Chromium VI in the site history it is likely that the Total Chromium concentration detected is comprised of entirely of Chromium III.

Therefore, for residential housing with minimal horticultural gardens for produce, the level of chromium detected is considered to not present a health risk for residential occupancy.

All results are below HILs for the protection of human health and are considered to not be an environmental risk to human health.

Results are also generally below the most sensitive Ecological Investigation Levels (EILs) for areas of ecological significance which affords a 99% level protection indicating a minimal level of ecological risk apart from Chromium which is above this guideline value. Notwithstanding the Chromium concentrations (assumed to be Chromium III) are within the acceptable threshold of EILs for urban parkland and residential use for typical soils when taking the Added Contaminant Limit (ACL) alone into account. Therefore the contaminant concentrations at the site are deemed to be of negligible ecological risk.

## 9.2 RESULT DISCUSSION AND ASSESSMENT OF RISK

The area associated with the former fuel storage area was identified as a potential area of concern for residual hydrocarbons within the soil, with the areas specifically targeted. Subsequent soil samples were collected from across the site from four locations where the preliminary conceptual model identified the highest risk.

All of the parameters measured were below the LOR or within background concentrations for hydrocarbons and PAH. This indicates negligible residual hydrocarbon contaminant occurs within these areas. Therefore, no risk to construction workers or future residential occupants was identified within the area tested.

It is important to note that while a PID was not engaged during the assessment due to logistics issues, the absence of this line of evidence is not considered to have impacted on the integrity of the assessment due to the absence of visual and olfactory observations and taken with the fact that the semi-volatile samples collected were analysed within the required holding time.

The soils appear to have elevated chromium content, and the chromium levels detected exceeded the HIL-A value for chromium VI, however were below the limits for HIL-B to HIL-D. Therefore, for low density residential housing (assuming usage of gardens for produce), the level of chromium detected is considered to not present a health risk for residential occupancy. In the event that (any) future more sensitive land use is proposed, (such as a health or aged care facility), further assessment of chromium valency (chromium VI) concentrations may be justified.

All of the remaining heavy metal concentrations were below the LOR or well within protection of human health guideline limits. This indicates negligible residual contaminant occurs within these areas. Therefore, low residual risk to construction workers or future residential occupants was identified within the area tested.

For calculation of site specific EILs, Added Contaminant Limits considered were those for NEPM 2013 and were extrapolated based on the soil type found at the site. In order to apply a conservative assessment of site specific EILs, the contribution of background concentration to the EIL was disregarded and ACL value only was considered as the applicable screening level.

Based on the above results a contiguous source-pathway-receptor relationship in the conceptual site model is not deemed to exist due to the absence of a source with concentrations above screening guideline values, present in soils at the site. Based on the evidence within the site history, in the event that historic spills had occurred in the past, these have now been removed from the site in the surface scrape. Based on the depth to groundwater and soil permeability characteristics, site conditions as assessed appear to indicate a minimal risk that historic minor spills have migrated to groundwater.

Therefore the final conceptual site model following assessment is considered to be characterised by an absence of complete contamination pathways to receptors which might result in impact to groundwater and surface water present at the site, future users and residences or the possibility of migration to off-site properties.

# 10 CONCLUSIONS AND RECOMMENDATIONS

Cardno, on behalf of Thamarrurr Development Corporation completed a Preliminary Environmental Site Assessment with preliminary sampling as part of a contaminated land investigation to establish the current condition of the proposed residential allotment (Lot 611) within South Wadeye. The area of the proposed residential allotment previously contained infrastructure associated with the Port Keats Airport, which following the construction of the new airport facilities further to the south, allowed the area to be redeveloped for residential housing.

The investigation included a desktop study which looked at historical land use for the site and surrounding area to identify potentially contaminating activities that may have occurred. A site conceptual model was developed to identify potential sources, pathways and receptors for contamination. This assessment identified one major potential source of concern:

Potential for residual petroleum hydrocarbon contamination from potential spills and leaks associated with the previous land use which encompassed the airport fuel depot (emergency fuel storage). The potential that through years of use localised spillages may have occurred and that contaminants of concern could enter the soil profile was investigated. As such the investigation aimed to identify if any accumulation of hydrocarbons was present and if so were the levels of contamination to a level considered detrimental to health and wellbeing of people and the environment exposed.

A sampling investigation was undertaken as part of this investigation. The sampling locations were targeted based on the most likely locations for soil contamination. Samples were collected from four locations within the site of the former fuel storage depot. Laboratory testing was undertaken and analysis of the results completed. The result of the analysis identified contaminants of concern within the materials sampled as either below the LOR or within background concentrations for surface and near surface soils samples. All of the analytes tested reported values below human or ecological risk screening levels for the proposed land use for ‘low density residential’, according to NEPM 2013.

The soils do appear to have elevated chromium content, however the chromium levels detected are considered to be comprised of Chromium III based on the site history profile and oxidation characteristics of Chromium VI. Therefore, for low density residential housing the level of chromium detected is considered to not present a health risk for residential occupancy. However, if a sensitive land use is proposed in the future (such as a health care facility), further assessment of chromium valency (chromium VI) concentrations may be justified.

Based on the preliminary ESA findings and conclusions, the site is considered suitable for the proposed residential land-use, subject to a site environmental management plan being put in place to assess and manage any unexpected indicators of contamination during future building works at the site.

No further assessment work is recommended in order to approve the proposed development from a contamination perspective; however future earthworks or building works should include monitoring for visible or olfactory contaminant markers relating to hydrocarbon contamination and the recommendations of this report should be reviewed in the event that additional evidence of site contamination comes to light.

# 11 LIMITATIONS

No part of this Preliminary ESA is to be taken in isolation from the whole report to represent the findings. This report must be read in its entirety, including appendices and attachments and is subject to the stated limitations. Environmental services are provided by Cardno Ullman & Nolan Geotechnic Pty Ltd (Cardno UNG) in accordance with generally accepted professional engineering and environmental practice in the area where these services are rendered. The client acknowledges that the present standard in the engineering and environmental profession does not include a guarantee of perfection, and no other warranty, expressed or implied, is extended by Cardno UNG.

Subject to the scope of work, Cardno's assessment was limited strictly to identifying the environmental conditions associated with the subject properties and does not include evaluation of any other issues. The absence of any identified hazardous or toxic materials should not be interpreted as a guarantee that such materials do not exist on the subject property. It is the reader's responsibility to verify the correct interpretation and intention of the recommendations presented herein. Cardno UNG assumes no responsibility for misunderstandings or improper interpretations that result in unsatisfactory or unsafe work products. It is the reader's further responsibility to acquire copies of any supplemental reports, addenda or responses to public agency reviews that may supersede recommendations in this report.

The findings presented in this report have been based on the investigation described herein, which was undertaken in general accordance with Australian Standard 4482.1-2005 and National Environment Protection (Assessment of Site Contamination) Measure (NEPM) 1999 (as amended) 2013. It is a report based on the concentrations of contaminants observed in soil at the time of sample collection. There are always some variations in subsurface conditions and contaminant concentrations across a site, which cannot be fully defined by investigation. The measurements and values obtained from sampling and testing during the investigation may not represent the extremes of conditions that may exist within this site. Hence, it is recommended that if any ground conditions significantly different to those described in this report are encountered, further advice should be immediately sought from Cardno UNG.

STAGE ONE ENVIRONMENTAL SITE ASSESSMENT

# FIGURES

## Figure 1 Site Layout and Sampling Location Plan

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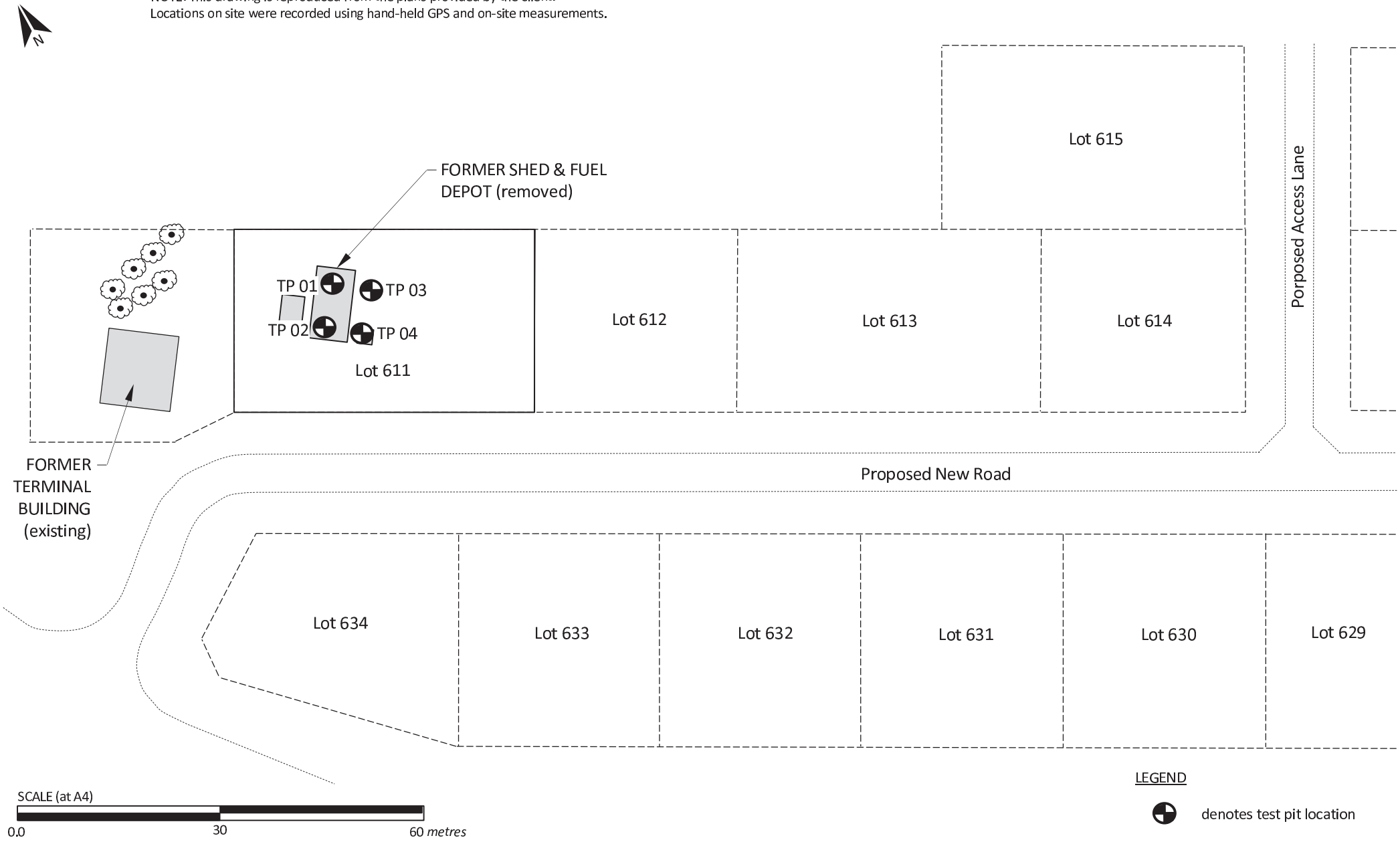
NOTE: This drawing is reproduced from the plans provided by the client.
Locations on site were recorded using hand-held GPS and on-site measurements.





Cardno Ullman & Nolan Geotechnic Pty Ltd
76 Benison Road, Winellie 0820
P.O Box 39623 Winnellie, 0820
Email: darwinlabs@cardno.com.au
Phone (08) 8984 4983 Fax (08) 8984 4659


**Notes**



| REV | DATE | DRAWN | CHECKED |
|---|---|---|---|
| A | 7/01/14 | RT | KP |
| B | 8/04/14 | RT | MT |

# SITE PLAN

**THAMARRURR DEVELOPMENT CORPORATION**
STAGE ONE ENVIRONMENTAL ASSESSMENT
LOT 611 WADEYE COMMUNITY NT

**PROJECT No.** U33277
**Drawing No.** U33277-Fig. 1
**SCALE** AS SHOWN

H:\ENGINEERING\CURRENT PROJECTS\Environmental Investigations\U33277_TDC_Lot 611 Wadeye Contamination Assessment\[U33277_TDC - Fig1rev2.xlsx]Sheet2

TIER 1 ENVIRONMENTAL SITE ASSESSMENT

# APPENDIX A
# SITE PHOTOGRAPHS

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**Photograph 1**

Taken from south of TP02 faceing westward

**Photograph 2**

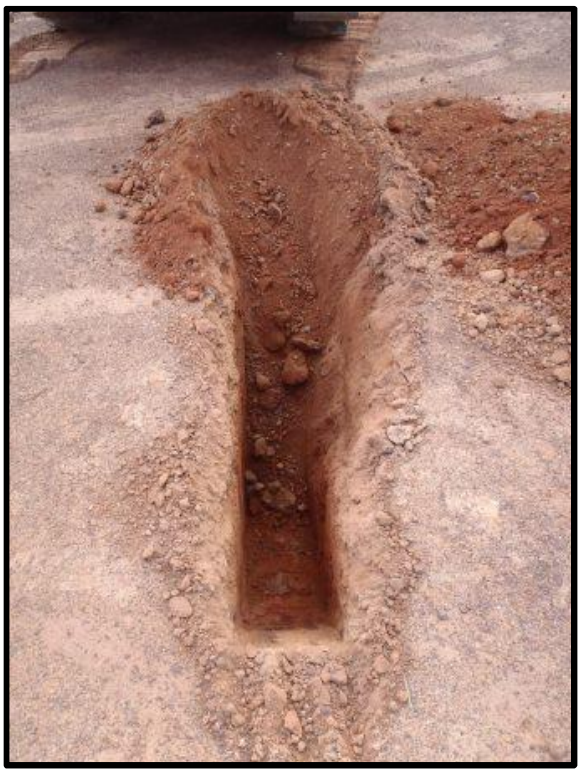
Shot from TP04 facing north north west

**Photograph 3**

Shot from TP03 towards the old terminal building

**Photograph 4**

Shot across site looking towards the south east



**Photograph 5**
TP01

**Photograph 6**
TP02

**Photograph 7**
TP03

**Photograph 8**
TP04

TIER 1 ENVIRONMENTAL SITE ASSESSMENT

# APPENDIX B
# TEST PIT LOGS

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# TEST PIT LOG
## Test Pit No. : TP 01
Sheet : 1 of 1

Client : Thamarrurr Development Corp.
Project : Stage One Environmental Contamination Assessment
Job No : U33277
Site : New Subdivision Development
Location : Lot 611 Wadeye NT

Hole Commenced : 11.12.13
Hole Completed : 11.12.13
Logged By : GC
Checked By : RT
Surface R.L. (m) : AHD

