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Geotechnics / Environment / Groundwater

Document History

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The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

	Signature	Date
Author		28 May 2014
Reviewer		28 May 2014

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GLOSSARY OF TERMS - LIST OF ABBREVIATIONS

General

ACM	asbestos cement materials
AHD	Australian Height Datum
ANZECC	Australian and New Zealand Environment and Conservation Council
AGST	above-ground storage tank
BRU	Beneficial Re-Use
CEMP	Construction Environmental Management Plan
CLM Act	Contaminated Land Management Act
COCD	Chain of Custody Documentation
CRA	Colebee Release Area
DA	development application
DEC	Department of Environment and Conservation
DECC	Department of Environment and Climate Change
DLWC	Department of Land and Water Conservation
DIPNR	Department of Planning and Natural Resources
DNR	Department of Natural Resources
DP	deposited plan
DSI	Detailed Site Investigation
DQI	data quality indicators
DQO	data quality objectives
DWE	Department of Energy and Water
EMP	environmental management plan
EPA	Environment Protection Authority
ESA	environmental site assessment
HDPE	high-density polyethylene
HIL	human health investigation level
HMTV	hardness modified trigger value
GSW	General Solid Waste
LOR	Limit of Reporting
MNA	monitored natural attenuation
MSDS	Material Safety Data Sheet
NATA	National Association of Testing Authorities
NEPM	National Environment Protection Measure
NPER	National Professional Engineers Register
NSW	New South Wales
NT EPA	Northern Territory Environmental Protection Authority
PASS	potential for acid sulphate soils
PCEMP	Post Construction Environmental Management Plan
PESA	preliminary environmental site assessment
PID	photo-ionisation detector
PPIL	provisional phyto-toxicity investigation level
PQL	practical quantitation limit
PSH	phase-separated hydrocarbons
PSI	Preliminary Site Investigation
QA	quality assurance
QC	quality control
RAP	remediation (remedial) action plan

RL	relative level
RPD	relative percentage difference
SAC	site assessment criteria
SAQP	sampling and analysis quality plan
SAP	sampling and analysis plan
SAS	site audit statement
SAR	site audit report
SIL	site investigation level
S(E)MP	site (environmental) management plan
SOP	standard operating procedure
SRN	sample receipt notification
SSC	sensitive site criteria
TCLP	Toxicity Characteristic Leaching Procedure
TBT	tri-butyl tin
UCL	upper confidence limit
UPSS	underground petroleum storage system
UST	underground storage tank
VMS	vapour mitigation system

Analytes – Inorganic

As	arsenic
Be	beryllium
B	boron
Cd	cadmium
Co	cobalt
Cr	chromium
Cu	copper
Fe	iron
Hg	mercury
Mn	manganese
Mo	molybdenum
Ni	nickel
Pb	lead
Sb	Antimony
Se	Selenium
Sn	Tin
V	Vanadium
Zn	zinc
CN	Cyanide

Analytes – Organic

BaP	benzo(a)pyrene
BTEX	benzene, toluene, ethylbenzene, xylene
OCP	organochlorine pesticides
OPP	organophosphorus pesticides
DDT	dichloro-diphenyl-trichloroethane
DDE	dichloro- diphenyl-dichloroethylene
PAH	polycyclic aromatic hydrocarbons

PCB	polychlorinated biphenyls
SVOC	semivolatile organic compounds
TPH	total petroleum hydrocarbons
VHC	volatile halogenated compounds
VOC	volatile organic compounds

Measures

µg/L	micrograms per litre
km	kilometer
L	litre
m	metre
m^2	square metre
m^3	cubic metres
mg/kg	milligrams per kilogram
mg/L	milligrams per litre
mm	millimeter

Note: All acronyms listed above may not have been used in the report

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Appendices

Statutory Site Audit Report
41 Boulter Road
Berrimah, Northern Territory

1. Introduction

1.1 Background

The subject of this Site Audit Report (SAR) is a 1.4 ha parcel of land located at 41 Boulter Road, Berrimah, Northern Territory (NT). The site is described as Section 5694, Hundred of Bagot, Plan L2003/067 Certificate of Title (CUFT) Volume 768 Folio 513 (**Figure 1, Appendix A**)[1] and is located within the Darwin City Council area. The site area is currently zoned Residential (Multiple Dwelling) in the Northern Territory Planning Scheme, Darwin Map (NT Government, July 2013).

The site was previously used as a plant nursery (palms, mangoes and flowers), with minor structures and has been vacant since 2004. The site was unoccupied during inspections and investigations by the assessment consultant (Coffey) and during a site inspection by the auditor's representative on 19 March 2014. Photographs of the site are shown in **Appendix B**.

The commission for the site audit was received by Douglas Partners Pty Ltd (DP) from Mr John Tannos of L J Superfund Pty Ltd on 5 February 2014 and the audit was notified to the NT EPA on 10 February 2014.

The land falls within the planning jurisdiction of Darwin City Council who require an audit to be completed as a requirement of Development Permit No. DP12/0309, dated 22 June 2012 (**Appendix C**). As the site is subject to development consent the audit is deemed to be statutory in nature as defined under the provisions of the Planning and Development Act 2007 as far as they extend to site auditing work in the NT under the NSW Scheme.

The purpose of this SAR is to determine, following investigations by Coffey, whether the subject land is suitable for any specified use or range of uses as defined in S1.3 (b) (iii) of the Guidelines for the NSW Site Auditor Scheme (2nd Edition), NSW DEC, 2006. The proposed land use is residential comprising 39 single storey dwellings which are presumed to have direct access to soils in the form of landscaped areas or gardens, although no detailed plans are understood to be currently available.

The site audit is based on the results of contamination investigations undertaken by Coffey between October 2013 and April 2014. The findings of the various investigations are outlined in the reports which are listed in Section 1.5.

This SAR has been prepared generally in accordance with the provisions of the Guidelines for the NSW Site Auditor Scheme (2nd Edition), NSW DEC, 2006. It has been prepared by Michael Nash

[1] Figure 1 and other associated figures are abstracted from the reports referenced in Section 1.5. Figure numbers may have been changed for convenience.

who is accredited as an auditor by the NSW EPA (Auditor No. 9822) under the Contaminated Land Management Act, 1997 and who is also a NPER registered engineer (No. 1168905) in both the Civil and Environmental Divisions of Engineers Australia. The provisions of the NSW Site Auditor Scheme have been adapted where feasible for the purposes of undertaking a Site Audit in the NT under Section 47 of the Waste Management and Pollution Control Act NT (see below).

1.2 Involvement of Consultants and Auditor

Coffey was engaged by the proponent to conduct contamination investigations on the subject site prior to the involvement of the site auditor and in this regard Coffey prepared a (preliminary) site contamination assessment (PSI) in October 2013 which involved some testing and sampling. Following auditor appointment in February 2014 Coffey was requested to undertake further testing of the site and provided a sampling analysis and quality plan (SAQP) in February 2014 (following comments on the PSI) and then prepared a combined PSI and DSI in May 2014 to report on the earlier and subsequent testing regime.

The auditor's representative has undertaken two site inspections during the course of works which was recorded in a series of photographs. Photographs 1 - 28 in **Appendix B** show selected views of the site on 19 March 2014.

1.3 Scope of the Site Audit Report

This site audit was carried out principally using the criteria established by the NSW EPA (formerly DEC, DECC, DECCW and OEH) in their publication Guidelines for the NSW Site Auditor Scheme (2nd Edition), NSW DEC, 2006, and in Guidelines for Assessing Former Orchards and Market Gardens, NSW DEC, 2005.

In addition, the auditor has referenced, where appropriate, other guidance documents made or approved by the NSW EPA under Section 105 of the Contaminated Land Management Act, 1997, and by the NT Government under the Waste Management and Pollution Control Act, as in force 1 January 2013 including inter alia:

- NT EPA (2013). Guidelines for Consultants Reporting on Environmental Issues, January 2013;
- NT EPA (2013). Guidelines on Conceptual Site Models, November 2013;
- NT EPA (2013). Asbestos Disposal in the Northern Territory, March 2013;
- NSW DECC (2009). Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997;
- NSW DEC (2007). Guidelines for the Assessment and Management of Groundwater Contamination (March 2007);
- ANZECC/ARMCANZ (2000). Australian Water Quality Guidelines for Fresh and Marine Waters;

- Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council (2000). Australian Water Quality Guidelines for Fresh and Marine Waters;
- National Environment Protection Council (NEPC), (1999). National Environment Protection (Assessment of Site Contamination) Measure, and as amended May 2013;
- NSW EPA (1997). Guidelines for Consultants Reporting on Contaminated Sites (reprinted August 2011);
- NSW EPA (1995). Sampling Design Guidelines;
- NSW EPA (1994). Guidelines for Assessing Service Station Sites, December 1994 (as updated 2003).

In completing the audit process the auditor has reviewed the consultant's reports and any supplementary information provided against checklists of requirements for reporting which have been adapted from Section 3.1 of the Guidelines for Consultants Reporting on Contaminated Sites (NSW EPA, 1997) and from Appendices IV and V of the Guidelines for the NSW Site Auditor Scheme (2nd Edition), NSW DEC, 2006 as well as the corresponding NT EPA guidelines (2013).

Other information referred to by the Auditor is listed in Section 1.5 and in the References and Bibliography at Section 9.

1.4 Limitations

The auditor has prepared this SAR and accompanying SAS on behalf of DP for the purposes specified in the above sections and as defined by Regulation and by the NSW EPA and NT EPA. The project scope of works undertaken by the auditor was developed specifically for the purpose of meeting the objectives outlined above. The objectives and scope of works adopted by the contamination assessment consultants are understood to have been developed based on similar objectives.

The auditing work and reporting undertaken has been carried out to a standard of care and diligence normally expected of professional engineers and scientists practicing in the areas of contaminated land assessment and management in NSW and NT.

The degree of confidence in the findings and conclusions of the SAR and related SAS is governed by the typical limitations and constraints inherent to such audits. The audit is based entirely on the investigations undertaken by the contamination assessment consultants as well as on the reported relevance and quality of the information and data obtained.

Where there are shortcomings or limitations in regard to the data obtained from the site (investigations) or uncertainties in respect to the conclusions drawn from these data, such issues are identified in the SAR.

