

Appendix D - Report on Remediation Action Plan,
Proposed Residential Subdivision, Lot 3 Freds Pass
Road, Humpty Doo. May 2016 (DP Ref:
78156.01.R.003.Rev0)



Douglas Partners

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Report on
Remediation Action Plan

Proposed Residential Subdivision
Lot 3 Freds Pass Road, Humpty Doo

Prepared for
Tolinchlo Pty Ltd

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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.

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Report on Remediation Action Plan

Proposed Residential Subdivision

Lot 3 Freds Pass Road, Humpty Doo

1. Introduction

This Remediation Action Plan (RAP) details the soil contamination management to be undertaken at a site located at Lot 3 Freds Pass Road, Humpty Doo ("the site"). The site is subject to an Environmental Audit, being conducted by Mr John Throssell of GHD Pty Ltd ("GHD") who is an Environmental Auditor appointed pursuant to section 53S of the *Environment Protection Act 1970* (Vic). The Audit is required in order to demonstrate that the site is suitable for the proposed residential (medium- and low-density) development, and is a requirement of the Northern Territory Development Consent Authority (DCA).

Douglas Partners Pty Ltd (DP) was engaged to undertake preliminary and detailed site investigation works as part of the assessment phase of the Audit. At the conclusion of the detailed site investigation (DSI), residual contamination remains in shallow site soils across the site, and requires remediation.

Proposed remediation strategies were detailed in DP's letter to the Auditor dated 8 December 2015. It is understood that the Auditor generally accepted the strategies that were presented.

2. Objective

The objective of the proposed remediation is to remediate the site in an acceptable manner, with minimal environmental and human health effects, to a condition suitable for the proposed development.

3. Site Description and Contamination Status

3.1 Site Identification

The irregular shaped site covers an approximate area of 81,100 m² (8.11 ha). As of December 2015, the site was vacant, with the exception of the following structures located in the north western corner of the site:

- Above ground water tank;
- Underground septic system;
- Double garage; and
- Concrete slab, shipping containers and demountable.

These features are shown on Drawing 1, Appendix A.

3.2 Proposed Development

At this stage, the development plans have not been finalised, but it is likely that the site will be divided into two zones; these being a single dwelling (SD) zone and a multiple dwelling (MD) zone. A site plan, showing the proposed subdivision is presented as Drawing 2, Appendix A.

The SD zone covers an area of approximately 61,100 m² (6.11 ha) on the southern portion of the site. It is understood the proposed development will comprise subdivision into about 57 lots with access roads and a retention basin of 6,057 m². Across most of the zone, the surface level will be raised by between 0.5 m and 1.5 m by the placement of imported filling. However, in the retention basin area, the surface level will be reduced by excavation up to 1.0 m depth. It should be noted that the exact location of the retention basin has not yet been determined.

The MD zone covers an area of approximately 20,000 m² (2 ha). It is understood that the proposed development will comprise subdivision into about 47 lots. Across most of the zone, the surface level will be raised by up to 1.5 m by the placement of imported filling.

3.3 Previous Contamination Investigations and Results

In preparing this Remedial Action Plan, DP reviewed the results of our earlier Environmental Site Investigations summarised in the following reports:

- Douglas Partners, *Report on Preliminary Environmental Site Investigation, Lot 3 Freds Pass Road, Humpty Doo, NT – Revision 1.*, (Ref no: 79156.01), dated 16 April 2015,
- Douglas Partners, *Report on Detailed Site Investigation, Lot 3 Freds Pass Road, Humpty Doo, NT.*, (DP Ref: 78156.01.R.001.Rev2), dated 8 December 2016,

The results of the site history review as presented in the preliminary site investigation (PSI) report indicated the site has been a mango, banana and tomato orchard, anecdotally dating back to the 1960s. The site was previously occupied by a dwelling and a cool room / shed in the north western corner which was used for site orchard activities (*ie* storage of goods, chemicals and treatment of harvests). Surface vegetation and some topsoil were stripped in preparation for the proposed earthworks and filling prior to subdivision of the land. At the time of the PSI, the site was generally vacant and remained stripped of vegetation.

The PSI identified a number of potential sources of contamination within the site. The potential for contamination arising from previous site activities was considered to be low to moderate. The primary contaminating activities identified at the site are considered to be associated with the former orchard activities.

These primarily include the historic application of pesticides and herbicides used during the planting of mango trees and the disposal of dilute pesticides and fungicides in the north-western part of the site (MD Zone) following the application to harvested fruit. The use of these latter chemicals is understood to have been limited to the six week harvest periods and used at generally weekly frequency. Application and disposal of these chemicals was for a period of about ten years (*i.e.* not used the whole period of orchard operation).

The identified contaminants of concern comprised: pesticides, herbicides and insecticides associated with orchard activities; petroleum hydrocarbons which were the likely herbicides and pesticides solvent; and asbestos due to the demolition of a former on-site dwelling. The potential for asbestos impact at the site was generally considered to be low based on the licensed removal of asbestos prior to demolition of the dwelling.

The intrusive investigation as part of the detailed site investigation (DSI) comprised excavation of test pits and laboratory testing of soils within the proposed SD and MD Zones, as well as 'background' sampling off-site to assist with development of ecological criteria. The subsurface investigation was generally undertaken on a grid-based arrangement. Additional targeted test pits for the MD Zone were located in the vicinity of previous structures and dilute waste chemical application (*ie* north-western part of the site). In summary:

- 21 test pits (TP01 to TP21) were excavated for SD Zone (6.1 ha);
- 12 test pits (TP22 to TP28, TP30 to TP34) were excavated for MD Zone (2 ha), including five targeted test pits;
- One test pit (TP29) and two surface samples (S1 and S2) were excavated off-site for the assessment of background conditions.

Test locations are shown on Drawing 3, Appendix A.

While organochlorine pesticide (OCP) contaminant concentrations were identified exceeding the health investigation levels for residential land use, it is considered that removal of individual hot spots may be impracticable due to the dispersed nature within the site. It is considered that importation of filling to raise site levels for the proposed development may suitably reduce the risk of contaminant exposure. The importation of filling in the order of 1.5 m may suitably "cap" the site. However, DP acknowledges that surface levels would be reduced (excavated) by up to 1.0 m in the area of the proposed retention area.

Asbestos fibres were identified in surface soils from TP28, located in the north-western part of the site and vicinity of former site structures (MD Zone). Given that an asbestos clearance certificate exists for the removal of the site dwelling, and the absence of asbestos in the other eleven soil samples tested in MD zone, it is considered that the impact is likely to be localised and due to surficial impact from the demolition of the former site dwelling.

Recommendations in DP's DSI report included recommended remediation and validation is undertaken in accordance with this RAP to address soil impacted by OCPs over most of the site, and asbestos around the location of TP28.

4. Assessment and Remediation Criteria

With consideration of the proposed low density residential development, analytical results will be assessed against investigation levels outlined in Schedule B1 of the *National Environment Protection (Assessment of Site Contamination) Measure 1999* (amended 2013) ['NEPM']. The Schedule provides investigation and screening levels for commonly encountered contaminants which are applicable to generic land uses. The results of validation following soil remediation will be assessed against investigation levels for OCPs only.

4.1 Health Investigation Levels

Health Investigation Levels (HILs) are scientifically based, generic assessment criteria designed to be used in the first stage of an assessment of potential risks to human health from chronic exposure to contaminants. They are intentionally conservative and are based on a reasonable worst-case scenario for four generic land use scenarios. DP has compared soil data to HIL criteria for sensitive and land uses and given the proposed residential subdivision, HIL A criteria, applicable for residential land use with garden/accessible soil, is considered most relevant for the purpose of investigation at this time.

4.2 Ecologically-based Investigation Levels

The applicability of ecological investigation levels (EILs) was considered in preparing this RAP, and the practical implications of exceedances of those criteria were deemed to outweigh the possible associated risks. This was based on the fact that the remediation strategy includes capping of the site following vertical soil mixing, and the capping material shall meet the acceptance criteria. This means that current soil levels will be a minimum of 0.5 m (and up to 1.5 m) below the final site surface. However, ecologically-based criteria are included for OCP's in Table 1.

4.3 Adopted Criteria

The adopted HILs and EILs are presented in Table 1. These values have also been adopted as remediation objectives for the purposes of this Remediation Action Plan.

Where contaminant concentrations in validation samples exceed the listed EIL values, consideration will be given to the thickness of the capping layer to be applied at that location. If the capping layer is proposed more than 0.5 m, and the HIL value is not exceeded, no further soil will be excavated at that location. If the capping layer thickness is not greater than 0.5 m, or the HIL value is exceeded, further excavation will occur.

If contaminant concentrations in validation samples exceed the listed HIL values, further soil will be excavated at such locations, until contaminant concentrations are less than the HIL value.

Table 1: Health and Ecological Investigation Levels (HILs)

Contaminants		Residential Land Use HIL-A (mg/kg)	Ecological Investigation Level (mg/kg)
OCP/ OPP	Aldrin + Dieldrin	6	0.35
	Chlordane	50	4
	DDT+DDE+DDD	240	-
	DDT	-	1.7
	DDD	-	2.3
	DDE	-	34
	Endosulfan	270	-
	Endrin	10	-
	Heptachlor TEQ*	6	4
	HCB	10	-
	Methoxychlor	300	-
	Chlorpyrifos	160	-
Metals	Arsenic	100	
	Cadmium	20	
	Chromium	12%	
	Copper	6,000	
	Lead	300	
	Mercury	40	
	Nickel	400	
	Zinc	7,400	
Nitrogen species**	Nitrate	130,000	
	Nitrite	7,800	
	Ammonia	NC	
	TKN	NC	

Notes:

*Heptachlor TEQ is the sum of twice the heptachlor epoxide concentration and the heptachlor concentration.

** US EPA (2015) Regional Screening Levels

4.4 Waste Soil Categorisation Criteria (for Off-site Disposal)

If soil is to be removed from a site it should be classified as waste material in accordance with the current EPA Victoria guidelines outlined in Publication IWRG621, *Soil Hazard Categorisation and Management* (which superseded Publication 448.3 *Classification of Wastes* in 2009), which presents the current industry categorisation criteria used to assess soil prior to off-site disposal. Under these guidelines (which NT EPA currently adopts), soil can be classified into one of four categories based on its relative hazard. From least to most contaminated, the categories are:

- Fill Material (not contaminated);
- Category C Contaminated Soil (least contaminated);
- Category B Contaminated Soil; and
- Category A Contaminated Soil (most contaminated).

To fall into any one of the categories, the total contaminant concentration and leachable concentration level must be below that specified in Table 2 of IWRG621.

4.5 Asbestos

Asbestos identification will be undertaken on selected validation samples using an initial quantitative screening analysis only. The remediation and validation of asbestos in soil would be conducted in general accordance with the Western Australia (WA) Department of Health (DOH) *Guidelines for the Assessment, Remediation and Management of Asbestos-Contaminated Sites in Western Australia – May 2009*

5. Remediation Strategy

5.1 Asbestos and Septic System

Asbestos fibres identified in test pit TP28 during the DSI require remediation so as to minimise the potential exposure for future site users. It is understood that the existing septic system is to be removed during the MD development stage and would be subject inspection and validation. DP considers that the asbestos-impacted soil at the surface near TP28 could be stripped, removed and validated in conjunction with the septic system excavation.

DP proposes to excavate down to 0.3 m over a 5 m by 5 m area in the vicinity of TP28 to remove asbestos-impacted soil. The excavated soil is to be stockpiled, and managed in accordance with Section 6.2.1. Validation samples will be collected from the base and mid-section of the walls of the excavation (*ie* five samples in total) and tested for the presence or absence of asbestos. Additional soil samples will be collected from the surface 1.0 m beyond the extents of the 5 m by 5 m excavation and tested for asbestos. A tyvek suit (with booties) and P1 dust mask must be worn when collecting samples intended for asbestos analysis.

Three samples will be collected from the stockpile created by asbestos removal works, and analysed for the following:

- One sample for an EPA Publication IWRG 621 Table 2 Clean Fill Screen comprising metals / metalloids (As, Cd, Cu, Pb, Hg, Mo, Ni, Sn, Se, Ag, Zn), total Cr(VI), total cyanide, total fluoride, speciated phenols (halogenated plus non-halogenated), benzene, toluene, ethyl benzene, total xylenes (BTEX), total recoverable hydrocarbons (TRH), polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB) chlorinated hydrocarbons (volatile plus semi-volatile) and OCPs/OPPs; plus asbestos, and;
- Two samples for OCPs/OPPs and asbestos.

Following the removal of the septic system and associated fixtures, DP proposes to validate the excavation in the same manner as described above. The validation samples, collected at a ratio of one sample per 25 m² of excavation surface will be analysed for metals (As, Cd, Cr, Cu, Pb, Hg, Ni and Zn), OCP's, NOx, ammonia and TKN. The resultant stockpile will be managed in accordance with Section 6.2.1 and samples collected in accordance with EPA Publication IWRG 702 *Soil Sampling*, June 2009 and tested for analysed for the following:

- One sample for an EPA Publication IWRG 621 Table 2 Clean Fill Screen comprising metals / metalloids (As, Cd, Cu, Pb, Hg, Mo, Ni, Sn, Se, Ag, Zn), total Cr(VI), total cyanide, total fluoride, speciated phenols (halogenated plus non-halogenated), benzene, toluene, ethyl benzene, total xylenes (BTEX), total recoverable hydrocarbons (TRH), polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB) chlorinated hydrocarbons (volatile plus semi-volatile) and OCPs/OPPs; and
- Up to nine samples for metals (as per EPA Screen), and OCPs/OPPs.

Following successful validation, reinstatement of any excavations would be undertaken using material which meets the requirements for *Clean Fill Material* as defined by EPA Victoria.

5.2 OCP-Impacted Soil

DP evaluated a number of different remediation and management strategies, as outlined in correspondence dated 8 December 2015 (DP Ref: 78156.01.C.001.Rev0) and recommended on-site management of contaminated soils through: (i) removal of OCP "hot spots" and (ii) vertical mixing of remaining site soils. The latter approach has been shown to be a practical and effective means of reducing the levels of contaminants in soil as documented in NSW EPA (2003) *"Guidelines for the Vertical Mixing of Soil on Former Broad-Acre Agricultural Land"*. This approach has been successfully applied in New South Wales and New Zealand on former broad-acre agricultural land sites proposed for residential development as referenced in NSW EPA (2005) and Auckland Regional Council (2002) *"Remediation of Horticultural Broad-Acre Land Using Vertical Soil Mixing"*.

5.2.1 Vertical Delineation

Prior to the application of vertical mixing, the vertical extent of OCP-impact needs to be verified. DP acknowledges this has not been achieved at some test pit locations (TP01, TP10, TP17, TP18 and TP20 within the SD zone, and TP27 within the MD zone), where concentrations of OCPs exceeded the assessment criteria. The locations would be replicated using the recorded GPS coordinates recorded during the DSI, however, the replicate test pit would not be advanced through the previously backfilled test pit, rather as close as practicable.

The replicate location would be advanced to a maximum depth of 1.0 m using an excavator. Samples would be collected from the same depth where detectable OCPs were recorded and each half metre thereafter until termination depth. Selected samples will be analysed for OCPs and OPPs.

DP understands that preliminary discussions with Northern Territory EPA in December 2015 indicated that no specific remediation options are generally opposed and that their position is guided by the Auditor's recommendations.

5.2.2 Hot Spot Removal

Results of the DSI indicated that OCP concentrations at six locations (TP01, TP20, TP26, TP27 and TP30) were reported at greater than 2.5 times the HIL and are considered contamination "hotspots". DP acknowledges that OCP concentrations at TP28 also fall into this category but this area will be remediated as part of the asbestos and septic tank removal and validation works detailed in Section 5.1.

DP proposes to excavate down to approximately 0.4 m to 0.5 m below the depth of impact as defined by vertical delineation works in the vicinity of hot spot test pits. The locations would be determined using a hand-held GPS in the field. The excavated soil is to be managed in accordance with Section 6.2.1. Validation samples will be collected from the base and mid-section of the walls of the excavation (*ie* five samples in total) and tested for OCPs.

Two samples will be collected from each stockpile generated and analysed for the following:

- One sample for an EPA Publication IWRG 621 Table 2 Clean Fill Screen comprising metals / metalloids (As, Cd, Cu, Pb, Hg, Mo, Ni, Sn, Se, Ag, Zn), total Cr(VI), total cyanide, total fluoride, speciated phenols (halogenated plus non-halogenated), benzene, toluene, ethyl benzene, total xylenes (BTEX), total recoverable hydrocarbons (TRH), polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB) chlorinated hydrocarbons (volatile plus semi-volatile) and OCPs/OPPs; plus asbestos, and;
- One sample for OCPs/OPPs only.

Following successful validation (when the samples from the hot spot excavation meet the remediation objectives), reinstatement of any excavations would be undertaken using material which meets EPA Victoria Clean Fill Material Guidelines.

5.2.3 Vertical Mixing

The process of vertical mixing as a remediation strategy is based on taking clean soils from depth and mixing with the shallow, impacted soils so as to reduce the overall contaminant concentrations (not mass) throughout the soil profile. Soil mixing can be achieved on broad-acre sites by using a deep rippers or rotary hoes pulled behind a tractor or bulldozer. Deeper reaches from the mixing apparatus and a greater number of passes by the ripper will achieve a greater degree of mixing.

The estimated vertical mixing depth will be calculated by applying the following formula from the NSW EPA (2005):

$$y = \frac{x(a - b)}{0.9 H - b}$$

where :

- y = estimated vertical mixing depth in mm
- x = depth of soil profile in mm in which concentration is 'a' mg/kg
- a = maximum concentration for the principal contaminant in mg/kg
- b = background concentration of the principal contaminant in mg/kg
- H = ANZECC/NHMRC Human Health Investigation Level for the principal contaminant in mg/kg

The value of 0.9 is a safety factor which takes into account inefficiencies in the mixing process.

The proposed depth of vertical mixing can only be estimated following the proposed further vertical delineation works, however, a depth of between 0.3 m and 0.5 m would be anticipated, after the removal of hot spots as described in section 5.2.2 above.

Based on the mixing trials in Australia and New Zealand on broad-acre, former agricultural land, DP proposes the following methodology:

1. Mark out a 30 m by 30 m grid across the entire site using stakes (or similar);
2. Complete two passes using a tractor fitted with a deep (approx. 0.5 m) ripper which is at least 5 m wide, ensuring that each alternative pass is off-set by 15 m;
3. Repeat Step 2, this time making the passes at cross angles (*ie* 90 degrees);
4. Repeat Steps 1 – 3, using a plough and deep hoeing techniques (possibly with a road stabilising machine) instead of a deep ripper.

Soil mixing should be undertaken in the dry season, so as to minimise the likelihood of rain events and subsequent surface runoff and potential off-site contamination.

Following the completion of six passes in each direction (north-south plus east-west) using the ripper and hoe, the final site surface validation will be conducted. DP proposes to sample surface soil at 35 grid-based locations across the site. The number of sampling points is consistent with the rationale adopted during the DSI (*ie* one-third of the recommended sampling points referenced in Table E1 of Australian Standard AS4482.1-2005 "*Guide to the investigation and sampling of sites with potentially contaminated soil, Part 1: Non-volatile and semi-volatile organic compounds*"). Soil samples collected will be analysed for OCPs/OPPs only.

The validation criteria to be met are:

- The 95% upper confidence limit of the mean (95% UCL_{mean}) concentrations for any contaminant is less than the HIL A value;
- No single value is greater than 2.5 times the HIL A value; and
- The standard deviation of the data set is less than half the HIL A value.

If validation is not successful, contingencies such as further/deeper mixing or stripping of shallow soil would be considered.

5.3 Site capping

The vertically mixed soils would be covered by imported filling, placed with reference to geotechnical considerations. Imported soil would be subject to inspection and/or testing as required and must meet EPA IWRG621 Clean Fill Material Guidelines before being brought on to site. Additional sourcing of soil, further to what DP has currently undertaken may be required, subject to finalisation of fill volumes. A preliminary earthworks plan is shown as Drawing 4, Appendix A.

6. Work Methods

6.1 Soil Sampling Methodology

Environmental sampling will be performed according to the standard operating procedures outlined in the DP *Field Procedures Manual*. The general sampling procedures will be as follows:

- i) Samples will be collected directly off the pit walls, an excavator bucket or surface using hand tools and disposable latex gloves (a new pair of gloves was used for each sample);
- ii) Labelling laboratory prepared glass jar sample containers with individual and unique identification including project number, sampling date and sample number;
- iii) Placing samples into prepared glass jars and then into a cooled, insulated and sealed container;
- iv) Decontaminating all sampling equipment using a 3% solution of phosphate-free detergent and then rinsing twice with de-ionised water prior to collection of each sample;
- v) Transportation of samples to the testing laboratory under chain of custody documentation.
- vi) Primary samples will be analysed by ALS Laboratory Group (ALS), a NATA accredited laboratory. All samples will be analysed within the holding times specified in AS 4482.1-2005.
- vii) Blind and split duplicate samples, rinse and trip blanks will be tested at the frequency outlined in Standards Australia AS 4482.1-2005. Envirolab Services, another NATA accredited laboratory will be used as the secondary laboratory for split duplicate samples.

6.2 Waste Categorisation and Spoil Management

Excavated spoil to be disposed off-site will be classified, managed and disposed in accordance with EPA Publications IWRG621 and IWRG702, which are the guidelines used to assess soil prior to offsite disposal, in the context of Victorian statutory requirement. All sampling will be undertaken with reference to IWRG701 *Sampling and Analysis of Waters, Wastewaters, Soils and Wastes*. Note that any soil remaining on-site within the development is not subject to the requirements of this section.

6.2.1 Stockpile Management

Whilst soil is stockpiled on-site awaiting final classification, the following procedures should be followed:

- Placement of potentially contaminated stockpiles (generated from the remediation) on an impermeable surface to prevent leaching. The surface should either comprise concrete/ asphalt or HDPE;
- Geotextile silt fences or hay bales should be erected around each stockpile to prevent losses from surface erosion;
- Stockpile heights should be restricted to less than 3 m above surrounding site levels and areas should be suitably bunded or baled to prevent material losses in the event of heavy rain; and
- If necessary to prevent dust generation, stockpiles should be lightly conditioned by sprinkler or covered by tack-coat, HDPE, geotextile or similar cover to prevent wind-blown dust.

6.2.2 Spoil Contingency Plan

Any materials which fail to meet the EPA Publication IWRG621 criteria for direct landfill disposal following initial classification testing, such as Category A Contaminated soils, will be required to be segregated and securely stockpiled pending further testing and treatment. The contingency plan to cater for the storage, treatment and disposal of excavated spoil which fails to meet landfill criteria is as follows:

- On the basis of on-site observations and the contaminant exceedances detected, materials will be carefully excavated, segregated and placed in well delineated locations;
- Stockpiles of excavated materials will be appropriately bunded with hay bales/ sandbags and if required covered and/ or lined with impermeable plastic sheeting;
- Sampling and analysis at a rate of 1 sample per 25 m³ (or a minimum of 3 samples) of segregated stockpiles will be conducted to determine the concentration of the target contaminant parameters in the excavated materials;
- Disposal arrangements will be determined based on sampling results as follows:
 - o material which meets the EPA Publication IWRG621 threshold criteria for disposal as Fill Material, Category C Contaminated Soil and Category B Contaminated Soil shall be disposed directly to landfill; and
 - o material which exceed the disposal guideline levels for Category B Contaminated Soils (*ie.* untreated Category A Contaminated Soil) shall remain segregated in stockpiles pending treatment/alternate disposal arrangements.