Contractor : Supplied by client
Machines : Machine Excavator
Excavation Method :
Dimensions :
Coords : AGD 84 52

| STRATA | | | | | | VISUAL SOIL DESCRIPTION | SAMPLING | TESTING |
|---|---|---|---|---|---|---|---|---|
| Depth (m) | RL (m AHD) | Graphic Log | Classification | Moisture | Consistency | Description (SOIL NAME; plasticity/grain size, colour, particle shape, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents) | Sampling | Testing |
| | | | GM | D | | **Silty Sandy Gravel**; pale brown, fine to coarse grained, angular to sub-angular, fine to coarse grained sand (FILL)<br>MPS 40 LL 15 P75 10<br>Comments: recent fill; void of organics; no odour; no sign of staining/streaks | ES<br>0.25m<br>ES | |
| 0.30 | | | GC | M | | **Clayey Sandy Gravel**; orange-brown, fine to medium grained, sub-angular to sub-rounded, fine to coarse grained sand (NATURAL)<br>MPS 20 LL 25 P75 20<br>Comments: natural soil; no odour; no sign of staining or streaks; no organic material | 0.50m<br>ES<br>0.75m<br>ES | |
| 0.5 | | | | | | | | |
| 1.0 | | | | | | TEST PIT TP 01 TERMINATED AT 1.00 m<br>Target depth | | |

| Moisture | | Consistency | | Visual Description | | Sampling | |
|---|---|---|---|---|---|---|---|
| D | Dry | VS | very soft | MPS | maximum particle size | U | Undisturbed Sample & Size in mm |
| M | Moist | S | soft | LL | Liquid Limit | D | Disturbed Sample |
| W | Wet | L | loose | P75 | % passing 75um sieve | PP | Pocket Penetrometer Value |
| | | VL | very loose | | | ES | Environmental Sample |
| | | D | dense | | | LAB | Sample sent to Lab |
| | | MD | medium dense | | | DUP | Duplicate Sample |
| | | VD | very dense | | | SPLIT | Split Sample |
| | | St | stiff | | | B | Bulk Sample |
| | | VSt | very stiff | | | | |
| | | F | firm | | | | |
| | | H | hard | | | | |

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# TEST PIT LOG

## Test Pit No. : TP 02



Client : Thamarrurr Development Corp.
Project : Stage One Environmental Contamination Assessment
Job No : U33277
Site : New Subdivision Development
Location : Lot 611 Wadeye NT

Hole Commenced : 11.12.13
Hole Completed : 11.12.13
Logged By : GC
Checked By : RT
Surface R.L. (m) : AHD

Contractor : Supplied by client
Machines : Machine Excavator
Excavation Method :
Dimensions :
Coords : AGD 84 52

| STRATA | | | | VISUAL SOIL DESCRIPTION | | | SAMPLING | TESTING |
|---|---|---|---|---|---|---|---|---|
| Depth (m) | RL (m AHD) | Graphic Log | Classification | Moisture | Consistency | Description (SOIL NAME; plasticity/grain size, colour, particle shape, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents) | Sampling | Testing |
| | | | GM | D | | **Silty Sandy Gravel**; pale brown, fine to coarse grained, angular to sub-angular, fine to coarse grained sand (FILL)<br>MPS 40 LL 15 P75 10<br>Comments: recent fill; void of organics; no odour; no sign of staining/streaks | ES<br>0.25m<br>ES | |
| 0.30 | | | GC | M | | **Clayey Sandy Gravel**; orange-brown, fine to medium grained, sub-angular to sub-rounded, fine to coarse grained sand (NATURAL)<br>MPS 20 LL 25 P75 20<br>Comments: natural soil; no odour; no sign of staining or streaks; no organic material | 0.50m<br>ES<br>0.75m<br>ES | |
| 0.5 | | | | | | | | |
| 1.0 | | | | | | TEST PIT TP 02 TERMINATED AT 1.00 m<br>Target depth | | |

| Moisture | | Consistency | | Visual Description | | Sampling | |
|---|---|---|---|---|---|---|---|
| D | Dry | VS | very soft | MPS | maximum particle size | U | Undisturbed Sample & Size in mm |
| M | Moist | S | soft | LL | Liquid Limit | D | Disturbed Sample |
| W | Wet | L | loose | P75 | % passing 75um sieve | PP | Pocket Penetrometer Value |
| | | VL | very loose | | | ES | Environmental Sample |
| | | D | dense | | | LAB | Sample sent to Lab |
| | | MD | medium dense | | | DUP | Duplicate Sample |
| | | VD | very dense | | | SPLIT | Split Sample |
| | | St | stiff | | | B | Bulk Sample |
| | | VSt | very stiff | | | | |
| | | F | firm | | | | |
| | | H | hard | | | | |

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# TEST PIT LOG

## Test Pit No. : TP 03



Client : Thamarrurr Development Corp.
Project : Stage One Environmental Contamination Assessment
Job No : U33277
Site : New Subdivision Development
Location : Lot 611 Wadeye NT

Hole Commenced : 11.12.13
Hole Completed : 11.12.13
Logged By : GC
Checked By : RT
Surface R.L. (m) : AHD

Contractor : Supplied by client
Machines : Machine Excavator
Excavation Method :
Dimensions :
Coords : AGD 84 52

| STRATA | | | | VISUAL SOIL DESCRIPTION | | | SAMPLING | TESTING |
|---|---|---|---|---|---|---|---|---|
| Depth (m) | RL (m AHD) | Graphic Log | Classification | Moisture | Consistency | Description (SOIL NAME; plasticity/grain size, colour, particle shape, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents) | Sampling | Testing |
| | | | GM | D | | **Silty Sandy Gravel**; pale brown, fine to coarse grained, angular to sub-rounded, fine to coarse grained sand (FILL)<br>MPS 40 LL 15 P75 10<br>Comments: recent fill; void of organics; no odour; no sign of staining/streaks | ES<br>0.25m<br>ES | |
| 0.30 | | | GC | M | | **Clayey Sandy Gravel**; orange-brown, fine or medium grained, sub-angular to sub-rounded, fine to coarse grained sand (NATURAL)<br>MPS 20 LL 25 P75 20<br>Comments: natural soil; no odour; no sign of staining or streaks; no organic material | 0.50m<br>ES<br>0.75m<br>ES | |
| 0.5 | | | | | | | | |
| 1.0 | | | | | | TEST PIT TP 03 TERMINATED AT 1.00 m<br>Target depth | | |

| Moisture | | Consistency | | Visual Description | | Sampling | |
|---|---|---|---|---|---|---|---|
| D | Dry | VS | very soft | MPS | maximum particle size | U | Undisturbed Sample & Size in mm |
| M | Moist | S | soft | LL | Liquid Limit | D | Disturbed Sample |
| W | Wet | L | loose | P75 | % passing 75um sieve | PP | Pocket Penetrometer Value |
| | | VL | very loose | | | ES | Environmental Sample |
| | | D | dense | | | LAB | Sample sent to Lab |
| | | MD | medium dense | | | DUP | Duplicate Sample |
| | | VD | very dense | | | SPLIT | Split Sample |
| | | St | stiff | | | B | Bulk Sample |
| | | VSt | very stiff | | | | |
| | | F | firm | | | | |
| | | H | hard | | | | |

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# TEST PIT LOG

## Test Pit No. : TP 04

Sheet : 1 of 1

Client : Thamarrurr Development Corp.
Project : Stage One Environmental Contamination Assessment
Job No : U33277
Site : New Subdivision Development
Location : Lot 611 Wadeye NT

Hole Commenced : 11.12.13
Hole Completed : 11.12.13
Logged By : GC
Checked By : RT
Surface R.L. (m) : AHD

Contractor : Supplied by client
Machines : Machine Excavator
Excavation Method :
Dimensions :
Coords : AGD 84 52

| STRATA | | | | VISUAL SOIL DESCRIPTION | | | SAMPLING | TESTING |
|---|---|---|---|---|---|---|---|---|
| Depth (m) | RL (m AHD) | Graphic Log | Classification | Moisture | Consistency | Description (SOIL NAME; plasticity/grain size, colour, particle shape, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents) | Sampling | Testing |
| | | | GM | D | | **Silty Sandy Gravel**; pale brown, fine to coarse grained, sub-angular to sub-rounded, fine to coarse grained sand (FILL)<br>MPS 40 LL 15 P75 10<br>Comments: recent fill; void of organics; no odour; no sign of staining/streaks | ES<br>0.25m<br>ES | |
| 0.30 | | | GC | M | | **Clayey Sandy Gravel**; orange-brown, fine to medium grained, sub-angular to sub-rounded, fine to coarse grained sand (NATURAL)<br>MPS 20 LL 25 P75 20<br>Comments: natural soil; no odour; no sign of staining or streaks; no organic material | 0.50m<br>ES<br>0.75m<br>ES | |
| 0.5 | | | | | | | | |
| 1.0 | | | | | | TEST PIT TP 04 TERMINATED AT 1.00 m<br>Target depth | | |

| Moisture | | Consistency | | Visual Description | | Sampling | |
|---|---|---|---|---|---|---|---|
| D | Dry | VS | very soft | MPS | maximum particle size | U | Undisturbed Sample & Size in mm |
| M | Moist | S | soft | LL | Liquid Limit | D | Disturbed Sample |
| W | Wet | L | loose | P75 | % passing 75um sieve | PP | Pocket Penetrometer Value |
| | | VL | very loose | | | ES | Environmental Sample |
| | | D | dense | | | LAB | Sample sent to Lab |
| | | MD | medium dense | | | DUP | Duplicate Sample |
| | | VD | very dense | | | SPLIT | Split Sample |
| | | St | stiff | | | B | Bulk Sample |
| | | VSt | very stiff | | | | |
| | | F | firm | | | | |
| | | H | hard | | | | |

TIER 1 ENVIRONMENTAL SITE ASSESSMENT

# APPENDIX C
# LABORATORY RESULTS SUMMARY TABLE

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TABLE 1: Summary of Heavy Metal Results

| | | | | Exchangable Cations (meq/100g) | | | | | | Metals (mg/kg) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | pH (pH unit) | Moisture Content % | Total Organic Carbon % | Exchangable Calcium | Exchangable Magnesium | Exchangable Potassium | Exchangable Sodium | Cation Exchange Capacity | Aluminium | Arsenic | Cadmium | Chromium | Copper | Iron | Lead | Mercury | Nickel | Zinc |
| Background range | | | | | | | | | - | 1-50 | 1 | 5 - 1000 | 2-100 | - | 2-200 | 0.03 | 5-500 | 10-300 |
| EIL - urban parkland and residential use (NEPC,2013)1 | | | | | | | | | | 100 | | 410 | 220 | | 1100 | | 270 | 670 |
| **EIL - ecological significance' (NEPC,2013)[1]** | | | | | | | | | - | 40 | - | 210 | 80 | - | 110 | | 50 | 280 |
| **HIL A (NEPC,2013)** | | | | | | | | | - | 100 | 20 | 100[2] | 6,000 | - | 300 | 40 | 400 | 7,400 |
| **HIL B (NEPC,2013)** | | | | | | | | | - | 500 | 150 | 500[2] | 30,000 | - | 1,200 | 120 | 1,200 | 60,000 |
| **HIL C (NEPC,2013)** | | | | | | | | | - | 300 | 90 | 300[2] | 17,000 | - | 600 | 80 | 1,200 | 30,000 |
| **HIL D (NEPC,2013)** | | | | | | | | | - | 3000 | 900 | 3600[2] | 240,000 | - | 1,500 | 730 | 6,000 | 400,000 |
| **Sample ID** | **Date Sampled** | | | | | | | | | | | | | | | | | |
| TP1 0.25 | 11/12/2013 | 4.5 | 4.5 | 0.24 | 0.2 | 0.2 | <0.1 | <0.1 | 0.5 | - | 31 | <1 | 185 | <5 | - | 13 | <0.1 | 9 | 13 |
| TP1 0.75 | 11/12/2013 | 1.2 | 17.5 | 0.19 | 0.2 | 1.0 | <0.1 | <0.1 | 1.2 | - | 31 | <1 | 194 | <5 | - | 16 | <0.1 | 10 | 44 |
| TP2 0.25 | 11/12/2013 | 4.7 | 14.8 | 0.29 | 1.2 | 0.2 | <0.1 | <0.1 | 1.5 | - | 36 | <1 | 272 | <5 | - | 21 | <0.1 | 15 | 13 |
| TP2 0.50 | 11/12/2013 | 4.2 | 9.0 | 0.15 | 1.0 | 0.7 | <0.1 | <0.1 | 1.8 | - | 37 | <1 | 218 | 5 | - | 17 | <0.1 | 11 | 12 |
| TP3 0.25 | 11/12/2013 | 4.1 | 15.1 | 0.40 | 0.3 | <0.1 | <0.1 | <0.1 | 0.4 | - | 31 | <1 | 213 | <5 | - | 33 | <0.1 | 9 | 10 |
| TP3 0.75 | 11/12/2013 | 4.2 | 9.8 | 0.2 | 0.4 | 0.4 | <0.1 | <0.1 | 0.9 | - | 38 | <1 | 198 | 5 | - | 16 | <0.1 | 10 | 10 |
| TP4 0.25 | 11/12/2013 | 4.0 | 9.3 | 0.2 | 0.8 | 0.2 | <0.1 | <0.1 | 1.0 | - | 33 | <1 | 223 | <5 | - | 14 | <0.1 | 10 | 10 |
| TP4 0.50 | 11/12/2013 | 4.2 | 12.4 | 0.1 | 1.2 | 0.6 | <0.1 | <0.1 | 1.8 | - | 30 | <1 | 200 | <5 | - | 16 | <0.1 | 8 | 10 |
| DUP 1 | 11/12/2013 | 4.4 | 14.3 | 0.2 | 1.2 | 0.5 | <0.1 | <0.1 | 1.8 | - | 30 | <1 | 301 | <5 | - | 19 | <0.1 | 10 | 12 |

[1] Site specific highest level of protection used for aged contaminants consisting of ACL only