The audit undertaken reflects the condition of the site at the time of audit and as specified elsewhere in this report based on the results of the investigations under audit. No liability can therefore be accepted for failure to identify site conditions or related environmental issues which may arise in the future from ongoing site uses, or which could not have reasonably been determined or envisioned

based on the scope of investigation works undertaken and the data obtained during the assessment. In this regard it is noted that site conditions are determined by the consultant during the assessment phases of investigations by means of both interpretative and statistical methods using data obtained during sampling, and it is noted that conditions between sampling locations may not be reflective of those actually sampled or analysed.

Accordingly, no liability is accepted by DP or the auditor for unidentified contamination or subsurface features or structures subsequently found to be present on the site where the investigations have been undertaken in substantial compliance with the guidelines endorsed by NSW EPA and NT EPA.

The data used to support the conclusions reached in this SAR have been obtained by other consultants and have been audited with a reasonable level of scrutiny, care and diligence by the auditor. No liability can be accepted for unreported omissions, alterations or errors in the data collected and presented by the other consultants. Accordingly, the data and information presented by others are taken and interpreted in good faith by the auditor.

This SAR should not be used for purposes other than those indicated in the previous sections of this report. The report and attached SAS (No. DP/NT/105) should not be reproduced without the permission of Douglas Partners Pty Ltd.

If additional copies of the report are required for any reason then the SAR should be reproduced in its entirety including the SAS to which this report is attached.

It is further noted that this SAR and related SAS provide an opinion on the contamination status of the site as reported by the consultant up to 11.00 am on 8 May 2014, including a large stockpile of imported material (from East Arm) estimated at some 500 m^3. This proviso is necessary as it is understood that further materials may be imported onto the site to raise levels, but which have necessarily not been characterised by the present investigations, or reviewed under the audit process. The investigations and audit therefore take no account of any materials which may be imported to the site after the above time and date.

This site audit does not address the geotechnical or engineering suitability of the site, or any materials thereon, and accordingly it is recommended that suitable specialist advice in this regard is obtained. Similarly the audit does not address the suitability of any materials for re-use on land which falls beyond the boundary of the site.

1.5 Associated Reports and Other Materials Referenced

The reports reviewed for this audit were as follows:

- Coffey (2013). Preliminary Site Investigation Plan PA2012/0097_1165 Section 5694, Hundred of Bagot 41 Boulter Road, Berrimah, NT, dated 18 September 2013;
- Coffey (2013). Site Contamination Assessment 41 Boulter Road, Berrimah, Northern Territory, dated 17 October 2013;
- Coffey (2014). Supplementary Detailed Site Investigation Sampling Analysis and Quality Plan 41 Boulter Road, Berrimah, Northern Territory, dated 11 March 2014;

- Coffey (2014). Site Contamination Assessment (Preliminary Site Investigation and Detailed Site Investigation), Version 3 41 Boulter Road Berrimah, Northern Territory, dated 19 May 2014.

Other relevant information including correspondence between the auditor and consultant and/or proponent and NT EPA is included at **Appendix C**.

2. Site Details

2.1 Site Description

The site comprises a 1.4 ha parcel of land located at 41 Boulter Road, Berrimah, Northern Territory (NT). The site is described as Section 5694, Hundred of Bagot, Plan L2003/067 Certificate of Title (CUFT) Volume 768 Folio 513 (**Figure 2, Appendix A**).

The site area is currently zoned Residential (multiple dwelling) in the Northern Territory Planning Scheme, Darwin Map (NT Government, July 2013) and is located within the Darwin City Council local government area.

At the time of the investigations the site was unoccupied and vacant (see Photographs at **Appendix B**) although two temporary structures (a shipping container and relocatable building) were located on the site. Vegetation had been cleared prior to inspections and some stockpiles of mainly vegetation and some soil were reported during the initial inspection by Coffey (October 2013), but were initially reported to have been removed by the time of the subsequent inspections and DSI by Coffey. However DPs inspection on 19 March 2014 reported a mulch stockpile and 4 small soil stockpiles were present, along with a larger soil stockpile (50 m x 5 m x 2 m) located on the north western site boundary.

A summary of site details is provided in Table 1 below and a survey plan provided by the auditor is shown at **Appendix D**.

Table 1: Summary of Site Information

Site Owner:	L and J Tannos as Trustee for L J Superfund Pty Ltd
Site Location:	41 Boulter Road, Berrimah, Northern Territory
Total Site Area:	1.4 ha
Title Identification:	Section 5694, Hundred of Bagot, Plan L2003/067 Certificate of Title (CUFT) Volume 768 Folio 513
Zoning:	Residential (Multiple Dwelling)
Recent Land Use:	Nursery (vacant)
Proposed End Land Use:	39 Single Storey Dwellings
Adjacent Land Use:	North – School and Road Easement South – Boulter Road and Commercial and Residential Developments East – Vacant Land and Residential Development (Former Nursery) West – Garden Centre (Nursery)

Auditor's Opinion

The auditor concurs with the site description and locational information provided by the consultant (and by the proponent) which appears to coincide with the actual site (and proposed land use) under audit. However, there appeared to be some doubt regarding the presence or absence of the soil stockpiles at the time of the original DSI reports (rev 1 and rev 2). In addition from the photographs, the soil stockpiles, and as shown on Drawing 1, **Appendix B**, were still present on 19 March 2014 (at the time of site testing for the DSI rev1 and 2) and on 4 May 2014, including one estimated as comprising some 500 m^3 of materials the provenance of which was unknown at the time. From the DP inspections the larger stockpiles (at least) comprised mainly soil. Accordingly Coffey were asked to review the situation (see correspondence) involving identification of the source site of the materials and further testing, resulting in an amendment to the DSI (rev3) dated 19 May 2014.

2.2 Topography, Drainage and Meteorology

Regional topography was not described in any detail by Coffey. However in their DSI (2014) Coffey indicated that:

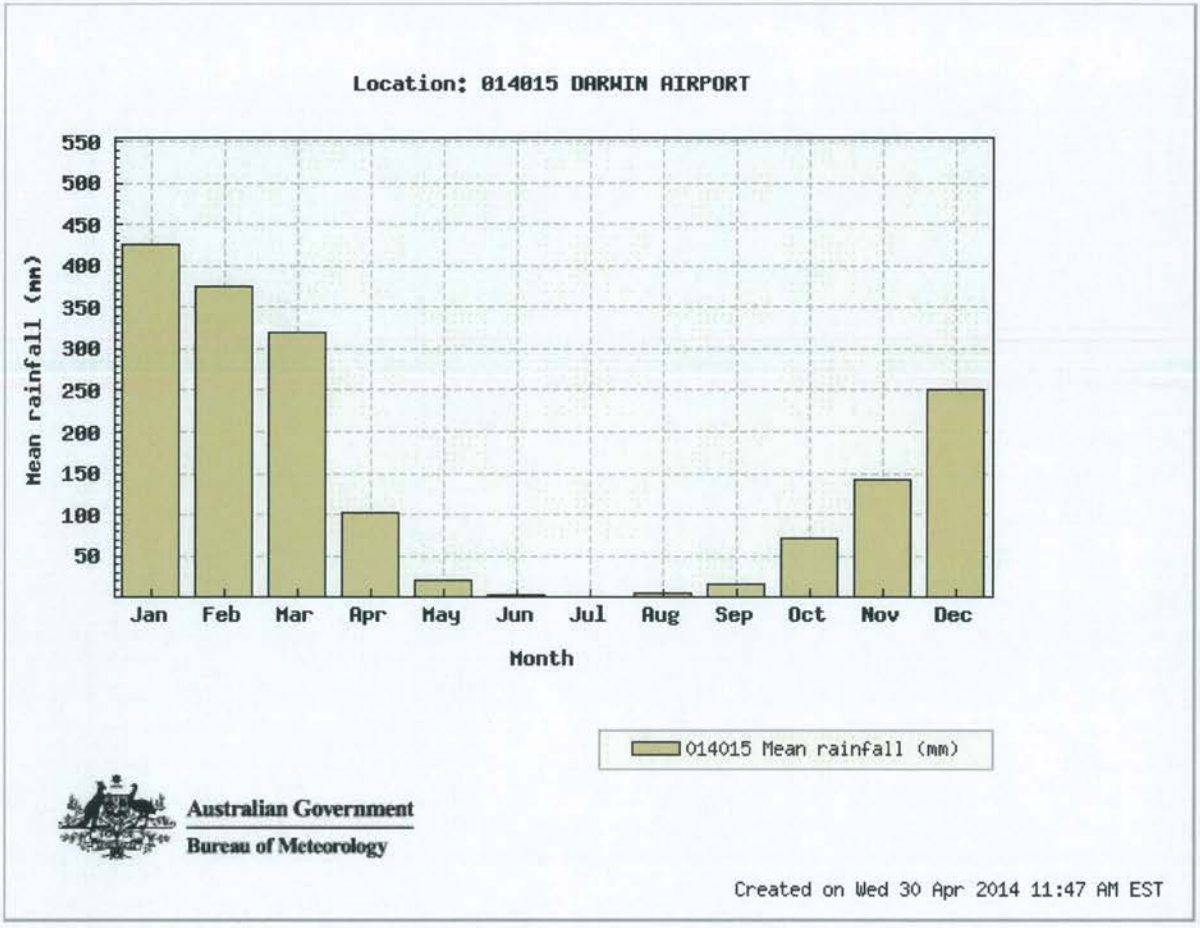
'... the site is relatively level with a slight incline to the south-south west towards Boulter Road...'.

The auditor notes that from Google Earth the site has an elevation of 40 mAD and is quite level as can be seen in the site photographs provided in **Appendix B**.

Coffey also provided the following information on surface water:

'... the nearest surface water bodies are the retention pond located within Marrara Christian College and Crocodylus Park approximately 0.5km and 1km north and north east of the site respectively. A creek is located within Holmes Jungle Park 2km to the north east of the site .....'.

Coffey did not comment on local meteorology, however the auditor notes that the site is located in an area of tropical climate with warm dry winters and hot wet summers (with typical annual temperature ranges of 18-33 degrees Celsius) and with annual rainfall at Darwin Airport (2 km to the south west of the site) of approximately 1740 mm, mostly falling in the summer months, as shown in the following graphic.



An underground utility search was not reported by Coffey and no services are known to be present at the site other than a soakaway from the temporary structure. Detailed service diagrams of the site were similarly not provided but noting that the site has not apparently had any permanent structures then services are unlikely to be present.