6.2.3 Loading and Transport of Contaminated Material

Transport of any material to and from the site shall be via a clearly delineated, pre-defined haul route to be implemented by the appointed contractor. It is intended to utilise the existing main gate and circular roads whilst maintaining the current access for tenants.

The loading, handling and disposal for spoil classified for off-site into one of four categories (Fill Material, Category C Contaminated Soil, Category B Contaminated Soil and Category A Contaminated Soil) is summarised below. Northern Territory requirements for handling soil for off-site disposal are provided in the following documents:

<http://www.ntepa.nt.gov.au/waste-pollution/guidelines/guidelines>

http://www.ntepa.nt.gov.au/_data/assets/pdf_file/0005/136472/completing_waste_transport_certificates.pdf

i) Fill Material

The industry refers to Fill Material as 'clean fill'. EPA has no restriction on where Fill Material may be disposed although councils may have other requirements. The disposal of Fill Material must not result in any off-site impact on surface or groundwaters. Fill material may contain contaminants above background levels and may not be suitable for all uses.

ii) Category C Contaminated Soil

Category C contaminated soil can only be disposed off-site to select landfills licensed by EPA to accept such material. Vehicles transporting Category C contaminated soil must have a current EPA Waste Transport Permit and an EPA Waste Transport Certificate must be completed for soil tracking purposes. All loads must be covered to prevent wind-blown loss and Leaks or spills of contaminated material to the environment must be prevented.

iii) Category B Contaminated Soil

Category B contaminated soil can only be disposed off-site to select landfills licensed by EPA. Vehicles transporting Category B contaminated soil must also have a current EPA Waste Transport Permit and a waste transport certificate for soil tracking purposes. All loads must be covered to prevent wind-blown loss and leaks or spills of contaminated material to the environment must be prevented.

iv) Category A Contaminated Soil

Category A contaminated soil cannot be disposed off-site to landfill without prior treatment. Commonly these soils are transported to a licensed facility for treatment.

Details of all contaminated and spoil materials removed from the site (including Fill Material) shall be documented by the contractor with copies of disposal docketts (where appropriate) provided to Douglas Partners.

6.3 Unexpected Finds Protocols

6.3.1 Unexpected Finds Protocol – Further Contamination

In the event that further areas of environmental concern (AEC), such as areas of deeper contaminated soil or an unexpected underground fuel storage tank, are encountered during the site work, the area of concern should be managed as follows:

- (i) Upon discovery of the AEC, the client's representative is to be notified and the area barricaded and physically demarcated;
- (ii) Visual identification of the nature of the issue and the likely extent of the AEC by a qualified Environmental Consultant;
- (iii) Conduct appropriate testing by the environmental consultant with a view to verify the nature and extent of the contamination;
- (iv) If contamination is found and remediation action considered necessary, an addendum to the RAP should be prepared by the Environmental Consultant.

6.3.2 Unexpected Finds Protocol – Asbestos

In the unexpected event that more than a few scattered pieces of asbestos are noted prior to, or during excavation works, the following procedure is recommended in accordance with the Northern Territory Work Health and Safety (National Uniform Legislation) Regulations (2012).

- (i) Upon discovery of suspected asbestos containing material, the client's representative is to be notified and the affected area closed off by the use of barrier tape and warning signs. Warning signs shall be specific to Asbestos Hazards and shall comply with the Australian Standard 1319-1994 – Safety Signs for the Occupational Environment;
- (ii) An Occupational Hygienist is to be notified to inspect the area and confirm the presence of asbestos and determine the extent of remediation works to be undertaken. A report detailing this information will be compiled by the Occupational Hygienist and provided to the client's representative;
- (iii) The impacted soil will be classified and disposed of, as a minimum, as Category C Contaminated Waste (asbestos contaminated) at an appropriately licensed facility. In dry and windy conditions the stockpile will be lightly wetted and covered with plastic sheet whilst awaiting disposal;
- (iv) All work associated with asbestos in soil will be undertaken by a contractor holding a class A License. Northern Territory WorkSafe must be notified in advance of any asbestos works;
- (v) Monitoring for airborne asbestos fibres should be undertaken in accordance with the requirements of the OH&S Act as required;
- (vi) Documentary evidence (disposal dockets) of correct disposal is to be provided to the builder's representative;
- (vii) At the completion of the excavation, a clearance inspection is to be carried out and written certification is to be provided by an environmental consultant or occupational hygienist that the area is free of observable asbestos;

- (viii) Details are to be recorded in the site record system; and
- (ix) Following validation clearance, the area may be reopened for further works.

6.4 Validation Reporting

A remediation and validation report will be prepared following completion of the works to present the findings of the remediation works undertaken and discuss results in the context of the protected beneficial uses. The validation report will also include a summary of the information from previous investigations, particularly the materials that remain on site, the assessment of risk from any residual contamination and the corresponding Environmental Management Plan (EMP) that may be required for the site.

The validation report will include details of the total volume of contaminated materials removed from site, present detailed analytical results where applicable, confirm that placed fill is clean and indicate the final disposal destination of the materials removed from site.

7. Remediation Environmental Management Plan

The proposed remediation works shall be undertaken with all due regard to the minimisation of environmental effects and to meet all statutory requirements. The following roles and responsibilities are proposed for the works:

Environmental Consultant (Douglas Partners)

- Prepare RAP documentation for the auditor's review;
- On-site monitoring and reporting of proposed works;
- Conduct field testing to assist in definition of excavation area;
- Collection of validation samples from final surfaces;
- Assessment of results for suitability within the final development; and,
- Preparation of a validation report summarising the outcome of remedial works.

Contractor (TBC)

- The Contractor will be in effective control of the site during remediation works, but will work under the direction of DP;
- Prepare a suitable Construction Environmental Management Plan (CEMP) and Occupational Health and Safety Plan (OHSP) if required under Northern Territory Work Health and Safety Regulations (2012);
- Ensure wastes arising at the site are disposed in an appropriate manner and tracking documentation is provided to DP;
- Minimise fugitive dust leaving the confines of the site;
- Provide and install suitable silt fences/ hay bales to minimise stormwater containing any suspended matter or contaminants leaving the site in a manner which could pollute the environment;

- Ensure vehicles are cleaned and secured so that no mud, soil or water are deposited on any public roadways or adjacent areas; and
- Comply with legislative requirements regarding noise and vibration levels at the site boundaries.

Client (Tolinchlo Pty Ltd)

- Appoint and manage the environmental consultant and contractor; and
- Arrange for site access, tenant notification, services isolation and traffic control as required.

Any existing pits or unstable areas on site that may generate potential occupational health and safety (OH&S) or operational risk should be demarcated and taped off, with appropriate rectification action undertaken (eg. backfilling of pits as soon as practicable to prevent undue injuries to workers etc.).

7.1 Soil Management Plan

7.1.1 Excavation and Stockpiling of Contaminated Material

Contaminated material shall be excavated and stockpiled at a suitably segregated location(s) away from sensitive areas and in a manner that will not cause nuisance to the neighbouring properties. All stockpiles of contaminated material shall be surrounded by star pickets and marking tape or other suitable material to clearly delineate their boundaries. Stockpiles shall be lightly conditioned by sprinkler or covered by geotextile or similar cover to prevent dust blow. Should the stockpile remain on-site for more than three days, geotextile silt fences, hay bales or equivalent should be erected around each stockpile to prevent losses by surface erosion. Any stockpile to remain on-site overnight should be adequately secured in order to reduce the risk of sediment runoff.

7.1.2 Rehabilitation and Reinstatement of the Site

It is intended that any excavations at the site will be made safe by battering or partially backfilling with site sourced material and there is no requirement for geotechnically-controlled backfilling. The contractor should be responsible for fencing/ battering excavations as appropriate to make them safe and prevent subsidence of surrounding buildings. If required, materials used to backfill excavations are to be either:

- Material sourced from the site, meeting the adopted site criteria; or
- Imported Fill Material meeting the requirements of EPA Publication IWRG621.

Analytical results presented by the contractor to validate imported Fill Material shall be NATA accredited and obtained at an appropriate sampling density according to EPA guidelines. Such Fill Material results will be presented in the final validation report along with details of site of origin, volume and date of receipt on the site.

7.2 Noise Control

The remediation works should comply with the requirements specified by the relevant authorities (eg. EPA and NT WorkSafe). Noise and vibration should be restricted to permissible levels. All equipment and machinery should be operated in an efficient manner to minimise the emission of noise.

7.3 Vibration Control

The use of any plant and/or machinery should not cause unacceptable vibrations to nearby properties and should meet Council requirements.

7.4 Dust Control

Dust emissions must be confined within the site boundary. The following dust control procedures will be employed to comply with this requirement as necessary:

- Erection of dust screens around the perimeter of the site (as applicable);
- Securely covering all loads entering or exiting the site;
- Use of water sprays across the site to suppress dust;
- Covering of all stockpiles of contaminated soil remaining on site more than three days; and
- Keeping excavation and stockpile surfaces moist.

7.5 Occupational Health and Safety

DP recommends that all personnel on-site be required to wear the following protection at all times:-

- Steel-capped boots or water-proof boots fitted with steel-toe;
- Safety glasses or safety goggles with side shields meeting AS1337-1992 requirements (as necessary);
- Hard hat meeting AS1801-1981 requirements; and
- Hearing protection meeting AS1270-1988 requirements when working around machinery or plant equipment if noise levels exceed exposure standards.

In the event that personnel are required to work in areas of potential contact with contaminated soil, other materials or water, the following additional protection will be required:-

- Disposable coveralls (if necessary) to prevent contact with splashed soil, materials or water;
- Nitrile work gloves meeting AS2161-1978 requirements or heavy duty gauntlet gloves;
- Respirator with organic vapour cartridge, as required.

It is noted that the contractor should be responsible for management of the risks to their own employees and they may adopt alternative measures to those suggested.

8. Limitations

Douglas Partners (DP) has prepared this report (or services) for this project at Lot 3 Freds Pass Road, Humpty Doo in accordance with DP's proposal dated 13 May 2015 and acceptance received from Tolinchlo Pty Ltd. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Tolinchlo Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

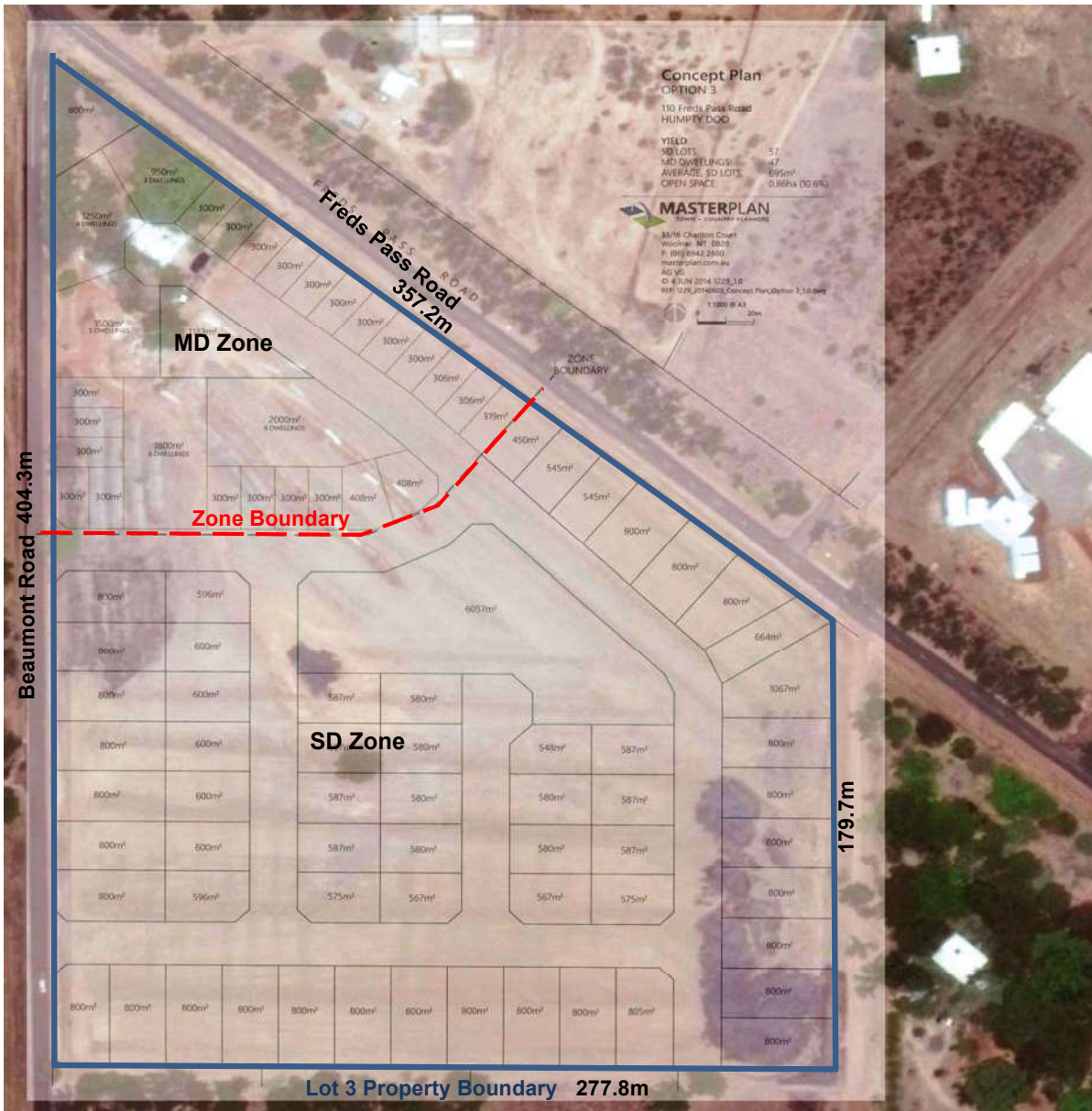
Douglas Partners Pty Ltd

9. References

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3. Douglas Partners Pty Ltd, April 2015, "Report on Preliminary Environmental Site Investigation, Revision 1, Lot 3 Freds Pass Road, Humpty Doo, NT (DP Ref: 78156.00, Rev 1).
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11. Standards Australia, 2005: "Guide to the investigation and sampling of sites with potentially contaminated soil, Part 1: Non-volatile and semi-volatile compounds", AS 4482.1-2005;
12. Northern Territory of Australia Government "Work Health and Safety (National Uniform Legislation) Regulations" 2012"


Appendix A

Drawings



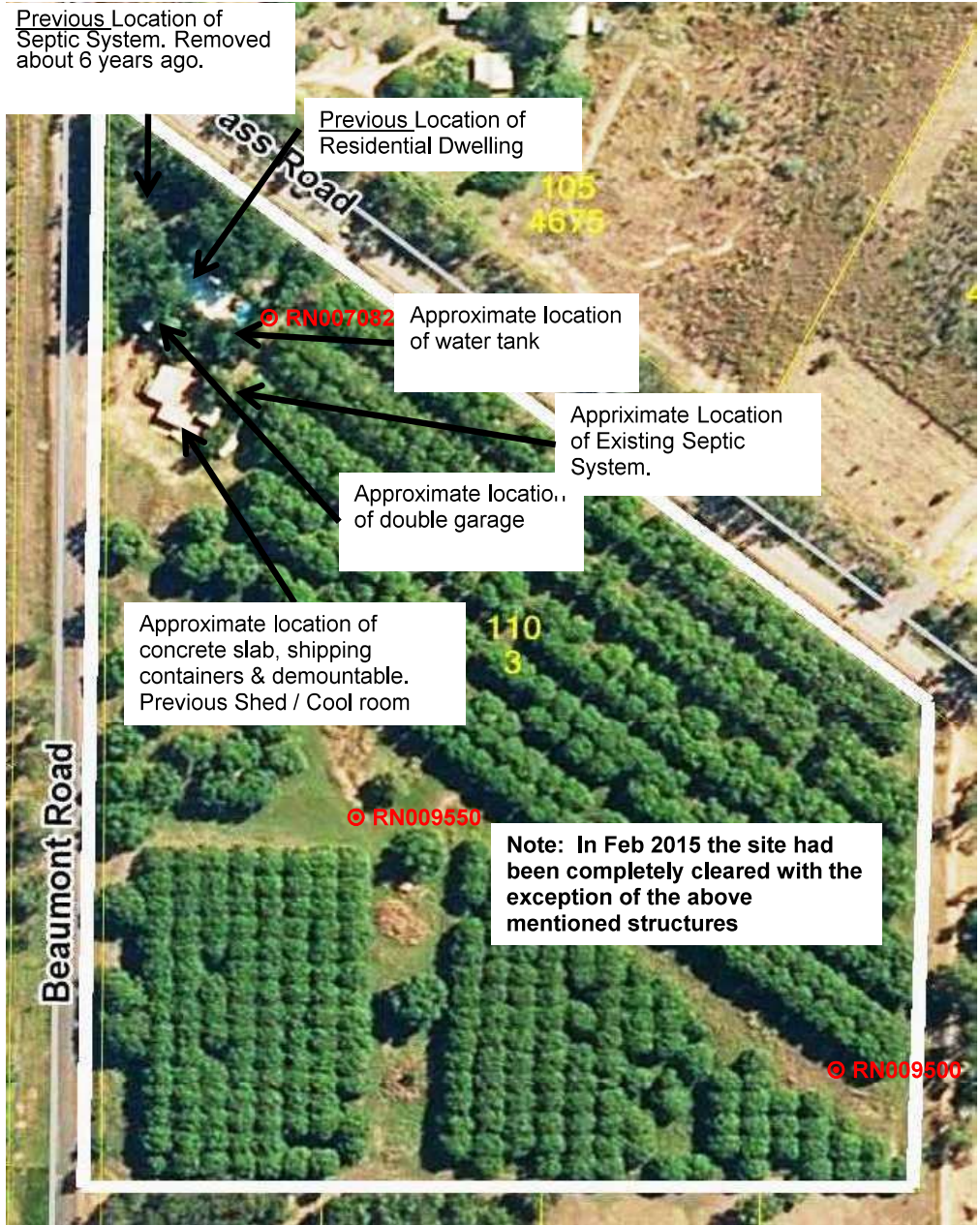
Scale as Shown

Sourced from Google Earth Pro & Drawing provided by client entitled *Concept Plan*

	Proposed Zones Proposed Residential Subdivision Lot 3 Freds Pass Road Humpty Doo, NT	Proposal 78156.01
	CLIENT: Tolinchlo Pty Ltd	DRAWING: 1
		REV: 0
		DATE: 18-Jun-15




Previous Location of Septic System. Removed about 6 years ago.

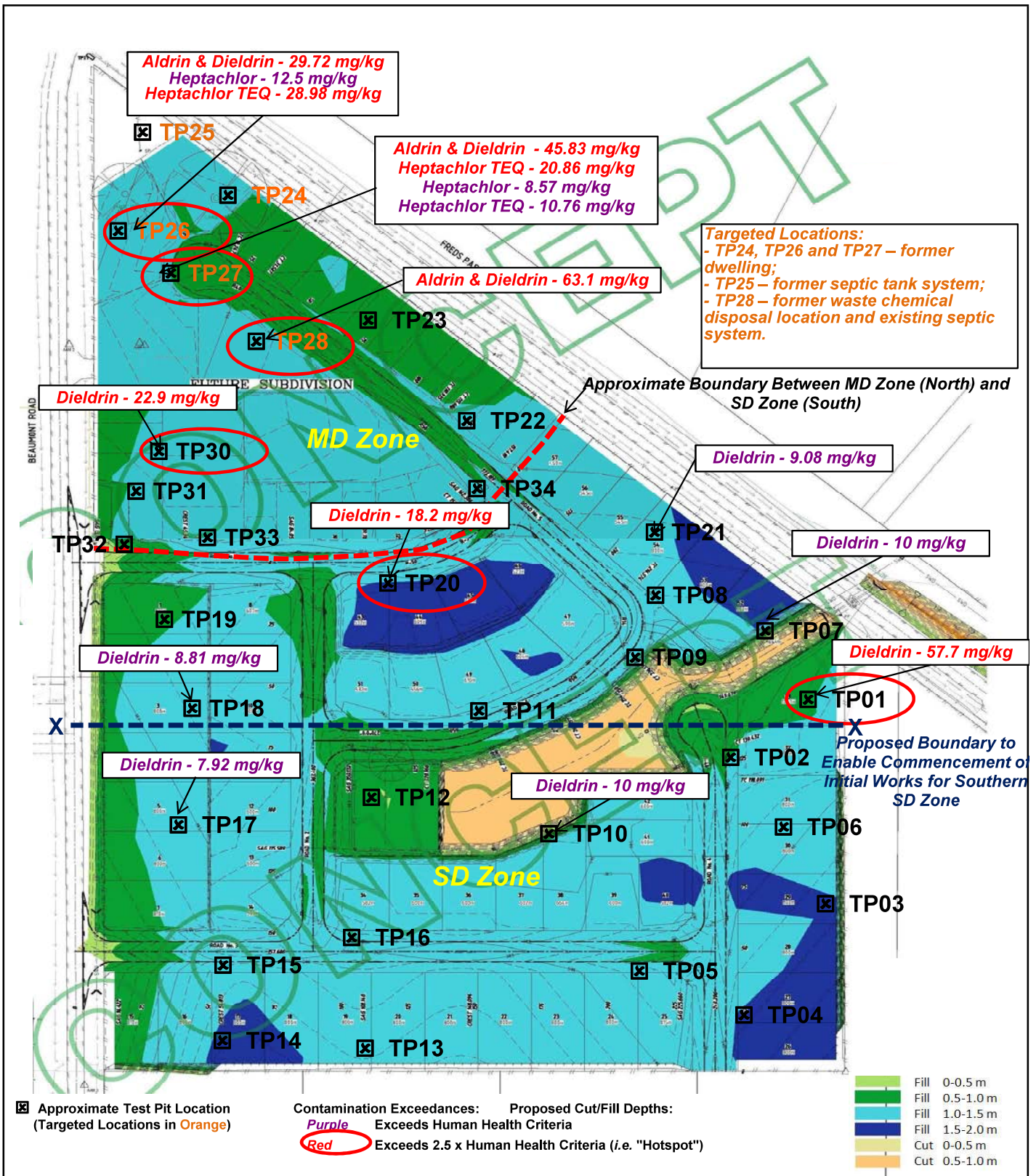


⊙ - Approximate Location of Registered Groundwater Bore


Drawing Not to Scale

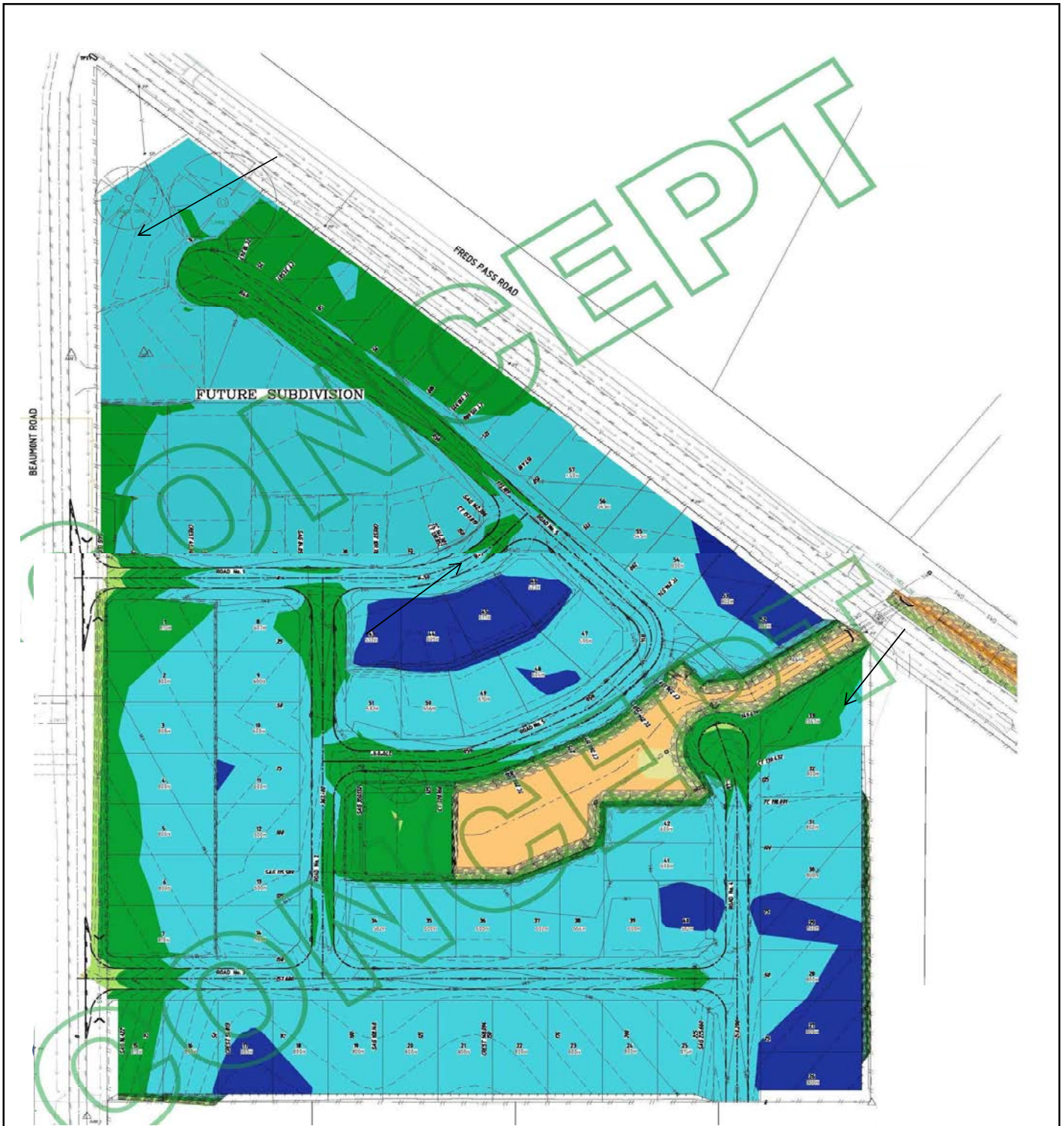
Sourced from Council Records. Original photo not dated, although likely to be dated 2012