[2] Value for chromium (VI) only

ND = Non-detect (below LOR) [2] value for chromium (IV) only

## TABLE A: Summary of BTEX and TRH Laboratory Results

| | | BTEXN (mg/kg) | | | | | TRH (mg/kg) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Benzene | Toluene | Ethylbenzene | Total Xylenes | Naphthalene | C6 - C10 Fraction minus BTEX (F1) | C6-C9 | >C10 - C16 Fraction | >C16 - C34 Fraction | >C34 - C40 Fraction | Sum of polycyclic aromatic hydrocarbons (mg/kg) |
| CCME Protection of Groundwater | Potable Supply | | | | | | 170 | - | 230 | NA | NA | - |
| (Agriculture for soils <3m) | Livestock Supply | | | | | | 4,200 | - | 10,000 | NA | NA | - |
| EILs (site specific) | National parks and high consevation | - | - | - | - | 10 | - | - | - | - | - | - |
| Management Limits (fine soils) | Residential, parklands and public open space | - | - | - | - | - | 800 | - | 1,000 | 3,500 | 10,000 | |
| ESLs (low reliability coarse soils)* | Ecological significance | 10 | 10 | 2 | 10.0 | - | 125 | - | 25 | - | - | - |
| ESLs (low reliability coarse soils)* | Urban residential/open space | 50 | 85 | 70 | 40.0 | - | 180 | - | 120 | 300 | 2,800 | - |
| HIL - A (NEPC, 2013) | | - | - | - | - | - | - | - | - | - | - | 300 |
| HIL - D (NEPC, 2013) | | - | - | - | - | - | - | - | - | - | - | 4000 |
| HSL- A (NEPC, 2013) | | 100 | 14,000 | 4,500 | 12,000 | 1,400 | 4,400 | - | 3,300 | 4,500 | 6,300 | na |
| HSL- D (NEPC, 2013) | | 430 | 99,000 | 27,000 | 81,000 | 11,000 | 26,000 | - | 20,000 | 27,000 | 38,000 | na |
| Vapour Intrusion - HSL C - SILT and CLAY | | | | | | | | | | | | |
| 0 to <1m | | NL | NL | NL | NL | NL | NL | NL | NL | na | na | na |
| 1 to <2m | | NL | NL | NL | NL | NL | NL | NL | NL | na | na | na |
| 2 to 4m | | NL | NL | NL | NL | NL | NL | NL | NL | na | na | na |

| Sample ID | Sample date: | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TP1 0.25 | 11/12/2013 | <0.2 | <0.5 | <0.5 | <0.5 | <1 | <10 | <10 | <50 | <100 | <100 | |
| TP1 0.75 | 11/12/2013 | <0.2 | <0.5 | <0.5 | <0.5 | <1 | <10 | <10 | <50 | <100 | <100 | |
| TP2 0.25 | 11/12/2013 | <0.2 | <0.5 | <0.5 | <0.5 | <1 | <10 | <10 | <50 | <100 | <100 | |
| TP2 0.50 | 11/12/2013 | <0.2 | <0.5 | <0.5 | <0.5 | <1 | <10 | <10 | <50 | <100 | <100 | |
| TP3 0.25 | 11/12/2013 | <0.2 | <0.5 | <0.5 | <0.5 | <1 | <10 | <10 | <50 | <100 | <100 | |
| TP3 0.75 | 11/12/2013 | <0.2 | <0.5 | <0.5 | <0.5 | <1 | <10 | <10 | <50 | <100 | <100 | |
| TP4 0.25 | 11/12/2013 | <0.2 | <0.5 | <0.5 | <0.5 | <1 | <10 | <10 | <50 | <100 | <100 | |
| TP4 0.50 | 11/12/2013 | <0.2 | <0.5 | <0.5 | <0.5 | <1 | <10 | <10 | <50 | <100 | <100 | |
| DUP 1 | 11/12/2013 | <0.2 | <0.5 | <0.5 | <0.5 | <1 | <10 | <10 | <50 | <100 | <100 | |
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TIER 1 ENVIRONMENTAL SITE ASSESSMENT

# APPENDIX D
# LABORATORY REPORT AND CHAIN OF CUSTODY DOCUMENTATION

Cardno
Shaping the Future

# CERTIFICATE OF ANALYSIS

| | | | |
|---|---|---|---|
| **Work Order** | : **ES1327287** | Page | : 1 of 7 |
| Client | : **CARDNO ULLMAN & NOLAN GEOTECHNIC PTY LTD** | Laboratory | : Environmental Division Sydney |
| Contact | : MR ROBERT TAYLOR | Contact | : Client Services |
| Address | : PO BOX 39623<br>WINNELLIE NT, AUSTRALIA 0821 | Address | : 277-289 Woodpark Road Smithfield NSW Australia 2164 |
| E-mail | : robert.taylor@cardno.com.au | E-mail | : sydney@alsglobal.com |
| Telephone | : +61 08 89844983 | Telephone | : +61-2-8784 8555 |
| Facsimile | : +61 08 89844659 | Facsimile | : +61-2-8784 8500 |
| Project | : U33277 LOT 611 WADEYE CONTAMINATION ASSESSMENT | QC Level | : NEPM 2013 Schedule B(3) and ALS QCS3 requirement |
| Order number | : ---- | | |
| C-O-C number | : ---- | Date Samples Received | : 13-DEC-2013 |
| Sampler | : GC | Issue Date | : 23-DEC-2013 |
| Site | : ---- | | |
| | | No. of samples received | : 9 |
| Quote number | : EN/024/12 | No. of samples analysed | : 9 |

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

## General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting



## Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

| Signatories | Position | Accreditation Category |
|---|---|---|
| Ashesh Patel | Inorganic Chemist | Sydney Inorganics |
| Celine Conceicao | Senior Spectroscopist | Sydney Inorganics |
| Di-An Dao | | Sydney Inorganics |
| Phalak Inthaksone | Laboratory Manager - Organics | Sydney Organics |
| SATISH.TRIVEDI | 2 IC Acid Sulfate Soils Supervisor | Brisbane Acid Sulphate Soils |

## Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

| Compound | CAS Number | LOR | Unit | Client sample ID | TP1 0.25M | TP1 0.75M | TP2 0.25M | TP2 0.50M | TP3 0.25M |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Client sampling date / time | 11-DEC-2013 09:00 | 11-DEC-2013 09:00 | 11-DEC-2013 09:00 | 11-DEC-2013 09:00 | 11-DEC-2013 09:00 |
| | | | | | ES1327287-001 | ES1327287-002 | ES1327287-003 | ES1327287-004 | ES1327287-005 |
| **EA002 : pH (Soils)** | | | | | | | | | |
| pH Value | ---- | 0.1 | pH Unit | | 4.5 | 4.2 | 4.7 | 4.2 | 4.1 |
| **EA055: Moisture Content** | | | | | | | | | |
| Moisture Content (dried @ 103°C) | ---- | 1.0 | % | | 4.5 | 17.5 | 14.8 | 9.0 | 15.1 |
| **ED007: Exchangeable Cations** | | | | | | | | | |
| Exchangeable Calcium | ---- | 0.1 | meq/100g | | 0.2 | 0.2 | 1.2 | 1.0 | 0.3 |
| Exchangeable Magnesium | ---- | 0.1 | meq/100g | | 0.2 | 1.0 | 0.2 | 0.7 | <0.1 |
| Exchangeable Potassium | ---- | 0.1 | meq/100g | | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| Exchangeable Sodium | ---- | 0.1 | meq/100g | | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| Cation Exchange Capacity | ---- | 0.1 | meq/100g | | 0.5 | 1.2 | 1.5 | 1.8 | 0.4 |
| **EG005T: Total Metals by ICP-AES** | | | | | | | | | |
| Arsenic | 7440-38-2 | 5 | mg/kg | | 31 | 31 | 36 | 37 | 31 |
| Cadmium | 7440-43-9 | 1 | mg/kg | | <1 | <1 | <1 | <1 | <1 |
| Chromium | 7440-47-3 | 2 | mg/kg | | 185 | 194 | 272 | 218 | 213 |
| Copper | 7440-50-8 | 5 | mg/kg | | <5 | <5 | <5 | 5 | <5 |
| Lead | 7439-92-1 | 5 | mg/kg | | 13 | 16 | 21 | 17 | 33 |
| Nickel | 7440-02-0 | 2 | mg/kg | | 9 | 10 | 15 | 11 | 9 |
| Zinc | 7440-66-6 | 5 | mg/kg | | 13 | 44 | 13 | 12 | 10 |
| **EG035T: Total Recoverable Mercury by FIMS** | | | | | | | | | |
| Mercury | 7439-97-6 | 0.1 | mg/kg | | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| **EP003: Total Organic Carbon (TOC) in Soil** | | | | | | | | | |
| Total Organic Carbon | ---- | 0.02 | % | | 0.24 | 0.19 | 0.29 | 0.15 | 0.40 |
| **EP080/071: Total Petroleum Hydrocarbons** | | | | | | | | | |
| C6 - C9 Fraction | ---- | 10 | mg/kg | | <10 | <10 | <10 | <10 | <10 |
| C10 - C14 Fraction | ---- | 50 | mg/kg | | <50 | <50 | <50 | <50 | <50 |
| C15 - C28 Fraction | ---- | 100 | mg/kg | | <100 | <100 | <100 | <100 | <100 |
| C29 - C36 Fraction | ---- | 100 | mg/kg | | <100 | <100 | <100 | <100 | <100 |
| ^ C10 - C36 Fraction (sum) | ---- | 50 | mg/kg | | <50 | <50 | <50 | <50 | <50 |
| **EP080/071: Total Recoverable Hydrocarbons - NEPM 2013** | | | | | | | | | |
| C6 - C10 Fraction | C6_C10 | 10 | mg/kg | | <10 | <10 | <10 | <10 | <10 |
| ^ C6 - C10 Fraction minus BTEX (F1) | C6_C10-BTEX | 10 | mg/kg | | <10 | <10 | <10 | <10 | <10 |
| >C10 - C16 Fraction | >C10_C16 | 50 | mg/kg | | <50 | <50 | <50 | <50 | <50 |
| >C16 - C34 Fraction | ---- | 100 | mg/kg | | <100 | <100 | <100 | <100 | <100 |

## Analytical Results

| Sub-Matrix: SOIL (Matrix: SOIL) | | | Client sample ID | TP1 0.25M | TP1 0.75M | TP2 0.25M | TP2 0.50M | TP3 0.25M |
|---|---|---|---|---|---|---|---|---|
| | | | Client sampling date / time | 11-DEC-2013 09:00 | 11-DEC-2013 09:00 | 11-DEC-2013 09:00 | 11-DEC-2013 09:00 | 11-DEC-2013 09:00 |
| Compound | CAS Number | LOR | Unit | ES1327287-001 | ES1327287-002 | ES1327287-003 | ES1327287-004 | ES1327287-005 |
| **EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 - Continued** | | | | | | | | |
| >C34 - C40 Fraction | ---- | 100 | mg/kg | <100 | <100 | <100 | <100 | <100 |
| ^ >C10 - C40 Fraction (sum) | ---- | 50 | mg/kg | <50 | <50 | <50 | <50 | <50 |
| ^ >C10 - C16 Fraction minus Naphthalene (F2) | ---- | 50 | mg/kg | <50 | <50 | <50 | <50 | <50 |
| **EP080: BTEXN** | | | | | | | | |
| Benzene | 71-43-2 | 0.2 | mg/kg | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| Toluene | 108-88-3 | 0.5 | mg/kg | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |
| Ethylbenzene | 100-41-4 | 0.5 | mg/kg | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |
| meta- & para-Xylene | 108-38-3 106-42-3 | 0.5 | mg/kg | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |
| ortho-Xylene | 95-47-6 | 0.5 | mg/kg | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |
| ^ Sum of BTEX | ---- | 0.2 | mg/kg | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| ^ Total Xylenes | 1330-20-7 | 0.5 | mg/kg | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |
| Naphthalene | 91-20-3 | 1 | mg/kg | <1 | <1 | <1 | <1 | <1 |
| **EP080S: TPH(V)/BTEX Surrogates** | | | | | | | | |
| 1.2-Dichloroethane-D4 | 17060-07-0 | 0.1 | % | **116** | **105** | **110** | **113** | **99.5** |
| Toluene-D8 | 2037-26-5 | 0.1 | % | **100** | **92.0** | **95.1** | **94.5** | **87.9** |
| 4-Bromofluorobenzene | 460-00-4 | 0.1 | % | **105** | **96.1** | **99.5** | **98.0** | **89.5** |

## Analytical Results

| Sub-Matrix: SOIL (Matrix: SOIL) | | | Client sample ID | TP3 0.75M | TP4 0.25M | TP4 0.50M | DUP 1 | ---- |
|---|---|---|---|---|---|---|---|---|
| | | | Client sampling date / time | 11-DEC-2013 09:00 | 11-DEC-2013 09:00 | 11-DEC-2013 09:00 | 11-DEC-2013 09:00 | ---- |
| Compound | CAS Number | LOR | Unit | ES1327287-006 | ES1327287-007 | ES1327287-008 | ES1327287-009 | ---- |
| **EA002 : pH (Soils)** | | | | | | | | |
| pH Value | ---- | 0.1 | pH Unit | 4.2 | 4.0 | 4.2 | 4.4 | ---- |
| **EA055: Moisture Content** | | | | | | | | |
| Moisture Content (dried @ 103°C) | ---- | 1.0 | % | 9.8 | 9.3 | 12.4 | 14.3 | ---- |
| **ED007: Exchangeable Cations** | | | | | | | | |
| Exchangeable Calcium | ---- | 0.1 | meq/100g | 0.4 | 0.8 | 1.2 | 1.2 | ---- |
| Exchangeable Magnesium | ---- | 0.1 | meq/100g | 0.4 | 0.2 | 0.6 | 0.5 | ---- |
| Exchangeable Potassium | ---- | 0.1 | meq/100g | <0.1 | <0.1 | <0.1 | <0.1 | ---- |
| Exchangeable Sodium | ---- | 0.1 | meq/100g | <0.1 | <0.1 | <0.1 | <0.1 | ---- |
| Cation Exchange Capacity | ---- | 0.1 | meq/100g | 0.9 | 1.0 | 1.8 | 1.8 | ---- |
| **EG005T: Total Metals by ICP-AES** | | | | | | | | |
| Arsenic | 7440-38-2 | 5 | mg/kg | 38 | 33 | 30 | 30 | ---- |
| Cadmium | 7440-43-9 | 1 | mg/kg | <1 | <1 | <1 | <1 | ---- |
| Chromium | 7440-47-3 | 2 | mg/kg | 198 | 223 | 200 | 301 | ---- |
| Copper | 7440-50-8 | 5 | mg/kg | 5 | <5 | <5 | <5 | ---- |
| Lead | 7439-92-1 | 5 | mg/kg | 16 | 14 | 16 | 19 | ---- |
| Nickel | 7440-02-0 | 2 | mg/kg | 10 | 10 | 8 | 10 | ---- |
| Zinc | 7440-66-6 | 5 | mg/kg | 10 | 10 | 10 | 12 | ---- |
| **EG035T: Total Recoverable Mercury by FIMS** | | | | | | | | |
| Mercury | 7439-97-6 | 0.1 | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 | ---- |
| **EP003: Total Organic Carbon (TOC) in Soil** | | | | | | | | |
| Total Organic Carbon | ---- | 0.02 | % | 0.18 | 0.24 | 0.14 | 0.20 | ---- |
| **EP080/071: Total Petroleum Hydrocarbons** | | | | | | | | |
| C6 - C9 Fraction | ---- | 10 | mg/kg | <10 | <10 | <10 | <10 | ---- |
| C10 - C14 Fraction | ---- | 50 | mg/kg | <50 | <50 | <50 | <50 | ---- |
| C15 - C28 Fraction | ---- | 100 | mg/kg | <100 | <100 | <100 | <100 | ---- |
| C29 - C36 Fraction | ---- | 100 | mg/kg | <100 | <100 | <100 | <100 | ---- |
| ^ C10 - C36 Fraction (sum) | ---- | 50 | mg/kg | <50 | <50 | <50 | <50 | ---- |
| **EP080/071: Total Recoverable Hydrocarbons - NEPM 2013** | | | | | | | | |
| C6 - C10 Fraction | C6_C10 | 10 | mg/kg | <10 | <10 | <10 | <10 | ---- |
| ^ C6 - C10 Fraction minus BTEX (F1) | C6_C10-BTEX | 10 | mg/kg | <10 | <10 | <10 | <10 | ---- |
| >C10 - C16 Fraction | >C10_C16 | 50 | mg/kg | <50 | <50 | <50 | <50 | ---- |
| >C16 - C34 Fraction | ---- | 100 | mg/kg | <100 | <100 | <100 | <100 | ---- |