Auditor's Opinion

The consultant's description of the topography, drainage and site meteorology is considered satisfactory in the overall context of the site and its setting and the site history. However, Coffey's description as the site topography in relation to the presence of soil stockpiles at the time of the DSI (March – April 2014) differed from DP's description and photographic evidence and as a result of discussions with Coffey further testing was undertaken on the large soil stockpile which was found to have been imported, but not reported by Coffey, in the first two versions of the DSI.

2.3 Geology and Hydrogeology

Coffey provided the following summary of the geology of the site:

'... according to the Geological Survey of Northern Territory - Darwin Region 1:250,000 Map (1988), the geological profile beneath the area of investigation is generally underlain by Quaternary sand, silt and clay. Ground conditions encountered during the 2013 site works generally consisted of silty sandy gravel to a maximum depth of 0.4 metres below ground surface (mbgs), underlain by sandy gravelly clay and sandy gravel to the maximum depth of investigation of 2mbgs. A water bore record at the adjacent property (see Section 2.5) indicates a 2m thick cover of topsoil overlying yellow clay with grey schist bedrock from 6 mbgs to at least the base of the borehole at 69 mbgs.

A summary of the hydrogeology of the site provided by Coffey was as follows:

'..... bore information obtained from the NT Land Information Systems (NTLIS) (2013) database indicates there are 14 water bores within a 1km radius of the site. Generally groundwater was struck within the productive wells at depths between 25 mbgs and 50 mbgs. Some wells were abandoned as dry at between 50 mbgs and 70 mbgs.

A water bore is present on the adjacent property to the east (#RN025695). The land parcel to the east was previously part of the larger land parcel encompassing the site. The bore was drilled in 1987 on the instruction of the previous site owner to 69 m and it is understood has not produced any groundwater since installation. As the groundwater bore is located on the adjacent site, it is considered to be representative of the site and indicates that groundwater would be unlikely to be encountered beneath the site prior to 69 mbgs.

A groundwater bore located on a golf course approximately 2.3km north west of the site reported standing water at 1.38 mbgs. This well was report (sic) to have been drilled some 4m north west of a dam, it is therefore considered likely that the standing water level recorded is indicative of the water level within the adjacent dam. The nearest surface water bodies are the retention pond located within Marrara Christian College and Crocodylus Park approximately 0.5km and 1km north and north east of the site respectively. A creek is located within Holmes Jungle Park 2km to the north east of the site ...'.

Accordingly, from the site history research by Coffey and from subsequent site testing the near surface soils comprise silty sandy gravels and sandy gravelly clays which is consistent with expectations based on the Geological Survey mapping.

Auditor's Opinion

The consultant's description of the nature of substrate materials in terms of site history search and from test pit logging and sampling is considered to be satisfactory and the information is considered to be consistent with published information in regard to the site area as well as the auditor's knowledge of the geotechnical and hydrogeological conditions generally encountered in the Darwin area.

The desktop assessment of local hydrogeological conditions by the consultants is considered to be adequate.

2.4 Site History

Coffey undertook a site history assessment in 2013, which included a review of aerial photographs, land title search, review of land title records (through the Land Titles Office, Department of Attorney General and Justice), interviews with the present and previous land owners. No previous building permits were discovered. No search for dangerous goods was undertaken by Coffey but the likelihood of any underground tanks, or buried drums or wastes being present on the site was considered remote by the auditor. Coffey undertook a search of the NTEPA data based and determined that there were no matters recorded under the Waste Management and Pollution Control Act and similarly no heritage or archaeological matters associated with the site. Coffey also undertook a search of local water bores (as referenced in Section 2.3).

Coffey examined aerial photographs from 1944-2009 which indicated some form of agricultural activity consistent with the known history of the site and which appears to show that the site has been subdivided recently from a larger block involved with nursery (market gardening) activities.

Table 2: Summary of Aerial Photograph Interpretation by Coffey

Year	Review of Historical Photograph
1944	Site appears to be vacant scrub land with a central dirt road running, north to south. The surrounding area is predominately scrub land, and an area is cleared to the south east which appears to be for some agricultural/horticultural activity. Land to the north east appears to be cleared in areas, possibly for future residential allotments.
1974	The site appears relatively unchanged when compared to the 1944 aerial photograph; however the road through the site is not now visible. The lands to the north, east and north east of the site appear to be developed with residential properties or are cleared for future development.
1990	The site and adjacent properties to the east and west appear to be developed as a horticulture property (nursery) which appears to be subdivided into three blocks by rows of fruit or palm trees. Boulter Road and a college are visible to the north west. Land to the east and south east appear further developed with residential and some commercial properties.
2000	The site appears generally unchanged from the 1990 aerial photograph. Site surrounds to the south, south east and north west appear more developed.
2009	The site remains divided into three blocks, with portions of the site cleared and two shed like structures present in the western portion. The surrounding land appears relatively unchanged.

A review of the land title documents was undertaken which determined the current and previous owners and Coffey undertook interviews with Mr John Tannos (current owner) and Mr Henning Olsen (previous owner). Coffey reported the following:

'... during the site walkover in September 2013 the site owner Mr John Tannos met with Coffey. Mr Tannos indicated in the time he had owned the site (~9 years), no chemicals had been used across the site (i.e. pesticides or herbicides) and no machinery had been stored as the site had been vacant and not in use during this time.

Mr Henning Olsen was interviewed and indicated he owned the site between 1982 and 2004 and the site was part of a larger site area (encompassing the adjacent property to the east and west). The larger site area was operated as a flower nursery. Prior to Mr Olsen acquiring the land, the site was

vacant scrub land. Mr Olsen indicated he used a minor amount of pesticides and herbicides for the operation of the flower nursery (details of specific chemicals utilised are not known) and that he had planted mango and palm trees around the perimeter of the area as a wind break. Machinery stored on the site comprised of a tractor…'.

It is understood that during Mr Olsen's tenure the site was actually owned by Terek Nominees Pty Ltd.

Auditor's Opinion

The detailed site history review undertaken by Coffey is reasonably comprehensive and is believed to have identified, as far as possible, the most likely types of potential contamination related to former land uses as a nursery.

2.5 Contaminants of Concern

Coffey identified series of contaminants of potential concern (COCs) in their PSI and DSI and provided the following summary:

'… on the basis of the site history review undertaken, Coffey identified that the most likely contaminants associated with the site's historical use and the surrounding land uses were the use of pesticides and herbicides, storage of machinery and the importation of fill for site development.

Chemicals of potential concern (COPC) associated with the site historical and current uses may include (but are not limited to) the following:

- *Total recoverable hydrocarbons (TRH), from oil/fuel spills from the result of utilisation and storage of machinery on the site between 1982 and 2004;*
- *Metals, from the use of agrochemicals or within any imported impacted fill material; and*
- *Pesticides and herbicides.*

Soil impacts resulting from application of agrochemicals (pesticides, herbicides and metals) would be expected to have occurred across the entire site and not present in the form of discrete hotspots. It is noted, however, that some heterogeneity in the distribution of agrochemicals on soil from spraying can occur at locations such as tractor turning areas (NSW DEC 2005).

Given the period of use (1982 and 2004), it is likely that some degradation of agrochemicals would have occurred since application. However, some agrochemicals utilised in this period have a relatively long half-life, and if applied in significant quantities may remain at the site.

It is understood that only a limited amount of agricultural machinery was utilised at the site, with a single tractor stored on the site during its use as a flower nursery. It is therefore anticipated that any TRH impacts. Heavy metal impacts within imported fill would generally be expected to be heterogeneously distributed within the fill and not present in the form of hotspots...'.

Coffey prepared and modified a conceptual site model (CSM) during the course of the assessment which identified potential transport mechanisms, exposure routes and receptors for potential contaminants on the site.

This appears to comprise a reasonable conceptual site model of contaminant migration pathways and related these to potential future land uses during construction and occupation. Coffey's preliminary CSM is shown below.

Hazard/Source of Contamination	Key Areas Affected	Potential Transport Mechanisms and Exposure Routes	Key Receptors
Hydrocarbon impacted soils	Whole site area, in particular areas of any former machinery storage	Direct contact, ingestion, inhalation, plant root uptake	Future site users, site neighbours and maintenance/ construction workers
Metals impacted soils	Whole site area, in particular areas of fill	Direct contact, ingestion, particulate inhalation, plant root uptake	Future site users, site neighbours and maintenance/ construction workers
Pesticide and herbicide impacted soils	Whole site area	Direct contact, ingestion, particulate inhalation, plant root uptake	Future site users, site neighbours and maintenance/ construction workers

Asbestos was not considered to be a COPC on the basis that no permanent structures were present and substantial filling (if any) had taken place and that no potential asbestos containing materials (ACM) had been observed on site.

Auditor's Opinion

Overall the range of potential contaminants identified and subsequently tested by Coffey was considered suitable to cater for the range of potential contamination likely to have derived from the previous land uses identified by the consultants.

The issue of imported soil (stockpile) was dealt with subsequently and involved a review of the history of the source site followed up by testing of the stockpile on 8 May 2014.

2.6 Site Redevelopment

No details have been supplied by the consultant or proponent of the proposed site redevelopment and/or layout, however the development is known to comprise 39 single storey dwellings comprising 34 single bedroom units and 5 double bedroom units.

For this purpose the auditor has assumed that the dwellings will have some access to soil and that the generic land use category in terms of contamination assessment and site characterisation will be 'Residential A (HIL A)' as defined in NEPM 2013 as 'residential with gardens/accessible soil (home grown produce <10% of fruit and vegetable intake (no poultry), also includes childcare centres, preschools and primary schools)'.

Auditor's Opinion

Coffey have identified the type of development proposed although the details of site layout etc. are not provided, nor do they appear in Development Permit DP12/0309. As noted above the nature of the proposed land use appears to classify the site as 'Residential A – HILA or Column 1 in the NSW Site Auditor Scheme (2006). As the nature of the development was not fully known Coffey opted to consider both Residential A and Residential B categories in their DSI.

3. Site Assessment

The soil investigation levels (criteria) adopted by the consultants during the course of the investigation programme were based largely on the National Environment Protection Council (1999). National Environment Protection Measure (Assessment of Site Contamination) Measure (NEPM), as amended May 2013.