	Site Location and Features Plan Proposed Residential Development Lot 3 Freds Pass Road Humpty Doo, NT	PROJECT: 78156.01
		DRAWING: 2
		REV: 1
	CLIENT: Tolinchlo Pty Ltd	DATE: 30-Mar-16



Drawing adapted from BMD Consulting Drawings B00153-CE001 and B00153-CE002

 <p>Douglas Partners Geotechnics Environment Groundwater</p>	<p>Test Pit Locations and Earthworks Plan Overlay</p> <p>Proposed Residential Subdivision</p> <p>Lot 3 Freds Pass Road</p> <p>Humpty Doo, NT</p>	<p>Project: 78156.01</p>
	<p>CLIENT: Tolinchlo Pty Ltd</p>	<p>DRAWING: 3</p>
	<p>DATE: 30-Mar-16</p>	<p>REV: 1</p>
	<p>CLIENT: Tolinchlo Pty Ltd</p>	<p>DATE: 30-Mar-16</p>



Proposed cut/fill depths

- Fill 0-0.5 m
- Fill 0.5-1.0 m
- Fill 1.0-1.5 m
- Fill 1.5-2.0 m
- Cut 0-0.5 m
- Cut 0.5-1.0 m

Not to Scale



Earthworks Plan Overlay
Proposed Residential Subdivision
Lot 3 Freds Pass Road
Humpty Doo, NT

CLIENT: Tolinchlo Pty Ltd

Project 78156.01

DRAWING: 4

REV: 0

DATE: 5-Apr-16

Appendix E - Report on Remediation and Validation
Assessment Single Dwelling (SD) Zone Proposed
Residential Subdivision Lot 3 Freds Pass Road, Humpty
Doo, NT. Oct 2016 (DP Ref: 78156.02.R.002.Rev0)



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Report on
Remediation and Validation Assessment

Multiple Dwelling (MD) Zone
Proposed Residential Subdivision
Lot 3 Freds Pass Road, Humpty Doo, NT

Prepared for
Mr Peter Poniris

Project: 78156.02
1 December 2016

Integrated Practical Solutions





Douglas Partners

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Document History

Document details

Project No.	78156.02	Document No.	R.004
Document title	Report on Remediation and Validation Assessment Multiple Dwelling (MD) Zone Proposed Residential Subdivision		
Site address	Lot 3 Freds Pass Road, Humpty Doo, NT		
Report prepared for	Mr Peter Poniris		

Document status and review

Status	Prepared by	Reviewed by	Date issued
0	Andrew Gane	Paul Moritz	1 December 2016

Distribution of copies

Status	Electronic	Paper	Issued to
0	1	0	Mr Peter Poniris GHD Pty Ltd – Mr John Throssell NT EPA – Mr Christopher Coombes

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		1 December 2016
Reviewer		1 December 2016



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Report on Remediation and Validation Assessment

Multiple Dwelling (MD) Zone of Proposed Residential Subdivision

Lot 3 Freds Pass Road, Humpty Doo, NT

1. Introduction

This report by Douglas Partners Pty Ltd (DP) presents the findings of validation works related to the site remediation of the Multiple Dwelling (MD) Zone of the proposed residential subdivision at Lot 3 Freds Pass Road, Humpty Doo ('the site'). The site also has an area designated for development of single dwellings, which has been remediated and validated in a similar manner to the MD Zone. The results of the remediation and validation of the Single Dwelling (SD) Zone have been reported separately. The SD and MD Zones are shown on Drawing 1 in Appendix A.

The work was commissioned in a services order dated 30 August 2016 from Mr Peter Poniris ('the client') and was undertaken in accordance with DP's proposal DWN160153, dated 23 August 2016.

DP had previously completed a preliminary site investigation (PSI, Ref 1) and detailed site investigation (DSI, Ref 2) between April and December 2015. The results of the DSI indicated that concentrations of organochlorine pesticides (OCP) were detected above the adopted assessment criteria at a number of locations across the site. Subsequently, a remediation action plan (RAP, Ref 3) was prepared by DP. The RAP is presented in Appendix A of this report. The RAP proposed remediation strategies and methodologies required to restore the beneficial uses of land for the proposed residential development. The RAP covers a number of remediation strategies, designed to be applied to different areas of the site, depending on the degree, nature and extent of contaminants encountered.

The site is the subject to an environmental audit by Mr John Throssell of GHD Pty Ltd (GHD), and all works by DP associated with investigation and remediation of the site have been reviewed by the Auditor as part of the audit process. Prior to commencement of remediation works, the PSI, DSI and proposed strategies and methodologies of the RAP were generally accepted by the Auditor as being satisfactory.

The purpose of this current work is to ensure remediation of the site was carried out in accordance with the RAP, and to validate the results of the remediation, by sampling and testing across the site. This report presents details of the remediation work and the findings of the validation testing. Specifically, this report presents:

- A summary of previous work and findings;
- Results of an intrusive groundwater investigation carried out during remediation works;
- Methods adopted for the following remediation and validation work in the MD Zone, and if / how the methods deviated from the RAP:
 - removal and validation of previously identified OCP hotspots;
 - removal and validation of soils affected by the presence of asbestos;

- removal of a septic system and affected soils, and validation of the resulting excavation and the excavated soil;
 - vertical mixing of near surface soils in the whole MD Zone, excluding hotspots and some minor areas where laterite was present at the surface;
 - validation testing of the mixed soil horizon;
 - testing of any soils intended to be removed from site; and
 - testing of imported soil proposed for use as filling to hotspot excavations.
- Results of site observations and laboratory testing;
 - Remediation/validation criteria and comparison of test results against these criteria;
 - Quality analysis and quality control procedures and results;
 - A discussion of the results and recommendations for any further works; and
 - Our conclusions relating to the overall results of remediation and validation works and the suitability of the site for its intended development.

It should be noted that, at the time of preparing this report, the site capping layer, as proposed in Section 5.3 of the RAP had not been completed. It is intended that the capping layer be completed as part of bulk earthworks at the site and this current report is required to enable bulk earthworks to commence.

This report should be read in conjunction with DP's notes About this Report, which are presented in Appendix A.

2. Summary of the Findings of Previous Work

2.1 Preliminary Site Investigation

DP was initially engaged to undertake a PSI for the entire site, including both the SD and MD zones. The results of this PSI are presented in our report dated April 2015 (Ref 2) and that report should be referenced for the full site history.

A summary of the PSI findings is presented below, with items specific to the entire site and the MD Zone (the subject of this report) separated into different groups.

Entire Site

- The site had been used for agriculture (banana and tomato crops, then a mango orchard) from circa 1970 and prior to this was likely to have been unallocated crown land covered in native vegetation.
- Pesticides and insecticides were thought to have been used at the site up until circa 1999 and disposal practices may not have been in accordance with the manufactures instructions.
- The mango orchard ceased operation in circa 2012.

- It was determined that the potential for contamination at the site was low to moderate and the site may be potentially contaminated with pesticides, herbicides, insecticides, petroleum hydrocarbons and / or asbestos.
- Intrusive sampling and testing was needed in order to confirm the site contamination status.

Information provided by the site owner, after the completion of the PSI, indicated that organochlorine pesticides were applied to the soil at each location where a mango seedling was planted. Before the seedling was planted, the hole into which it was to be placed was sprayed with dieldrin solution to prevent termite attack on the roots of the immature tree.

MD Zone

- An elevated residential dwelling containing asbestos construction materials had been present on the MD Zone.
- Other structures, including two sheds, a cool room and an elevated water tank had been constructed in the MD Zone over time.
- All trees (including roots) were removed and the site surface was partially stripped between 2012 and 2015.
- The asbestos-containing residential dwelling was removed and asbestos-containing materials were removed by a licensed asbestos removalist.
- One shed and the cool room were also removed. A single small shed and the water tank remained, along with the ground slab for the cool room.
- The remnants of a septic system, associated with the dwelling, were still present.

2.2 Detailed Site Investigation

Based on the results of the PSI, DP was engaged to undertake a DSI for the entire site (SD and MD Zones). The results of this DSI are presented in our report dated December 2015 (Ref 3) and this report should be read for comprehensive details of the findings of the DSI.

A summary of the DSI findings is presented below, with items specific to the entire site and the MD Zone (the subject of this report) separated into different groups.

Entire Site

- In addition to the site conditions identified in the PSI, a review of NT Government groundwater resources indicated that shallow groundwater is unlikely at the site and regional groundwater is likely to be at depths greater than about 50 m.
- Intrusive sampling comprised test pits in SD and MD Zones, and was followed by chemical laboratory testing of soils. 'Background' sampling off-site to confirm the absence of widespread contamination of the local area was also carried out.
- Grid sampling (across most of the site) and targeted sampling (near the former dwelling, the former septic system, the former waste chemical disposal area and where remnants of the septic system were still present) was undertaken.

- One test pit (TP29) and two surface samples (S1 and S2) were excavated off-site for the assessment of background conditions.
- The conditions observed during intrusive work on both the SD and MD Zones indicated the general absence of gross contamination to soils at the locations and depths tested (*i.e.* absence of visual or olfactory indicators of contamination).
- Hotspots were assigned based on NEPC guidance for contamination exceeding 250% of the assessment criteria.
- OCP/OPP contamination was identified in the SD and MD Zones (see specific comments below) and it was considered to be representative of broad acre application.
- Elevated OCP concentrations were typically identified in surface and near-surface soils and OCP concentrations were generally higher for the MD Zone.
- Suggested remediation options considered suitable to render the site suitable for the proposed development included:
 - Removal of identified hotspots;
 - On-site management beneath a fill capping layer;
 - On-site management via vertical soil mixing of the upper profile; and
 - A combination of off-site disposal and on-site management.
- Further investigation work to delineate the vertical extent of contamination at some locations in the SD and MD Zones, and to validate the excavation of the septic system in the MD Zone after its removal was also recommended, but it was acknowledged that this could be done in conjunction with other remediation work.
- Regarding groundwater, it was considered that due to the low mobility of OCP/OPP contaminants and the site activities, the potential for contamination to groundwater was low. Therefore assessment of groundwater was not considered warranted for the DSI.

A drawing for the whole site, showing the distribution and contaminant concentrations for identified human health criteria exceedances, including “hot spots”, was prepared for the DSI. This drawing has been reproduced for this report and is presented as Drawing 1 in Appendix A. Validation sampling carried out for this current assessment has been added to the drawing.

MD Zone

- Five targeted test pits (TP24 to TP28) near the former dwelling, the former septic system, the former waste chemical disposal area and where remnants of the septic system were still present were excavated on the MD Zone.
- Seven grid-based test pits (TP22, TP23 and TP30 to TP34) were also excavated on the MD Zone (2 ha).
- The number of test pits represented about 40% of the recommended number for the assessment of site conditions as outlined in AS-4482 (Ref 10), but as per the SD Zone, it is considered a statistically significant number of sampling locations and the reduced grid-based sampling density combined with targeted sampling was considered suitable for the assessment given the historical activities on the MD Zone.

- Laboratory testing indicated organochlorine pesticides (OCPs) in 12 of 18 primary soils tested in MD Zone, confirming the presence of pesticide-impacted soil, likely due to former chemical application at the site.
- OPPs were not detected at concentrations above laboratory detection limits in samples tested from the MD Zone.
- Comparison of test results with investigation criteria indicated:
 - the concentrations of OCPs, OPPs, TRH and phenoxy herbicides were less than adopted ecological investigation criteria, except for OCP (specifically Aldrin) concentrations in test pits TP25, TP26 and TP27, located in the MD Zone;
 - concentrations of OCPs were generally within the human health investigation levels for residential land use in the MD Zone, with the exception of samples that had exceedances of aldrin and dieldrin and / or heptachlor in TP26, TP27, TP28 and TP30. All four of these had exceedances that more than 250% of the criteria for aldrin and dieldrin and two locations (TP26 and TP27) had exceedances of Heptachlor TEQ.
- Statistical analyses of concentration data for the MD Zones indicated 95% UCL concentrations remained above site assessment criteria, with and without consideration of hot spots.
- Vertical delineation of OCPs was not achieved in one test pit (TP27) in the MD Zone. This location was also a hotspot.
- Asbestos fibres were identified in soil near TP28, located in the vicinity of former site structures in the MD Zone, therefore gross asbestos impact across the site was considered unlikely.

2.3 Remediation Action Plan (RAP)

On the basis of the findings of the DSI, a Remediation Action Plan (RAP) was developed by DP for the site. The RAP is presented in our report dated May 2016 (Ref 4) and in broad general terms the recommended remediation strategy comprised:

- Removal of OCP Hotspots at TP01, TP20 in the SD Zone and TP26, TP27, TP28 and TP30 in the MD Zone by removing soil to a depth of between 0.4 m to 0.5 m below the depth of impacted soil, over a 5 m by 5 m square area;
- Vertical delineation of OCP-impacted soil at TP01, TP10, TP17, TP18 and TP20 in the SD Zone, and TP27 in the MD Zone;
- Vertical mixing of the upper soil profile to a depth of between 0.3 m and 0.5 m over the entire site area (SD and MD Zones), with the purpose of taking clean soils from depth and mixing them with the shallow, impacted soils.
- Removal of asbestos-impacted soil at TP28 in the MD Zone by removing soil to a depth of 0.3 m over a 5 m by 5 m square area, prior to removing OCP-impacted soil at the same location;
- Removal of the septic system, associated fixtures and any soils impacted by the septic system in the MD Zone.
- Finally, after all other remediation strategies are complete placement of a capping layer over the vertically mixed soils. It should be noted that at the time of reporting this capping was intended to be placed as part of bulk earthworks, which was yet to commence.

Full details on the methods used to implement each remediation strategy given above are presented in the RAP. Any deviations from these methods are discussed in Section 4 of this report.

Vertical delineation of OCP-impacted soils was required so that the depth of vertical mixing could be established with some confidence. The lack of vertical delineation of OCP-impacted soils during the DSI meant that limited results were available, particularly for the SD Zone, to establish the required vertical mix depth. Additional information was considered necessary.

Validation sampling typically involved recovery of soil samples from excavation faces or from the site surface, after completion of remediation works. As noted above, the proposed validation sampling for each stage of remediation was presented in detail in the RAP, and actual validation sampling carried out during the works is presented in Section 4 of this report.

The RAP also provided information on remediation criteria for the validation samples (ie Health Investigation Levels, Ecologically Based Investigation Levels, Waste Soil Categorisation and Asbestos). The assessment criteria is summarised in Section 2.4.

Finally, the RAP provided detailed information on soil sampling methods, waste categorisation, stockpile management, unexpected finds protocols for contamination by OCP or asbestos, and validation reporting. It also included an environmental management plan for the remediation works at the site.

2.4 Adopted Remediation Criteria

As detailed in the RAP, the analytical results were assessed against investigation levels outlined in Schedule B1 of the NEPM (See Ref 9) for a low density residential development, which is the land use proposed at the site.

Health Investigation Levels (HILs) have been adopted as they are intentionally conservative and the results have been compared to HIL A criteria, which is applicable for residential land use with garden / accessible soil. DP considers this the most relevant end use for this site at this time.

The applicability of Ecological Investigation Levels (EILs) was considered in the RAP, but the implications of exceedances of those criteria were deemed to outweigh the possible associated risks.

The adopted HIL and EIL criteria were presented in Table 1 of the RAP (Ref 4) and are reproduced on the tabulated results tables in Appendix C for ease of comparison.

It should be noted that the validation testing of soil, following vertical mixing operations, was only concerned with OCPs.

Actions required for any exceedances of analytical test results compared against HILs and EILs are given in the RAP (Ref 4).

2.5 Waste Soil Categorisation Criteria (for Off-site Disposal)

Any soils to be removed from site will be classified as 'waste material' in accordance with the current EPA Victoria guidelines outlined in Publication IWRG621 (See Ref 5), which presents the current categorisation criteria used to assess soil prior to off-site disposal. The EPA Victoria guidance for waste categorisation is adopted in the Northern Territory.

Under these guidelines, any soils to be removed off-site will be classified into one of four categories based on its relative hazard. From least to most contaminated, these categories are:

- Fill Material (not contaminated);
- Category C Contaminated Soil (least contaminated);
- Category B Contaminated Soil; and
- Category A Contaminated Soil (most contaminated).

Off-site disposal must be carried out by the methods given in the IWRG621 guideline, depending upon the classification of the 'waste material'.

The criteria for waste soil categorisation are specified in Table 2 of IWRG621 (Ref 6). They are also reproduced on the tabulated results tables in Appendix C for ease of comparison.

2.6 Asbestos

As provided in the RAP, the remediation and validation of asbestos in soil were to be conducted in general accordance with the WA Department of Health Guidelines (See Ref 10).

3. Intrusive Groundwater Investigation

As discussed in the DSI, and summarised in Section 2.2 of this report, shallow groundwater at the site was considered unlikely and, due to the low mobility of OCP/OPP contaminants, the potential for groundwater contamination was considered low.

Even so, a limited groundwater intrusive investigation was carried out for the site while remediation works were being completed. The scope for the groundwater investigation comprised drilling a single borehole to a depth of 5.5 m below the ground surface level. The borehole was positioned adjacent to TP28 on the MD Zone of the site, and it was drilled using a 150 mm diameter auger.

The borehole location was chosen because it was a OCP contamination hotspot; it was located on the MD Zone, which was broadly more contaminated than the SD Zone; it was also the location of the chemical waste disposal area, and; it was located near the remnants of a septic system. Therefore, it was considered an area with potential for groundwater contamination to occur, if groundwater was present at relatively shallow depth.

A detailed log of the borehole is presented in Appendix B and a summary of the ground conditions encountered is given below.

The conditions encountered in the borehole were similar to those encountered in the test pits, which are also presented on logs in Appendix B, and comprised a thin surficial layer of gravelly silty sand, overlying cemented laterite soils from about 0.3 m. The laterite soils continued and became less cemented with depth then transitioned to weak, weathered siltstone rock, that was recovered as a 'soil' during drilling. Detailed logging of the rock was not possible due to the method of drilling adopted.

No groundwater was encountered during drilling, and neither were moist or saturated soil conditions observed. Even so, a groundwater piezometer was installed to the full depth of the borehole. The piezometer was checked on several occasions between the installation date (16 September 2016) and the date of this report, but no groundwater was observed on any occasion. However, it should be noted that groundwater levels will fluctuate with time, particularly between wet and dry seasons, and the groundwater level at the site could rise and be encountered within the depth of investigation during the wet season.

4. Remediation and Validation Work

4.1 Remediation Work Methods

4.1.1 General

The remediation and validation works for the MD Zone were carried out between 14 September and 5 November 2016. The works were in general accordance with the auditor-endorsed RAP and the methods adopted are presented below. Where applicable, any deviations from the RAP are discussed.

A site layout plan is presented as Drawing 1 in Appendix A and it shows:

- the SD and MD Zones;
- DSI test pit locations;
- sample locations for OCP hotspots;
- sample locations for the area identified as having asbestos contamination; and
- sample locations for the area where the septic system was removed.

Drawing 2, also in Appendix A, shows the surface validation sample locations used after completion of vertical mixing.

Logging of excavations for OCP hotspots (see Section 4.1.2), the area identified as having asbestos contamination and for the excavation associated with removal of the septic system (see Section 4.1.3) was carried out by an experienced geotechnical engineer. The detailed logs are presented in Appendix B.

4.1.2 OCP Hotspots

Excavation of OCP Hotspots was carried out on the 14 and 15 September 2016 and it comprised:

- Locating the previous test pits of concern (TP26, TP27 and TP30 on the 14 September 2016 and TP28 on the 15 September 2016) were located using previously reported coordinates and a hand held Garmin GPS device (position accuracy of about 5 m), and by visual inspection of disturbed surface soils (*ie* lateritic gravel exposed at the surface);
- Soil was then excavated over an approximate 5 m by 5 m area, to a maximum depth of 1.6 m, using a 12 tonne excavator. The area excavated was centred as close as practical to the location of TP26, TP27, TP28 and TP30;
- The excavated soil was stockpiled adjacent to the excavation where it awaited waste categorisation for disposal off site (Refer to Section 5 for classification);
- The stockpiles were placed directly on the ground surface with no barrier between the stockpile and underlying soils. This was considered acceptable because the underlying soils were yet to be remediated by stripping of topsoil and vertical mixing, and the principal contaminant of concern (dieldrin) has a low mobility;
- Validation samples were collected (HSR series) from the base (designated B) and mid-section (designated S1 to S4) of the walls of the hotspot excavations; and
- Validation samples for waste categorisation were collected from the stockpiled material excavated from TP26, TP27, TP28 and TP30 (HSR series, designated SP1 and SP2). Samples were collected systematically in the stockpile at variable locations and depths, as shown on the stockpile sketches following the logs of TP26, TP27, TP28 and TP30 in Appendix B.