## Analytical Results

| Sub-Matrix: SOIL (Matrix: SOIL) | | | Client sample ID | TP3 0.75M | TP4 0.25M | TP4 0.50M | DUP 1 | ---- |
|---|---|---|---|---|---|---|---|---|
| | | | Client sampling date / time | 11-DEC-2013 09:00 | 11-DEC-2013 09:00 | 11-DEC-2013 09:00 | 11-DEC-2013 09:00 | ---- |
| Compound | CAS Number | LOR | Unit | ES1327287-006 | ES1327287-007 | ES1327287-008 | ES1327287-009 | ---- |
| **EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 - Continued** | | | | | | | | |
| >C34 - C40 Fraction | ---- | 100 | mg/kg | <100 | <100 | <100 | <100 | ---- |
| ^ >C10 - C40 Fraction (sum) | ---- | 50 | mg/kg | <50 | <50 | <50 | <50 | ---- |
| ^ >C10 - C16 Fraction minus Naphthalene (F2) | ---- | 50 | mg/kg | <50 | <50 | <50 | <50 | ---- |
| **EP080: BTEXN** | | | | | | | | |
| Benzene | 71-43-2 | 0.2 | mg/kg | <0.2 | <0.2 | <0.2 | <0.2 | ---- |
| Toluene | 108-88-3 | 0.5 | mg/kg | <0.5 | <0.5 | <0.5 | <0.5 | ---- |
| Ethylbenzene | 100-41-4 | 0.5 | mg/kg | <0.5 | <0.5 | <0.5 | <0.5 | ---- |
| meta- & para-Xylene | 108-38-3 106-42-3 | 0.5 | mg/kg | <0.5 | <0.5 | <0.5 | <0.5 | ---- |
| ortho-Xylene | 95-47-6 | 0.5 | mg/kg | <0.5 | <0.5 | <0.5 | <0.5 | ---- |
| ^ Sum of BTEX | ---- | 0.2 | mg/kg | <0.2 | <0.2 | <0.2 | <0.2 | ---- |
| ^ Total Xylenes | 1330-20-7 | 0.5 | mg/kg | <0.5 | <0.5 | <0.5 | <0.5 | ---- |
| Naphthalene | 91-20-3 | 1 | mg/kg | <1 | <1 | <1 | <1 | ---- |
| **EP080S: TPH(V)/BTEX Surrogates** | | | | | | | | |
| 1.2-Dichloroethane-D4 | 17060-07-0 | 0.1 | % | **117** | **105** | **106** | **104** | ---- |
| Toluene-D8 | 2037-26-5 | 0.1 | % | **97.9** | **92.2** | **89.9** | **85.3** | ---- |
| 4-Bromofluorobenzene | 460-00-4 | 0.1 | % | **101** | **89.4** | **92.2** | **87.0** | ---- |

## Surrogate Control Limits

Sub-Matrix: **SOIL**

| Compound | CAS Number | Recovery Limits (%) Low | High |
|---|---|---|---|
| **EP080S: TPH(V)/BTEX Surrogates** | | | |
| **1.2-Dichloroethane-D4** | 17060-07-0 | 72.8 | 133.2 |
| **Toluene-D8** | 2037-26-5 | 73.9 | 132.1 |
| **4-Bromofluorobenzene** | 460-00-4 | 71.6 | 130.0 |

# CHAIN OF CUSTODY

ALS Laboratory: please tick →


☐ Sydney: 277 Woodpark Rd, Smithfield NSW 2176 Ph: 02 8784 8555 E:samples.sydney@alsenviro.com
☐ Newcastle: 5 Rosegum Rd, Warabrook NSW 2304 Ph:02 4968 9433 E:samples.newcastle@alsenviro.com
☐ Brisbane: 32 Shand St, Stafford QLD 4053 Ph:07 3243 7222 E:samples.brisbane@alsenviro.com
☐ Townsville: 14-15 Desma Ct, Bohle QLD 4818 Ph:07 4796 0600 E: townsville environmental@alsenviro.com
☐ Melbourne: 2-4 Westall Rd, Springvale VIC 3171 Ph:03 8549 9600 E: samples.melbourne@alsenviro.com
☐ Adelaide: 2-1 Burma Rd, Pooraka SA 5095 Ph: 08 8359 0890 E:adelaide@alsenviro.com
☐ Perth: 10 Hod Way, Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsenviro.com
☐ Launceston: 27 Wellington St, Launceston TAS 7250 Ph: 03 6331 2155 E: launceston@alsenviro.com


| | | |
|---|---|---|
| CLIENT: Cardno Ullman & Nolan | TURNAROUND REQUIREMENTS : (Standard TAT may be longer for some tests e.g.. Ultra Trace Organics) | ☐ Standard TAT (List due date): ☐ Non Standard or urgent TAT (List due date): |
| OFFICE: 76 Benison Road, Winnellie, NT 0821 | | |
| PROJECT: Lot 611 Wadeye Contamination Assessment PROJECT NO U33277 | ALS QUOTE NO.: | COC SEQUENCE NUMBER (Circle) COC: 1 2 3 4 5 6 7 |
| ORDER NUMBER: PURCHASE ORDER NO.: | COUNTRY OF ORIGIN: | OF: 1 2 3 4 5 6 7 |
| PROJECT MANAGER: RT | CONTACT PH: 08 89844983 | |
| SAMPLER: GC | SAMPLER MOBILE: | RELINQUISHED BY: DATE/TIME: 12/12/13 |
| COC Emailed to ALS? (NO) | EDD FORMAT (or default): | RECEIVED BY: g.T DATE/TIME: 12/12/13 11:30am |
| Email Reports to (will default to PM if no other addresses are listed): emer.guckian@cardno.com.au | | RELINQUISHED BY g.T DATE/TIME: 12/12/13 2:30pm |
| Email Invoice to (will default to PM if no other addresses are listed): darwinlabs@cardno.com.au | | RECEIVED BY: Steven DATE/TIME: 13/12/13 8:30 |

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

| | SAMPLE DETAILS MATRIX: Solid(S) Water(W) | | | CONTAINER INFORMATION | | ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required). | | | | | | | | Additional Information |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LAB ID | SAMPLE ID | DATE / TIME | MATRIX | TYPE & PRESERVATIVE (refer to codes below) | TOTAL BOTTLES | Ph | ED007 | EP005 | S-5 | | | | | Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc. |
| 1 | TP1 0.25m | 11/12/2013 AM | S | JAR | 1 | X | X | X | X | | | | | LAB OF ORIGIN: DARWIN |
| 2 | TP1 0.75m | 11/12/2013 AM | S | JAR | 1 | X | X | X | X | | | | | |
| 3 | TP2 0.25m | 11/12/2013 AM | S | JAR | 1 | X | X | X | X | | | | | |
| 4 | TP2 0.50m | 11/12/2013 AM | S | JAR | 1 | X | X | X | X | | | | | |
| 5 | TP3 0.25m | 11/12/2013 AM | S | JAR | 1 | X | X | X | X | | | | | |
| 6 | TP3 0.75m | 11/12/2013 AM | S | JAR | 1 | X | X | X | X | | | | | |
| 7 | TP4 0.25m | 11/12/2013 AM | S | JAR | 1 | X | X | X | X | | | | | |
| 8 | TP4 0.50m | 11/12/2013 AM | S | JAR | 1 | X | X | X | X | | | | | |
| 9 | DUP 1 | 11/12/13 AM | S | JAR | 1 | X | X | X | X | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | TOTAL | 9 | | | | | | | | | |

HT

Environmental Division
Sydney
Work Order
**ES1327287**

Telephone : +61-2-8784 8555

*Water Container Codes:* P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag; LI = Lugols Iodine Preserved Bottles; STT = Sterile Sodium Thiosulfate Preserved Bottles.

Environmental Division

# SAMPLE RECEIPT NOTIFICATION (SRN)

## Comprehensive Report

| | | | |
|---|---|---|---|
| **Work Order** | : **ES1327287** | | |
| Client | : **CARDNO ULLMAN & NOLAN GEOTECHNIC PTY LTD** | Laboratory | : Environmental Division Sydney |
| Contact | : MR ROBERT TAYLOR | Contact | : Client Services |
| Address | : PO BOX 39623<br>WINNELLIE NT, AUSTRALIA 0821 | Address | : 277-289 Woodpark Road Smithfield<br>NSW Australia 2164 |
| E-mail | : robert.taylor@cardno.com.au | E-mail | : sydney@alsglobal.com |
| Telephone | : +61 08 89844983 | Telephone | : +61-2-8784 8555 |
| Facsimile | : +61 08 89844659 | Facsimile | : +61-2-8784 8500 |
| Project | : U33277 LOT 611 WADEYE CONTAMINATION ASSESSMENT | Page | : 1 of 2 |
| Order number | : ---- | | |
| C-O-C number | : ---- | Quote number | : EB2013CARULL0335 (EN/024/12) |
| Site | : ---- | | |
| Sampler | : GC | QC Level | : NEPM 2013 Schedule B(3) and ALS QCS3 requirement |

## Dates

| | | | |
|---|---|---|---|
| Date Samples Received | : 13-DEC-2013 | Issue Date | : 16-DEC-2013 14:04 |
| Client Requested Due Date | : 23-DEC-2013 | Scheduled Reporting Date | : **23-DEC-2013** |

## Delivery Details

| | | | |
|---|---|---|---|
| Mode of Delivery | : Carrier | Temperature | : 4.8'C - Ice present |
| No. of coolers/boxes | : 1 HARD | No. of samples received | : 9 |
| Security Seal | : Intact. | No. of samples analysed | : 9 |

## General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Proactive Holding Time Report
  - Requested Deliverables
- **Samples received in appropriately pretreated and preserved containers.**
- **Please refer to the Proactive Holding Time Report table below which summarises breaches of recommended holding times that have occurred prior to samples/instructions being received at the laboratory. The absence of this summary table indicates that all samples have been received within the recommended holding times for the analysis requested.**
- Please direct any queries you have regarding this work order to the above ALS laboratory contact.
- Analytical work for this work order will be conducted at ALS Sydney.
- Sample Disposal - Aqueous (14 days), Solid (60 days) from date of completion of work order.

## Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

- **No sample container / preservation non-compliance exist.**

## Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process neccessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.
If no sampling time is provided, the sampling time will default to 15:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory for processing purposes and will be shown bracketed without a time component.

Matrix: **SOIL**

| *Laboratory sample ID* | *Client sampling date / time* | *Client sample ID* | SOIL - EA002 pH (1:5) | SOIL - ED007 Def CEC / Exchangeable Cations (ED007) -Default | SOIL - EP003 Total Organic Carbon (TOC ) in Soil | SOIL - S-05 TRH/BTEXN/8 Metals |
|---|---|---|---|---|---|---|
| ES1327287-001 | 11-DEC-2013 09:00 | TP1 0.25M | ✓ | ✓ | ✓ | ✓ |
| ES1327287-002 | 11-DEC-2013 09:00 | TP1 0.75M | ✓ | ✓ | ✓ | ✓ |
| ES1327287-003 | 11-DEC-2013 09:00 | TP2 0.25M | ✓ | ✓ | ✓ | ✓ |
| ES1327287-004 | 11-DEC-2013 09:00 | TP2 0.50M | ✓ | ✓ | ✓ | ✓ |
| ES1327287-005 | 11-DEC-2013 09:00 | TP3 0.25M | ✓ | ✓ | ✓ | ✓ |
| ES1327287-006 | 11-DEC-2013 09:00 | TP3 0.75M | ✓ | ✓ | ✓ | ✓ |
| ES1327287-007 | 11-DEC-2013 09:00 | TP4 0.25M | ✓ | ✓ | ✓ | ✓ |
| ES1327287-008 | 11-DEC-2013 09:00 | TP4 0.50M | ✓ | ✓ | ✓ | ✓ |
| ES1327287-009 | 11-DEC-2013 09:00 | DUP 1 | ✓ | ✓ | ✓ | ✓ |

## Proactive Holding Time Report

Sample(s) have been received within the recommended holding times for the requested analysis.

## Requested Deliverables

**EMER GUCKIAN**

| | | |
|---|---|---|
| - *AU Certificate of Analysis - NATA ( COA ) | Email | emer.guckian@cardno.com.au |
| - *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) ( QCI ) | Email | emer.guckian@cardno.com.au |
| - *AU QC Report - DEFAULT (Anon QC Rep) - NATA ( QC ) | Email | emer.guckian@cardno.com.au |
| - A4 - AU Sample Receipt Notification - Environmental HT ( SRN | Email | emer.guckian@cardno.com.au |
| - Chain of Custody (CoC) ( COC ) | Email | emer.guckian@cardno.com.au |
| - EDI Format - ENMRG ( ENMRG ) | Email | emer.guckian@cardno.com.au |
| - EDI Format - ESDAT ( ESDAT ) | Email | emer.guckian@cardno.com.au |

**MR ROBERT TAYLOR**

| | | |
|---|---|---|
| - *AU Certificate of Analysis - NATA ( COA ) | Email | robert.taylor@cardno.com.au |
| - *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) ( QCI ) | Email | robert.taylor@cardno.com.au |
| - *AU QC Report - DEFAULT (Anon QC Rep) - NATA ( QC ) | Email | robert.taylor@cardno.com.au |
| - A4 - AU Sample Receipt Notification - Environmental HT ( SRN | Email | robert.taylor@cardno.com.au |
| - Chain of Custody (CoC) ( COC ) | Email | robert.taylor@cardno.com.au |
| - EDI Format - ENMRG ( ENMRG ) | Email | robert.taylor@cardno.com.au |
| - EDI Format - ESDAT ( ESDAT ) | Email | robert.taylor@cardno.com.au |

**MS ACCOUNTS -TRACEY TURNER**

| | | |
|---|---|---|
| - A4 - AU Tax Invoice ( INV ) | Email | tracey.turner@cardno.com.au |

**THE ACCOUNTS PAYABLE (CARDNO)**

| | | |
|---|---|---|
| - A4 - AU Tax Invoice ( INV ) | Email | darwinlabs@cardno.com.au |

# QUALITY CONTROL REPORT

| | | | |
|---|---|---|---|
| **Work Order** | : **ES1327287** | Page | : 1 of 8 |
| Client | : **CARDNO ULLMAN & NOLAN GEOTECHNIC PTY LTD** | Laboratory | : Environmental Division Sydney |
| Contact | : MR ROBERT TAYLOR | Contact | : Client Services |
| Address | : PO BOX 39623<br>WINNELLIE NT, AUSTRALIA 0821 | Address | : 277-289 Woodpark Road Smithfield NSW Australia 2164 |
| E-mail | : robert.taylor@cardno.com.au | E-mail | : sydney@alsglobal.com |
| Telephone | : +61 08 89844983 | Telephone | : +61-2-8784 8555 |
| Facsimile | : +61 08 89844659 | Facsimile | : +61-2-8784 8500 |
| Project | : U33277 LOT 611 WADEYE CONTAMINATION ASSESSMENT | QC Level | : NEPM 2013 Schedule B(3) and ALS QCS3 requirement |
| Site | : ---- | | |
| C-O-C number | : ---- | Date Samples Received | : 13-DEC-2013 |
| Sampler | : GC | Issue Date | : 23-DEC-2013 |
| Order number | : ---- | | |
| | | No. of samples received | : 9 |
| Quote number | : EN/024/12 | No. of samples analysed | : 9 |

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

## General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC



## Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

| Signatories | Position | Accreditation Category |
|---|---|---|
| Ashesh Patel | Inorganic Chemist | Sydney Inorganics |
| Celine Conceicao | Senior Spectroscopist | Sydney Inorganics |
| Di-An Dao | | Sydney Inorganics |
| Phalak Inthaksone | Laboratory Manager - Organics | Sydney Organics |
| SATISH.TRIVEDI | 2 IC Acid Sulfate Soils Supervisor | Brisbane Acid Sulphate Soils |

## Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR:- No Limit; Result between 10 and 20 times LOR:- 0% - 50%; Result > 20 times LOR:- 0% - 20%.