Coffey noted that as the nature of the redevelopment was not fully known optional (alternative) criteria were proposed as follows:

- NEPC (2013) National Environment Protection (Assessment of Site Contamination) Measure (NEPM) – Soil HIL A Low-Medium Density Residential;
- NEPC (2013) National Environment Protection (Assessment of Site Contamination) Measure (NEPM) – Soil HIL B High Density Residential; and
- NEPC (2013) National Environment Protection (Assessment of Site Contamination) Measure (NEPM) – Soil HSL (A & B) Low Density to High Density Residential.

Coffey noted that these criteria are human health based levels and that EILs have been developed for assessing risk to terrestrial ecosystems, and that these depend on specific soil physiochemical properties and land use scenarios and generally apply to the top 2 m of soil. The EILs from the amended ASC NEPM were adopted for Coffey's assessment.

In addition from the results of the testing programme at the PSI stage and noting the site history Coffey opined that the adoption of the soil HSLs (for TPH and BTEX compounds) was not necessary as there was no likelihood of their occurrence. The auditor tends to concur with this view (see correspondence at **Appendix C**).

On this basis Coffey proposed two sets of soil assessment criteria for comparison purposes as shown in the tables below.

Table 3: Adopted Site Assessment Criteria for Pesticides and Herbicides - HILs and EILs

Analyte	Health-based Investigation Levels (HILs) (mg/kg)		Ecological Investigation Levels (EILs) (mg/kg)
	HIL A	HIL B	Urban residential & public open space
DDT	--	--	180[2]
DDT + DDD + DDE	240	600	--
Aldrin + Dieldrin	6	10	--
Chlordane	50	90	--
Endosulfan	270	400	--
Endrin	10	20	--
Heptachlor	6	10	--
HCB	10	15	--
Mirex	10	20	--
Methoxychlor	300	500	--
Toxaphene	20	30	--
2,4,5-T	600	900	--
2,4,5-D	900	1,600	--
MCPA	600	900	--

Table 4: Adopted Site Assessment Criteria for Heavy Metals - HILs and EILs

Analyte	Health-based Investigation Levels (HILs) (mg/kg)		Ecological Investigation Levels (EILs) (mg/kg)
	HIL A	HIL B	Urban residential & public open space
Arsenic	100	500	100[2]
Cadmium	20	150	..
Chromium III	..	..	190
Chromium IV	100	500	..
Copper	6,000	30,000	60[#]
Lead	300	1,200	1,100[2]
Mercury (inorganic)	40	80	..
Nickel	400	1,200	30[#]
Zinc	7,400	60,000	70[#]

#. If value exceeded, EIL's for Cu, Ni and Zn to be re-calculated based on soil CEC/pH.

The comparative site assessment levels adopted by Coffey as site investigation levels (SILs) comprising HILs and EILs and are appropriate to the likely proposed land uses.

Groundwater was not encountered during the investigations by Coffey and was considered to be located at considerable depth beneath the site. Moreover, following the PSI in October 2013 where no evidence of significant contamination was detected Coffey opted not to specify groundwater criteria for the site (or to test groundwater). This view is considered reasonable and is supported by the auditor.

Coffey did not consider the potential for acid sulphate soils (PASS) but the auditor is of the view that PASS soils would not be an issue on the site on the basis of the observed substrate conditions, regional geology and location of the property.

Auditor's Opinion

Ultimately for the purposes of site characterisation the SILs adopted by the consultant are generally in accordance with the likely (planned) residential land-use(s).

Whilst no criteria were provided by the consultant for asbestos in soil, asbestos is not likely to be present based on the information available to date. The same is true for acid sulphate soils and for groundwater the latter being at depth and is unlikely to be impacted based on the testing results and general condition of the site soils.

As far as is known surface water is not generally present on the site.

4. Site Investigation

4.1 Overview of Testing

Site investigations were undertaken by Coffey in October 2013 and March 2014 (the letter reported in April 2014 and again in early May 2014 (stockpile testing)). These included a PSI and DSI, with an intervening SAQP.

A total of 10 sampling locations – test pits (TP1-TP10) were undertaken as part of the PSI and a further 24 locations (S1-S24) as part of the DSI Sampling locations are shown on **Figure 2, Appendix A**. Test pits generally reached a depth of 2.0 m whilst the subsequent sampling focussed on shallower depths (0 - 0.25 m). The shallow testing was undertaken for two reasons:

- To fill in (horizontal) data gaps occasioned by an inadequate sampling density in the PSI (only 10 test pits over a site area of 1.4 ha which is substantially less than the minimum sampling design); and
- To fill in vertical data gaps occasioned by omitting to test near surface soils (Coffey tested only from 0.5 m depth and deeper in the PSI) which based on the site history was the most likely horizon to have been contaminated by previous land uses (i.e. broadcasting of pesticides, herbicides and fertilisers).

In the PSI Coffey analysed samples for TRH (NEPM 2013 Fractions F1 and F2), 16 metals (including As, B, Cd, Co, Cr, Cu, Pb, Hg, Mn, Ni and Zn etc), OCP/OPP, herbicides and phenols. Soil moisture content was also tested.

During the DSI TRH was omitted and the analytical regime was restricted to key metals (As, Cd, Cr, Cu, Pb, Hg, Ni and Zn) as well as a range of common pesticides and herbicides.

During the PSI 28 samples were submitted for analysis from test pits including field QA/QC samples. However, as noted above the lateral sampling distribution was limited and moreover the shallowest sample analysed was from 0.5 m depth (shallower samples were also submitted to the laboratory but were not tested upon instructions from Coffey).

For the DSI a much wider sampling grid was adopted comprising 24 locations but the samples were triple composited based on the recommendations in the Guidelines for Assessing Former Orchards and Market Gardens (NSW DEC, 2005), see correspondence at **Appendix C**. Accordingly, 8 samples (COMP1 – COMP8) plus field QA/QC were analysed as part of the DSI.

Based on the PSI and DSI by Coffey a wider range of sampling locations and depths were assessed which in the auditor's opinion has sufficiently characterised the site soils.

The test pit logs and the sampling distribution undertaken by Coffey are considered to provide sufficient information to broadly characterise the substrate conditions at the site. Logs for TP1-TP10 and S1-S24 are provided in **Appendix E**.

As noted above the identification of a large stockpile of imported soil on site resulted in further sampling (on 8 May 2014) by Coffey. Sampling involved 10 test pits excavated within the stockpile with a corresponding number of soil samples being submitted for the analysis of a range of potential

contaminants based on the source site location of the imported materials from the Dawson Street East Arm development area. In this regard Coffey noted that:

'... The Dawson Street, East Arm Development Area referred to is a former hill that was flattened to form level industrial sites. Therefore any material that has come from this area is likely to be broken down meta-siltstone, and the allotment the soil has come from is likely to have shallow rock.... It is therefore apparent that it is unlikely that significant potentially contaminating activities have taken place in the vicinity of the stockpile source area. To confirm that the soil is suitable for use on the site, sampling and analysis of the material for a suite of common potential contaminants was required...'.

Coffey undertook sampling of the stockpiled material as follows:

- With the use of a backhoe, the stockpile was opened at ten locations to enable representative sampling from within the body of the stockpile at locations shown on the attached field-notes sketch plan;
- Soil samples were collected from each location within using a hand trowel from the soil within the backhoe bucket;
- Soil samples collected were logged in accordance with the USCS and field screened for the presence of VOCs using a PID;
- Submission of eight primary samples for a Broad Contaminant Screen (BCS) and two primary samples for a metals screen; and
- Collection and submission of one intra-laboratory duplicate soil sample, inter-laboratory triplicate soil sample and one equipment rinsate and trip blank sample for selected analysis.

All stockpile samples were collected from within the stockpile, no surface samples were collected.

4.2 Adopted Sampling Pattern

Coffey reportedly employed a combination of judgmental and systematic sampling across the subject site comprising 1.4 ha. The 10 soil sampling locations from the Coffey (2013) PSI combined with the additional 24 soil sampling locations from the Coffey DSI (2014) gave a total of 34 locations which exceeds the minimum sampling density (24 locations) set out in the Sampling Design Guidelines (NSW EPA, September 1995). Sampling extended to depth of 2.0 m during the PSI and 0.25 m during the DSI. In the latter the surface sample 0.0 - 0.1 m was generally selected for compositing (from different locations) with deeper samples being held by the laboratory pending the need to undertake further analysis (which was not deemed necessary).

The initial sampling density adopted by Coffey in the PSI was inadequate but the combined sampling design generally satisfies the guideline requirements. The auditor notes that the nature of contamination and previous activities at this site are unlikely to result in pockets of contamination which may have been missed during investigations as the laydown mechanism was likely to have been by broadcasting of pesticides, herbicides etc. and where concentrations may have occurred then the use of a broad grid based sampling design and compositing of samples should have been sufficient to detect any significant anomalies.

The basis of the soil sampling undertaken was to provide an overall assessment of the soil quality to determine the nature, extent and location of any potential contamination. Stockpile sampling was

undertaken by Coffey on a grid basis involving 10 locations giving an estimated sampling density of 1 sample per 50 m^3. The stockpile materials were noted to comprise clayey sand with some gravels which is in line with the expected material from the Hudson Creek East Arm development.

Coffey's sampling locations are shown on **Figures 2 - 4, Appendix A**.

The results from sampling are discussed in detail in Section 4.3 of this report.

Auditor's Opinion

In general the sampling pattern adopted by Coffey and the analytical regime undertaken (when the PSI and DSI are combined) are considered adequate to characterise the site both vertically and horizontally) based on the site history and the observed site conditions (inspection and test pitting and sampling). Subsequent testing of the imported soil stockpile was satisfactory in terms of sampling design and sampling density based on the information provided on the source site (origin) of the materials in question.

4.3 Results of Site Investigations

Coffey reported in their DSI that:

'.. all soil analytical results from both Stage One and Stage Two fieldworks (PSI and DSI) were reported below the relevant nominated HILs, HSLs and EILs. There is no readily available information on background concentrations and therefore a conservative approach was adopted for the screening assessment of composite sample analytical data.

Adjusted investigation levels were developed by dividing the relevant HIL and/or EIL by the number of subsamples that make up the composite samples (three). All composite sample analytical results were below the relevant adjusted nominated HILs and EILs.