4.1.3 Asbestos- and Septic-Impacted Soils

Asbestos-impacted soils were only encountered at TP28 in the surface soils. The methods used for remediation and validation of these soils are detailed below. It should be noted that TP28 was also identified as an OCP Hotspot and it was also treated as detailed in Section 4.1.2. The asbestos-impacted soils were only considered to be at the surface (*ie* upper 0.3 m), so they were treated on 14 September 2016 before excavation of the hotspot on the 15 September 2016, and excavated material was stockpiled separately.

For Asbestos-impacted soils:

- The previous test pit of concern (TP28) was located using previously reported coordinates and a hand held Garmin GPS device (position accuracy of about 5 m), and by visual inspection of any disturbed surface soil (*ie* lateritic gravel exposed at the surface);
- Soil was excavated over an approximate 5 m by 5 m area, to a maximum depth of 0.3 m, using a 12 tonne excavator. The area excavated was centred as close as practical to the location of TP28;
- The excavated soil was stockpiled adjacent to the excavation where it awaited waste categorisation for disposal off site (see comments below about disposal);
- The stockpiles were placed directly on the ground surface with no barrier between the stockpile and underlying soils. This was considered acceptable because the underlying soils were yet to

be remediated, and the principal contaminant of concern was bound (non-fibrous) asbestos sheeting;

- Validation samples were collected (ASB series) from the base (designated B), the mid-section (designated S1 to S4) of the walls, and from the surface at 1 m from the edge of each side of the excavation (designated S5 to S8); and
- Validation samples for waste categorisation were collected from the stockpiled material excavated from TP28 (ASB series, designated SP1, SP2 and SP3). Samples were collected systematically in the stockpile at variable locations and depths, as shown on the stockpile sketch following the log of TP28 in Appendix B.

Remnants of an old septic system were identified close to the location of TP28 (See Drawing 1 in Appendix B). The remnants of this system were removed during remediation works and the resulting excavation was validated by sampling on the 15 September 2026, as detailed below:

- The area of concern (near TP28) was visually located and the coordinates of the position were recorded using a hand held Garmin GPS device (accuracy of about 5 m);
- The pipework associated with the septic system and the soil surrounding the pipework was excavated over an area with approximate dimensions of 2.8 m by 3.2 m and 6 m by 0.6 m, as shown on Test Pit Log SS/TP in Appendix B. The area was excavated to a maximum depth of 1.2 m;
- The excavation works were completed using a 12 tonne excavator;
- The excavated soil was stockpiled adjacent to the excavation where it awaited waste categorisation for disposal off site (Refer to Section 5 for classification);
- The stockpiles were placed directly on the ground surface with no barrier between the stockpile and underlying soils. This was considered acceptable because the underlying soils were yet to be remediated;
- Validation samples were collected (SS series) from the mid-section (designated S1 and S2) of two excavation faces at a sampling rate of 1 sample per 25 m² of excavated surface area; and
- Validation samples for waste categorisation were collected from the stockpiled material (SS series, designated SP1, SP2 and SP3). Samples were collected systematically in the stockpile at variable locations and depths, as shown on the stockpile sketch following the Test Pit Log SS/TP in Appendix B.

During removal of the septic system, DP personnel made note of a small stockpile (~2 to 3 m³) of soil near the septic system. It was apparent that a small amount of potential asbestos-containing material (fibro sheeting) was mixed in the soil of the stockpile. The client was alerted to the presence of this material and the client then engaged a licensed asbestos removal contractor (Northern Trade Solutions) to remove the soil from site. The contractor tested the potential asbestos-containing material prior to removal and it was confirmed as containing asbestos. At the same time, the contractor removed the potential asbestos-impacted soil that had been excavated from TP28 and stockpiled (see above), even though testing of this stockpiled material did not identify the presence of asbestos.

The Asbestos Clearance Certificate associated with the removal of this material is presented in Appendix B

4.1.4 Vertical Mixing

The process of vertical mixing started on the 24 October 2016 with commencement of topsoil stripping. The process adopted on site for vertical mixing of near surface soils was substantially different from the method described in the RAP. The method was revised to account for topsoil stripping, which wasn't included in the RAP, and to suit the equipment which the earthworks contractor had readily available (*ie* excavators and graders). The revised method comprised:

- Stripping of all remaining grass and vegetation, and topsoil or other soils containing vegetation or organic material from the MD Zone, up to a maximum depth of about 50 mm. The stripped vegetation and soils were temporarily stockpiled on a remediated area of the SD Zone, near the northern site boundary where they awaited waste categorisation for disposal off site (Refer to Section 5 for classification). The stockpiles were placed directly on the ground surface with no barrier between the stockpile and underlying soils. This was considered acceptable because of the likelihood that the stripped material would be categorised as Clean Fill, the principal contaminant of concern (dieldrin) has a low mobility, and the drainage path leading away from the stockpiled area was protected by mulch silt traps.
- Ripping with a Caterpillar 12G Grader with a five tyne ripper exposed near surface soils across most of the MD Zone to depths of between 0.3 m (hard ripping) and 0.5 m (easy ripping). In a few areas, as shown on Drawing 2 in Appendix A, heavily cemented laterite soils near the site surface restricted ripping depths. These areas were either left untreated and validated by surface sampling (see Section 5), or they were ripped as deep as possible with the grader traversing in two perpendicular directions.
- Using the grader blade to turn over ripped soils, bringing clean soils at depth to the surface and mixing them with shallow OCP-impacted soils (if remaining), which was the overall aim of the vertical mixing method described in the RAP.
- The ripping and blade mixing was carried out in long traverses that were generally parallel to one of the site boundaries, those being the northeast and west boundaries. The traverses typically started adjacent to the boundary and worked towards the centre of the site. Each traverse was between 60 m and 180 m long, depending on which boundary was being followed and whether any obstructions (*ie* buildings and slabs) were present (see comments below). Each successive traverse had a minor overlap of the previous one. Inevitably, as the traverses approached the centre of the site and the intersection of boundaries, there was some crossover of traverses and mixing in two directions.
- Once vertical mixing was completed to the satisfaction of the supervising personnel from DP, validation surface samples (designated VMS33 to VMS44) were collected across the site using grid-based locations (approximate 50 m spacings); and across the site at typical spacings of between about 30 m and 80 m (see comments below); and
- Waste categorisation sampling of the stockpile arising from topsoil stripping was also carried out. Samples (designated TSSPS18 to TSSPS29) were collected systematically throughout the stockpile at varying locations and depths, as shown on the sketch presented in Appendix B. The samples were collected after the material was stockpiled on the SD Zone.

DP personnel attended site periodically during stripping, ripping and mixing operations to witness site activities, give direction to the earthworks contractor as required, and to collect the validation samples.

Topsoil stripping was required prior to vertical mixing to meet engineering earthworks requirements. Mixing of topsoil and vegetation into the underlying soils would have resulted in a layer of soil unsuitable for engineering purposes, and which would have to be removed at the commencement of bulk earthworks.

Vertical mixing was not possible in two areas of the MD Zone. One of these areas was occupied by a ground slab (previous cool room) and a water tank, and the other area was occupied by a shed. These structures are shown on Photo 1 in Appendix B. The PSI report indicates that these structures were constructed in circa 1994 / 95. It is not clear whether pesticides were used at the site prior to construction but it cannot be discounted. Therefore, it will be necessary to validate these areas after demolition and removal of the structures. It is expected that validation will simply comprise surface sampling. Further comments relating to this are given in Section 6.

As detailed in DP's report for the SD Zone, before commencement of vertical mixing with the revised method, DP supervised a small trial area (about 10 m by 40 m) to determine if the proposed method was suitable. It was considered suitable and it was concluded that orthogonal ripping, as presented in the RAP, would not significantly improve the mixing achieved by blade mixing. Therefore, orthogonal ripping was discontinued, except in areas where shallow laterite was present, where it was not possible to effectively blade mix.

During mixing works, a water cart was used, as required, to wet the surface soils to aid mixing operations and to minimise dust at the site. Periodic rainfall occurred during mixing, which meant only minimal use of the water cart was required.

The MD Zone was ripped and blade-graded in small stages to allow validation and re-compaction works (see below) to continue without delay. Each stage essentially comprised about one quarter of the MD Zone. Ripping of each stage involved a minimum of two passes of the five tyne ripper. If hard ground was encountered additional passes (up to six) were carried out.

Vertical mix validation samples were collected systematically by completing traverses on foot parallel to the direction of mixing, which was typically parallel to a site boundary (see comments above). The samples were collected at approximate intervals of 50 paces (approximately equivalent to 50 m). As some of the long traverses overlapped, the distance between sample locations became variable (less than 50 m in some cases and up to about 60 m at some locations). Furthermore, the sampling density was also reduced in areas where hotspots had been removed (ie near TP26, TP27, TP28 and TP30).

After validation sampling was complete, the site surface was graded flat, then compacted using several passes of a pad foot roller. A final pass was undertaken using a flat drum roller to seal the site surface so that any rainfall would more effectively run off the site, and not pool in areas and create muddy conditions.

4.1.5 Capping Layer

As discussed previously, the capping layer will be placed as part of bulk earthworks, which is yet to commence. The development approval conditions for the site state that bulk earthworks can't commence until the site remediation has been completed to the satisfaction of the NT EPA.

4.2 Validation Sampling (Including Stockpile Sampling)

All validation soil sampling was performed in general accordance with standard operating procedures outlined in DP's Field Procedures Manual, and as shown in Section 6.1 of the RAP. Specifically it involved:

- Transferring by hand soil samples from excavation faces, the excavator bucket, or from the soil surface, into laboratory-prepared glass jars, using a new pair of disposable nitrile gloves for each sample;
- Immediately capping glass jars, then labelling each with individual and unique identification details, including project number, sample number with relevant test pit if applicable, sampling date, and the person responsible for sampling;
- Placing the glass jars into a cooled, insulated and sealed container for transport to the testing laboratory; and
- Preparing chain of custody (COC) documentation and ensuring that the document was endorsed by the laboratory, acknowledging receipt, when returned to DP.

All samples that required testing were submitted to the testing laboratory. Samples not analysed were stored under refrigerated conditions at DP's Darwin laboratory for future analyses, as and when required.

4.3 Site Supervision

The remedial works on site were carried out in general accordance with the RAP prepared by DP and the works were supervised by appropriately-experienced staff from DP. Specifically, DP's supervising role on the site involved:

- Full-time supervision during excavation of hotspots at TP26, TP27, TP28 and TP30 and during placement of excavated material in stockpiles;
- Full-time supervision of the excavation associated with the asbestos-impacted soil at TP28;
- Full-time supervision during removal of the remnants of the septic system near TP28;
- Periodic (part-time) supervision of topsoil stripping activities, including formation of topsoil stockpiles; and
- Periodic (part-time) supervision of ripping and mixing across the MD Zone once a mixing method had been established and agreed between the contractor, client and DP.

It should be noted that the mixing method was established and agreed while completing a trial mix area during early remedial works on the SD Zone. The trial mixing was carried out under the full-time supervision of DP staff. Further details of the trial mix can be found in our validation report for the SD Zone.

For part-time supervision, DP staff were on site during the early stages of work and remained on site until work methods were established and agreed with the contractor and client. Once the work methods were established, DP carried out periodic inspections only, either daily or every second day. These latter inspections only involved 1 to 2 hours on site.

The full-time and part-time supervision on site was carried out by geotechnical engineers. Where required, advice on site works was also sought from a DP principal environment scientist.

A summary log of personnel attendance on site during remediation works for the MD Zone is presented below in Table 1.

Table 1: Log of Site Attendance (MD Zone) during Remediation Works

Date	Person(s) Attending Site	Reason for Visit
14/9/16	Andrew Gane – Senior Geotechnical Engineer Vanessa Harrington – Technician	Excavation and sampling of OCP Hotspots and asbestos impacted soils
15/9/16	Andrew Gane – Senior Geotechnical Engineer Vanessa Harrington – Technician	Excavation and sampling of OCP Hotspots and septic-impacted soils
16/9/16	Andrew Gane – Senior Geotechnical Engineer Richard Arbon – Experienced Geotechnical Engineer	Drilling and sampling of groundwater bore and installation of well
25/10/16	Richard Arbon – Experienced Geotechnical Engineer	Inspection of topsoil stripping
28/10/16	Andrew Gane – Senior Geotechnical Engineer	Inspection of topsoil stripping and mixing works, and validation and topsoil stockpile sampling
5/11/16	Andrew Gane – Senior Geotechnical Engineer	Inspection of mixing works, and validation and topsoil stockpile sampling

Aside from confirming that works were proceeding in general accordance with the RAP, the supervising personnel were responsible for confirming when topsoil was adequately stripped and the underlying soils were adequately ripped so that vertical mixing could commence. They were also responsible for confirming when the soils were adequately mixed and validation sampling could commence.

Validation sampling of OCP hotspots, asbestos-impacted soils and for the septic system removal, and validation sampling after vertical mixing was complete, was carried out by the supervising personnel during the various site visits. Waste categorisation sampling of topsoil, OCP hotspot stockpiles and the stockpiles of material from the asbestos-impacted soil and the septic system, was carried out by the same supervising personnel during their site visits.

Site activities observed during each visit were recorded by the supervising personnel and were retained on DPs project files.

All logging of excavations on site (*ie* test pits and hotspots) was carried out by the experienced geotechnical engineer.

5. Results of Validation Work

5.1 Site Conditions

The subsurface conditions encountered in the hotspot excavations, the excavations for asbestos-impacted soils and the septic system, and during stripping and mixing of site soils, were generally consistent with the previous findings of the PSI and DSI. These conditions typically comprised natural silty sand, grading to clayey sand or clayey sandy gravel at depth, with some frequent shallow cemented zones. The conditions are consistent with typical laterite profiles in the Darwin and surrounding area.

Detailed logs of the excavations, showing soil descriptions, sample details and excavation photographs are provided in Appendix B, and should be read with the accompanying notes, also in Appendix B.

Prior to commencement of vertical mixing, topsoil was stripped from the MD Zone using the grader, as noted above. Topsoil was shaped into windrows and then moved and stockpiled on the SD Zone using an excavator and side tipping truck. The material was stockpiled while testing for waste categorisation was completed, so that it could be disposed of, appropriately, off site.

The topsoil horizon was typically quite thin (about 20 mm to 50 mm) and at some locations it was not present at all. It generally comprised silty / clayey sand with thick grass rootlets. No large roots were evident.

Ripping of the soils with the grader generally achieved a ripped depth of between 0.3 m and 0.5 m, depending upon the depth of rippable soil. In some areas, heavily cemented laterite soils at the site surface restricted mixing, as they could not be effectively ripped and turned over. In some of these areas, the cemented laterite was left *in situ* and a surface sample was collected from the laterite in order to validate that area of the site. Such areas are shown on Drawing 2 in Appendix A. Some laterite cobbles and boulders were also pushed to the surface during ripping and were generally graded to the site boundary for subsequent crushing then re-compaction into the finished site surface.

Mixing with the grader blade typically turned over soils to a depth of between about 0.3 m and 0.5 m. The extent of mixing was easily evident from the variation in soil colour in areas that had been worked, as the deeper soils (typically orange brown in colour) were brought to the surface, displacing the darker surface soils (typically dark brown to brown in colour).

A selection of site photographs, showing topsoil stripping, vertical mixing operations and general conditions encountered during the site inspections are presented in Appendix B.

Drawing 1 and 2 in Appendix A, show the site layout and sample locations (HSR, ASB and VM samples).

5.2 Laboratory Analysis

Each sample collected during field work was sent for analysis at Envirolab Group (Envirolab), which is accredited by the National Association of Testing Authorities (NATA) for the tests performed.

The analytical testing was selected to target contaminants of potential concern (CoPC) as identified from the PSI and DSI, and it comprised the following:

- a total of twenty validation samples from the four hotspot excavations (HSR series), tested for OCPs;
- a total of eight samples from the four hotspot excavation stockpiles (HSR series, designated SP), tested for a broader analytical suite as follows:
 - o four of eight samples – EPA Publication IWRG 621 Table 3 Clean Fill Screen comprising metals / metalloids (arsenic, cadmium, chromium (VI), copper, lead, mercury, molybdenum, nickel, selenium, silver and zinc), total cyanide, total fluoride, speciated phenols (halogenated plus non-halogenated), benzene, toluene, ethyl benzene, total xylenes (BTEX), total recoverable hydrocarbons (TRH), polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB), chlorinated hydrocarbons (volatile plus semi-volatile);
 - o all eight samples – OCP/OPP; and
 - o four of eight samples – asbestos identification.
- a total of two validation samples from the septic system excavation (SS series), tested for OCPs, 8 metals (arsenic, cadmium, chromium (VI), copper, lead, mercury, nickel and zinc), and nitrogen-based contaminants;
- a total of three samples from the septic system excavation stockpile (SS series, designated SP), tested for a broader analytical suite as follows:
 - o one of three samples – EPA Publication IWRG 621 Table 3 Clean Fill Screen (see above);
 - o all three samples – OCP/OPP; and
 - o two of three samples – metals only of the EPA Publication IWRG 621 Table 3 Clean Fill Screen (see above).
- a total of nine validation samples from the asbestos-impacted soil excavation (ASB series), tested for asbestos identification;
- a total of three samples from the asbestos-impacted soil excavation (ASB series, designated SP), tested for a broader analytical suite as follows:
 - o one of three samples – EPA Publication IWRG 621 Table 3 Clean Fill Screen (see above);
 - o all three samples – OCP/OPP and asbestos identification.
- Eight of twelve surface validation samples recovered after completion of vertical mixing (VM series), tested for OCP/OPP;
- Eight of twelve samples recovered from the topsoil stockpiles after topsoil stripping (TSSP series), tested as follows:
 - o two samples – EPA Publication IWRG 621 Table 3 Clean Fill Screen (see above); and
 - o all eight samples – OCP/OPP.
- a total of four samples recovered from imported fill material (FILL series, designated SP), that was being used to backfill hotspot excavations, tested in accordance with the EPA Publication IWRG 621 Table 3 Clean Fill Screen (see above).

Nine field duplicate / replicate samples were collected and analysed for OCPs only (4 samples) or OCPs and OPPs (5 samples), for QC purposes.

No split replicates were collected for the MD Zone, as two split replicates were previously collected for the SD Zone and tested at the NATA accredited laboratory, ALS.

5.3 Laboratory Results

Detailed laboratory test reports are presented in Appendix C, along with a summary of the results, shown on Tables C1 and C2.

Results are discussed in the following sections for each stage of the remediation works.

5.3.1 OCP Hotspots

All samples recovered and tested from the walls and base of the hotspot excavations at TP26, TP27, TP28 and TP30 recorded contaminant concentrations below the LOR and, hence, below the adopted assessment and remediation criteria.

5.3.2 Asbestos and Septic-Impacted Soils

Asbestos was not detected in any of the validation samples recovered from the excavation for the asbestos-impacted soils at TP28. Therefore, the validation samples are below the adopted assessment and remediation criteria.

For the purpose of validating the septic system excavation, two samples were collected across the excavated faces and tested for OCPs, OPPs, metals and nitrogen species. The OCP and OPP concentrations recorded were below the LOR of 0.01mg/kg. Metals were recorded in both samples but at low concentrations that were below the concentrations adopted as assessment and remediation criteria. Nitrogen species were also recorded, but each concentration was also low and below the concentrations adopted as assessment and remediation criteria.

5.3.3 Vertical Mixing Validation Testing

Similarly to the SD Zone, adoption of relatively conservative parameters (*ie* dieldrin concentration of 10 mg/kg and a maximum depth of contamination of 0.3 m) a required vertical mix depth of about 0.5 m can be estimated using the methods in Section 5.2.3 of the RAP. This mix depth could be taken as the 'maximum' required mix depth because the adopted dieldrin concentration of 10 mg/kg is above the average concentration recorded in the DSI in the MD Zone, after removal of hotspots, and the maximum depth of contamination in the MD Zone is generally 0.3 m or less. It is noted that at TP31, a dieldrin concentration of 1.62 mg/kg was recorded at 0.5 m depth but this was not typical outside of the hotspot locations.

The actual mix depths observed on site during remediation works for the MD Zone were typically about 0.3 m to 0.5 m, which is considered adequate for the concentrations of dieldrin encountered and the depth of contamination measured at the site. The mix depths were estimated by measuring the depth of cut by the grader blade. As noted in Section 5.1, in some areas heavily cemented laterite

soils at the surface prevented effective ripping and mixing, and in some of these areas, the cemented laterite was left *in situ* and a surface sample was collected to validate the area.

For the purpose of validating the mixing process twelve surface samples plus one replicate were collected across the MD Zone after mixing was complete. Of these, eight were tested for OCPs and OPPs. Of the samples tested, four recorded OCP and OPP concentrations below the LOR of 0.01mg/kg. The other four recorded dieldrin, only, at concentrations of between 0.01 mg/kg and 0.07 mg/kg. The OCP concentration for the replicate sample was below the LOR, which was the same result as its primary sample. Of all the validation samples that recorded dieldrin concentrations above the LOR, no concentrations were above the adopted assessment and remediation criteria of 6 mg/kg (HIL A) and 0.35 mg/kg (EIL).

5.3.4 Waste Categorisation

Approximately 160 m³ (based on in situ measurement, no bulking factor) of material was excavated from the combined hotspots at TP26, TP27, TP28 and TP30, moved and stockpiled temporarily near the centre of the SD Zone. This process mixed the excavated soils, which would have led to dilution of contaminants. Eight samples were recovered from the stockpiles (two from each stockpile) before they were moved to the SD Zone, and each sample was tested. All samples recorded contaminant concentrations either below the LOR or below the EPA IWRG 621 Guidelines for 'Fill Material'. Based on this, the material excavated from the hotspots could be considered as *Clean Fill Material* and there are no restrictions on where it can be disposed of, with the provision that it does not have any off-site impact on surface or groundwater.

Similarly, about 400 to 700 m³ of topsoil was stripped from the MD Zone and stockpiled separately near the northeast boundary of the SD Zone. Stripping was carried out using a grader and stockpiling was achieved with an excavator and side-tipping truck. During this process, the topsoil was turned, mixed and aerated. After it was stockpiled, twelve samples were recovered from the stockpiles and eight were tested. All of the samples tested recorded concentrations of dieldrin, between 0.03 mg/kg and 0.11 mg/kg, averaging 0.07 mg/kg. Low concentrations of chlordane (0.02 to 0.07 mg/kg), heptachlor (0.03 and 0.04 mg/kg) and chlorpyrifos (0.19 mg/kg) were also recorded in up to three of the samples tested, along with low concentrations of metals in the two samples subject to the EPA IWRG 621 suite of testing. Overall, contaminant concentrations in all samples tested were below the EPA IWRG 621 Guidelines, including the criterion of 1 mg/kg total of OCPs, for 'Fill Material'. Based on this, the stockpiled topsoil could be considered as *Clean Fill Material*, and there are no restrictions on where it can be disposed of, provided it does not have any off-site impact on surface or groundwater.