Sub-Matrix: **SOIL**

| | | | | Laboratory Duplicate (DUP) Report | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *Laboratory sample ID* | *Client sample ID* | *Method: Compound* | *CAS Number* | *LOR* | *Unit* | *Original Result* | *Duplicate Result* | *RPD (%)* | *Recovery Limits (%)* |
| **EA002 : pH (Soils) (QC Lot: 3213542)** | | | | | | | | | |
| ES1327147-001 | Anonymous | EA002: pH Value | ---- | 0.1 | pH Unit | 9.8 | 9.8 | 0.0 | 0% - 20% |
| ES1327287-006 | TP3 0.75M | EA002: pH Value | ---- | 0.1 | pH Unit | 4.2 | 4.1 | 0.0 | 0% - 20% |
| **EA055: Moisture Content (QC Lot: 3217331)** | | | | | | | | | |
| ES1327287-003 | TP2 0.25M | EA055-103: Moisture Content (dried @ 103°C) | ---- | 1.0 | % | 14.8 | 14.9 | 0.9 | 0% - 50% |
| ES1327527-005 | Anonymous | EA055-103: Moisture Content (dried @ 103°C) | ---- | 1.0 | % | 14.8 | 12.9 | 13.2 | 0% - 50% |
| **ED007: Exchangeable Cations (QC Lot: 3218904)** | | | | | | | | | |
| ES1327287-001 | TP1 0.25M | ED007: Exchangeable Calcium | ---- | 0.1 | meq/100g | 0.2 | 0.2 | 0.0 | 0% - 20% |
| | | ED007: Exchangeable Magnesium | ---- | 0.1 | meq/100g | 0.2 | 0.2 | 0.0 | 0% - 20% |
| | | ED007: Exchangeable Potassium | ---- | 0.1 | meq/100g | <0.1 | <0.1 | 0.0 | 0% - 20% |
| | | ED007: Exchangeable Sodium | ---- | 0.1 | meq/100g | <0.1 | <0.1 | 0.0 | 0% - 20% |
| | | ED007: Cation Exchange Capacity | ---- | 0.1 | meq/100g | 0.5 | 0.5 | 0.0 | 0% - 20% |
| ES1327373-004 | Anonymous | ED007: Exchangeable Calcium | ---- | 0.1 | meq/100g | 0.2 | 0.2 | 0.0 | 0% - 20% |
| | | ED007: Exchangeable Magnesium | ---- | 0.1 | meq/100g | 2.9 | 2.8 | 4.6 | 0% - 20% |
| | | ED007: Exchangeable Potassium | ---- | 0.1 | meq/100g | 0.2 | 0.2 | 0.0 | 0% - 20% |
| | | ED007: Exchangeable Sodium | ---- | 0.1 | meq/100g | <0.1 | <0.1 | 0.0 | 0% - 20% |
| | | ED007: Cation Exchange Capacity | ---- | 0.1 | meq/100g | 3.4 | 3.2 | 4.7 | 0% - 20% |
| **EG005T: Total Metals by ICP-AES (QC Lot: 3221527)** | | | | | | | | | |
| ES1327148-001 | Anonymous | EG005T: Cadmium | 7440-43-9 | 1 | mg/kg | 3 | 3 | 0.0 | No Limit |
| | | EG005T: Chromium | 7440-47-3 | 2 | mg/kg | 8 | 9 | 0.0 | No Limit |
| | | EG005T: Nickel | 7440-02-0 | 2 | mg/kg | 4 | 4 | 0.0 | No Limit |
| | | EG005T: Arsenic | 7440-38-2 | 5 | mg/kg | 11 | 11 | 0.0 | No Limit |
| | | EG005T: Copper | 7440-50-8 | 5 | mg/kg | 45 | 48 | 6.9 | No Limit |
| | | EG005T: Lead | 7439-92-1 | 5 | mg/kg | 150 | 138 | 8.2 | 0% - 20% |
| | | EG005T: Zinc | 7440-66-6 | 5 | mg/kg | 243 | 262 | 7.5 | 0% - 20% |
| ES1327179-004 | Anonymous | EG005T: Cadmium | 7440-43-9 | 1 | mg/kg | <1 | <1 | 0.0 | No Limit |
| | | EG005T: Chromium | 7440-47-3 | 2 | mg/kg | 19 | 21 | 11.2 | 0% - 50% |
| | | EG005T: Nickel | 7440-02-0 | 2 | mg/kg | 14 | 12 | 12.8 | No Limit |
| | | EG005T: Arsenic | 7440-38-2 | 5 | mg/kg | 9 | 10 | 0.0 | No Limit |
| | | EG005T: Copper | 7440-50-8 | 5 | mg/kg | 25 | 19 | 26.8 | No Limit |
| | | EG005T: Lead | 7439-92-1 | 5 | mg/kg | 15 | 15 | 0.0 | No Limit |
| | | EG005T: Zinc | 7440-66-6 | 5 | mg/kg | 58 | 64 | 10.3 | 0% - 50% |
| **EG035T: Total Recoverable Mercury by FIMS (QC Lot: 3221528)** | | | | | | | | | |
| ES1327148-001 | Anonymous | EG035T: Mercury | 7439-97-6 | 0.1 | mg/kg | 0.1 | 0.1 | 0.0 | No Limit |
| ES1327179-004 | Anonymous | EG035T: Mercury | 7439-97-6 | 0.1 | mg/kg | <0.1 | <0.1 | 0.0 | No Limit |
| **EP003: Total Organic Carbon (TOC) in Soil (QC Lot: 3218205)** | | | | | | | | | |

Sub-Matrix: **SOIL**

| | | | | Laboratory Duplicate (DUP) Report | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *Laboratory sample ID* | *Client sample ID* | *Method: Compound* | *CAS Number* | *LOR* | *Unit* | *Original Result* | *Duplicate Result* | *RPD (%)* | *Recovery Limits (%)* |
| **EP003: Total Organic Carbon (TOC) in Soil (QC Lot: 3218205) - continued** | | | | | | | | | |
| EM1313161-002 | Anonymous | EP003: Total Organic Carbon | ---- | 0.02 | % | 0.09 | 0.09 | 0.0 | No Limit |
| ES1327287-009 | DUP 1 | EP003: Total Organic Carbon | ---- | 0.02 | % | 0.20 | 0.23 | 13.8 | 0% - 50% |
| **EP080/071: Total Petroleum Hydrocarbons (QC Lot: 3213537)** | | | | | | | | | |
| ES1327147-001 | Anonymous | EP080: C6 - C9 Fraction | ---- | 10 | mg/kg | <10 | <10 | 0.0 | No Limit |
| ES1327287-005 | TP3 0.25M | EP080: C6 - C9 Fraction | ---- | 10 | mg/kg | <10 | <10 | 0.0 | No Limit |
| **EP080/071: Total Petroleum Hydrocarbons (QC Lot: 3214256)** | | | | | | | | | |
| ES1327312-011 | Anonymous | EP071: C15 - C28 Fraction | ---- | 100 | mg/kg | <100 | <100 | 0.0 | No Limit |
| | | EP071: C29 - C36 Fraction | ---- | 100 | mg/kg | <100 | <100 | 0.0 | No Limit |
| | | EP071: C10 - C14 Fraction | ---- | 50 | mg/kg | <50 | <50 | 0.0 | No Limit |
| ES1327287-005 | TP3 0.25M | EP071: C15 - C28 Fraction | ---- | 100 | mg/kg | <100 | <100 | 0.0 | No Limit |
| | | EP071: C29 - C36 Fraction | ---- | 100 | mg/kg | <100 | <100 | 0.0 | No Limit |
| | | EP071: C10 - C14 Fraction | ---- | 50 | mg/kg | <50 | <50 | 0.0 | No Limit |
| **EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 (QC Lot: 3213537)** | | | | | | | | | |
| ES1327147-001 | Anonymous | EP080: C6 - C10 Fraction | C6_C10 | 10 | mg/kg | <10 | <10 | 0.0 | No Limit |
| ES1327287-005 | TP3 0.25M | EP080: C6 - C10 Fraction | C6_C10 | 10 | mg/kg | <10 | <10 | 0.0 | No Limit |
| **EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 (QC Lot: 3214256)** | | | | | | | | | |
| ES1327312-011 | Anonymous | EP071: >C16 - C34 Fraction | ---- | 100 | mg/kg | <100 | <100 | 0.0 | No Limit |
| | | EP071: >C34 - C40 Fraction | ---- | 100 | mg/kg | <100 | <100 | 0.0 | No Limit |
| | | EP071: >C10 - C16 Fraction | >C10_C16 | 50 | mg/kg | <50 | <50 | 0.0 | No Limit |
| ES1327287-005 | TP3 0.25M | EP071: >C16 - C34 Fraction | ---- | 100 | mg/kg | <100 | <100 | 0.0 | No Limit |
| | | EP071: >C34 - C40 Fraction | ---- | 100 | mg/kg | <100 | <100 | 0.0 | No Limit |
| | | EP071: >C10 - C16 Fraction | >C10_C16 | 50 | mg/kg | <50 | <50 | 0.0 | No Limit |
| **EP080: BTEXN (QC Lot: 3213537)** | | | | | | | | | |
| ES1327147-001 | Anonymous | EP080: Benzene | 71-43-2 | 0.2 | mg/kg | <0.2 | <0.2 | 0.0 | No Limit |
| | | EP080: Toluene | 108-88-3 | 0.5 | mg/kg | <0.5 | <0.5 | 0.0 | No Limit |
| | | EP080: Ethylbenzene | 100-41-4 | 0.5 | mg/kg | <0.5 | <0.5 | 0.0 | No Limit |
| | | EP080: meta- & para-Xylene | 108-38-3<br>106-42-3 | 0.5 | mg/kg | <0.5 | <0.5 | 0.0 | No Limit |
| | | EP080: ortho-Xylene | 95-47-6 | 0.5 | mg/kg | <0.5 | <0.5 | 0.0 | No Limit |
| | | EP080: Naphthalene | 91-20-3 | 1 | mg/kg | <1 | <1 | 0.0 | No Limit |
| ES1327287-005 | TP3 0.25M | EP080: Benzene | 71-43-2 | 0.2 | mg/kg | <0.2 | <0.2 | 0.0 | No Limit |
| | | EP080: Toluene | 108-88-3 | 0.5 | mg/kg | <0.5 | <0.5 | 0.0 | No Limit |
| | | EP080: Ethylbenzene | 100-41-4 | 0.5 | mg/kg | <0.5 | <0.5 | 0.0 | No Limit |
| | | EP080: meta- & para-Xylene | 108-38-3<br>106-42-3 | 0.5 | mg/kg | <0.5 | <0.5 | 0.0 | No Limit |
| | | EP080: ortho-Xylene | 95-47-6 | 0.5 | mg/kg | <0.5 | <0.5 | 0.0 | No Limit |
| | | EP080: Naphthalene | 91-20-3 | 1 | mg/kg | <1 | <1 | 0.0 | No Limit |

## Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **SOIL**

| | | | | Method Blank (MB) Report | Laboratory Control Spike (LCS) Report | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Spike | Spike Recovery (%) | Recovery Limits (%) | |
| Method: Compound | CAS Number | LOR | Unit | Result | Concentration | LCS | Low | High |
| **ED007: Exchangeable Cations (QCLot: 3218904)** | | | | | | | | |
| ED007: Exchangeable Calcium | ---- | 0.1 | meq/100g | <0.1 | ---- | ---- | ---- | ---- |
| ED007: Exchangeable Magnesium | ---- | 0.1 | meq/100g | <0.1 | ---- | ---- | ---- | ---- |
| ED007: Exchangeable Potassium | ---- | 0.1 | meq/100g | <0.1 | ---- | ---- | ---- | ---- |
| ED007: Exchangeable Sodium | ---- | 0.1 | meq/100g | <0.1 | ---- | ---- | ---- | ---- |
| ED007: Cation Exchange Capacity | ---- | 0.1 | meq/100g | <0.1 | ---- | ---- | ---- | ---- |
| **EG005T: Total Metals by ICP-AES (QCLot: 3221527)** | | | | | | | | |
| EG005T: Arsenic | 7440-38-2 | 5 | mg/kg | <5 | 21.7 mg/kg | 111 | 87 | 129 |
| EG005T: Cadmium | 7440-43-9 | 1 | mg/kg | <1 | 4.64 mg/kg | 105 | 80 | 122 |
| EG005T: Chromium | 7440-47-3 | 2 | mg/kg | <2 | 43.9 mg/kg | 117 | 71 | 133 |
| EG005T: Copper | 7440-50-8 | 5 | mg/kg | <5 | 32.0 mg/kg | 107 | 86 | 128 |
| EG005T: Lead | 7439-92-1 | 5 | mg/kg | <5 | 40.0 mg/kg | 105 | 81 | 123 |
| EG005T: Nickel | 7440-02-0 | 2 | mg/kg | <2 | 55.0 mg/kg | 116 | 84 | 130 |
| EG005T: Zinc | 7440-66-6 | 5 | mg/kg | <5 | 60.8 mg/kg | 111 | 81 | 133 |
| **EG035T: Total Recoverable Mercury by FIMS (QCLot: 3221528)** | | | | | | | | |
| EG035T: Mercury | 7439-97-6 | 0.1 | mg/kg | <0.1 | 2.57 mg/kg | 88.4 | 66 | 112 |
| **EP003: Total Organic Carbon (TOC) in Soil (QCLot: 3218205)** | | | | | | | | |
| EP003: Total Organic Carbon | ---- | 0.02 | % | <0.02 | 0.11 % | 112 | 70 | 130 |
| **EP080/071: Total Petroleum Hydrocarbons (QCLot: 3213537)** | | | | | | | | |
| EP080: C6 - C9 Fraction | ---- | 10 | mg/kg | <10 | 26 mg/kg | 81.0 | 68.4 | 128 |
| **EP080/071: Total Petroleum Hydrocarbons (QCLot: 3214256)** | | | | | | | | |
| EP071: C10 - C14 Fraction | ---- | 50 | mg/kg | <50 | 200 mg/kg | 95.7 | 71 | 131 |
| EP071: C15 - C28 Fraction | ---- | 100 | mg/kg | <100 | 300 mg/kg | 106 | 74 | 138 |
| EP071: C29 - C36 Fraction | ---- | 100 | mg/kg | <100 | 200 mg/kg | 113 | 64 | 128 |
| **EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 (QCLot: 3213537)** | | | | | | | | |
| EP080: C6 - C10 Fraction | C6_C10 | 10 | mg/kg | <10 | 31 mg/kg | 82.6 | 68.4 | 128 |
| **EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 (QCLot: 3214256)** | | | | | | | | |
| EP071: >C10 - C16 Fraction | >C10_C16 | 50 | mg/kg | <50 | 250 mg/kg | 99.0 | 70 | 130 |
| EP071: >C16 - C34 Fraction | ---- | 100 | mg/kg | <100 | 350 mg/kg | 109 | 74 | 138 |
| EP071: >C34 - C40 Fraction | ---- | 100 | mg/kg | <100 | ---- | ---- | ---- | ---- |
| | | 50 | mg/kg | ---- | 150 mg/kg | 124 | 63 | 131 |
| **EP080: BTEXN (QCLot: 3213537)** | | | | | | | | |
| EP080: Benzene | 71-43-2 | 0.2 | mg/kg | <0.2 | 1 mg/kg | 78.2 | 62 | 116 |
| EP080: Toluene | 108-88-3 | 0.5 | mg/kg | <0.5 | 1 mg/kg | 86.7 | 62 | 128 |