As expected, some metal concentrations were reported above the laboratory limits of reporting (LOR) in the soil samples collected, which were indicative of background levels. All petroleum hydrocarbon, pesticide and herbicide analytical results were below the laboratory limit of reporting (LOR)....'

In addition Coffey reported that:

'... no obvious visual or olfactory evidence of site contamination was identified during this investigation. Laboratory chemical analysis of soil samples for identified potential chemicals of concern revealed concentrations of chemical substances either at levels indicative of background concentrations or below the laboratory limits of reporting...'.

No asbestos (ACM) was reported on site by Coffey during their inspections and investigations and none was logged in any of the test pits or samples. Similarly no such materials were observed during the site inspections by the auditor's representative (Mr Andrew Gane of DP's Darwin Office) and no evidence of any filling containing construction materials was observed during inspections or testing.

Summary tables of all results provided by Coffey are shown herein at **Appendix F.**

4.4 Waste Management

Several stockpiles of vegetation and some soils were observed by Coffey during the PSI inspection/investigations, these had originally been reported to have been removed by early 2014, but no evidence of legal (off-site) disposal was provided. However, as reported by the auditor's representative soil stockpiles were present on the site at 19 March 2014 (see Drawing 1 and photographs in **Appendix B**). Subsequently, following correspondence with Coffey the imported stockpile material (only the large stockpile) was tested (as described above). The materials had previously been brought onto the site without the benefit of any identification of the source site or precautionary testing which might have resulted in the subject site being cross-contaminated by inappropriate materials. Other smaller stockpiles of materials were reportedly the result of on-site materials being moved and stockpiled and accordingly did not require further testing.

In this regard it is understood that further materials may be brought on the site for the purposes of raising levels. However, it is noted that the Coffey DSI (rev3) specifically notes that their investigations provide findings and conclusions regarding the site conditions up to 11 am on 8 May 2014 when the stockpile testing was completed. The inference being that if further materials are imported then the investigations and conclusions regarding the site suitability do not extend to cover such events. Similarly the findings of this audit report are correspondingly constrained.

Auditor's Opinion

The imported stockpile of materials from East Arm have been adequately characterised and found suitable for the proposed land use. Any future materials imported to the site should be similarly characterised. In any event the investigations by Coffey and this SAR and accompanying SAS provide an opinion on the status of the site only up to 11 am on 8 May 2014.

5. Completeness and Adequacy of Investigations

5.1 Sampling Strategy and Plan

Investigations were based on site history review, site inspections and a CSM, undertaken by Coffey between October 2013 and April 2014 which identified former land uses and potential contaminants of concern. The PSI and DSI included a review of historical aerial photographs which determined the location and lateral (aerial) extent of the various areas of environmental concern related to former land uses including the use of the site as a nursery with rows of cultivated trees (understood to be palms and mangoes).

Coffey employed a systematic sampling grid across the subject site comprising 1.4 ha comprising initially 10 test pits (TP1-TP10) to 2.0 m depth in the PSI and subsequently 24 shallow (0.25 m depth) test pits S1-S24) in the DSI. When combined (34 locations) the adopted sampling density satisfies the minimum required in the Sampling Design Guidelines (NSW EPA, 1995) for the site (24 locations).

Following the development of an initial CSM at the PSI stage, Coffey refined the CSM for the DSI to cater for the findings of the initial assessment and following the DSI findings to reflect the final version of the CSM based on the overall results of the investigations.

In this regard Coffey observed in regard to the CSM that:

'...no obvious visual or olfactory evidence of site contamination was identified during this investigation. There was found to be no evidence or likelihood of buried drums or tanks at the site from the PSI and DSI works undertaken. Pockets of imported fill were not identified from the site walkover or intrusive investigations.

Laboratory chemical analysis of soil samples for identified potential contaminants of concern revealed concentrations of chemical substances either at levels indicative of background concentrations or below the laboratory limit of reporting.

Given the apparent absence of significant contamination source material, the assessment works undertaken to date have not identified any complete exposure pathways under current or proposed site conditions..'.

On the basis of the site history and various versions of CSM the adopted strategy, including the stockpile sampling strategy is considered sufficient to characterise the site in terms of environmental contamination.

Auditor's Opinion

After correspondence with Coffey following review of the PSI (**Appendix C**), additional sampling was undertaken to fill in both lateral and vertical data gaps. In addition following identification of an imported stockpile of material from East Arm additional testing was undertaken by Coffey on 8 May 2014 as described in Revision 3 of their DSI.

Accordingly the overall sampling strategy and plans prepared by the consultants and sampling density undertaken were considered satisfactory and sufficient to characterise the site.

5.2 Sampling Procedures

Sampling procedures adopted by Coffey involved a range of testing and sampling methods, including, test pitting and hand tools (excavation walls and base). Test pits (TP1-TP10 and SP1-SP10) were excavated using a small mechanical excavator, with bucket width reported to be 500 mm. It is noted that the test pit logs are referred to as drilling logs by Coffey although they are clearly labelled as Test Pits. GPS coordinates were provided for each test pit. Soil samples were recovered at depths of 0 - 0.2 m (not tested) 0.5 m (generally tested), 1.0 m and 2.0 m depth.

Readings using a photo-ionisation detector (PID) were taken at regular intervals and were reported as zero. PID readings were obtained reportedly using a pre-calibrated device to determine if VOCs were present in soils. The head space method was used in the majority of cases, by measuring VOCs emitted from bagged (replicate) soil samples.

Logging of the test pits was undertaken according to ASTM (Standard D2487-93 and the unified soil classification system (USCS). The standard of the logs is considered to be satisfactory.

Test locations S1-S24 were drilled using hand tools forming a 150 mm diameter hole. PID readings were taken at intervals (as above) with zero readings in all cases. As noted above logging was undertaken according to ASTM (Standard D2487-93) and USCS.

Samples SP1-SP10 were obtained by Coffey on 8 May 2014 using hand tools from 2 m deep backhoe pits in the stockpile and send for analysis. Stockpile materials were described and photographed by Coffey and appear to comprise uniform clayey sand with some gravels.

Samples were appropriately labelled with unique numbering according to the COCD and were collected in laboratory prepared 250 gram glass jars and were immediately stored on ice in a chilled container and then couriered to the receiving NATA registered laboratories (Eurofins mgt and Envirolab Services).

The names of the field staff, reporters and reviewers were supplied in the various reports by Coffey and on COCD, with initials/names on the field logs, and as far as is known the personnel involved were experienced and qualified field engineers and scientists.

Coffey did not specify in any detail how the samples were handled or collected on site but the laboratory Sample Receipt Notices (SRN) indicated that 'appropriately preserved sample containers have been used, organic samples had Teflon liners, sample containers for volatile analysis received with zero headspace, COCD has been completed correctly, and an attempt to chill samples was evident, all samples were received in good condition and samples have been provided within adequate time to commence analysis in accordance with the relevant holding times'.

Auditor's Opinion

The various sampling procedures were considered adequate for the ground and stockpile conditions encountered and the range of contaminants likely or potentially present at the site.

5.3 Quality Assurance and Quality Control (QA/AC)

5.3.1 Field QA/QC

Coffey provided data quality objectives and data quality indicators based on the seven step planning approach outlined in the NEPM, 1999 (amended 2013) as shown below and generally applied this to both the PSI and DSI.

Step 1 – State the Problem
Define the problem; identify the planning team; examine budget, schedule

↓

Step 2 – Identify the Decision
State decision; identify study question; define alternative actions

↓

Step 3 – Identify the Inputs to the Decision
Identify information needed for the decision (information sources, basis for Action Level, sampling/analysis method)

↓

Step 4 – Define the Boundaries of the Study
Specify sample characteristics; define spatial/temporal limits, units of decision making

↓

Step 5 – Develop a Decision Rule
Define statistical parameter (mean, median); specify Action Level; develop logic for action

↓

Step 6 – Specify tolerable Limits on Decision Error
Set acceptable limits for decision errors relative to consequences (health effects, costs)

↓

Step 7 – Optimise the Design for Obtaining Data
Select resource-effective sampling and analysis plan that meets the performance criteria

During the investigation Coffey generally identified the issues relevant to the site and the methods to ensure that the DQOs deriving from the process were largely achieved. Where issues related to sampling design were identified by the auditor Coffey amended their sampling design appropriately.

Coffey identified the elements of Field Quality Control to be achieved including use of appropriate field team and site management during fieldwork, adoption of a suitable QA/QC system, recording of sampling (logs, field sheets, etc.), equipment calibration, chain of custody documentation (COCD) and Sample Receipt Notification (SRN) from the laboratories, sample preservation and integrity during handling, transport and delivery, collection of field duplicates and other field QA/QC samples and achievement of holding times.

Coffey provided a detailed SAQP between the PSI and DSI stages for auditor approval which was duly provided.

Coffey provided the following summary of DQOs in their report:

Table 5: Summary of DQOs in Coffey DSI Report

DQO	Outcome
State the Problem	The primary objective of the SAQP is to provide additional data to suitably characterise the site for future residential land use. The main problems are: • How many additional surface sampling locations should be undertaken? • What sampling layout should be used to achieve the above objective? • What analytes should be tested?
Identify the Decision	Do the potential chemical substances pose a risk to human health and/or the environment?
Identify inputs to the Decision	The inputs to the decisions are: • Site history; • Conceptual Site Model; • COPCs; and • Visual observations and field measurements.
Define the Study Boundaries	The study boundary is shown in Figure 2. The proposed sampling locations are shown in Figure 2 (Appendix A herein).
Develop a Decision Rule	The decision statements are: *Health Investigation Levels (HILs)* Individual results are to be less than the HILs. Where individual concentrations are more than the HILs, then further assessment and/or management may be required. • Where the 95% upper confidence limit (UCL) of the arithmetic mean for a data set can be calculated, the 95% UCLs are to be less than the HILs / HSLs. • Where the 95% UCL is more than the HILs, then further assessment and/or management may be required. • The validity of the data set as a single population will be reviewed if individual results in the data set are to be greater than 250% of the assessment criteria, and the standard deviation of the data set greater than 50% of the assessment criteria. *Environmental Investigation Levels (EILs)* Data is to be compared directly to EILs. Where individual concentrations are more than the EILs, further assessment and/or management may be required.