The results of testing indicated that the suspected asbestos-impacted soils excavated from and stockpile near TP28 were free of asbestos contamination. Even though, the material was disposed of off-site by a licensed contractor (see comments in Section 4.1.3).

Approximately 10 m³ (based on in situ measurement, no bulking factor) of material was excavated during removal of the septic system. It was stockpiled adjacent to the excavation and three samples were recovered from the stockpile for testing. All samples recorded contaminant concentrations either below the LOR or below the EPA IWRG 621 Guidelines for 'Fill Material'. Based on this, the material excavated from the hotspots could be considered as *Clean Fill Material* and there are no restrictions on where it can be disposed of, with the proviso that it does not have any off-site impact on surface or

groundwater. Once this material was confirmed as *Clean Fill*, it was moved and stockpiled temporarily near the centre of the SD Zone with the stockpiles of material excavated from the hotspots.

5.3.5 Imported Fill Material

Approximately 400 m³ of fill material was imported on to the site to backfill the hotspot excavations at TP01 and TP20 on the SD Zone (approximately 100 m³ including bulking factor), hotspot excavations at TP26, TP27, TP28 and TP30 on the MD Zone (approximately 300 m³ including bulking factor), as well as the septic system excavation.

The material was imported by Earthworks NT Pty Ltd from virgin ground at its approved Sunday Creek extractive lease EMPs 22804, 1331, 27676, 22804, 27786 and 1316 (refer to statement in Appendix B).

Four samples were recovered at random from the imported material and tested. All samples recorded contaminant concentrations either below the LOR or below the EPA IWRG 621 Guidelines for 'Fill Material'. The number of samples tested was only 40% of the 10 sample tests recommended in EPA IWRG 702. The reduced sampling is considered appropriate as the material was recovered from virgin ground.

Based on the above, it is considered that the imported material is suitable for use as backfill to hotspot excavations.

5.4 Quality Assurance and Quality Control (QA/QC)

A detailed discussion of the QA/QC information and data is presented in Appendix D.

Overall the accuracy and precision of the soil testing procedures, as inferred by the QA/QC data, is considered by DP to be of sufficient standard to enable the data, as reported by the NATA accredited laboratory, Envirolab, to be used by DP for interpretation of site contamination conditions.

6. Conclusions and Recommendations

6.1 OCP Hotspots

Based on the results of this remediation and validation work, it is considered that the hotspots previously located at TP26, TP27, TP28 and TP30 have been effectively remediated and validated, and the soil excavated from the hotspots can be categorised as *Clean Fill Material* in accordance with IWRG 621.

Given that high dieldrin concentrations were previously reported at the hotspot locations, it is recommended that the excavated soil be taken off-site. However, based on the most recent results, it can be treated as *Clean Fill Material* in accordance with IWRG 621 and there are no restrictions on where it can be disposed of, with the provision that it does not have any off-site impact on surface or groundwater.

It is noted that the previously high dieldrin concentrations recorded at the hotspots were probably confined to the near surface soils (upper 0.5 m) and during excavation and stockpiling the concentration has most likely been diluted by mixing.

The material excavated from the hotspots has been approved for use as landfill capping material at the Shoal Bay Waste Disposal Facility (SBWDF), by the City of Darwin (operators of the facility). However, at the time of reporting the material was still awaiting disposal.

The hotspot excavations at TP26, TP27, TP28 and TP30 were backfilled and compacted with imported soil that met the requirements of IWRG 621 Fill Material (refer to Section 5.3.5). The backfill was compacted in layers but at the time of reporting no density testing had been carried out in the filling. Density testing will be required if the backfill is to meet engineered fill requirements.

6.2 Asbestos and Septic-Impacted Soil

Based on the results of this remediation and validation work, it is considered that the asbestos-impacted soils previously located at TP28 have been effectively remediated and validated. The soil excavated from this area has been removed from site by a licensed contractor, even though testing indicated asbestos containing material was not present in the soil. The asbestos fragments and associated soils, identified on site near the septic system during remediation works have also been removed from site by a licensed contractor. Therefore, it can be considered that the site is free of asbestos contamination.

Based on the results of this remediation and validation work, it is considered that the septic system excavation located near TP28 has been validated, and the soil excavated from the system can be categorised as *Clean Fill Material* in accordance with IWRG 621. Given that the material was excavated from an area where a septic system existed, it is recommended that the excavated soil be taken off-site. However, based on the most recent results, it can be treated as *Clean Fill Material* in accordance with IWRG 621 and there are no restrictions on where it can be disposed of, with the provision that it does not have any off-site impact on surface or groundwater.

The septic system excavation was backfilled and compacted with imported soil that met the requirements of IWRG 621 Fill Material (refer to Section 5.3.5). The backfill was compacted in layers but at the time of reporting no density testing had been carried out in the filling. Density testing will be required if the backfill is to meet engineered fill requirements.

6.3 Vertical Mixing and Topsoil

Based on the results of this assessment, it is considered that the upper soils of the MD Zone have been effectively remediated and validated, and topsoil stripped from the MD Zone can be categorised as *Clean Fill Material* in accordance with IWRG 621.

Dieldrin concentrations up to about 5 mg/kg were previously reported in the near surface soils of the MD Zone, excluding hotspot locations, so it is recommended that the stockpiled topsoil be taken off-site. However, based on the most recent results, it can be treated as *Clean Fill Material* in accordance with IWRG 621 and there are no restrictions on where it can be disposed of, with the proviso that it does not have any off-site impact on surface or groundwater.

As also discussed in Section 6.1, it is noted that the dieldrin concentrations recorded previously have probably been diluted by significant mixing of the topsoil during stripping and stockpiling.

It should also be noted that during the DSI, twelve locations were sampled and tested in the MD Zone. Of these, nine recorded dieldrin contamination and five were above the HIL. Four of these were considered hotspots and have since been removed. Therefore, prior to topsoil removal, there remained only one location in the MD Zone with recorded contamination above the HIL. Hence, it could be considered that at the time of commencement of topsoil stripping, dieldrin contamination was not widespread across the MD Zone.

As noted previously, vertical mixing was not possible in two areas of the MD Zone where a ground slab (previous cool room) and a water tank, and a shed exist. It is considered that these areas be validated after removal of the structures by surface sampling.

At the time of reporting, the topsoil that was stripped from the MD Zone is stockpiled near the northeast site boundary in the SD Zone, as detailed in the preceding sections. It is stockpiled there while a suitable disposal location is sought.

6.4 Capping Layer

The last stage of the RAP for the MD Zone involves placement of the capping layer. It is understood that this capping layer will be placed during bulk earthworks at the site. The bulk earthworks are considered 'site works' rather than 'remediation works' and with the current development approval it is understood that site works can't commence until remediation works are complete to the satisfaction of the NT EPA.

Given the results of this assessment, and the absence of significant contaminant concentrations across the MD Zone, as shown by the validation test results, it is the opinion of DP that soil conditions at the site are suitable for the proposed use (medium density residential).

It is however noted that DP must be on site periodically during placement of the capping layer to witness site activities, so that validation of the final stage of remediation can be confirmed.

All imported fill material proposed for use as the capping layer must also be assessed by DP (sampled and tested) to confirm its suitability. It is noted that at this stage of reporting, the source of fill material was unknown but it is expected to possibly comprise virgin ground from the Earthworks NT Pty Ltd Sunday Creek extractive lease (see statement in Appendix B).

7. References

1. Douglas Partners Pty Ltd, April 2015, "Report on Preliminary Environmental Site Investigation, Revision 1, Lot 3 Freds Pass Road, Humpty Doo, NT (DP Ref: 78156.00, Rev 1).
2. Douglas Partners Pty Ltd, December 2015, "Report on Detailed Site Investigation, Lot 3 Fred Pass Road, Humpty Doo, NT (DP Ref: 78156.01.R.001.Rev2).
3. Douglas Partners Pty Ltd, May 2016, "Report on Remediation Action Plan, Proposed Residential Subdivision, Lot 3 Freds Pass Road, Humpty Doo (DP Ref: 78156.01.R.003.Rev0).

4. Dutch Soil Remediation Circular 2009.
5. Environment Protection Authority of Victoria (EPA), June 2009, "Soil Hazard Categorisation and Management" Publication IWRG621.
6. Environment Protection Authority of Victoria (EPA), June 2009 "Sampling and Analysis of Waters, Wastewaters, Soils and Wastes" Publication IWRG701.
7. Environment Protection Authority of Victoria (EPA), June 2009 "Soil Sampling" Publication IWRG702;
8. National Environment Protection Council (2013): "National Environmental Protection (*Assessment of Site Contamination*) Measure" (as amended 2013) [NEPM].
9. Standards Australia, 2005: "Guide to the investigation and sampling of sites with potentially contaminated soil, Part 1: Non-volatile and semi-volatile compounds", AS 4482.1-2005.
10. Western Australia (WA) Department of Health (DOH) Guidelines for the Assessment, Remediation and Management of Asbestos-Contaminated Sites in Western Australia – May 2009
11. Douglas Partners Pty Ltd: "Field Procedures Manual" and "Project Management Manual", which form part of the Company Quality System (accredited to AS/NZS ISO 9001:2000).
12. New South Wales Environment Protection Authority (NSW EPA), 2003 'Guidelines for the Vertical Mixing of Soil on Former Broad-Acre Agricultural Land'.

8. Limitations

Douglas Partners Pty Ltd (DP) has prepared this report for the MD Zone of the proposed residential subdivision at Lot 3 Freds Pass Road, Humpty Doo, in accordance with DP's proposal DWN160153, dated 23 August 2016, and the services order dated 30 August 2016 from Mr Peter Poniris. The work was carried out under DP's Conditions of Engagement. This report is provided exclusively for use on this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and / or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and / or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

Douglas Partners Pty Ltd

Appendix A

Notes About this Report

Drawing 1 – Test Pit and HSR Locations – MD Zone

Drawing 2 – VM Sampling Location – MD Zone

Remediation Action Plan

About this Report

Douglas Partners



Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

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This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;

- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

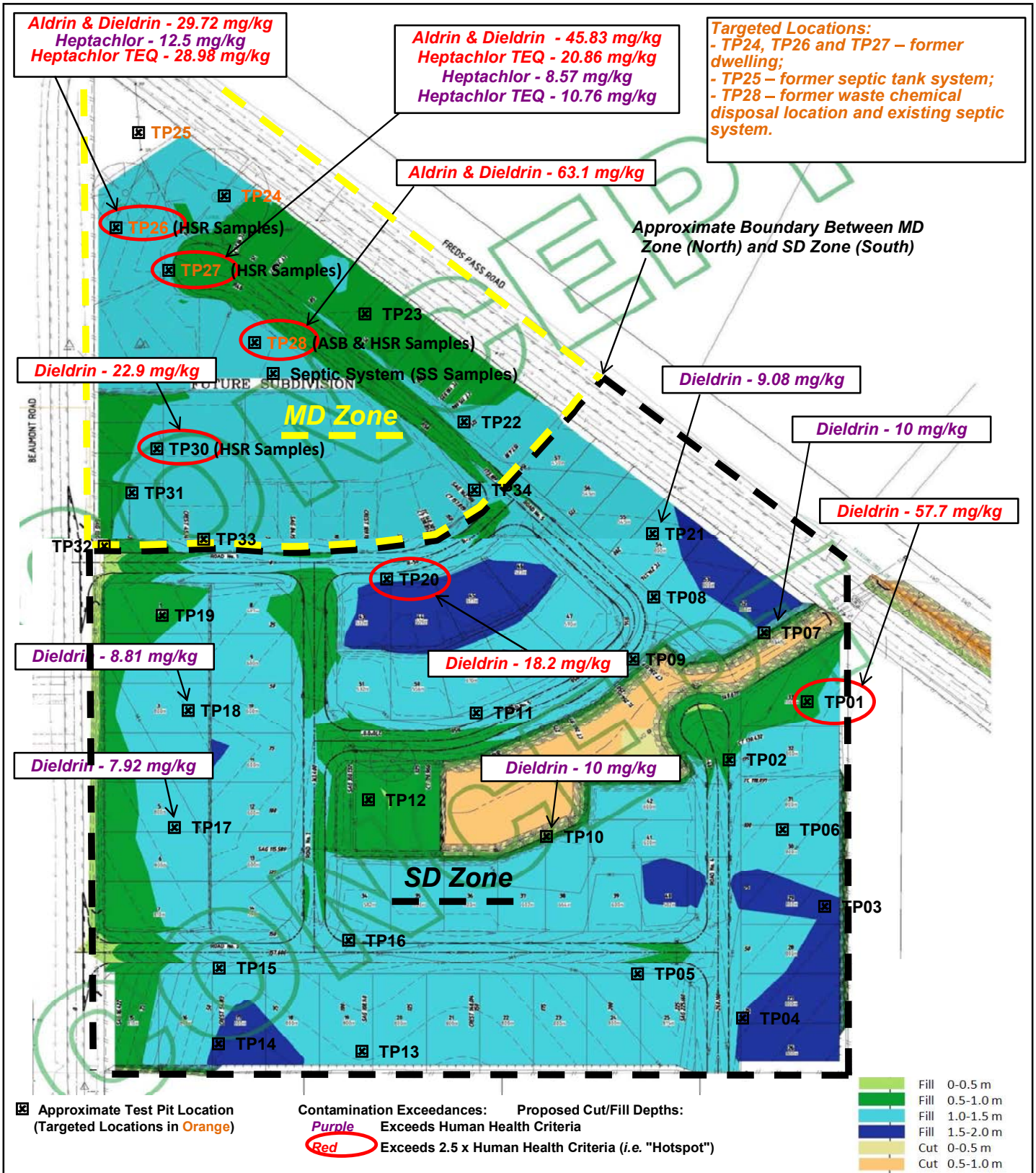
In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes


Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

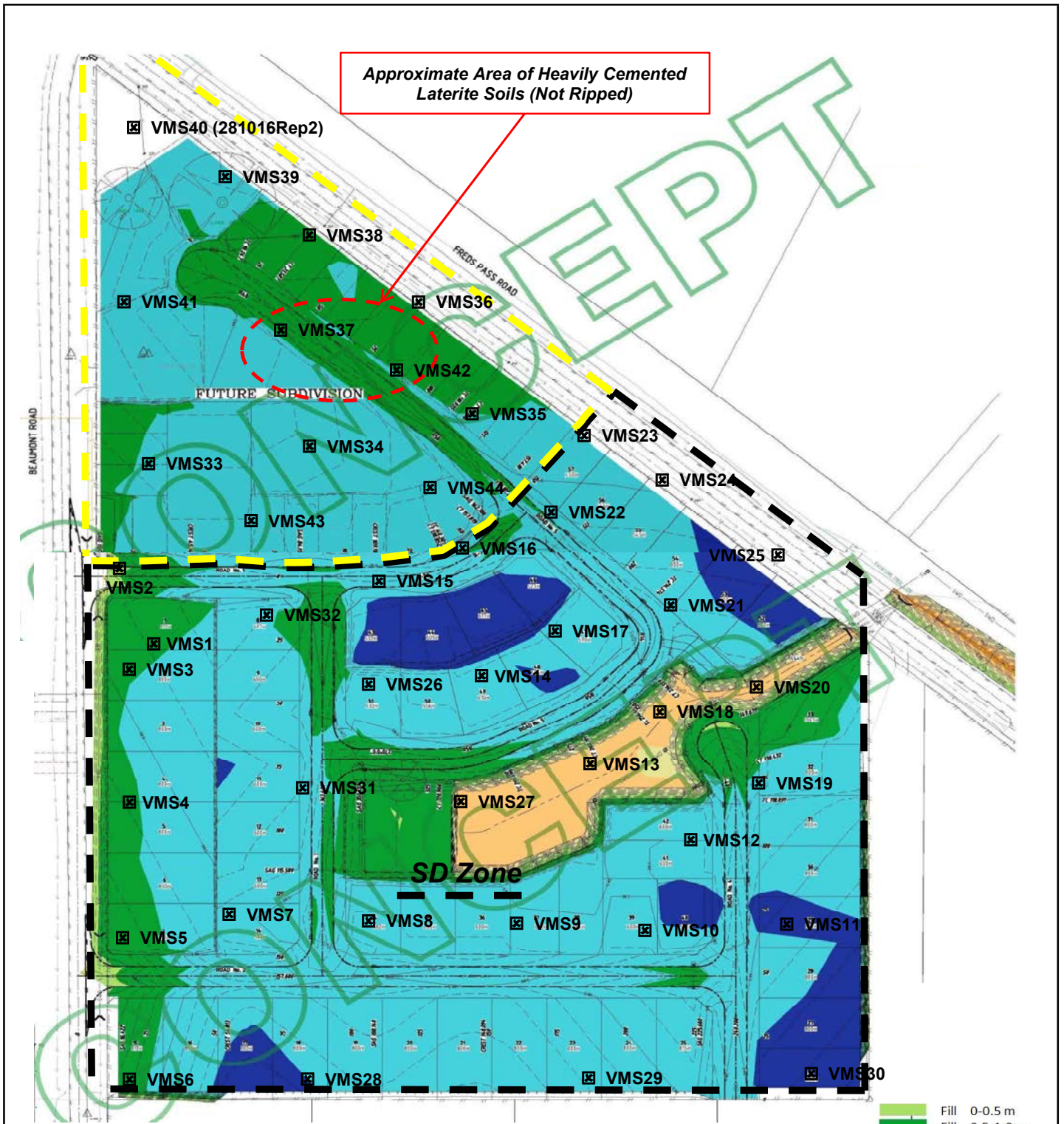
Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.



Drawing adapted from BMD Consulting Drawings B00153-CE001 and B00153-CE002 (Not to Scale)


 <p>Douglas Partners Geotechnics Environment Groundwater</p>	<p>Test Pit and HSR Sampling Locations - MD Zone Proposed Residential Subdivision Lot 3 Freds Pass Road Humpty Doo, Northern Territory</p>	<p>Project: 78156.02</p>
	<p>CLIENT: Mr Peter Poniris</p>	<p>DRAWING: 1</p>
	<p>DATE: 7-Nov-16</p>	<p>REV: 0</p>
	<p>DATE: 7-Nov-16</p>	<p>REV: 0</p>



☒ Approximate Sampling Location

- Fill 0-0.5 m
- Fill 0.5-1.0 m
- Fill 1.0-1.5 m
- Fill 1.5-2.0 m
- Cut 0-0.5 m
- Cut 0.5-1.0 m

Drawing adapted from BMD Consulting Drawings B00153-CE001 and B00153-CE002 (Not to Scale)

 <p>Douglas Partners Geotechnics Environment Groundwater</p>	<p>VM Sampling Locations - MD Zone</p> <p>Proposed Residential Subdivision</p> <p>Lot 3 Freds Pass Road</p> <p>Humpty Doo, Northern Territory</p>	<p>Project 78156.02</p>
	<p>CLIENT: Mr Peter Poniris</p>	<p>DRAWING: 2</p>
	<p>DATE: 7-Nov-16</p>	<p>REV: 0</p>
	<p>DATE: 7-Nov-16</p>	<p>DATE: 7-Nov-16</p>



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Geotechnics | Environment | Groundwater

Report on
Remediation Action Plan

Proposed Residential Subdivision
Lot 3 Freds Pass Road, Humpty Doo

Prepared for
Tolinchlo Pty Ltd

Project : 78156.01
R.003.Rev1
16 May 2016



Douglas Partners

Geotechnics | Environment | Groundwater

Document History

Document details

Project No.	78156.01	Document No.	R.003.Rev1
Document title	Report on Remediation Action Plan		
Site address	Proposed Residential Subdivision Lot 3 Freds Pass Road, Humpty Doo		
Report prepared for	Tolinchlo Pty Ltd		


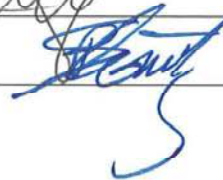
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The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

	Signature	Date
Author		16 May 2016
Reviewer		16 May 2016



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Appendix A: Drawings

Report on Remediation Action Plan

Proposed Residential Subdivision

Lot 3 Freds Pass Road, Humpty Doo

1. Introduction

This Remediation Action Plan (RAP) details the soil contamination management to be undertaken at a site located at Lot 3 Freds Pass Road, Humpty Doo ("the site"). The site is subject to an Environmental Audit, being conducted by Mr John Throssell of GHD Pty Ltd ("GHD") who is an Environmental Auditor appointed pursuant to section 53S of the *Environment Protection Act 1970* (Vic). The Audit is required in order to demonstrate that the site is suitable for the proposed residential (medium- and low-density) development, and is a requirement of the Northern Territory Development Consent Authority (DCA).

Douglas Partners Pty Ltd (DP) was engaged to undertake preliminary and detailed site investigation works as part of the assessment phase of the Audit. At the conclusion of the detailed site investigation (DSI), residual contamination remains in shallow site soils across the site, and requires remediation.

Proposed remediation strategies were detailed in DP's letter to the Auditor dated 8 December 2015. It is understood that the Auditor generally accepted the strategies that were presented.

2. Objective

The objective of the proposed remediation is to remediate the site in an acceptable manner, with minimal environmental and human health effects, to a condition suitable for the proposed development.

3. Site Description and Contamination Status

3.1 Site Identification

The irregular shaped site covers an approximate area of 81,100 m² (8.11 ha). As of December 2015, the site was vacant, with the exception of the following structures located in the north western corner of the site:

- Above ground water tank;
- Underground septic system;
- Double garage; and
- Concrete slab, shipping containers and demountable.

These features are shown on Drawing 1, Appendix A.

3.2 Proposed Development

At this stage, the development plans have not been finalised, but it is likely that the site will be divided into two zones; these being a single dwelling (SD) zone and a multiple dwelling (MD) zone. A site plan, showing the proposed subdivision is presented as Drawing 2, Appendix A.

The SD zone covers an area of approximately 61,100 m² (6.11 ha) on the southern portion of the site. It is understood the proposed development will comprise subdivision into about 57 lots with access roads and a retention basin of 6,057 m². Across most of the zone, the surface level will be raised by between 0.5 m and 1.5 m by the placement of imported filling. However, in the retention basin area, the surface level will be reduced by excavation up to 1.0 m depth. It should be noted that the exact location of the retention basin has not yet been determined.

The MD zone covers an area of approximately 20,000 m² (2 ha). It is understood that the proposed development will comprise subdivision into about 47 lots. Across most of the zone, the surface level will be raised by up to 1.5 m by the placement of imported filling.

3.3 Previous Contamination Investigations and Results

In preparing this Remedial Action Plan, DP reviewed the results of our earlier Environmental Site Investigations summarised in the following reports:

- Douglas Partners, *Report on Preliminary Environmental Site Investigation, Lot 3 Freds Pass Road, Humpty Doo, NT – Revision 1.*, (Ref no: 79156.01), dated 16 April 2015,
- Douglas Partners, *Report on Detailed Site Investigation, Lot 3 Freds Pass Road, Humpty Doo, NT.*, (DP Ref: 78156.01.R.001.Rev2), dated 8 December 2016,

The results of the site history review as presented in the preliminary site investigation (PSI) report indicated the site has been a mango, banana and tomato orchard, anecdotally dating back to the 1960s. The site was previously occupied by a dwelling and a cool room / shed in the north western corner which was used for site orchard activities (*ie* storage of goods, chemicals and treatment of harvests). Surface vegetation and some topsoil were stripped in preparation for the proposed earthworks and filling prior to subdivision of the land. At the time of the PSI, the site was generally vacant and remained stripped of vegetation.