Sub-Matrix: **SOIL**

| Method: Compound | CAS Number | LOR | Unit | Method Blank (MB) Report: Result | Laboratory Control Spike (LCS) Report: Spike Concentration | Spike Recovery (%): LCS | Recovery Limits (%): Low | Recovery Limits (%): High |
|---|---|---|---|---|---|---|---|---|
| **EP080: BTEXN (QCLot: 3213537) - continued** | | | | | | | | |
| EP080: Ethylbenzene | 100-41-4 | 0.5 | mg/kg | <0.5 | 1 mg/kg | 87.5 | 58 | 118 |
| EP080: meta- & para-Xylene | 108-38-3<br>106-42-3 | 0.5 | mg/kg | <0.5 | 2 mg/kg | 87.9 | 60 | 120 |
| EP080: ortho-Xylene | 95-47-6 | 0.5 | mg/kg | <0.5 | 1 mg/kg | 94.5 | 60 | 120 |
| EP080: Naphthalene | 91-20-3 | 1 | mg/kg | <1 | 1 mg/kg | 90.9 | 62 | 138 |

## Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **SOIL**

| Laboratory sample ID | Client sample ID | Method: Compound | CAS Number | Matrix Spike (MS) Report: Spike Concentration | SpikeRecovery(%): MS | Recovery Limits (%): Low | Recovery Limits (%): High |
|---|---|---|---|---|---|---|---|
| **EG005T: Total Metals by ICP-AES (QCLot: 3221527)** | | | | | | | |
| ES1327148-001 | Anonymous | EG005T: Arsenic | 7440-38-2 | 50 mg/kg | 101 | 70 | 130 |
| | | EG005T: Cadmium | 7440-43-9 | 50 mg/kg | 106 | 70 | 130 |
| | | EG005T: Chromium | 7440-47-3 | 50 mg/kg | 108 | 70 | 130 |
| | | EG005T: Copper | 7440-50-8 | 125 mg/kg | 108 | 70 | 130 |
| | | EG005T: Lead | 7439-92-1 | 125 mg/kg | 100 | 70 | 130 |
| | | EG005T: Nickel | 7440-02-0 | 50 mg/kg | 108 | 70 | 130 |
| | | EG005T: Zinc | 7440-66-6 | 125 mg/kg | 111 | 70 | 130 |
| **EG035T: Total Recoverable Mercury by FIMS (QCLot: 3221528)** | | | | | | | |
| ES1327148-001 | Anonymous | EG035T: Mercury | 7439-97-6 | 5 mg/kg | 91.4 | 70 | 130 |
| **EP080/071: Total Petroleum Hydrocarbons (QCLot: 3213537)** | | | | | | | |
| ES1327147-001 | Anonymous | EP080: C6 - C9 Fraction | ---- | 32.5 mg/kg | 105 | 70 | 130 |
| **EP080/071: Total Petroleum Hydrocarbons (QCLot: 3214256)** | | | | | | | |
| ES1327312-011 | Anonymous | EP071: C10 - C14 Fraction | ---- | 640 mg/kg | 76.4 | 73 | 137 |
| | | EP071: C15 - C28 Fraction | ---- | 3140 mg/kg | 75.9 | 53 | 131 |
| | | EP071: C29 - C36 Fraction | ---- | 2860 mg/kg | 65.6 | 52 | 132 |
| **EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 (QCLot: 3213537)** | | | | | | | |
| ES1327147-001 | Anonymous | EP080: C6 - C10 Fraction | C6_C10 | 37.5 mg/kg | 98.9 | 70 | 130 |
| **EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 (QCLot: 3214256)** | | | | | | | |
| ES1327312-011 | Anonymous | EP071: >C10 - C16 Fraction | >C10_C16 | 850 mg/kg | 101 | 73 | 137 |
| | | EP071: >C16 - C34 Fraction | ---- | 4800 mg/kg | 68.9 | 53 | 131 |
| | | EP071: >C34 - C40 Fraction | ---- | 2400 mg/kg | 53.7 | 52 | 132 |
| **EP080: BTEXN (QCLot: 3213537)** | | | | | | | |
| ES1327147-001 | Anonymous | EP080: Benzene | 71-43-2 | 2.5 mg/kg | 82.8 | 70 | 130 |

Sub-Matrix: **SOIL**

| | | | | Matrix Spike (MS) Report | | | |
|---|---|---|---|---|---|---|---|
| | | | | Spike | SpikeRecovery(%) | Recovery Limits (%) | |
| Laboratory sample ID | Client sample ID | Method: Compound | CAS Number | Concentration | MS | Low | High |
| **EP080: BTEXN (QCLot: 3213537) - continued** | | | | | | | |
| ES1327147-001 | Anonymous | EP080: Toluene | 108-88-3 | 2.5 mg/kg | 94.4 | 70 | 130 |
| | | EP080: Ethylbenzene | 100-41-4 | 2.5 mg/kg | 96.7 | 70 | 130 |
| | | EP080: meta- & para-Xylene | 108-38-3<br>106-42-3 | 2.5 mg/kg | 96.4 | 70 | 130 |
| | | EP080: ortho-Xylene | 95-47-6 | 2.5 mg/kg | 97.3 | 70 | 130 |
| | | EP080: Naphthalene | 91-20-3 | 2.5 mg/kg | 86.4 | 70 | 130 |

## Matrix Spike (MS) and Matrix Spike Duplicate (MSD) Report

The quality control term Matrix Spike (MS) and Matrix Spike Duplicate (MSD) refers to intralaboratory split samples spiked with a representative set of target analytes. The purpose of these QC parameters are to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **SOIL**

| | | | | Matrix Spike (MS) and Matrix Spike Duplicate (MSD) Report | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Spike | Spike Recovery (%) | | Recovery Limits (%) | | RPDs (%) | |
| Laboratory sample ID | Client sample ID | Method: Compound | CAS Number | Concentration | MS | MSD | Low | High | Value | Control Limit |
| **EP080/071: Total Petroleum Hydrocarbons (QCLot: 3213537)** | | | | | | | | | | |
| ES1327147-001 | Anonymous | EP080: C6 - C9 Fraction | ---- | 32.5 mg/kg | 105 | ---- | 70 | 130 | ---- | ---- |
| **EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 (QCLot: 3213537)** | | | | | | | | | | |
| ES1327147-001 | Anonymous | EP080: C6 - C10 Fraction | C6_C10 | 37.5 mg/kg | 98.9 | ---- | 70 | 130 | ---- | ---- |
| **EP080: BTEXN (QCLot: 3213537)** | | | | | | | | | | |
| ES1327147-001 | Anonymous | EP080: Benzene | 71-43-2 | 2.5 mg/kg | 82.8 | ---- | 70 | 130 | ---- | ---- |
| | | EP080: Toluene | 108-88-3 | 2.5 mg/kg | 94.4 | ---- | 70 | 130 | ---- | ---- |
| | | EP080: Ethylbenzene | 100-41-4 | 2.5 mg/kg | 96.7 | ---- | 70 | 130 | ---- | ---- |
| | | EP080: meta- & para-Xylene | 108-38-3<br>106-42-3 | 2.5 mg/kg | 96.4 | ---- | 70 | 130 | ---- | ---- |
| | | EP080: ortho-Xylene | 95-47-6 | 2.5 mg/kg | 97.3 | ---- | 70 | 130 | ---- | ---- |
| | | EP080: Naphthalene | 91-20-3 | 2.5 mg/kg | 86.4 | ---- | 70 | 130 | ---- | ---- |
| **EP080/071: Total Petroleum Hydrocarbons (QCLot: 3214256)** | | | | | | | | | | |
| ES1327312-011 | Anonymous | EP071: C10 - C14 Fraction | ---- | 640 mg/kg | 76.4 | ---- | 73 | 137 | ---- | ---- |
| | | EP071: C15 - C28 Fraction | ---- | 3140 mg/kg | 75.9 | ---- | 53 | 131 | ---- | ---- |
| | | EP071: C29 - C36 Fraction | ---- | 2860 mg/kg | 65.6 | ---- | 52 | 132 | ---- | ---- |
| **EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 (QCLot: 3214256)** | | | | | | | | | | |
| ES1327312-011 | Anonymous | EP071: >C10 - C16 Fraction | >C10_C16 | 850 mg/kg | 101 | ---- | 73 | 137 | ---- | ---- |
| | | EP071: >C16 - C34 Fraction | ---- | 4800 mg/kg | 68.9 | ---- | 53 | 131 | ---- | ---- |
| | | EP071: >C34 - C40 Fraction | ---- | 2400 mg/kg | 53.7 | ---- | 52 | 132 | ---- | ---- |
| **EG005T: Total Metals by ICP-AES (QCLot: 3221527)** | | | | | | | | | | |
| ES1327148-001 | Anonymous | EG005T: Arsenic | 7440-38-2 | 50 mg/kg | 101 | ---- | 70 | 130 | ---- | ---- |
| | | EG005T: Cadmium | 7440-43-9 | 50 mg/kg | 106 | ---- | 70 | 130 | ---- | ---- |
| | | EG005T: Chromium | 7440-47-3 | 50 mg/kg | 108 | ---- | 70 | 130 | ---- | ---- |

Sub-Matrix: **SOIL**

| | | | | Matrix Spike (MS) and Matrix Spike Duplicate (MSD) Report | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Spike | Spike Recovery (%) | | Recovery Limits (%) | | RPDs (%) | |
| Laboratory sample ID | Client sample ID | Method: Compound | CAS Number | Concentration | MS | MSD | Low | High | Value | Control Limit |
| **EG005T: Total Metals by ICP-AES (QCLot: 3221527) - continued** | | | | | | | | | | |
| ES1327148-001 | Anonymous | EG005T: Copper | 7440-50-8 | 125 mg/kg | 108 | ---- | 70 | 130 | ---- | ---- |
| | | EG005T: Lead | 7439-92-1 | 125 mg/kg | 100 | ---- | 70 | 130 | ---- | ---- |
| | | EG005T: Nickel | 7440-02-0 | 50 mg/kg | 108 | ---- | 70 | 130 | ---- | ---- |
| | | EG005T: Zinc | 7440-66-6 | 125 mg/kg | 111 | ---- | 70 | 130 | ---- | ---- |
| **EG035T: Total Recoverable Mercury by FIMS (QCLot: 3221528)** | | | | | | | | | | |
| ES1327148-001 | Anonymous | EG035T: Mercury | 7439-97-6 | 5 mg/kg | 91.4 | ---- | 70 | 130 | ---- | ---- |

# APPENDIX C

## Auditor Correspondence

**Ci – Golder Associates, Notice of Request to Issue a Certificate of Environmental Audit (Ref: 147663038-001-L-Rev0, dated 13 June 2014)**

**Cii – Golder Associates, Lot 611 Wadeye Community, Northern Territory – Auditor Comments on Final report on Stage One Environmental Site Assessment (Ref: 147663038-002-L-Rev0, dated 18 June 2014)**

**Ciii – Cardno Ullman & Nolan, Summary of Auditor Comments for Lot 611 Wadeye Community, NT – Final Report on Stage One Environmental Site Assessment, June 2014**

13 June 2014 Project No. 147663038-001-L-Rev0

Ryan Wagner
Environmental Officer - Pollution Control
Northern Territory Environment Protection Authority
Level 2, Darwin Plaza
Smith St Mall, Darwin

**NOTIFICATION OF REQUEST TO ISSUE A CERTIFICATE OF ENVIRONMENTAL AUDIT**

Dear Ryan,

Please find attached a completed Environment Protection Authority Victoria (EPA) Form 759.2 for the preparation of a Section 53X Audit for Lot 611, Wadeye Community, Wadeye, Northern Territory.

If you have any queries relating to this notification, please do not hesitate to contact me at this office.

Yours faithfully

**GOLDER ASSOCIATES PTY LTD**

Roger Parker
Environmental Auditor (appointed pursuant to the Environment Protection Act 1970)

NB:RP/eo

CC: Kirstine Cossens
Thamarrurr Development Corporation

Attachments: Figure 1: Site Location Plan
Figure 2: Site Boundary Plan
Notification of Request to Issue a Certificate of Environmental Audit

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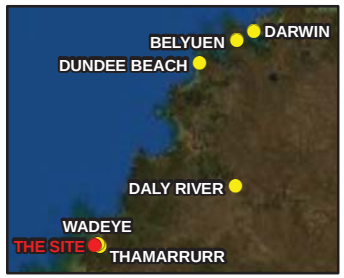
SITE ENVIRONMENTAL AUDIT REPORT
LOT 611, WADEYE COMMUNITY,
WADEYE, NORTHERN TERRITORY

THAMARRURR DEVELOPMENT CORPORATION

## SITE LOCATION PLAN




### LEGEND

Approximate Site Boundary



### COPYRIGHT

World_Imagery - Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community. Aerial image sourced from World Imagery, sourced 123.06.2014.

Township and road data sourced from MapInfo StreetPro.