DQO	Outcome
Specify Limits on Decision Errors	The acceptable limit on decision errors is a 5% probability of a false negative (i.e. assessing that the average concentrations of COPC in are less than the assessment criteria when they are actually greater than the assessment criteria). Where data sets are sufficiently populated, the 95% UCL of the arithmetic mean will be used to calculate this probability and the 95% UCLs are to be less than the assessment criteria.
Optimise the Design for Obtaining Data	The depth for obtaining data will generally meet or exceed requirements of ASC NEPM as amended (NEPC, 2013) *Schedule B(2) Guidelines on Site Characterisation*. Systematic sampling will be used as justified in Section 5.1

Coffey reportedly collected and analysed the following Field QA/QC samples:

- Inter-laboratory duplicate and intra-laboratory triplicate soil samples at a rate of 5% of the total number of primary samples collected;
- Trip blank and trip spike samples at a rate of one sample per day for soil; and
- Rinsate blanks at a rate of one sample per day where non-dedicated sampling equipment is used.

Samples were analysed for a suite of metals, TPH, BTEX OCP, OPP, herbicides, phenols in the PSI and for metals, OCP, OPP and herbicides in the DSI. In the PSI only 3 QA/QC samples were submitted from a total of 28 samples analysed namely QC1, QC2 and QC3. A further 15 samples were submitted but not analysed (including surficial samples – see earlier discussion). Of these only QC1 was soil (QC2 and QC3 were water comprising sampling rinsate and trip blank) indicating that the duplicate frequency for soil was <10% (i.e. one sample from 25 primary samples). The duplicate frequency does not match the DQOs for the site. One duplicate (QC6) and one triplicate or inter-laboratory duplicate (QC6A) was submitted in respect to the DSI sampling (24 samples composited into 8 samples for analysis). No second laboratory was engaged to undertake triplicate analysis of field replicate samples during the PSI.

Coffey noted that the observed range of RPDs was generally below ± 50%, although the auditor notes that for inorganic species ±30% is normally stated as the acceptance limit. The rinsate sample (QC2) showed a trace of zinc at 4µg/L but this is not considered to represent an issue in terms of potential cross contamination particularly noting the low zinc results from the site sampling.

Coffey also reported that in the DSI that one QC field duplicate sample (QC6) and one QC field triplicate sample (QC6A) corresponding to primary sample S12 0.0-0.1m was collected and submitted for selected laboratory analysis during the March 2014 investigation and that RPDs for comparisons of primary and duplicate samples were below 30% with the exception of arsenic and zinc for pair S12 0.0-0.1 m depth and QC6A. Coffey considered that the elevated RPDs were due the natural variability of soils in this vicinity and were not considered to affect the integrity of the results as the highest concentration was adopted (as a conservative measure) as the representative sample. The auditor concurs with this view.

Two rinsates samples, one duplicate and one inter laboratory duplicate (SP6) were analysed in respect of the stockpile sampling exercise, namely QC7, QC8, QC9 and QC9A. Field QA/QC was found to be satisfactory with only minor exceedance of the RPDs (±30%) in the case of arsenic and nickel which were considered to be at background levels

Whilst the field QA/QC program employed by Coffey in the DSI was not fully compliant with guidelines the results of the field QA/QC program, and results of the samples taken were generally within the SILs for the site and only marginally above the acceptance criteria (RPD range). Coffey considered that the overall results indicated an acceptable data set which could be relied upon for the assessment of the site. The auditor concurs with this view.

5.3.2 Laboratory Quality Assurance and Quality Control

The laboratory analytical reports prepared by Eurofins mgt and Envirolab Services, were presented by Coffey in the site investigation reports (as referenced previously) for soil analysis (and rinsate/trip analysis) as follows:

PSI

- Eurofins mgt report no. 395064-S and 395064-W, dated 10 October 2013; (soil samples) and
- Eurofins mgt report no. 395064-W, dated 10 October 2013 (water samples).

DSI

- Eurofins mgt report no. 412388-S, dated 27 March 2014 (soil samples):
- Eurofins mgt report no. 412388 -W, dated 27 March 2014 (water samples);
- Envirolab Services Certificate of Analysis 3539, dated 27 March 2014 (soil sample);
- Eurofins mgt report no. 417672-S, dated 14 May 2014 (soil samples plus rinsates); and
- Envirolab Services Certificate of Analysis 3894, dated 14 May 2014 (soil sample).

In addition to providing these reports, Coffey also supplied appropriate signed COCD and laboratory SRNs for each batch of samples.

Coffey indicated in terms of laboratory quality control that:

- All target analytes in the analysis blank samples, were below the laboratory LOR;
- RPDs for all analytes in duplicate samples were within the laboratory acceptance criteria;
- Percentage recovery results were reported inside the acceptable range;
- Laboratory internal standards, calibration blanks and mid-range calibration verifications were acceptable; and
- Laboratory QC results are acceptable for the purpose of this investigation.

All laboratories were NATA accredited for the analyses undertaken, and analytical methods were undertaken using appropriate methods and detection limits. The analytical methods adopted by these laboratories are, however, in-house methods which may not be equivalent to US EPA endorsed methods, but are nevertheless NATA endorsed.

The laboratories provided details of the condition of the samples received, date of receipt, date of extraction (where applicable), extraction methods, laboratory methods adopted (including confirmation of the use of purge and trap method for volatiles), spiking method and the detection limits for each analyte and date of analysis. Also included were details of laboratory blanks, duplicates, spikes and spike recoveries.

The laboratory reports in respect to this project were appropriately endorsed with a NATA stamp/logo for each certificate/report issued. Method detection limits were generally appropriate for the analytes and for soil media tested, and were suitable in respect of the adopted soil investigation levels and remediation acceptance criteria for the site.

The laboratories undertook a range of internal QA/QC checks on analytical precision and repeatability including method blanks, laboratory duplicates of samples submitted, matrix spike recoveries and surrogate spike duplicates.

RPDs between laboratory duplicates were generally within tolerable limits for all analyses conducted by Eurofins and Envirolab Services. Laboratory (method) blank samples showed no evidence of cross contamination during preparation and analysis at any stage of the investigations or validation.

The laboratories' analytical precision and accuracy are considered adequate for this type of investigation and these were assessed by each laboratory undertaking internal duplicates, (surrogate) spike recovery and method blank tests as well as other QC checks. No record of the use of certified reference materials was provided.

The range of analytes tested on behalf of the consultants, the laboratory methods adopted and the detection limits employed by each of the contract laboratories appears to be generally satisfactory when compared with the expected contaminants on the site and the levels of contamination acceptable to remain on the site dictated by the adopted SILs (HILs and EILs).

The auditor considers that the samples obtained by the consultant and tested by the laboratories as part of the site investigations are, on the balance of probabilities, representative of both the observed and actual site conditions. The overall accuracy, precision and repeatability of the results provided by the laboratory are also considered appropriate and are therefore sufficient to characterise the site.

It is understood that laboratories are no longer allowed by NATA to make a statement that they are in compliance with the requirements of NEPM in regard to the equivalence with referenced methods or non-standard methods adopted.

The overall accuracy, precision and repeatability of the assessment (investigations) results and data obtained by the consultants during remedial validation sampling, and from the analytical laboratories, are considered to be acceptable and suitable for the purposes of forming an opinion on the condition of the site. Zinc above detection limits was observed in a rinsate sample, but Coffey provided a reasonable argument that this was not germane to the overall outcome of the site investigations and their explanation has been accepted by the auditor and is not considered to adversely affect the

outcome of the audit in terms of the reliability of the site characterization or determination of whether the site is suitable for the intended land use.

Coffey noted in general that:

'... fieldwork undertaken and soil laboratory analysis is acceptable for the purposes of confirming the reliability and repeatability of the sampling and laboratory analysis procedures. As such, all primary sample results are considered to be acceptable...'.

Analysis of field and laboratory DQOs by Coffey against the requirements of the Guidelines for Consultants Reporting on Contaminated Sites (NSW EPA, 1997) are as summarized below in Table 6.

Table 6: Summary of Field and Laboratory DQO Achievement

DQO	Assessment/Evaluation Criteria	Comments
Document Completeness	• Instrument calibration records	• Coffey indicated in their SAQP that certificates would be provided on a daily basis but this information was not provided by consultants
	• Test pit and borehole logs	• Yes – bore logs/test pit logs and sample descriptions provided by all consultants
	• Chain of Custody	• Yes – COCD and SRNs provided by consultants and laboratories respectively. COCD generally signed/stamped/dated upon receipt
	• NATA Test Certificates	• Yes – NATA laboratory test reports provided for all testing events
Data Completeness	• Sampling Density (Area)	• Sampling density exceeded the minimum of 24 sample points according to the Sampling Design Guidelines, NSW EPA 1995. Stockpile sampling was in line with ASC NEPM 2013 and other relevant guidance.
	• Sampling Density (Vertical)	• Vertical sampling was sufficient in the DSI following comments by the auditor on the PSI
	• Range of Analytes Based on Site History	• Range of analytes was suitable based on identified land uses and practices.

DQO	Assessment/Evaluation Criteria	Comments
	• Number of Analytes	• Number of analytes was generally satisfactory in the investigations programmes when combined
Data Comparability	• Sampling Methods	• Sampling methods were generally suitable with test pits and hand tools (disturbed samples) used rather than push tubes/SPTs, possibly leading to a risk of volatile loss (however not likely to be a significant problem on this site).
	• Sample storage, handling etc.	• Satisfactory
	• Laboratory procedures	• Satisfactory
Data Representativeness	• Sampling Coverage	• Satisfactory in all sampling events (noting comments on stockpiled materials)
	• Representative Samples Over Site Area	• Satisfactory (see above)
Accuracy and Precision of Sampling Data (Field)	• Adequately Trained Field Staff	• Yes
	• Blind Duplicates collected >10% of original samples	• Duplicates collection but at <10% in PSI
	• Other Field Check Samples – Rinsate and field blanks/spikes etc.	• Yes
	• Calibration of Screening Gear	• Proposed but not corroborated- not likely to be an issue on this site.
	• RPD <30% or <50% for organic species	• Generally achieved with some exceedances – generally attributed to heterogeneity of sampled matrix
Accuracy and Precision of Laboratory Data	• Laboratory Quality Control	• Satisfactory

Auditor's Opinion

The narrative by the consultants on the evaluation of the field and laboratory data in respect to the achievement of the stated DQOs in terms of QA/QC was satisfactory. A QA programme and broadly suitable number and range of field QA/QC samples were undertaken by Coffey and the overall reliability of QA/QC in terms of data completeness and accuracy to be considered satisfactory.