The PSI identified a number of potential sources of contamination within the site. The potential for contamination arising from previous site activities was considered to be low to moderate. The primary contaminating activities identified at the site are considered to be associated with the former orchard activities.

These primarily include the historic application of pesticides and herbicides used during the planting of mango trees and the disposal of dilute pesticides and fungicides in the north-western part of the site (MD Zone) following the application to harvested fruit. The use of these latter chemicals is understood to have been limited to the six week harvest periods and used at generally weekly frequency. Application and disposal of these chemicals was for a period of about ten years (*i.e.* not used the whole period of orchard operation).

The identified contaminants of concern comprised: pesticides, herbicides and insecticides associated with orchard activities; petroleum hydrocarbons which were the likely herbicides and pesticides solvent; and asbestos due to the demolition of a former on-site dwelling. The potential for asbestos impact at the site was generally considered to be low based on the licensed removal of asbestos prior to demolition of the dwelling.

The intrusive investigation as part of the detailed site investigation (DSI) comprised excavation of test pits and laboratory testing of soils within the proposed SD and MD Zones, as well as 'background' sampling off-site to assist with development of ecological criteria. The subsurface investigation was generally undertaken on a grid-based arrangement. Additional targeted test pits for the MD Zone were located in the vicinity of previous structures and dilute waste chemical application (*ie* north-western part of the site). In summary:

- 21 test pits (TP01 to TP21) were excavated for SD Zone (6.1 ha);
- 12 test pits (TP22 to TP28, TP30 to TP34) were excavated for MD Zone (2 ha), including five targeted test pits;
- One test pit (TP29) and two surface samples (S1 and S2) were excavated off-site for the assessment of background conditions.

Test locations are shown on Drawing 3, Appendix A.

While organochlorine pesticide (OCP) contaminant concentrations were identified exceeding the health investigation levels for residential land use, it is considered that removal of individual hot spots may be impracticable due to the dispersed nature within the site. It is considered that importation of filling to raise site levels for the proposed development may suitably reduce the risk of contaminant exposure. The importation of filling in the order of 1.5 m may suitably "cap" the site. However, DP acknowledges that surface levels would be reduced (excavated) by up to 1.0 m in the area of the proposed retention area.

Asbestos fibres were identified in surface soils from TP28, located in the north-western part of the site and vicinity of former site structures (MD Zone). Given that an asbestos clearance certificate exists for the removal of the site dwelling, and the absence of asbestos in the other eleven soil samples tested in MD zone, it is considered that the impact is likely to be localised and due to surficial impact from the demolition of the former site dwelling.

Recommendations in DP's DSI report included recommended remediation and validation is undertaken in accordance with this RAP to address soil impacted by OCPs over most of the site, and asbestos around the location of TP28.

4. Assessment and Remediation Criteria

With consideration of the proposed low density residential development, analytical results will be assessed against investigation levels outlined in Schedule B1 of the *National Environment Protection (Assessment of Site Contamination) Measure 1999* (amended 2013) ['NEPM']. The Schedule provides investigation and screening levels for commonly encountered contaminants which are applicable to generic land uses. The results of validation following soil remediation will be assessed against investigation levels for OCPs only.

4.1 Health Investigation Levels

Health Investigation Levels (HILs) are scientifically based, generic assessment criteria designed to be used in the first stage of an assessment of potential risks to human health from chronic exposure to contaminants. They are intentionally conservative and are based on a reasonable worst-case scenario for four generic land use scenarios. DP has compared soil data to HIL criteria for sensitive and land uses and given the proposed residential subdivision, HIL A criteria, applicable for residential land use with garden/accessible soil, is considered most relevant for the purpose of investigation at this time.

4.2 Ecologically-based Investigation Levels

The applicability of ecological investigation levels (EILs) was considered in preparing this RAP, and the practical implications of exceedances of those criteria were deemed to outweigh the possible associated risks. This was based on the fact that the remediation strategy includes capping of the site following vertical soil mixing, and the capping material shall meet the acceptance criteria. This means that current soil levels will be a minimum of 0.5 m (and up to 1.5 m) below the final site surface. However, ecologically-based criteria are included for OCP's in Table 1.

4.3 Adopted Criteria

The adopted HILs and EILs are presented in Table 1. These values have also been adopted as remediation objectives for the purposes of this Remediation Action Plan.

Where contaminant concentrations in validation samples exceed the listed EIL values, consideration will be given to the thickness of the capping layer to be applied at that location. If the capping layer is proposed more than 0.5 m, and the HIL value is not exceeded, no further soil will be excavated at that location. If the capping layer thickness is not greater than 0.5 m, or the HIL value is exceeded, further excavation will occur.

If contaminant concentrations in validation samples exceed the listed HIL values, further soil will be excavated at such locations, until contaminant concentrations are less than the HIL value.

Table 1: Health and Ecological Investigation Levels (HILs)

Contaminants		Residential Land Use HIL-A (mg/kg)	Ecological Investigation Level (mg/kg)
OCP/ OPP	Aldrin + Dieldrin	6	0.35
	Chlordane	50	4
	DDT+DDE+DDD	240	-
	DDT	-	1.7
	DDD	-	2.3
	DDE	-	34
	Endosulfan	270	-
	Endrin	10	-
	Heptachlor TEQ*	6	4
	HCB	10	-
	Methoxychlor	300	-
	Chlorpyrifos	160	-
Metals	Arsenic	100	
	Cadmium	20	
	Chromium	12%	
	Copper	6,000	
	Lead	300	
	Mercury	40	
	Nickel	400	
	Zinc	7,400	
Nitrogen species**	Nitrate	130,000	
	Nitrite	7,800	
	Ammonia	NC	
	TKN	NC	

Notes:

*Heptachlor TEQ is the sum of twice the heptachlor epoxide concentration and the heptachlor concentration.

** US EPA (2015) Regional Screening Levels

4.4 Waste Soil Categorisation Criteria (for Off-site Disposal)

If soil is to be removed from a site it should be classified as waste material in accordance with the current EPA Victoria guidelines outlined in Publication IWRG621, *Soil Hazard Categorisation and Management* (which superseded Publication 448.3 *Classification of Wastes* in 2009), which presents the current industry categorisation criteria used to assess soil prior to off-site disposal. Under these guidelines (which NT EPA currently adopts), soil can be classified into one of four categories based on its relative hazard. From least to most contaminated, the categories are:

- Fill Material (not contaminated);
- Category C Contaminated Soil (least contaminated);
- Category B Contaminated Soil; and
- Category A Contaminated Soil (most contaminated).

To fall into any one of the categories, the total contaminant concentration and leachable concentration level must be below that specified in Table 2 of IWRG621.

4.5 Asbestos

Asbestos identification will be undertaken on selected validation samples using an initial quantitative screening analysis only. The remediation and validation of asbestos in soil would be conducted in general accordance with the Western Australia (WA) Department of Health (DOH) *Guidelines for the Assessment, Remediation and Management of Asbestos-Contaminated Sites in Western Australia – May 2009*

5. Remediation Strategy

5.1 Asbestos and Septic System

Asbestos fibres identified in test pit TP28 during the DSI require remediation so as to minimise the potential exposure for future site users. It is understood that the existing septic system is to be removed during the MD development stage and would be subject inspection and validation. DP considers that the asbestos-impacted soil at the surface near TP28 could be stripped, removed and validated in conjunction with the septic system excavation.

DP proposes to excavate down to 0.3 m over a 5 m by 5 m area in the vicinity of TP28 to remove asbestos-impacted soil. The excavated soil is to be stockpiled, and managed in accordance with Section 6.2.1. Validation samples will be collected from the base and mid-section of the walls of the excavation (*ie* five samples in total) and tested for the presence or absence of asbestos. Additional soil samples will be collected from the surface 1.0 m beyond the extents of the 5 m by 5 m excavation and tested for asbestos. A tyvek suit (with booties) and P1 dust mask must be worn when collecting samples intended for asbestos analysis.

Three samples will be collected from the stockpile created by asbestos removal works, and analysed for the following:

- One sample for an EPA Publication IWRG 621 Table 2 Clean Fill Screen comprising metals / metalloids (As, Cd, Cu, Pb, Hg, Mo, Ni, Sn, Se, Ag, Zn), total Cr(VI), total cyanide, total fluoride, speciated phenols (halogenated plus non-halogenated), benzene, toluene, ethyl benzene, total xylenes (BTEX), total recoverable hydrocarbons (TRH), polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB) chlorinated hydrocarbons (volatile plus semi-volatile) and OCPs/OPPs; plus asbestos, and;
- Two samples for OCPs/OPPs and asbestos.

Following the removal of the septic system and associated fixtures, DP proposes to validate the excavation in the same manner as described above. The validation samples, collected at a ratio of one sample per 25 m² of excavation surface will be analysed for metals (As, Cd, Cr, Cu, Pb, Hg, Ni and Zn), OCP's, NOx, ammonia and TKN. The resultant stockpile will be managed in accordance with Section 6.2.1 and samples collected in accordance with EPA Publication IWRG 702 *Soil Sampling*, June 2009 and tested for analysed for the following:

- One sample for an EPA Publication IWRG 621 Table 2 Clean Fill Screen comprising metals / metalloids (As, Cd, Cu, Pb, Hg, Mo, Ni, Sn, Se, Ag, Zn), total Cr(VI), total cyanide, total fluoride, speciated phenols (halogenated plus non-halogenated), benzene, toluene, ethyl benzene, total xylenes (BTEX), total recoverable hydrocarbons (TRH), polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB) chlorinated hydrocarbons (volatile plus semi-volatile) and OCPs/OPPs; and
- Up to nine samples for metals (as per EPA Screen), and OCPs/OPPs.

Following successful validation, reinstatement of any excavations would be undertaken using material which meets the requirements for *Clean Fill Material* as defined by EPA Victoria.

5.2 OCP-Impacted Soil

DP evaluated a number of different remediation and management strategies, as outlined in correspondence dated 8 December 2015 (DP Ref: 78156.01.C.001.Rev0) and recommended on-site management of contaminated soils through: (i) removal of OCP "hot spots" and (ii) vertical mixing of remaining site soils. The latter approach has been shown to be a practical and effective means of reducing the levels of contaminants in soil as documented in NSW EPA (2003) *"Guidelines for the Vertical Mixing of Soil on Former Broad-Acre Agricultural Land"*. This approach has been successfully applied in New South Wales and New Zealand on former broad-acre agricultural land sites proposed for residential development as referenced in NSW EPA (2005) and Auckland Regional Council (2002) *"Remediation of Horticultural Broad-Acre Land Using Vertical Soil Mixing"*.

5.2.1 Vertical Delineation

Prior to the application of vertical mixing, the vertical extent of OCP-impact needs to be verified. DP acknowledges this has not been achieved at some test pit locations (TP01, TP10, TP17, TP18 and TP20 within the SD zone, and TP27 within the MD zone), where concentrations of OCPs exceeded the assessment criteria. The locations would be replicated using the recorded GPS coordinates recorded during the DSI, however, the replicate test pit would not be advanced through the previously backfilled test pit, rather as close as practicable.

The replicate location would be advanced to a maximum depth of 1.0 m using an excavator. Samples would be collected from the same depth where detectable OCPs were recorded and each half metre thereafter until termination depth. Selected samples will be analysed for OCPs and OPPs.

DP understands that preliminary discussions with Northern Territory EPA in December 2015 indicated that no specific remediation options are generally opposed and that their position is guided by the Auditor's recommendations.

5.2.2 Hot Spot Removal

Results of the DSI indicated that OCP concentrations at six locations (TP01, TP20, TP26, TP27 and TP30) were reported at greater than 2.5 times the HIL and are considered contamination "hotspots". DP acknowledges that OCP concentrations at TP28 also fall into this category but this area will be remediated as part of the asbestos and septic tank removal and validation works detailed in Section 5.1.

DP proposes to excavate down to approximately 0.4 m to 0.5 m below the depth of impact as defined by vertical delineation works in the vicinity of hot spot test pits. The locations would be determined using a hand-held GPS in the field. The excavated soil is to be managed in accordance with Section 6.2.1. Validation samples will be collected from the base and mid-section of the walls of the excavation (*ie* five samples in total) and tested for OCPs.

Two samples will be collected from each stockpile generated and analysed for the following:

- One sample for an EPA Publication IWRG 621 Table 2 Clean Fill Screen comprising metals / metalloids (As, Cd, Cu, Pb, Hg, Mo, Ni, Sn, Se, Ag, Zn), total Cr(VI), total cyanide, total fluoride, speciated phenols (halogenated plus non-halogenated), benzene, toluene, ethyl benzene, total xylenes (BTEX), total recoverable hydrocarbons (TRH), polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB) chlorinated hydrocarbons (volatile plus semi-volatile) and OCPs/OPPs; plus asbestos, and;
- One sample for OCPs/OPPs only.

Following successful validation (when the samples from the hot spot excavation meet the remediation objectives), reinstatement of any excavations would be undertaken using material which meets EPA Victoria Clean Fill Material Guidelines.

5.2.3 Vertical Mixing

The process of vertical mixing as a remediation strategy is based on taking clean soils from depth and mixing with the shallow, impacted soils so as to reduce the overall contaminant concentrations (not mass) throughout the soil profile. Soil mixing can be achieved on broad-acre sites by using a deep rippers or rotary hoes pulled behind a tractor or bulldozer. Deeper reaches from the mixing apparatus and a greater number of passes by the ripper will achieve a greater degree of mixing.

The estimated vertical mixing depth will be calculated by applying the following formula from the NSW EPA (2005):

$$y = \frac{x(a - b)}{0.9 H - b}$$

where :

- y = estimated vertical mixing depth in mm
- x = depth of soil profile in mm in which concentration is 'a' mg/kg
- a = maximum concentration for the principal contaminant in mg/kg
- b = background concentration of the principal contaminant in mg/kg
- H = ANZECC/NHMRC Human Health Investigation Level for the principal contaminant in mg/kg

The value of 0.9 is a safety factor which takes into account inefficiencies in the mixing process.

The proposed depth of vertical mixing can only be estimated following the proposed further vertical delineation works, however, a depth of between 0.3 m and 0.5 m would be anticipated, after the removal of hot spots as described in section 5.2.2 above.

Based on the mixing trials in Australia and New Zealand on broad-acre, former agricultural land, DP proposes the following methodology:

1. Mark out a 30 m by 30 m grid across the entire site using stakes (or similar);
2. Complete two passes using a tractor fitted with a deep (approx. 0.5 m) ripper which is at least 5 m wide, ensuring that each alternative pass is off-set by 15 m;
3. Repeat Step 2, this time making the passes at cross angles (*ie* 90 degrees);
4. Repeat Steps 1 – 3, using a plough and deep hoeing techniques (possibly with a road stabilising machine) instead of a deep ripper.

Soil mixing should be undertaken in the dry season, so as to minimise the likelihood of rain events and subsequent surface runoff and potential off-site contamination.

Following the completion of six passes in each direction (north-south plus east-west) using the ripper and hoe, the final site surface validation will be conducted. DP proposes to sample surface soil at 35 grid-based locations across the site. The number of sampling points is consistent with the rationale adopted during the DSI (*ie* one-third of the recommended sampling points referenced in Table E1 of Australian Standard AS4482.1-2005 "*Guide to the investigation and sampling of sites with potentially contaminated soil, Part 1: Non-volatile and semi-volatile organic compounds*"). Soil samples collected will be analysed for OCPs/OPPs only.

The validation criteria to be met are:

- The 95% upper confidence limit of the mean (95% UCL_{mean}) concentrations for any contaminant is less than the HIL A value;
- No single value is greater than 2.5 times the HIL A value; and
- The standard deviation of the data set is less than half the HIL A value.

If validation is not successful, contingencies such as further/deeper mixing or stripping of shallow soil would be considered.

5.3 Site capping

The vertically mixed soils would be covered by imported filling, placed with reference to geotechnical considerations. Imported soil would be subject to inspection and/or testing as required and must meet EPA IWRG621 Clean Fill Material Guidelines before being brought on to site. Additional sourcing of soil, further to what DP has currently undertaken may be required, subject to finalisation of fill volumes. A preliminary earthworks plan is shown as Drawing 4, Appendix A.

6. Work Methods

6.1 Soil Sampling Methodology

Environmental sampling will be performed according to the standard operating procedures outlined in the DP *Field Procedures Manual*. The general sampling procedures will be as follows:

- i) Samples will be collected directly off the pit walls, an excavator bucket or surface using hand tools and disposable latex gloves (a new pair of gloves was used for each sample);
- ii) Labelling laboratory prepared glass jar sample containers with individual and unique identification including project number, sampling date and sample number;
- iii) Placing samples into prepared glass jars and then into a cooled, insulated and sealed container;
- iv) Decontaminating all sampling equipment using a 3% solution of phosphate-free detergent and then rinsing twice with de-ionised water prior to collection of each sample;
- v) Transportation of samples to the testing laboratory under chain of custody documentation.
- vi) Primary samples will be analysed by ALS Laboratory Group (ALS), a NATA accredited laboratory. All samples will be analysed within the holding times specified in AS 4482.1-2005.
- vii) Blind and split duplicate samples, rinse and trip blanks will be tested at the frequency outlined in Standards Australia AS 4482.1-2005. Envirolab Services, another NATA accredited laboratory will be used as the secondary laboratory for split duplicate samples.

6.2 Waste Categorisation and Spoil Management

Excavated spoil to be disposed off-site will be classified, managed and disposed in accordance with EPA Publications IWRG621 and IWRG702, which are the guidelines used to assess soil prior to offsite disposal, in the context of Victorian statutory requirement. All sampling will be undertaken with reference to IWRG701 *Sampling and Analysis of Waters, Wastewaters, Soils and Wastes*. Note that any soil remaining on-site within the development is not subject to the requirements of this section.

6.2.1 Stockpile Management

Whilst soil is stockpiled on-site awaiting final classification, the following procedures should be followed:

- Placement of potentially contaminated stockpiles (generated from the remediation) on an impermeable surface to prevent leaching. The surface should either comprise concrete/ asphalt or HDPE;
- Geotextile silt fences or hay bales should be erected around each stockpile to prevent losses from surface erosion;
- Stockpile heights should be restricted to less than 3 m above surrounding site levels and areas should be suitably bunded or baled to prevent material losses in the event of heavy rain; and
- If necessary to prevent dust generation, stockpiles should be lightly conditioned by sprinkler or covered by tack-coat, HDPE, geotextile or similar cover to prevent wind-blown dust.

6.2.2 Spoil Contingency Plan

Any materials which fail to meet the EPA Publication IWRG621 criteria for direct landfill disposal following initial classification testing, such as Category A Contaminated soils, will be required to be segregated and securely stockpiled pending further testing and treatment. The contingency plan to cater for the storage, treatment and disposal of excavated spoil which fails to meet landfill criteria is as follows:

- On the basis of on-site observations and the contaminant exceedances detected, materials will be carefully excavated, segregated and placed in well delineated locations;
- Stockpiles of excavated materials will be appropriately bunded with hay bales/ sandbags and if required covered and/ or lined with impermeable plastic sheeting;
- Sampling and analysis at a rate of 1 sample per 25 m³ (or a minimum of 3 samples) of segregated stockpiles will be conducted to determine the concentration of the target contaminant parameters in the excavated materials;
- Disposal arrangements will be determined based on sampling results as follows:
 - o material which meets the EPA Publication IWRG621 threshold criteria for disposal as Fill Material, Category C Contaminated Soil and Category B Contaminated Soil shall be disposed directly to landfill; and
 - o material which exceed the disposal guideline levels for Category B Contaminated Soils (*ie.* untreated Category A Contaminated Soil) shall remain segregated in stockpiles pending treatment/alternate disposal arrangements.

6.2.3 Loading and Transport of Contaminated Material

Transport of any material to and from the site shall be via a clearly delineated, pre-defined haul route to be implemented by the appointed contractor. It is intended to utilise the existing main gate and circular roads whilst maintaining the current access for tenants.

The loading, handling and disposal for spoil classified for off-site into one of four categories (Fill Material, Category C Contaminated Soil, Category B Contaminated Soil and Category A Contaminated Soil) is summarised below. Northern Territory requirements for handling soil for off-site disposal are provided in the following documents:

<http://www.ntepa.nt.gov.au/waste-pollution/guidelines/guidelines>

http://www.ntepa.nt.gov.au/_data/assets/pdf_file/0005/136472/completing_waste_transport_certificates.pdf

i) Fill Material

The industry refers to Fill Material as 'clean fill'. EPA has no restriction on where Fill Material may be disposed although councils may have other requirements. The disposal of Fill Material must not result in any off-site impact on surface or groundwaters. Fill material may contain contaminants above background levels and may not be suitable for all uses.

ii) Category C Contaminated Soil

Category C contaminated soil can only be disposed off-site to select landfills licensed by EPA to accept such material. Vehicles transporting Category C contaminated soil must have a current EPA Waste Transport Permit and an EPA Waste Transport Certificate must be completed for soil tracking purposes. All loads must be covered to prevent wind-blown loss and Leaks or spills of contaminated material to the environment must be prevented.

iii) Category B Contaminated Soil

Category B contaminated soil can only be disposed off-site to select landfills licensed by EPA. Vehicles transporting Category B contaminated soil must also have a current EPA Waste Transport Permit and a waste transport certificate for soil tracking purposes. All loads must be covered to prevent wind-blown loss and leaks or spills of contaminated material to the environment must be prevented.

iv) Category A Contaminated Soil

Category A contaminated soil cannot be disposed off-site to landfill without prior treatment. Commonly these soils are transported to a licensed facility for treatment.

Details of all contaminated and spoil materials removed from the site (including Fill Material) shall be documented by the contractor with copies of disposal docketts (where appropriate) provided to Douglas Partners.

6.3 Unexpected Finds Protocols

6.3.1 Unexpected Finds Protocol – Further Contamination

In the event that further areas of environmental concern (AEC), such as areas of deeper contaminated soil or an unexpected underground fuel storage tank, are encountered during the site work, the area of concern should be managed as follows:

- (i) Upon discovery of the AEC, the client's representative is to be notified and the area barricaded and physically demarcated;
- (ii) Visual identification of the nature of the issue and the likely extent of the AEC by a qualified Environmental Consultant;
- (iii) Conduct appropriate testing by the environmental consultant with a view to verify the nature and extent of the contamination;
- (iv) If contamination is found and remediation action considered necessary, an addendum to the RAP should be prepared by the Environmental Consultant.

6.3.2 Unexpected Finds Protocol – Asbestos

In the unexpected event that more than a few scattered pieces of asbestos are noted prior to, or during excavation works, the following procedure is recommended in accordance with the Northern Territory Work Health and Safety (National Uniform Legislation) Regulations (2012).

- (i) Upon discovery of suspected asbestos containing material, the client's representative is to be notified and the affected area closed off by the use of barrier tape and warning signs. Warning signs shall be specific to Asbestos Hazards and shall comply with the Australian Standard 1319-1994 – Safety Signs for the Occupational Environment;
- (ii) An Occupational Hygienist is to be notified to inspect the area and confirm the presence of asbestos and determine the extent of remediation works to be undertaken. A report detailing this information will be compiled by the Occupational Hygienist and provided to the client's representative;
- (iii) The impacted soil will be classified and disposed of, as a minimum, as Category C Contaminated Waste (asbestos contaminated) at an appropriately licensed facility. In dry and windy conditions the stockpile will be lightly wetted and covered with plastic sheet whilst awaiting disposal;
- (iv) All work associated with asbestos in soil will be undertaken by a contractor holding a class A License. Northern Territory WorkSafe must be notified in advance of any asbestos works;
- (v) Monitoring for airborne asbestos fibres should be undertaken in accordance with the requirements of the OH&S Act as required;
- (vi) Documentary evidence (disposal dockets) of correct disposal is to be provided to the builder's representative;
- (vii) At the completion of the excavation, a clearance inspection is to be carried out and written certification is to be provided by an environmental consultant or occupational hygienist that the area is free of observable asbestos;

- (viii) Details are to be recorded in the site record system; and
- (ix) Following validation clearance, the area may be reopened for further works.