0 50 100 200 300 400 500 metres

**SCALE (at A4)** 1:15,000

DATUM GDA 94, PROJECTION MGA Zone 52

PROJECT: **147663038**
DATE: **13 JUN 2014**
DRAWN: **KB**
CHECKED: **NB**

**FIGURE 1**

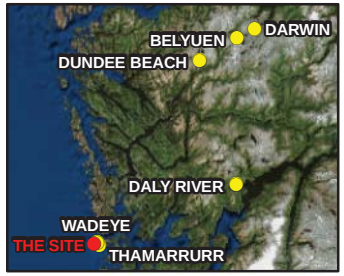
Golder Associates

File Location: \\mel1-s-file01\Jobs\ ...mxd


SITE ENVIRONMENTAL AUDIT REPORT
LOT 611, WADEYE COMMUNITY,
WADEYE, NORTHERN TERRITORY

THAMARRURR DEVELOPMENT CORPORATION

# SITE BOUNDARY PLAN




## LEGEND

Approximate Site Boundary

## COPYRIGHT



0 5 10 20 30 40 50 metres

**SCALE (at A4)** 1:2,000

DATUM GDA 94, PROJECTION MGA Zone 52

PROJECT: **147663038**
DATE: **13 JUN 2014**
DRAWN: **KB**
CHECKED: **NB**

**FIGURE 2**

Golder Associates

File Location: \\mel1-s-file01\Jobs\ ...mxd

**NOTIFICATION OF REQUEST TO UNDERTAKE AN ENVIRONMENTAL AUDIT (CONTAMINATED LAND) IN NORTHERN TERRITORY**

13 June 2014

Ryan Wagner
Environmental Officer – Pollution Control
Northern Territory Environment Protection Authority
Level 2, Darwin Plaza
Smith St Mall, Darwin

**Lot 611, Wadeye Community, Wadeye, Northern Territory**

I, Roger Parker, a person appointed as an environmental auditor (contaminated land) by the Environment Protection Authority under s. 53S of the *Environment Protection Act 1970* (Vic.), have been requested to undertaken an environmental audit for the above site. Details are as follows.

| | |
|---|---|
| Auditor | Roger Parker |
| | |
| Auditor appointment end date | 21 November 2016 |
| Auditor's appointment category | Contaminated Land |
| Audit Type | Contaminated Land |
| Name of person requesting audit | Kirstine Cossens |
| Relationship of person requesting audit to site | Acting CEO of Thamarrurr Development Corporation |
| Date of auditor engagement | 3 June 2014 |
| Proposed completion date of the audit | 18 July 2014 |
| Reason for audit | Condition Precident 1 of Planning Development Permit DP12/0070:<br>*"Prior to the commencement of works on Lot 611, the applicant must demonstrate to the satisfaction of the Consent Authority, on the advice of NRETAS that the land is suitable for the intended residential use in accordance with the National Environment Protection (Assessment of Site Contamination) Measures 1999."* |
| Environmental Segments | Air, Land, Groundwater, Surface water |
| If the audit was required by an EPA notice, licence or other, please provide EPA service order number | NA |
| Current land use zoning | Residential |
| | |
| Municipality | Wadeye Community |
| Dominant Lot on title plan | Lot 611, N.T. Portion 01637 |
| Additional Lot on title plan(s) | - |
| Site/Premises name | Lot 611, Wadeye Community |
| Building/complex sub-unit/Lot No. | - |
| Street/Lot – Lower No. | 611 |
| Street/Lot – Upper No. | - |
| Street Name | - |
| Street type (road, court, etc) | - |

| | |
|---|---|
| Street suffix (North, South etc) | - |
| Suburb | Wadeye Community |
| Postcode | 0822 |
| GIS Coordinate of Site centroid[1]<br>Latitude (GDA94) | -14.244714° |
| Longitude (GDA94) | 129.522791° |
| Site area (in square metres) | 775 $m^2$ |
| Plan of site/premises showing the audit site boundary attached | Yes |
| Plan of site/premises showing the audit site boundary attached in a spatial data format | Yes |
| Proposed support team | None |

In notifying EPA of this request to issue a certificate of environmental audit, I state that:

I am not aware of any conflict of interest that would preclude me from undertaking this environmental audit for the above site.

I have not had prior involvement in any assessment or cleanup works at the site, which would preclude me from undertaking this environmental audit for the above site.

A copy of a site plan indicating the proposed audit boundary is attached.

Yours sincerely,

Signed: _____

Roger John Parker

ENVIRONMENTAL AUDITOR

(APPOINTED PURSUANT TO *THE ENVIRONMENT PROTECTION ACT 1970*) (Victoria)

[1] Longitude and latitude (decimal degrees) coordinates in the 1994 Geocentric Datum of Australia (GDA94) is required to six decimal places.

18 June 2014 Project No. 147663038-002-L-Rev0

Kirstine Cossens
Thamarrurr Development Corporation
Lot 463, Perdjert Street,
Wadeye Community, N.T. 0822

(sent by email: Kirstine.Cossens@thamarrurr.org.au)

**LOT 611 WADEYE COMMUNITY, NORTHERN TERRITORY - AUDITOR COMMENTS ON FINAL REPORT ON STAGE ONE ENVIRONMENTAL SITE ASSESSMENT**

Dear Kirstine

Mr Roger Parker of Golder Associates Pty Ltd (Golder) was engaged by Thamarrurr Development Corporation to act as Contaminated Sites Auditor (the Auditor) for Lot 611, Wadeye Community, Northern Territory (the site).

The following Stage One Environmental Site Assessment report has been prepared by Cardno Ullman and Nolan to identify the potential for contamination within the proposed allotment as part of the residential subdivision development and was submitted to the Auditor for review:

> *Cardno Ullman and Nolan (2014). Final Report on Stage One Environmental Site Assessment, Lot 611 Wadeye Community, NT. Report prepared for Thamarrurr Development Corporation, dated 9 June 2014*

This letter has been prepared based on the Auditor review of the above report. Auditor comments are summarised in Attachment A to this letter.

The Auditor notes that there is no clear statement within the report that the land is suitable for low density residential use. Similarly, there is no clear statement that the assessment of groundwater contamination is not needed.

The attached comments are required to be addressed before the Auditor can make a statement on whether Planning Condition 1 of Development Permit (Ref: DP12/0070) has been addressed. The comments relate to the provision of additional clarification or interpretation rather than requiring additional investigation.

Yours sincerely

**GOLDER ASSOCIATES PTY LTD**

Roger Parker
Accredited Contaminated Sites Auditor

NB/RJP/eo

Attachments: **Attachment A**
Summary of Auditor Comments for Lot 611 Wadeye Community, NT – Final Report on Stage One Environmental Site Assessment, June 2014

## Summary of Auditor Comments for Lot 611 Wadeye Community, NT – Final Report on Stage One Environmental Site Assessment, June 2014

| Section | Comments | Questions | Cardno Resonse |
|---|---|---|---|
| General | There are a number of matters in the Cardno UNG Report that need further consideration. These could be addressed in a letter if it is not appropriate to update the report. | | |
| | The Auditor notes the cover letter attached to the report explaining the context of the report. Neither this letter nor the main report reach a conclusion on the suitability of the land for the proposed low density residential use. | Can Cardno UNG make a clear statement about the suitability of the site for the proposed residential use (or need for further investigation is they consider that to be the case)? | |
| | There is no mention of field screening of soil samples using a photo-ionisation detector (PID) anywhere in the report. | Was a PID used in the investigation? | |
| Section 1.1 | It is noted that "the primary objective of this Stage One ESA is to identify the potential for contamination within the proposed allotment as part of the residential subdivision development" | Is the objective also to consider if further investigation is needed or if not, the site is suitable for the proposed low density residential use? | |
| Section 1.2 | Cardno UNG states "It is the reader's responsibility to verify the correct interpretation and intention of the recommendations presented herein". No recommendations are provided. However, a recommendation on suitability of land use or recommendation for further investigation should be provided. | | |
| Section 2.1 | | Why is reference made to National Environment Protection Council (NEPC),1999 and Draft 2010 Variation? Not relevant to any works current or past. | |
| Section 2.2 | Cardno UNG states "Given, the intended land use is a residential property and the areas under study were previously occupied by an operational airstrip, the soil results have not been compared to ESLs or EILs". The Auditor considers ecological receptors should always be considered for residential development. The Auditor notes that various EILs have been included in tables at the back of the Cardno UNG report. | | |
| Section 3 | | Why is the Data Quality Objective (DQO) approach "preliminary"? Is Cardno UNG expecting to make some change to this? | |
| Table 3.1 | The following statement is made in Table 3.1. "A Stage 1 ESA with preliminary soil sampling is required to identify human and ecological health risks associated with potential onsite contamination relative to proposed land use, and particularly notifiable EMR activity. The ESA will be limited to the investigation of relevant media (either: soil; groundwater; air; and noise etc.) based on desktop study information". | Ecological risk is clearly identified in this table. Why is it excluded elsewhere in the document?<br>Why is there mention of Environmental Management Register (EMR) notifiable activity?<br>Why is noise relevant to the assessment? | |
| | Table 3.1 states that "comprehensive historical data, site information and chemical soil data is required to determine health risks for onsite and offsite receptors." | Can Cardno UNG make a clear statement about the contamination status of the site in terms of both onsite and offsite receptors? | |
| | The following statement is made in Table 3.1. "The investigation has been designed in a manner to best satisfy project requirements, timeframes, budgets and data quality". | Is Cardno UNG satisfied that the assessment is not constrained in any way and that a clear statement on suitability of the land for low density residential use can be provided? | |
| Section 4.2 | In relation to ASS, the following is stated "This means that construction within this area is only considered to be within the Acid Sulfate Soils Special Management Zone if there are excavations below 5m AHD". Similar inference made in following paragraph. | Can Cardno UNG clarify this statement as it is likely to be a mis-interpretation of ASS guidance? | |

| Section | Comments | Questions | Cardno Resonse |
|---|---|---|---|
| Section 4.3 | This section is discussion of wells in area rather than a discussion of hydrogeology. | Can Cardno UNG provide a description of local hydrogeology? | |
| Table 4.1 | | In Table 4.1, what are the standing water levels referenced to? Are they depth below ground level? | |
| Section 4.5 | The Auditor notes that the site itself and future site users are not listed as sensitive receiving environments. | Should the title of this section read “Sensitive offsite Receptors”? | |
| Section 5 | | Reference is made to NEPM 1999. Is this meant to be NEPM 1999 (amended)? | |
| Section 5.2 | Section 5.2 states “prior to 2005, are of a very large coverage area with low resolution. Therefore, the site location and surface features are unable to be distinguished for the study region and surrounding areas.” | Has Cardno UNG reviewed aerial photography from 2005 to present? Recent photographs should be provided if relevant to the assessment. | |
| Section 6.2 | The following statement is made in Section 6.2, “The most significant area of concern is the site of the original emergency fuel depot, situated within the boundaries of Lot 611”. | Are there other matters of concern? The Auditor would have expected that the placement of fill (of undefined origin) on the site could have been an area of potential environmental concern. The Auditor notes that lab testing for metals, petroleum hydrocarbons and PAHs was undertaken on shallow soil and indicates that fill (where placed) is not contaminated. Discussion with the site engineer also indicated that the fill was obtained from a borrow source remote from the township. Can Cardno UNG assess that the fill is unlikely to be contaminated? | |
| Table 7.1 | | Should importation of fill be included in Table 7.1? | |
| Section 7.2.1 | | Should importation of fill be included as a potential contaminating source? | |
| Section 7.2 | The table includes the following statement “The majority of Lot 611 was previously sealed with bitumen prior to the subdivision development”. | Was the drum store on a sealed area? | |
| | The table includes the following statement “There is potential for leaks/spills to reach groundwater, particularly when the water table is near the ground surface, however would be heavily dependent on the subsurface geology”. This statement does not appear to be closed out anywhere in the document. Cardno UNG will need to close out this matter. | Is there risk that groundwater could be contaminated? | |
| Section 7.2.3 | Cardno UNG states “High level risk remains to construction workers during the construction of foundations….” While risk to construction workers should be considered in all development sites, generally, the most sensitive receptors are young children and residents who remain potentially exposed for long periods. | Cardno UNG should reconsider the statement. | |
| | Cardno UNG states “It is understood that during the recent subdivision development, 450m$^3$ of soil was removed from the surface of the site, and backfilled with 60m$^3$ of select fill”. | Can the source of this understanding be provided? The Auditor spoke to the site engineer who confirmed this matter. | |
| | The Auditor’s inspection and discussion with the site engineer indicates that there was cut over most of the site with fill in for levelling in one area. The whole site was then covered with a thin layer of fill to create an even surface over the rocky cut surface. | Does Cardno UNG need to reconsider any discussion in the light of the Auditor’s understanding of filling? | |
| | | Should other receptors be considered? Vegetation on site? People and ecology off site? | |

| Section | Comments | Questions | Cardno Resonse |
|---|---|---|---|
| Section 8.1 | Statement made “Sampling rationale was based on the preliminary conceptual site model and from the collection of samples from the locations assessed to have been most likely exposed to contamination from site activities”. | While the Auditor accepts that the appropriate targets have been sampled, can Cardno UNG provide rationale for sampling in the light of sampling recommendations in AS 4482.1-2005? | |
| Section 8.2 | Statement made “Samples were collected from the surface, top half metre (0.0-0.5m) and from 0.5 to 1.0m. Selected samples across all three sampling depths were analysed for potential contaminants since the depth of recently placed fill during the recent earthworks is unknown”. | Considering what is presented on the test pit logs can Cardo UNG clarify:<br>- The statement about sampling depths?<br>- The unknown depth of fill given the logs state fill depth to be 0.3 m in all pits? | |
| | In dot point list it is stated “….with the excavator bucket cleaned in between each sampling location using Decon90 phosphate detergent and distilled water….” | Was this actually done (it is not common practice – not wrong but wanting to make sure statements in report are accurate)? | |
| | | Were the samples chilled prior to transport to the laboratory? Could Cardno provide the laboratory Sample Receipt Notification and laboratory QA/QC report which should include sample temperature upon receipt? | |
| Section 9.1 | | Can Cardno include discussion of duplicates for petroleum hydrocarbons (Auditor note all below LOR but comment should be included here)?. | |
| | Please provide discussion of why QA/QC was not in accord with AS 4482.1-2005 (e.g. no triplicates and other QA samples). Please discuss implications on the investigation. Also note that the heading of this section is Field and Split Duplicates. This is misleading since it appears only duplicates and no triplicates. | | |
| Section 9.2 | Following statements are made in this section:<br>- All scientific meters used throughout the sampling investigation were calibrated according to manufacturer’s specifications.<br>- All sample holding times have been met.<br>- All samples received were adequately chilled during transport to the nominated laboratories with the correct preservations used for the specified target analyte. All samples were received in good working order. | Please provide clarification as follows:<br>- Where are records of calibrations if any?<br>- Auditor cannot check holding times with data provided – can further records be provided from lab?<br>- As above, Auditor cannot check status of sample delivery – normal for lab receipt information to be provided? | |
| Section 10.1.2 | It is stated “……the HIL-A value for chromium VI was exceeded, however were below the limits for HIL-B to HIL-D”.<br>This assumes that the total chromium reported is present as chromium VI | Can Cardno UNG reconsider the exceedance of HIL A? How likely is it that total chromium measured includes chromium VI?<br>Can Cardno UNG reconsider the statement “but were below limits for HIL B to HIL D” – seems irrelevant as residential land use with gardens is proposed? | |
| | It is stated “Therefore, for residential housing with minimal horticultural gardens for produce, the level of chromium detected is considered to not present a health risk for residential occupancy. Where residential housing is likely to contain extensive horticultural gardens for produce further assessment of chromium valency (chromium VI) concentrations may be justified.”<br>Consideration of HIL A is relevant to the site. HIL A applies to low density residential areas which include gardens. It may become irrelevant when Cardno UNG further considers the chromium results. | Please clarify statement? | |

| Section | Comments | Questions | Cardno Resonse |
|---|---|---|---|
| | It is stated “Possible prior land use that can contribute to high chromium content include the use of phosphate fertilisers or the presence of treated timber” | Are these really likely? May be irrelevant after reconsideration of chromium. | |
| Section 10.2 | It is stated “Therefore, for residential housing with minimal horticultural gardens for produce, the level of chromium detected is considered to not present a health risk for residential occupancy”.<br><br>Consideration of HIL A is relevant to the site. HIL A applies to low density residential areas which include gardens. Exceedence of HIL A should be assessed following reconsideration of chromium results. | | |
| | It is stated: “Subsequent soil samples were collected from across the site from four locations where the preliminary conceptual model identified the highest risk.” | Can Cardno state how this area was identified as being of higher risk? | |
| Section 11 | Cardno UNG will need to reconsider the conclusions once the above matters have been addressed | Can Cardno UNG make a clear statement about the suitability of the site for the proposed residential use (or need for further investigation if they consider that not to be the case)? | |
| Appendix B | No environmental observations on logs. Given no mention of PID use, observations of odour or staining are important. | Can Cardno UNG provide information on observations during test pit excavation? | |
| Appendix B | Logs include fill depths but elsewhere in report says no information on fill depth. Clarification needed as to whether fill depth is known or unknown across the site. | | |
| Appendix C | The laboratory results summary table does not include units for exchangeable cations and other parameters. | Can Cardno UNG provide units for these parameters ? | |
| | | Can Cardno UNG provide a reference for the “background range” data source? | |
| | Information on the derivation of EILs and ESLs is not provided. | Can Cardno UNG provide calculations or an explanation of how the EILs have been derived including any assumptions made? | |
| | The table lists criteria for “fine” soils. This does not correlate with the description of the material in the test pit logs. | Can Cardno UNG ensure that the most appropriate soil classification (i.e. coarse or fine) is used when deriving the most appropriate ESL. | |
| | The table includes “EILs” however, these appear to be ESLs. Consideration of both EILs and ESLs are appropriate to this site. | Can Cardno UNG ensure that the table makes the correct distinction between EILs and ESLs? | |