Overall it is considered that the results obtained were satisfactory and representative of the previous investigations (PSI) and more recent investigations (DSI), including stockpile assessment, and that

these were sufficient to determine the status of the site, and are of adequate quality to conclude that the site has been adequately characterised.

6. Reporting Standards

Consultant's reports dealing with the contamination status of the site and related issues were provided by Coffey in the form of site investigation and assessment reports. The reports focused on soil conditions as groundwater was not considered to be an issue on the site. As noted earlier a PSI and DSI were prepared during the period October 2013 to May 2014.

The reports, as provided, were prepared in a manner generally consistent with the Guidelines for Consultants Reporting on Contaminated Sites (NSW EPA, 1997), and were provided to the auditor for review for each stage of the investigation, eliciting auditor comments which resulted in further sampling being undertaken.

Commentary on the submitted versions of the reports by Coffey was mainly related to technical clarifications, and/or the request for additional information and/or for additional sampling work to be undertaken and in regard to the status of a stockpile which was initially not reported. Generally this information was supplied by Coffey and helped to elucidate the final outcome of each stage of the work undertaken by the consultants.

Where departures from the published guidelines were noted these are not considered to detract significantly from the overall outcome or conclusions stemming from the consultant's reports. Where issues regarding the quality or outcomes of the report or observations noted in the reports were considered worthy of further comment these matters were discussed and resolved in correspondence.

Relevant correspondence between the auditor, consultants and other parties can be found in **Appendix C**.

Auditor's Opinion

The reports prepared by Coffey, and the investigation data set contained in the reports are considered sufficient to form a view on the site conditions and are also considered appropriate to determine the suitability of the site for the proposed land use (Residential with Access to Soils – i.e. Residential A).

7. Future Environmental and Human Health Risks

Based on the results from the site investigation Coffey concluded that:

'... the site history review undertaken for the site has identified potential site contamination issues associated with known historical activities at the site including the use of pesticides and herbicides associated with nursery activities; petroleum hydrocarbons associated with the storage of machinery at the site; and various chemicals associated with the possible importation of fill for site development.

The intrusive shallow soil investigations undertaken at the site encountered silty sandy gravels underlain by sandy gravelly clays and sandy gravels across the site to the maximum depth of investigation of 2 mbgs.

No obvious visual or olfactory evidence of site contamination was identified during this investigation. There was found to be no evidence or likelihood of buried drums or tanks at the site from the PSI and DSI works undertaken. Pockets of imported fill were not identified from the site walkover or intrusive investigations.

Laboratory chemical analysis of soil samples for identified potential chemicals of concern revealed concentrations of chemical substances either at levels indicative of background concentrations or below the laboratory limits of reporting.

As a groundwater bore is located on the adjacent site, it is considered to be representative of the site and indicates that groundwater would be unlikely to be encountered beneath the site prior to 69mbgs.

It is not expected that groundwater would be impacted from previous site activities and act as a potential transport mechanism or means of exposure to potential receptors. No groundwater investigation was therefore undertaken as part of this assessment.

It is possible that the maximum levels of site contamination have not been encountered by the investigations undertaken. It must be noted that the composition of local soil material could vary significantly over short distances and pockets of contaminated soil may occur in areas between sampling locations.

If stained or odorous soils or soils varying from the typical soil profile described in this report (colour, texture, etc.) be (are) encountered during the future proposed redevelopment of the site further advice should be sought from a suitably qualified environmental consultant.

This investigation has not revealed any potentially unacceptable long term risks to human health and the environment that would preclude the use of the site for sensitive purposes……'.

The auditor considers these conclusions to be reasonable given the works undertaken and notes that the sampling design undertaken (34 locations) is well in excess of the minimum requirement for a site of 1.4 ha and on this basis any contamination which may remain undiscovered would necessarily be of limited dimensions. Based on the investigations undertaken the auditor considers that the discovery of unidentified contamination is extremely unlikely. Issues raised by the auditor in regard to the provenance and quality of stockpiled materials observed on site by the auditor's representative have been resolved via supplementary testing of the stockpile and investigation as to the origin of the materials in question. Coffey concluded that the results of stockpile sampling on the site (as at 11 am on 8 May 2014) indicated that:

'… the soils imported to the site from the East Arm Development are suitable for use at the site…'.

Accordingly the auditor concludes that future environmental and human health risks posed by the identified soil conditions on the site are insignificant. Neighbouring sites are apparently still used for nursery activities and accordingly some risk of future cross contamination from airborne contaminants or runoff is possible as is the possibility of fly tipping occurring on the site, but these risks are likely to be no more than would be experienced elsewhere in the locality.

Based on the results obtained from the investigations by Coffey the likelihood of unacceptable odours (or other aesthetic issues), or vapour emissions from the site soils is also considered highly unlikely.

From the sampling results presented the auditor also considers that impacts on structures from soil/groundwater conditions are unlikely. Accordingly, the auditor considers that the site is suitable for the proposed residential land use.

8. Conclusions

Based on the information provided by Coffey, the auditor considers that the parcel of land located at 41 Boulter Road, Northern Territory (NT) and described as Section 5694, Hundred of Bagot, Plan L2003/067 Certificate of Title (CUFT) Volume 768 Folio 513 has been adequately investigated, and is suitable for the proposed development comprising 39 residential (Multiple Dwelling) houses or similar.

Based on the information presented by the consultants, the auditor therefore also concludes that:

- Site investigation and sampling have been undertaken by the consultants in a generally appropriate manner which meets or exceeds the minimum requirement for a site of 1.4 ha, i.e. as defined in the Sampling Design Guidelines, NSW EPA, 1995 and is also adequate for a stockpile of imported soil materials with an estimated volume of some 500 m^3;
- Based on the historical information potential contaminants at the site were adequately identified and assessed;
- Results of investigations by Coffey revealed no evidence of soil contamination from prior land uses and no filling was identified on the site;
- No asbestos bearing materials were observed during site inspections or during testing and there are no known structures past or present on the site which are likely to have contained asbestos;
- Vegetation and minor amounts of soil have been stripped and stockpiled and some vegetation also stripped from site has been mulched and stockpiled on site but it is highly unlikely that these materials were contaminated. Similarly, 500 m^3 of soil materials imported from East Arm has been characterised and found to be suitable to remain on site. Further soil from this location may be imported and accordingly the investigation by Coffey and the audit cannot take this into account and accordingly the investigations and audit report on the condition of the site up to the time of the final site investigation which concluded at 11 am on 8 May 2014. It is therefore recommended that any further soil materials imported onto the site after the above date and time are tested for suitability
- Groundwater quality is not considered likely to have been significantly affected by the previous land-uses and moreover groundwater is known to be at considerable depth beneath the site;
- No significant potential for the off-site migration of contaminants is likely either prior to investigations or since;
- No significant aesthetic concerns (such as odours or vapour emissions) are likely based on the site observations and sampling results;
- Surface water is not known to be present on the site and in any event based on the sampling results contaminated runoff from the site is highly unlikely. Sediment runoff could occur during heavy rainfall particularly bearing in mind that vegetation has been stripped.

Under the above circumstances it is considered that the site is suitable for the proposed development or similar re-development.

A site audit statement (No. DP/NT/105) has been prepared to accompany this site audit report which states that the site is suitable (as at 11.00 am on 8 May 2014) for the proposed residential land-use comprising 39 residential (multiple dwelling) houses.

9. References and Bibliography

Other than the references quoted in earlier sections of this report, the following references and bibliography were consulted.

Australian and New Zealand Environment and Conservation Council National Health and Medical Research Council (1992). Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites.

Australian and New Zealand Environment and Conservation Council National Health and Medical Research Council /ARMCANZ (2000). Australian Water Quality Guidelines for Fresh and Marine Waters.

EnHealth (2001). Exposure Scenarios and Exposure Settings.

NSW DEC (2007). Guidelines for the Assessment and Management of Groundwater Contamination (March 2007);

NSW DECC (2009). Contaminated Sites: Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997

NSW EPA (1994). Guidelines for Assessing Service Station Sites, December 1994.

NSW EPA (1999). Contaminated Sites: Guidelines on Significant Risk of Harm from Contaminated Land and the Duty to Report.

Standards Australia (2005) Guide to the Sampling and Investigation of Potentially Contaminated Soil. Part 1: Non-volatile and semi-volatile compounds, AS 4482.1-2005.

Douglas Partners Pty Ltd

Appendix A

Figures

SOURCE: AUSTRALIAN CITIES UBD
DIGITAL STREET MAPPING, 2009, VERSION 6.0.0

drawn	MV
approved	FM
date	07/03/14
scale	NTS
original size	A4

coffey

client: LJ SUPERFUND

project: SITE CONTAMINATION ASSESSMENT
41 BOULTER ROAD, BERRIMAH, NORTHERN TERRITORY

title: SITE LOCATION PLAN

project no: ENAUKESW01228AC-D01

figure no: FIGURE 1

PLOT DATE: 7/03/2014 11:27:55 AM DWG FILE: F:\ENV\PROJECTS\...ER OFFICES\ENAUKES\MENAUKESW01228AA- BERRI...NT\DRAWINGS\ENAUKESW01228AC-D01.DWG

coffey

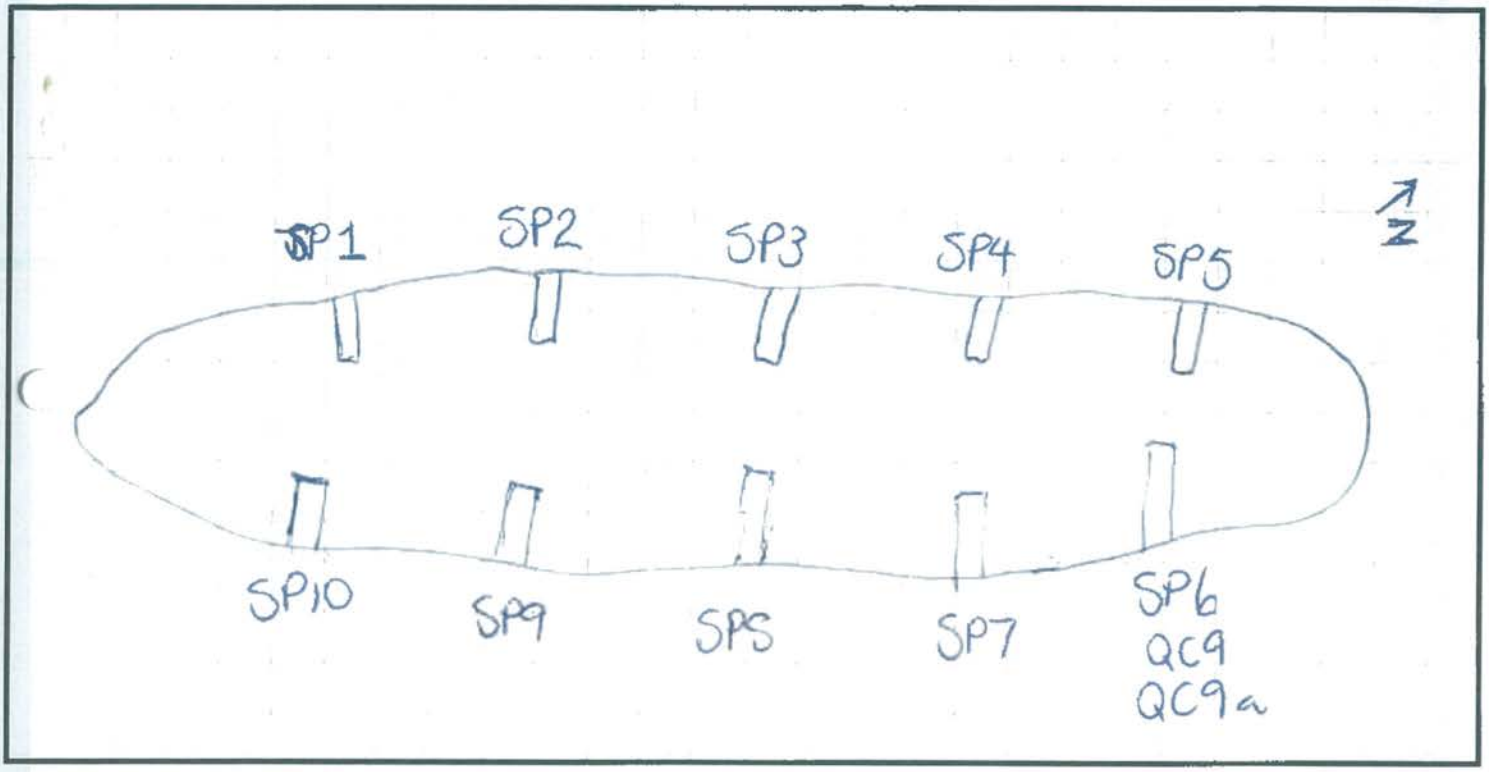
FIELD SOIL SCREENING (EXCAVATIONS/STOCKPILES)

Project Name: LJ Superfund - Stockpile Sampling

Field Personnel (Initials): CH

Project Manager (Initials): FM **PID ID :** PID3000AB

Project No.	ENAUKESW01228AD
Date:	8/05/2014
Page	1 of



Sample ID	Soil Description (soil type, moisture, colour etc)	Depth (m)	Staining/ Odour (descriptive)	PID (ppm)
SP1	Clayey, Sand, Some large angular gravel, Medium red brown, grey, moist	2m	N/A	0.3
SP2	" " "	2m	N/A	0.0
SP3	" " "	"	N/A	0.0
SP4	" " "	"	N/A	0.0
SP5	" " "	"	N/A	0.0
SP6	" " "	"	N/A	0.0
SP7	" " "	"	N/A	0.0
SP8	" " "	"	N/A	0.0
SP9	" " "	"	N/A	0.0
SP10	" " "	"	N/A	0.0

Figure 3

Appendix B

Site Photographs

Photo 1: View of OUD on south side of Boulter Road showing laterite profile

Photo 2: View of site, looking north from Boulter Road

Douglas Partners Geotechnics / Environment / Groundwater	Project No. 73847.00	Site Photographs
	Date: 19 Mar 2014	Lot 5694 (41) Boulter Road, Berrimah, NT
		Client: L J Superfund Pty Ltd

Photo 3: View of site, looking north from southeast site corner

Photo 4: View of site, looking north from southwest site corner

Douglas Partners Geotechnics / Environment / Groundwater	Project No. 73847.00	Site Photographs
	Date: 19 Mar 2014	Lot 5694 (41) Boulter Road, Berrimah, NT
		Client: L J Superfund Pty Ltd

Photo 5: View of site, looking north centre of southwest site boundary

Photo 6: Typical sampling location and excavation equipment, sampling at 0.25m depth

Douglas Partners Geotechnics / Environment / Groundwater	Project No. 73847.00	Site Photographs
	Date: 19 Mar 2014	Lot 5694 (41) Boulter Road, Berrimah, NT
		Client: L J Superfund Pty Ltd

Photo 7: Close up view of sampling location

Photo 8: Typical sampling location, from surface

Douglas Partners Geotechnics / Environment / Groundwater	Project No. 73847.00	Site Photographs
	Date: 19 Mar 2014	Lot 5694 (41) Boulter Road, Berrimah, NT
		Client: L J Superfund Pty Ltd

Photo 9: View of previous sampling location, backfilled Test Pit TP6

Photo 10: Spoil from TP6

Douglas Partners Geotechnics / Environment / Groundwater	Project No. 73847.00	Site Photographs
	Date: 19 Mar 2014	Lot 5694 (41) Boulter Road, Berrimah, NT
		Client: L J Superfund Pty Ltd

Photo 11: View of temporary structure, from near TP6 and facing east

Photo 12: View of ship container north of temporary structure, from near TP6 and facing north

Douglas Partners Geotechnics / Environment / Groundwater	Project No. 73847.00	Site Photographs
	Date: 19 Mar 2014	Lot 5694 (41) Boulter Road, Berrimah, NT
		Client: L J Superfund Pty Ltd

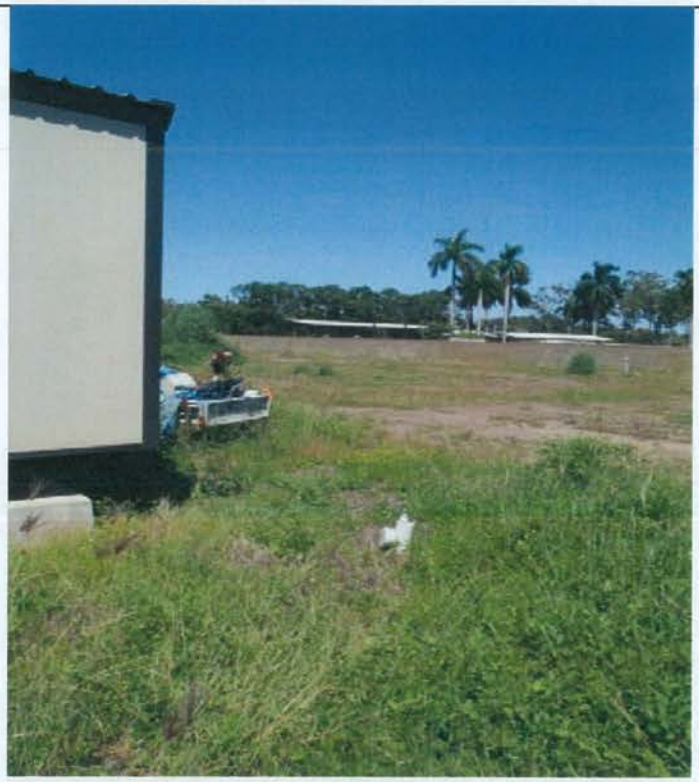


Photo 13: View of septic system location near temporary structure

Photo 14: View of pipe work leading to septic system

Douglas Partners Geotechnics / Environment / Groundwater	Project No. 73847.00	Site Photographs
	Date: 19 Mar 2014	Lot 5694 (41) Boulter Road, Berrimah, NT
		Client: L J Superfund Pty Ltd

Photo 15: View of shipping container, facing north

Photo 16: View of concrete cover to septic system

Douglas Partners Geotechnics / Environment / Groundwater	Project No. 73847.00	Site Photographs
	Date: 19 Mar 2014	Lot 5694 (41) Boulter Road, Berrimah, NT
		Client: L J Superfund Pty Ltd

Photo 17: Typical sampling location, sampling at 0.25m depth

Photo 18: Typical sampling location, sampling at 0.25m depth

Douglas Partners Geotechnics / Environment / Groundwater	Project No. 73847.00	Site Photographs
	Date: 19 Mar 2014	Lot 5694 (41) Boulter Road, Berrimah, NT
		Client: L J Superfund Pty Ltd

Photo 19: View of mulch stockpile near north end of site, looking east

Photo 20: View of mulch stockpile near north end of site, looking west

Douglas Partners Geotechnics / Environment / Groundwater	Project No. 73847.00	Site Photographs
	Date: 19 Mar 2014	Lot 5694 (41) Boulter Road, Berrimah, NT
		Client: L J Superfund Pty Ltd

Photo 21: View of soil stockpile, looking west from northeast corner of site

Photo 22: View of site, looking south from near centre of north boundary

Douglas Partners Geotechnics / Environment / Groundwater	Project No. 73847.00	Site Photographs
	Date: 19 Mar 2014	Lot 5694 (41) Boulter Road, Berrimah, NT
		Client: L J Superfund Pty Ltd

Photo 23: View of topsoil stockpile

Photo 24: View of topsoil stockpile

Douglas Partners Geotechnics / Environment / Groundwater	Project No. 73847.00	Site Photographs
	Date: 19 Mar 2014	Lot 5694 (41) Boulter Road, Berrimah, NT
		Client: L J Superfund Pty Ltd

Photo 25: View of soil stockpile

Photo 26: View of soil stockpile

Douglas Partners Geotechnics / Environment / Groundwater	Project No. 73847.00	Site Photographs
	Date: 19 Mar 2014	Lot 5694 (41) Boulter Road, Berrimah, NT
		Client: L J Superfund Pty Ltd

Photo 27: View of north end of site

Photo 28: View of south end of site

Douglas Partners Geotechnics / Environment / Groundwater	Project No. 73847.00	Site Photographs
	Date: 19 Mar 2014	Lot 5694 (41) Boulter Road, Berrimah, NT
		Client: L J Superfund Pty Ltd