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**Summary of Auditor Comments for Lot 611 Wadeye Community, NT – Final Report on Stage One Environmental Site Assessment, June 2014**

| Section | Comments | Questions | Cardno Response |
|---|---|---|---|
| General | There are a number of matters in the Cardno UNG report that need further consideration. These could be addressed in a letter if it is not appropriate to update the report. | | Report update has been provided |
| | The Auditor notes the cover letter attached to the report explaining the context of the report. Neither this letter nor the main reports reach a consideration on the suitability of the land for the proposed low density residential use. | Can Cardno UNG make a clear statement about the suitability of the site for the proposed residential use (or need for further investigation is they consider that to be the case)? | Report has been updated to provide such a statement |
| | There is no mention of field screening of soil samples using a photo-ionisation detector (PID) anywhere in the report. | Was a PID used in the investigation? | No; due to logistical considerations, the investigation relies on site history, olfactory, visual and sample analytical evidence. |
| Section 1.1 | It is noted that the primary objective of the Stage One ESA is to identify the potential for contamination within the proposed allotment as part of the residential subdivision development | Is the objective also to consider if further investigation is needed or if not, the site is suitable for the proposed low density residential use? | This objective has been added. |
| Section 1.2 | Cardno UNG states “it is the readers’ responsibility to verify the correct interpretation and intention of the recommendations presented herein”. No recommendations are provided. However, a recommendation on suitability of land use or recommendation for future investigation should be provided. | | This recommendation has been provided. |
| Section 2.1 | | Why is reference made to National Environment Protection Council (NEPC), 1999 and Draft 2010 Variation? Not relevant to any works current or past. | Reference has been amended. |
| Section 2.2 | Cardno UNG states “Given, the intended land use is a residential property and the areas under study were previously occupied by an operational airstrip, the soil results have not been compared to ESLs or EILs”. The Auditor considers ecological receptors should always be considered for residential development. The Auditor notes that various EILs have been included in tables at the back of the Cardno UNG | | EIL comment has been provided. |

| Section | Comments | Questions | Cardno Response |
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| | report. | | |
| Section 3 | | Why is the Data Quality Objective (DQO) approach “preliminary”? Is Cardno UNG expecting to make some change to this? | Wording has been amended. DQO approach is integral to investigative process. |
| Table 3.1 | The following statement is made in Table 3.1 “A Stage 1 ESA with preliminary soil sampling is required to identify human and ecological health rieks associated with potential onsite contamination relative to proposed land use, and particularly notifiable EMR activity. The ESA will be limited to the investigation of relevant media (either, soil, groundwater, air and noise etc) base on desktop study information”. | Ecological risk is clearly identified in this table. Why is it excluded elsewhere in the document?<br>Why is there mention of Environmental Management Register (EMR) notifiable activity?<br>Why is noise relevant to the assessment? | Ecological risks are now considered.<br>Table has been amended.<br>Reference to noise issues has been removed. |
| | Table 3.1 states that “comprehensive historical data, site information and chemical soil data is required to determine health risks for onsite and offsite receptors? | Can Cardno UNG make a clear statement about eh contamination status of the site in terms of both onsite and offsite receptors? | Report has been clarified in this regard. |
| | The following statement is made in Table 3.1 “The investigation has been designed in a manner to best satisfy project requirements, timeframes, budgets and data quality”. | Is Cardno UNG satisfied that the assessment is not constrained in any way and that a clear statement on suitability of the land for low density residential use can be provided? | Budget is often a constraint/consideration yet is not deemed to impact on the integrity of the current study. |
| Section 4.2 | In relation to ASS, the following is stated “This means the construction within this area is only considered to be within the Acid Sulfate Soils Special Management Zone if there are excavations below 5m AHD”. Similar inference mad in following paragraph. | Can Cardno UNG clarify this statement as it is likely to be a mis-interpretation of ASS guidance? | Location of ASS Special Management Zone is not considered particularly relevant to the investigation; therefore this statement has been removed. |
| Section 4.3 | This section if discussion of wells in area rather than a discussion of hydrogeology. | Can Cardno UNG provide a description of local hydrogeology? | The specified hydrogeology is now deemed adequate to meet the requirement of NEPM 2013 and AS4482 for a site of this nature and complexity. |
| Table 4.1 | | In Table 4.1 what are the standing water levels referenced to? Are they depth below ground level? | Mbtc (meters below top of casing) |
| Section 4.5 | The Auditor notes that the site itself and future site users are not listed as sensitive receiving environments. | Should the title of this section read “Sensitive offsite Receptors? | This section has been renamed and amended. |

| Section | Comments | Questions | Cardno Response |
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| Section 5 | | Reference is made to NEPM 1999. Is this meant to be NEPM 1999 (amended)? | NEPM 2013 is the abbreviation of NEPM 2013 which has been utilised in the report and this error has been corrected. |
| Section 5.2 | Section 5.2 states "prior to 2005, are of a very large coverage area with low resolution. Therefore, the site location and surface features are unable to be distinguished for the study region and surrounding areas". | Has Cardno UNG reviewed aerial photography from 2005 to present? Recent photographs should be provided if relevant to the assessment? | Statement has been made regarding availability of further Google earth imagery and conclusions drawn. |
| Section 6.2 | The following statement is made in Section 6.2, "The most significant area of concern is the site of the original emergency fuel depot, situated within the boundaries of Lot 611". | Are there other matters of concern? The Auditor would have expected that the placement of fill (of undefined origin) on the site could have been an area of potential environmental concern. The Auditor notes that the lab testing for metals, petroleum hydorcarbons and PAHs was undertaken on shallow soil and indicates that fill (where placed) is not contaminated. Discussion with the site engineer also indicated that the fill was obtained from a borrow source remote from the township. Can Cardno UNG assess that the fill is unlikely to be contaminated? | Test results and observations made during the investigation did not suggest there are any concerns with regards to contamination within the recent fill material, therefore investigation focused on the most likely source of contamination coming from the prior fuel storage<br>Comment from Kirstine Cossens on 6th July "The fill was sourced from a local gravel pit about 7 kms outside of Wadeye, it was select material grade from an approved DOI borrow pit." |
| Table 7.1 | | Should importation of fill be included in Table 7.1? | This has been included and discounted. |
| Section 7.2.1 | | Should importation of fill be included as a potential contaminating source? | See previous statement |
| Section 7.2 | The table includes the following statement, "The majority of Lot 611 was previously sealed with bitumen prior to the subdivision development". | Was the drum store on a sealed area? | Comment from Kirstine Cossens on 6th July "The fuel was stored in drums, a lot of these drums in the past were also then stored in small containers. Some drums were stored simply on the asphalt and the whole area was always fenced and secure" |
| | The table includes the following statement, "There is potential for leaks/spills to reach groundwater, particularly when the | Is there risk that groundwater could be | Possibility of risk to groundwater has been |

| Section | Comments | Questions | Cardno Response |
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| | water table is near the ground surface, however, would be heavily dependent on the subsurface geology". The statement does not appear to be closed out anywhere in the document. Cardno UNG will need to close out this matter. | contaminated? | discussed and discounted. |
| Section 7.2.3 | Cardno UNG states, "High level risk remains to construction workers during the construction of foundations….". While risk to construction workers should be considered in all development areas, generally, the most sensitive receptors are young children and residents who remain potentially exposed for long periods. | Cardno UNG should reconsider the statement. | This statement has been reconsidered. This section is now 4.2.3 |
| | Cardno UNG states, "It is understood that during the recent subdivision development, 450m$^3$ of soil was removed from the surface of the site, and backfilled with 60m$^3$ of select fill. | Can the source of this understanding be provided? The auditor spoke to the site engineer who confirmed this matter. | Pers comm Kirstine Cossens |
| | The Auditor's inspection and discussion with the site engineer indicates that there was cut over most of the site with fill in for levelling in one area. The whole site was then covered with a thin layer of fill to create an even surface over the rocky cut surface. | Does Cardno UNG need to reconsider any discussion in the light of the Auditor's understanding of filling? | The Auditor observations do not change Cardno's understanding of the risks based on discussions with those who provided factual information regarding source of fill/ |
| | | Should other receptors be considered? Vegetation of site? People and ecology off site? | These have been now considered. |
| Section 8.1 | Statement made "Sampling rationale was based on the preliminary conceptual site model and from the collection of samples from the locations assessed to have been most likely exposed to contamination from site activities? | While the Auditor accepts that the appropriate targets have been samples, can Cardno UNG provide rational for sampling in the light of sampling recommendations in AS 4462-2005? | Rationale has been included. |
| Section 8.2 | Statement made, "Samples were collected from the surface, top half metre (0.0-0.5m) and from 0.5 to 1.0m. Selected samples across all these sampling depths were analysed for potential contaminants since the depth of recently placed fill during the recent earthworks is unknown". | Considering what is presented on the test pit logs carn Cardno UNG clarify:<br>• The statement about sampling depths?<br>• The unknown depth of fill given the logs state fill depth to the 0.3m in all pits? | This text has been amended. |

| Section | Comments | Questions | Cardno Response |
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| | In dot point list it is stated, "with the excavator bucket cleared in between each sampling location using Decon90 phosphate detergent and distilled water…". | Was this actually done (it is not common practice – not wrong but wanting to make sure statements in report are accurate)? | This is a miscommunication. Cleaning was done initially but not in between samples. |
| | | Were the samples chilled prior to transport to the laboratory? Could Cardno provide the laboratory Sample Receipt Notification and laboratory QA/QC report which should include sample temperature upon receipt? | Yes. SRN is included. |
| Section 9.1 | | Can Cardno include discussion of duplicates for petroleum hydrocarbons (Auditor note a;; below LOR but comment should be included here)? | Included. |
| | Please provide discussion of why QA/QC was not in accord with AS 4462-2005 (eg no triplicates and other QA samples). Please discuss implications on the investigation. Also note that the heading of this section is Field and Spill Duplicates. This is misleading since it appears only duplicates and no triplicates. | | The QA/QC scope is considered adequate based on the scope and level of risk associated with the investigation. Internal lab processes will account mainly for QA/QC adequacy. |
| Section 9.2 | Following statements are made in this section:<br>• All scientific meters used throughout the sampling investigation were calibrated according to manufacturer's specifications<br>• All sample holding times have been met<br>• All samples received were adequately chilled during transport to the nominated laboratories with the correct preservations used for the specified target analyte. All samples were received in good working order | Please provide clarification as follows:<br>• Where are records of calibrations if any?<br>• Auditor cannot check holding times with data provided – can further records be provided from lab?<br>• As above, Auditor cannot check status of samples delivery – normal for lab receipt information to be provided? | No calibration was completed as no PID was used on site.<br>Records from lab are provided to check holding and sample receipt. |
| Section 10.1.2 | It is stated "… the HIL –A value for chromium V1 as exceeded, however were below the limits for HIL – B to HIL – D".<br>This assumes that the total chromium reports I present as chromium V1. | Carn Cardno UNG reconsider the exceedance of HIL A? How likely is it that total chromium measured includes chromium V1?<br>Can Cardno UNG reconsider the statement "but were below limits for HIL B to HIL D" – | Reconsidered. |

| Section | Comments | Questions | Cardno Response |
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| | | seems irrelevant as residential land use with gardens is proposed? | |
| | It is stated “Therefore, for residential housing with minimal horticultural gardens for produce, the level of chromium detected is considered to not present a health risk for residential occupancy. Where residential housing is likely to contain extensive horticultural gardens for produce further assessment of chromium valency (chromium V1) concentrations may be justified”.<br>Consideration of HIL A is relevant to the site. HIL A applies to low density residential areas which include gardens. It may become irrelevant when Cardno UNG further considers the chromium results. | Please clarify statement? | This has been clarified. |
| | It is stated “Possible prior land use that can contribute to high chromium content include the use of phosphate fertilisers or the presence of treated timber”. | Are these really likely? May be irrelevant after reconsideration of chromium. | Statement regarding likelihood has been included. |
| Section 10.2 | It is stated , “Therefore, for residential housing with minimal horticultural gardens ro produce, the level of chromium detected is considered to not present a health risk for residential occupancy.<br>Consideration of HIL A is relevant to the site. HIL A applies to low density residential areas which include gardens. Exceedance of HIL A should be assessed following reconsideration of chromium results. | | This has been clarified. |
| | It is stated “Subsequent soil samples were collected from across the site from four locations where the preliminary conceptual model identified the highest risk”. | Can Cardno state how this areas was identified as being of higher risk? | This has been clarified as the area of the former fuel storage. |
| Section 11 | Cardno UNG will need to reconsider the conclusions once the above matters have been addressed. | Can Cardno UNG make a clear statement about eh suitability of the site for the proposed residential use (or need for further investigation if they consider that not to be the case)? | The site is considered suitable, this statement has been included. |
| Appendix | No environmental observations on logs. Given no mention of | Can Cardno UNG provide information on | These are contained in report and in photograph commentary, the absence of |

| Section | Comments | Questions | Cardno Response |
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| B | PID use, observations of odour or staining are important. | observations during test pit excavation? | comment indicates nothing noteworthy |
| Appendix C | The laboratory results summary table does not include units for exchangeable cations and other parameters. | Can Cardno UNG provide units for these parameters? | Provided. |
| | | Can Cardno UNG provide a reference to the “background range” data source? | Olzowy et al is referenced. |
| | Information the derivation of EILs and ESLs is not provided. | Can Cardno UNG provide calculations or an explanation of how the EILs have been derived including any assumptions made? | Explanation included in report. |
| | The table lists criteria for “fine” soils. This does not correlate with the description of the material in the test pit logs. | Carn Cardno UNG ensure that the most appropriate soil classification (ie. Coarse or fine) is used when deriving the most appropriate ESL. | The more conservative coarse values have now been applied to the assessment. |
| | The table includes “EILS” however, these appear to be ESLs. Consideration of both EILs and ESLs are appropriate to this site. | Can Cardno UNG ensure that the table makes the correct distinction between EILs and ESLs? | Table has been amended, |

# APPENDIX D

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## LIMITATIONS

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|---|---|
| Africa | + 27 11 254 4800 |
| Asia | + 86 21 6258 5522 |
| Australasia | + 61 3 8862 3500 |
| Europe | + 356 21 42 30 20 |
| North America | + 1 800 275 3281 |
| South America | + 55 21 3095 9500 |

solutions@golder.com
www.golder.com

**Golder Associates Pty Ltd**
**Centrepoint Business Centre, Level 1, 48-50 Smith Street**
**Darwin, Northern Territory 0800**
**Australia**
**T: +61 8943 0689**


Golder Associates