6.4 Validation Reporting

A remediation and validation report will be prepared following completion of the works to present the findings of the remediation works undertaken and discuss results in the context of the protected beneficial uses. The validation report will also include a summary of the information from previous investigations, particularly the materials that remain on site, the assessment of risk from any residual contamination and the corresponding Environmental Management Plan (EMP) that may be required for the site.

The validation report will include details of the total volume of contaminated materials removed from site, present detailed analytical results where applicable, confirm that placed fill is clean and indicate the final disposal destination of the materials removed from site.

7. Remediation Environmental Management Plan

The proposed remediation works shall be undertaken with all due regard to the minimisation of environmental effects and to meet all statutory requirements. The following roles and responsibilities are proposed for the works:

Environmental Consultant (Douglas Partners)

- Prepare RAP documentation for the auditor's review;
- On-site monitoring and reporting of proposed works;
- Conduct field testing to assist in definition of excavation area;
- Collection of validation samples from final surfaces;
- Assessment of results for suitability within the final development; and,
- Preparation of a validation report summarising the outcome of remedial works.

Contractor (TBC)

- The Contractor will be in effective control of the site during remediation works, but will work under the direction of DP;
- Prepare a suitable Construction Environmental Management Plan (CEMP) and Occupational Health and Safety Plan (OHSP) if required under Northern Territory Work Health and Safety Regulations (2012);
- Ensure wastes arising at the site are disposed in an appropriate manner and tracking documentation is provided to DP;
- Minimise fugitive dust leaving the confines of the site;
- Provide and install suitable silt fences/ hay bales to minimise stormwater containing any suspended matter or contaminants leaving the site in a manner which could pollute the environment;

- Ensure vehicles are cleaned and secured so that no mud, soil or water are deposited on any public roadways or adjacent areas; and
- Comply with legislative requirements regarding noise and vibration levels at the site boundaries.

Client (Tolinchlo Pty Ltd)

- Appoint and manage the environmental consultant and contractor; and
- Arrange for site access, tenant notification, services isolation and traffic control as required.

Any existing pits or unstable areas on site that may generate potential occupational health and safety (OH&S) or operational risk should be demarcated and taped off, with appropriate rectification action undertaken (eg. backfilling of pits as soon as practicable to prevent undue injuries to workers etc.).

7.1 Soil Management Plan

7.1.1 Excavation and Stockpiling of Contaminated Material

Contaminated material shall be excavated and stockpiled at a suitably segregated location(s) away from sensitive areas and in a manner that will not cause nuisance to the neighbouring properties. All stockpiles of contaminated material shall be surrounded by star pickets and marking tape or other suitable material to clearly delineate their boundaries. Stockpiles shall be lightly conditioned by sprinkler or covered by geotextile or similar cover to prevent dust blow. Should the stockpile remain on-site for more than three days, geotextile silt fences, hay bales or equivalent should be erected around each stockpile to prevent losses by surface erosion. Any stockpile to remain on-site overnight should be adequately secured in order to reduce the risk of sediment runoff.

7.1.2 Rehabilitation and Reinstatement of the Site

It is intended that any excavations at the site will be made safe by battering or partially backfilling with site sourced material and there is no requirement for geotechnically-controlled backfilling. The contractor should be responsible for fencing/ battering excavations as appropriate to make them safe and prevent subsidence of surrounding buildings. If required, materials used to backfill excavations are to be either:

- Material sourced from the site, meeting the adopted site criteria; or
- Imported Fill Material meeting the requirements of EPA Publication IWRG621.

Analytical results presented by the contractor to validate imported Fill Material shall be NATA accredited and obtained at an appropriate sampling density according to EPA guidelines. Such Fill Material results will be presented in the final validation report along with details of site of origin, volume and date of receipt on the site.

7.2 Noise Control

The remediation works should comply with the requirements specified by the relevant authorities (eg. EPA and NT WorkSafe). Noise and vibration should be restricted to permissible levels. All equipment and machinery should be operated in an efficient manner to minimise the emission of noise.

7.3 Vibration Control

The use of any plant and/or machinery should not cause unacceptable vibrations to nearby properties and should meet Council requirements.

7.4 Dust Control

Dust emissions must be confined within the site boundary. The following dust control procedures will be employed to comply with this requirement as necessary:

- Erection of dust screens around the perimeter of the site (as applicable);
- Securely covering all loads entering or exiting the site;
- Use of water sprays across the site to suppress dust;
- Covering of all stockpiles of contaminated soil remaining on site more than three days; and
- Keeping excavation and stockpile surfaces moist.

7.5 Occupational Health and Safety

DP recommends that all personnel on-site be required to wear the following protection at all times:-

- Steel-capped boots or water-proof boots fitted with steel-toe;
- Safety glasses or safety goggles with side shields meeting AS1337-1992 requirements (as necessary);
- Hard hat meeting AS1801-1981 requirements; and
- Hearing protection meeting AS1270-1988 requirements when working around machinery or plant equipment if noise levels exceed exposure standards.

In the event that personnel are required to work in areas of potential contact with contaminated soil, other materials or water, the following additional protection will be required:-

- Disposable coveralls (if necessary) to prevent contact with splashed soil, materials or water;
- Nitrile work gloves meeting AS2161-1978 requirements or heavy duty gauntlet gloves;
- Respirator with organic vapour cartridge, as required.

It is noted that the contractor should be responsible for management of the risks to their own employees and they may adopt alternative measures to those suggested.

8. Limitations

Douglas Partners (DP) has prepared this report (or services) for this project at Lot 3 Freds Pass Road, Humpty Doo in accordance with DP's proposal dated 13 May 2015 and acceptance received from Tolinchlo Pty Ltd. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Tolinchlo Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

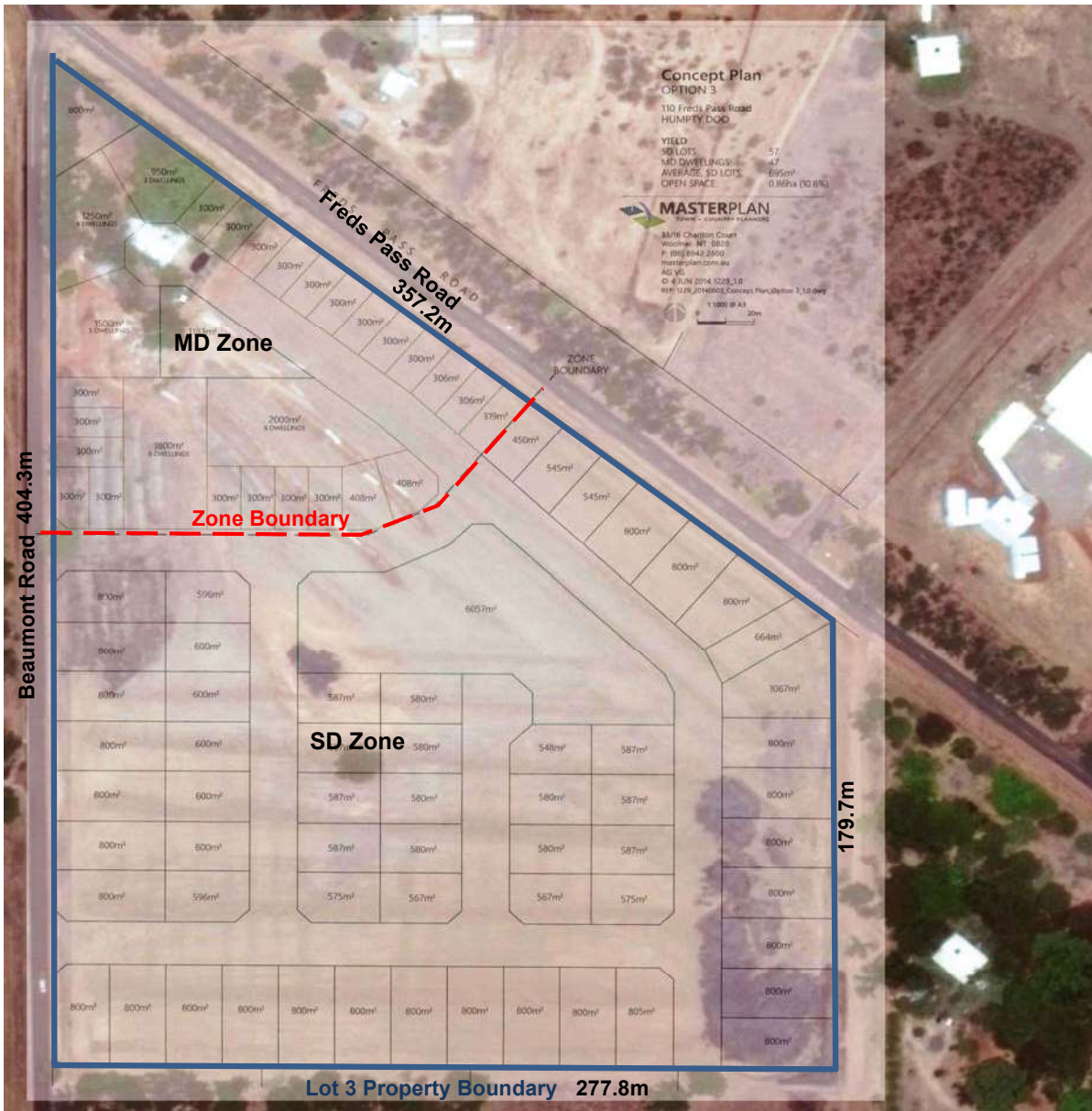
Douglas Partners Pty Ltd

9. References

1. Auckland Regional Council, 2002 "Remediation of Horticultural Broad-Acre Land Using Vertical Soil Mixing".
2. Douglas Partners Pty Ltd: "Field Procedures Manual" and "Project Management Manual", which form part of the Company Quality System (accredited to AS/NZS ISO 9001:2000).
3. Douglas Partners Pty Ltd, April 2015, "Report on Preliminary Environmental Site Investigation, Revision 1, Lot 3 Freds Pass Road, Humpty Doo, NT (DP Ref: 78156.00, Rev 1).
4. Douglas Partners Pty Ltd, December 2015, "Report on Detailed Site Investigation, Lot 3 Fred Pass Road, Humpty Doo, NT (DP Ref: 78156.01.R.001.Rev2).
5. Dutch Soil Remediation Circular 2009.
6. Environment Protection Authority of Victoria (EPA), June 2009, "Soil Hazard Categorisation and Management" Publication IWRG621.
7. Environment Protection Authority of Victoria (EPA), June 2009 "Sampling and Analysis of Waters, Wastewaters, Soils and Wastes" Publication IWRG701.
8. Environment Protection Authority of Victoria (EPA), June 2009 "Soil Sampling" Publication IWRG702;
9. National Environment Protection Council (2013): "National Environmental Protection (*Assessment of Site Contamination*) Measure" (as amended 2013) [NEPM].
10. New South Wales Environment Protection Authority (NSW EPA), 2003 "Guidelines for the Vertical Mixing of Soil on Former Broad –Acre Agricultural Land".
11. Standards Australia, 2005: "Guide to the investigation and sampling of sites with potentially contaminated soil, Part 1: Non-volatile and semi-volatile compounds", AS 4482.1-2005;
12. Northern Territory of Australia Government "Work Health and Safety (National Uniform Legislation) Regulations" 2012"


Appendix A

Drawings



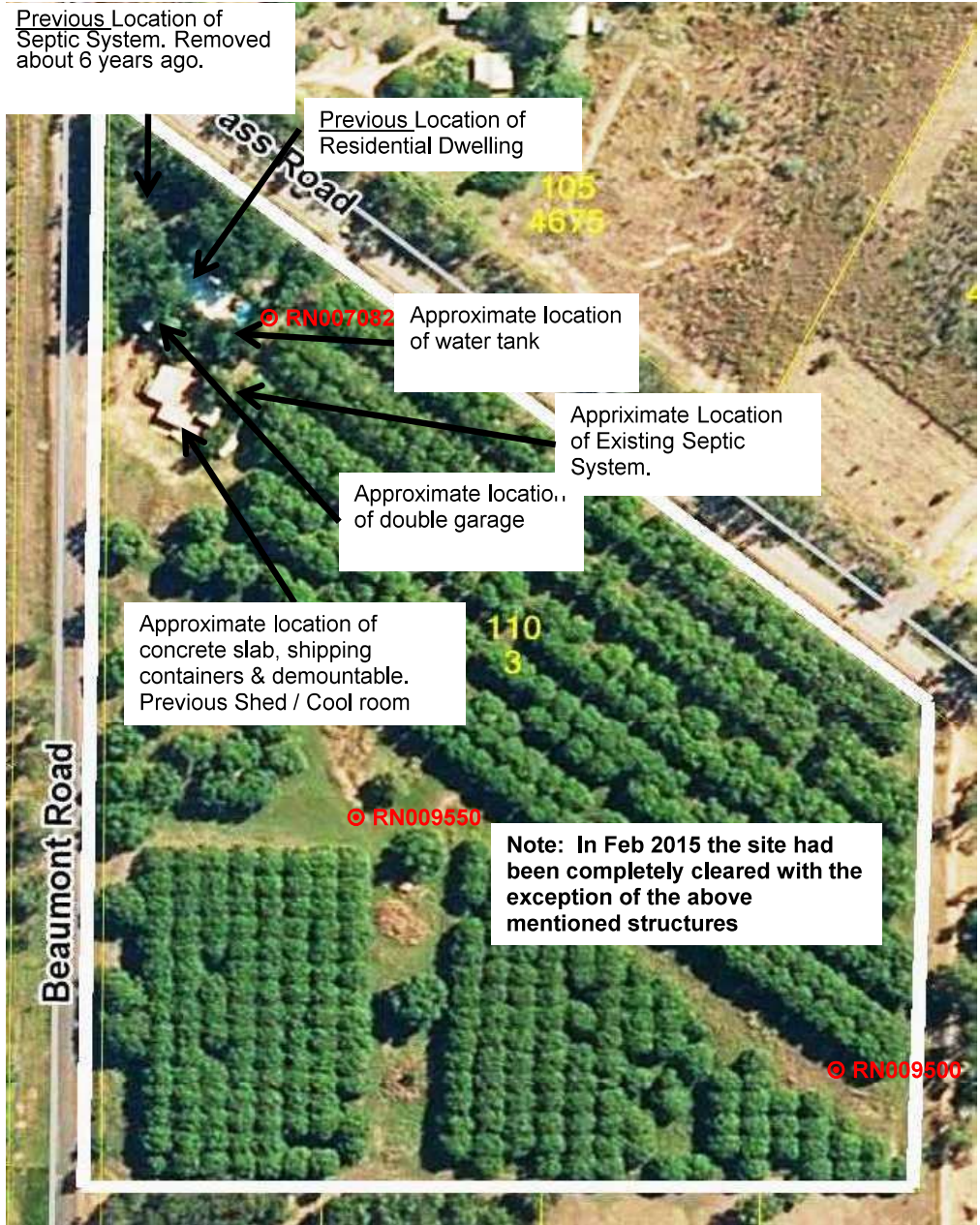
Scale as Shown

Sourced from Google Earth Pro & Drawing provided by client entitled *Concept Plan*

	Proposed Zones	Proposal	78156.01
	Proposed Residential Subdivision	DRAWING:	1
	Lot 3 Freds Pass Road	REV:	0
	Humpty Doo, NT	DATE:	18-Jun-15
CLIENT:	Tolinchlo Pty Ltd		




Previous Location of Septic System. Removed about 6 years ago.

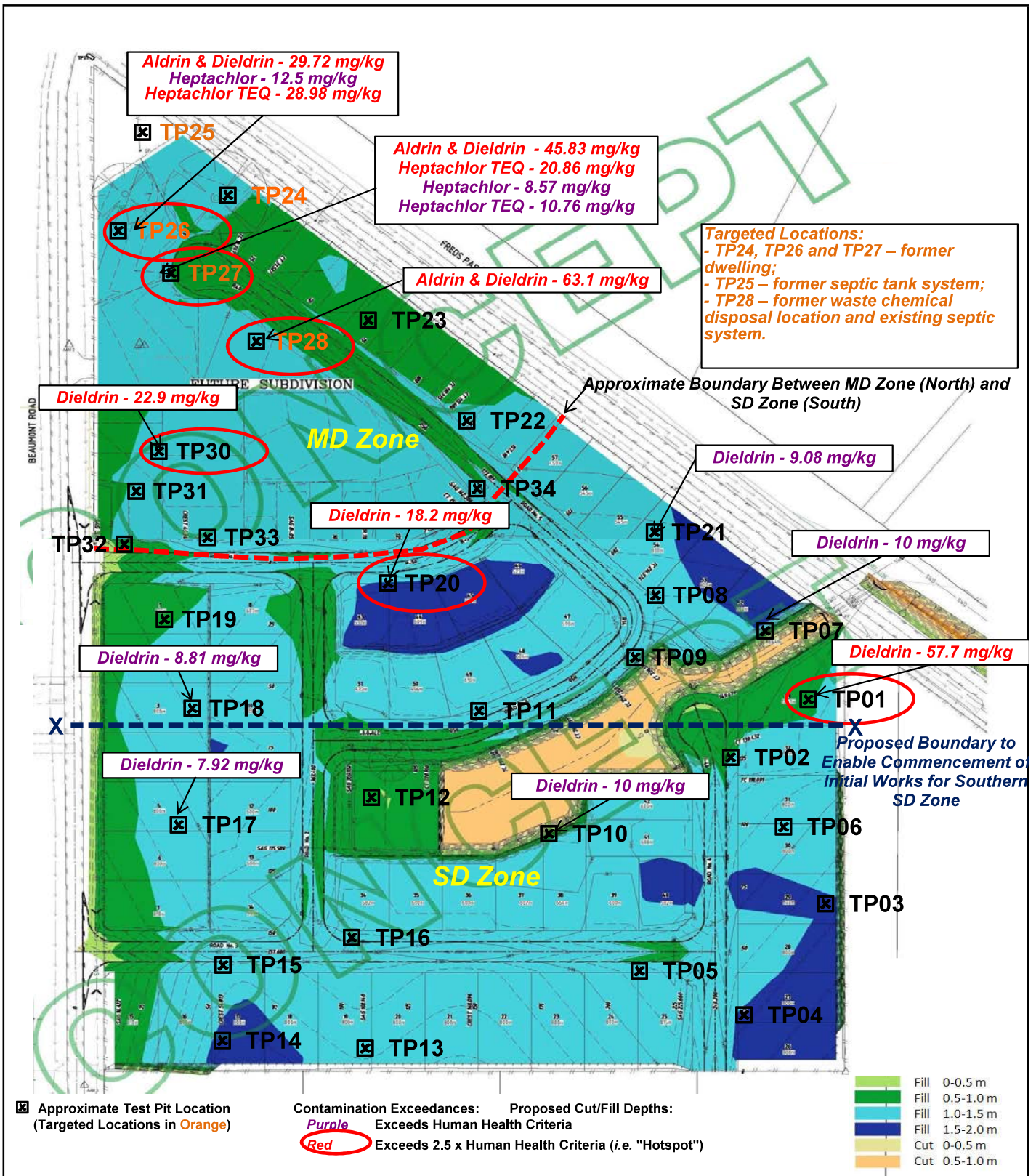


⊙ - Approximate Location of Registered Groundwater Bore


Drawing Not to Scale

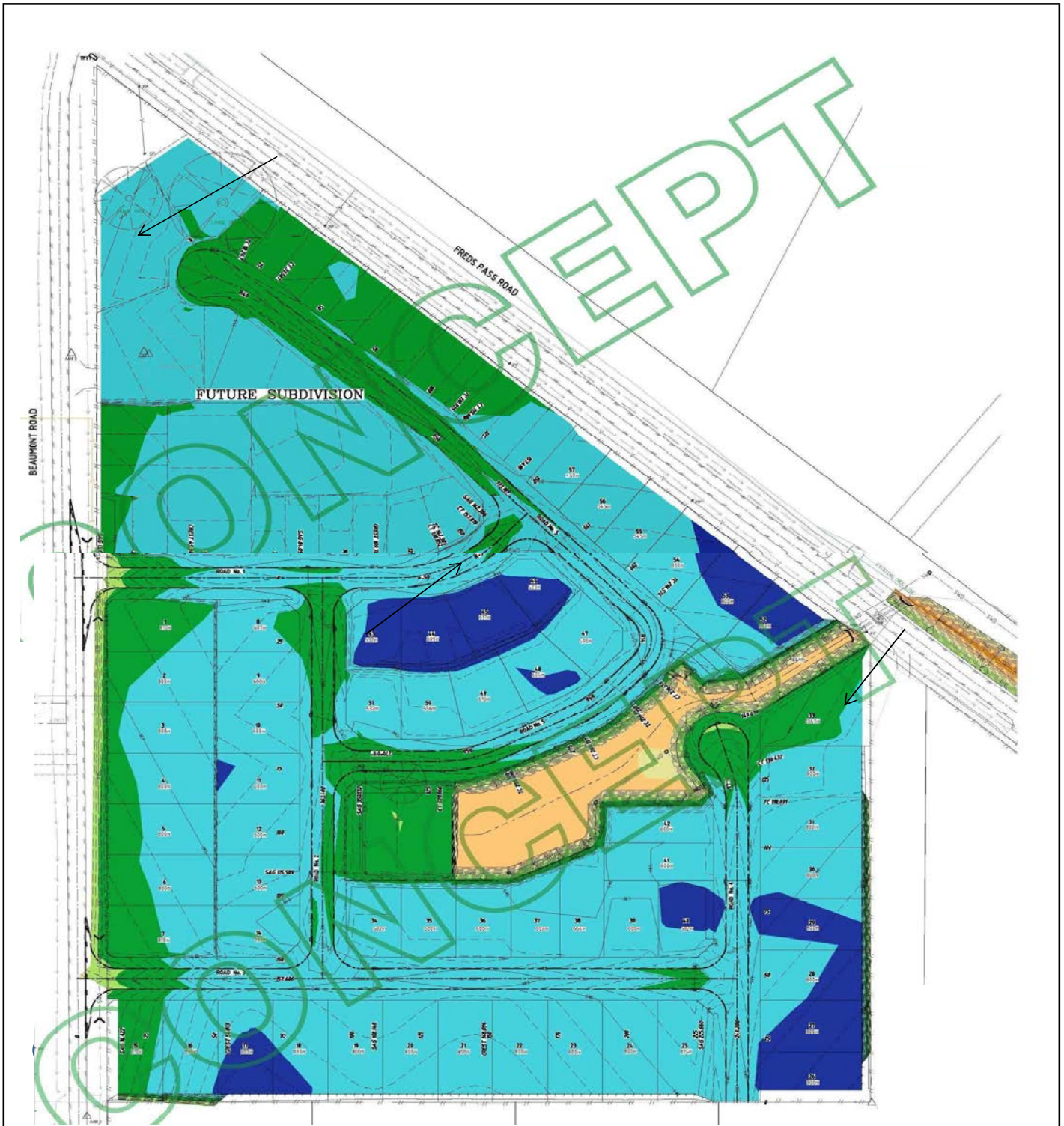
Sourced from Council Records. Original photo not dated, although likely to be dated 2012

	Site Location and Features Plan Proposed Residential Development Lot 3 Freds Pass Road Humpty Doo, NT	PROJECT: 78156.01
		DRAWING: 2
		REV: 1
	CLIENT: Tolinchlo Pty Ltd	DATE: 30-Mar-16



Drawing adapted from BMD Consulting Drawings B00153-CE001 and B00153-CE002

 <p>Douglas Partners Geotechnics Environment Groundwater</p>	<p>Test Pit Locations and Earthworks Plan Overlay</p> <p>Proposed Residential Subdivision</p> <p>Lot 3 Freds Pass Road</p> <p>Humpty Doo, NT</p>	<p>Project: 78156.01</p>
	<p>CLIENT: Tolinchlo Pty Ltd</p>	<p>DRAWING: 3</p>
	<p>DATE: 30-Mar-16</p>	<p>REV: 1</p>
	<p>CLIENT: Tolinchlo Pty Ltd</p>	<p>DATE: 30-Mar-16</p>



Proposed cut/fill depths

- Fill 0-0.5 m
- Fill 0.5-1.0 m
- Fill 1.0-1.5 m
- Fill 1.5-2.0 m
- Cut 0-0.5 m
- Cut 0.5-1.0 m

Not to Scale



Earthworks Plan Overlay
Proposed Residential Subdivision
Lot 3 Freds Pass Road
Humpty Doo, NT

CLIENT: Tolinchlo Pty Ltd

Project 78156.01

DRAWING: 4

REV: 0

DATE: 5-Apr-16

Appendix B

Notes on Sampling Methods, Soil Descriptions and
Symbols & Abbreviations

Test Pits Logs

Borehole Log

Sketch of ASB and OCP Hotspot Stockpile Sampling Locations

Site Stripping Reports

Sketch of Topsoil Stockpile Sampling Locations

Site Photographs

Asbestos Clearance Certificate

Extractive Lease Statement for Imported Fill Material



Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low

reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:
4,6,7
N=13
- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:
15, 30/40 mm

Sampling Methods

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.



Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726, Geotechnical Site Investigations Code. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	20 - 63
Medium gravel	6 - 20
Fine gravel	2.36 - 6
Coarse sand	0.6 - 2.36
Medium sand	0.2 - 0.6
Fine sand	0.075 - 0.2

The proportions of secondary constituents of soils are described as:

Term	Proportion	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	20 - 35%	Sandy Clay
Slightly	12 - 20%	Slightly Sandy Clay
With some	5 - 12%	Clay with some sand
With a trace of	0 - 5%	Clay with a trace of sand

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	vs	<12
Soft	s	12 - 25
Firm	f	25 - 50
Stiff	st	50 - 100
Very stiff	vst	100 - 200
Hard	h	>200

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	SPT N value	CPT qc value (MPa)
Very loose	vl	<4	<2
Loose	l	4 - 10	2 - 5
Medium dense	md	10 - 30	5 - 15
Dense	d	30 - 50	15 - 25
Very dense	vd	>50	>25

Soil Descriptions

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Transported soils - formed somewhere else and transported by nature to the site; or
- Filling - moved by man.

Transported soils may be further subdivided into:

- Alluvium - river deposits
- Lacustrine - lake deposits
- Aeolian - wind deposits
- Littoral - beach deposits
- Estuarine - tidal river deposits
- Talus - scree or coarse colluvium
- Slopewash or Colluvium - transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.

Symbols & Abbreviations

Douglas Partners



Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core Drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U ₅₀	Undisturbed tube sample (50mm)
W	Water sample
pp	pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough



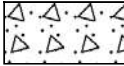

Other

fg	fragmented
bnd	band
qtz	quartz



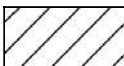

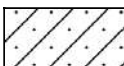


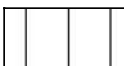

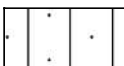
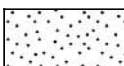
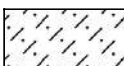



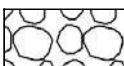

Symbols & Abbreviations

Graphic Symbols for Soil and Rock




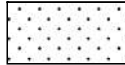
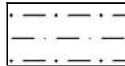
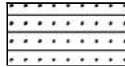
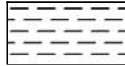

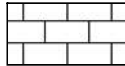
General

	Asphalt
	Road base
	Concrete
	Filling

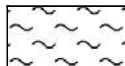
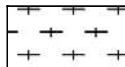
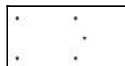
Soils

	Topsoil
	Peat
	Clay
	Silty clay
	Sandy clay
	Gravelly clay
	Shaly clay
	Silt
	Clayey silt
	Sandy silt
	Sand
	Clayey sand
	Silty sand
	Gravel
	Sandy gravel
	Cobbles, boulders
	Talus

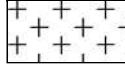

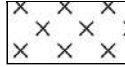
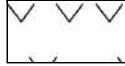

Sedimentary Rocks

	Boulder conglomerate
	Conglomerate
	Conglomeratic sandstone
	Sandstone
	Siltstone
	Laminite
	Mudstone, claystone, shale
	Coal
	Limestone

Metamorphic Rocks

	Slate, phyllite, schist
	Gneiss
	Quartzite

Igneous Rocks

	Granite
	Dolerite, basalt, andesite
	Dacite, epidote
	Tuff, breccia
	Porphyry

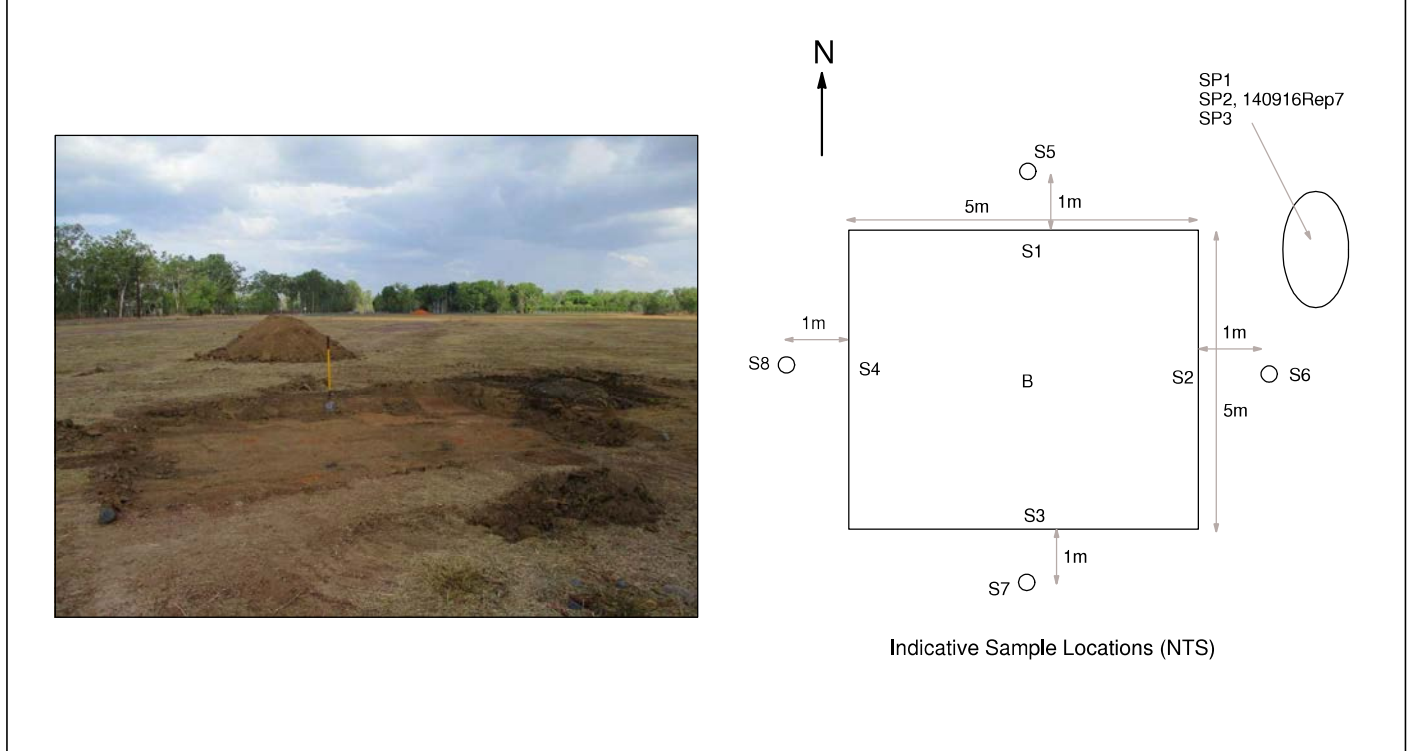
TEST PIT LOG

CLIENT: Mr Peter Poniris
PROJECT: Validation Assessment
LOCATION: Lot 3 Fred Pass Road, Humpty Doo, NT

SURFACE LEVEL: --
EASTING: 7828873
NORTHING: 8608521

PIT No: ASB/TP28
PROJECT No: 78156.02
DATE: 14/9/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per mm)				
				Type	Depth	Sample	Results & Comments		5	10	15	20	
	0.0	SILTY SANDY GRAVEL: medium dense, grey-brown, silty sandy gravel, fine to medium, sub-angular to sub-rounded, laterite.		E	0.0		S1						
	0.15					S2							
	0.3					S3							
	0.3	Pit discontinued at 0.3m					S4						
							S5						
							S6						
							S7						
							S8						
							B						



RIG: CAT12t excavator with 1200mm shovel bucket

LOGGED: A. Gane

SURVEY DATUM: WGS84 Zone 52

WATER OBSERVATIONS: No free groundwater observed

REMARKS: ,TPD on well cemented laterite, clayey gravel to gravelly clay

- Sand Penetrometer AS1289.6.3.3
- Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	≧	Water seep
E	Environmental sample	≧	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)

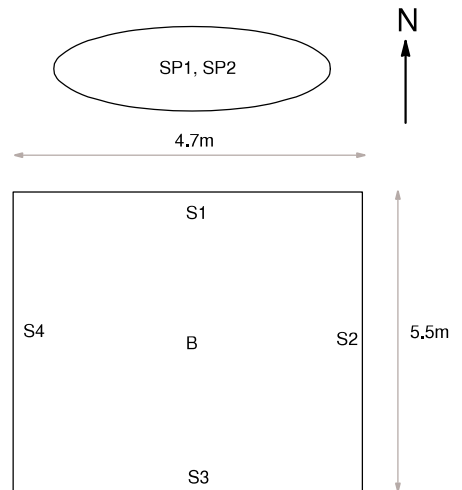
TEST PIT LOG

CLIENT: Mr Peter Poniris
PROJECT: Validation Assessment
LOCATION: Lot 3 Fred Pass Road, Humpty Doo, NT

SURFACE LEVEL: --
EASTING: 728830
NORTHING: 8608562

PIT No: HSR/TP26
PROJECT No: 78156.02
DATE: 14/9/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per mm)				
				Type	Depth	Sample	Results & Comments		5	10	15	20	
	0.5	SILTY GRAVELLY SAND: medium dense, grey-brown, silty gravelly sand, fine to medium, minor grass roots.											
	0.5	SILTY SANDY GRAVEL: medium dense, orange-brown, silty sandy gravel, fine to medium, sub-angular to sub-rounded, laterite, humid.		E	0.8	S1 S2, 140916Rep5 S3 S4, 140916Rep6							
	1.1	CLAYEY GRAVEL/GRAVELLY CLAY: variably cemented, red-brown with orange-brown mottling, clayey gravel and gravelly clay, laterite, humid.			1.1								
	1.5	Pit discontinued at 1.5m	E	1.5		B							



Indicative Sample Locations (NTS)

RIG: CAT12t excavator with 1200mm shovel and 450mm rock tooth bucket **LOGGED:** A. Gane **SURVEY DATUM:** WGS84 Zone 52

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

- Sand Penetrometer AS1289.6.3.3
- Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	≧	Water seep
E	Environmental sample	≧	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pc	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)

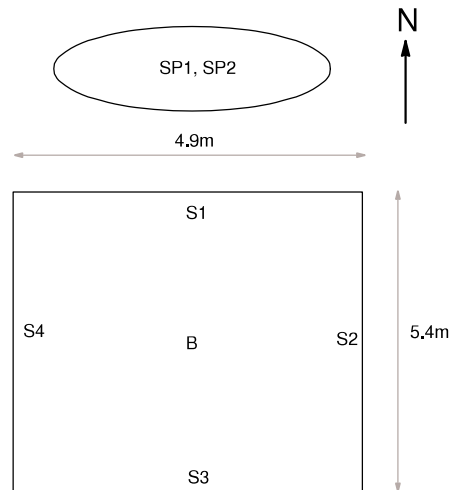
TEST PIT LOG

CLIENT: Mr Peter Poniris
PROJECT: Validation Assessment
LOCATION: Lot 3 Fred Pass Road, Humpty Doo, NT

SURFACE LEVEL: --
EASTING: 728850
NORTHING: 8608548

PIT No: HSR/TP27
PROJECT No: 78156.02
DATE: 14/9/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per mm)					
				Type	Depth	Sample	Results & Comments		5	10	15	20		
		GRAVELLY SILTY SAND: medium dense, grey-brown, gravelly silty sand, dry.												
	0.5	SANDY GRAVEL: medium dense/stable, orange-brown, sandy gravel, sub-angular to sub-rounded, medium to coarse lateritic gravel, dry to humid.			0.5									
	1.1	CLAYEY GRAVEL/GRAVELLY CLAY: variably cemented, red-brown with yellow brown mottling, clayey gravel to gravelly clay, laterite.			1.1		S1 S2, 140916Rep3 S3 S4							
	1.5	Pit discontinued at 1.5m			1.5		B, 140916Rep4							



RIG: CAT12t excavator with 1200mm shovel and 450mm rock tooth bucket **LOGGED:** A. Gane **SURVEY DATUM:** WGS84 Zone 52

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

- Sand Penetrometer AS1289.6.3.3
- Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	≻	Water seep
E	Environmental sample	≻	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)

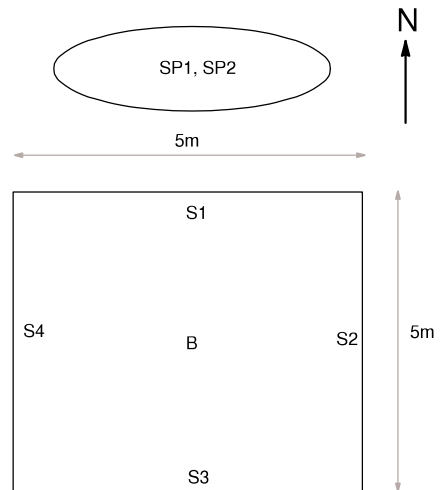
TEST PIT LOG

CLIENT: Mr Peter Poniris
PROJECT: Validation Assessment
LOCATION: Lot 3 Fred Pass Road, Humpty Doo, NT

SURFACE LEVEL: --
EASTING: 7828873
NORTHING: 8608521

PIT No: HSR/TP28
PROJECT No: 78156.02
DATE: 15/9/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per mm)					
				Type	Depth	Sample	Results & Comments		5	10	15	20		
		SANDY SILTY GRAVEL: medium dense, grey-brown, sandy silty gravel, fine to medium, sub-angular to sub-rounded, laterite.					S1 S2, 150916Rep1 S3, 150916Rep2 S4							
	0.5	SILTY SANDY GRAVEL: medium dense, orange-brown, silty sandy gravel, laterite.		E	0.5									
	0.9	CLAYEY GRAVEL: well cemented, red-brown, with orange-brown, yellow-brown & off-white mottling, clayey gravel grading to gravelly clay.			0.9									
	1.5	Pit discontinued at 1.5m		E	1.5		B							



Indicative Sample Locations (NTS)

RIG: CAT12t excavator with 1200mm shovel and 450mm rock tooth bucket **LOGGED:** A. Gane **SURVEY DATUM:** WGS84 Zone 52

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

- Sand Penetrometer AS1289.6.3.3
- Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	≧	Water seep
E	Environmental sample	≧	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pc	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)

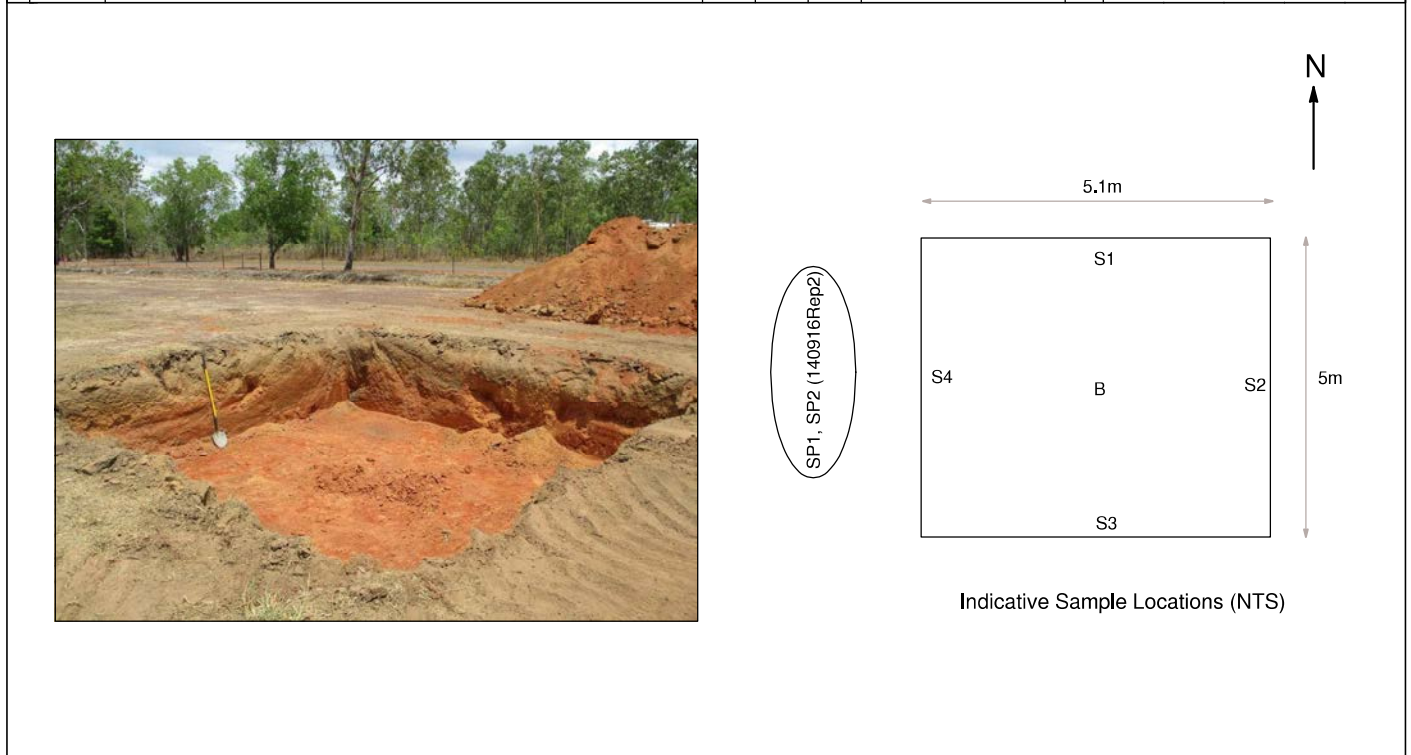
TEST PIT LOG

CLIENT: Mr Peter Poniris
PROJECT: Validation Assessment
LOCATION: Lot 3 Fred Pass Road, Humpty Doo, NT

SURFACE LEVEL: --
EASTING: 728840
NORTHING: 8608480

PIT No: HSR/TP30
PROJECT No: 78156.02
DATE: 14/9/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per mm)					
				Type	Depth	Sample	Results & Comments		5	10	15	20		
		GRAVELLY SILTY SAND: medium dense, light brown, gravelly silty sand												
	0.35	SANDY GRAVEL: medium dense, light brown, sandy gravel												
	0.6	SANDY GRAVEL: medium dense, orange brown, sandy gravel		E	0.6		S1 S2 S3 S4							
	1.2	GRAVELLY SAND with GRAVELLY CLAY: variably cemented, red-brown, gravelly sand with gravelly clay zones.			1.2									
	1.6	Pit discontinued at 1.6m	E	1.6			-B, 140916Rep1							



RIG: CAT12t excavator with 1200mm shovel and 450mm rock tooth bucket **LOGGED:** A. Gane **SURVEY DATUM:** WGS84 Zone 52

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

- Sand Penetrometer AS1289.6.3.3
- Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	≻	Water seep
E	Environmental sample	≻	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)

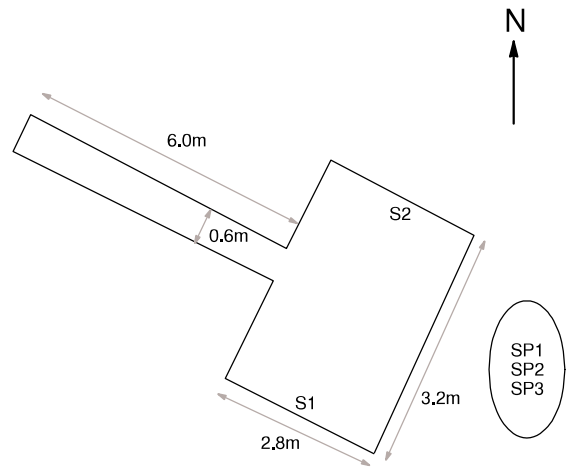
TEST PIT LOG

CLIENT: Mr Peter Poniris
PROJECT: Validation Assessment
LOCATION: Lot 3 Fred Pass Road, Humpty Doo, NT

SURFACE LEVEL: --
EASTING: 728869
NORTHING: 8608507

PIT No: SS/TP
PROJECT No: 78156.02
DATE: 15/9/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per mm)				
				Type	Depth	Sample	Results & Comments		5	10	15	20	
	0.2	SILTY GRAVELLY SAND: medium dense, grey-brown, fine to medium, silty gravelly sand.	[Graphic Log: Silty Gravelly Sand]		0.2								
		GRAVELLY SILTY SAND: medium dense, orange-brown, gravelly silty sand, fine to medium, lateritic gravel.		E	0.6		S1 S2						
1	1.0	GRAVELLY CLAY: well cemented, red-brown, orange-brown & yellow-brown, gravelly clay, laterite.			1.0								
	1.2	Pit discontinued at 1.2m											



RIG: CAT12t excavator with 1200mm shovel and 450mm rock tooth bucket **LOGGED:** A. Gane **SURVEY DATUM:** WGS84 Zone 52

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

- Sand Penetrometer AS1289.6.3.3
- Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	≧	Water seep
E	Environmental sample	≧	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)

BOREHOLE LOG

CLIENT: Mr Peter Poniris
PROJECT: Validation Assessment
LOCATION: Lot 3 Fred Pass Road, Humpty Doo, NT

SURFACE LEVEL:--
EASTING: 728876
NORTHING: 8608515
DIP/AZIMUTH: 90°/--

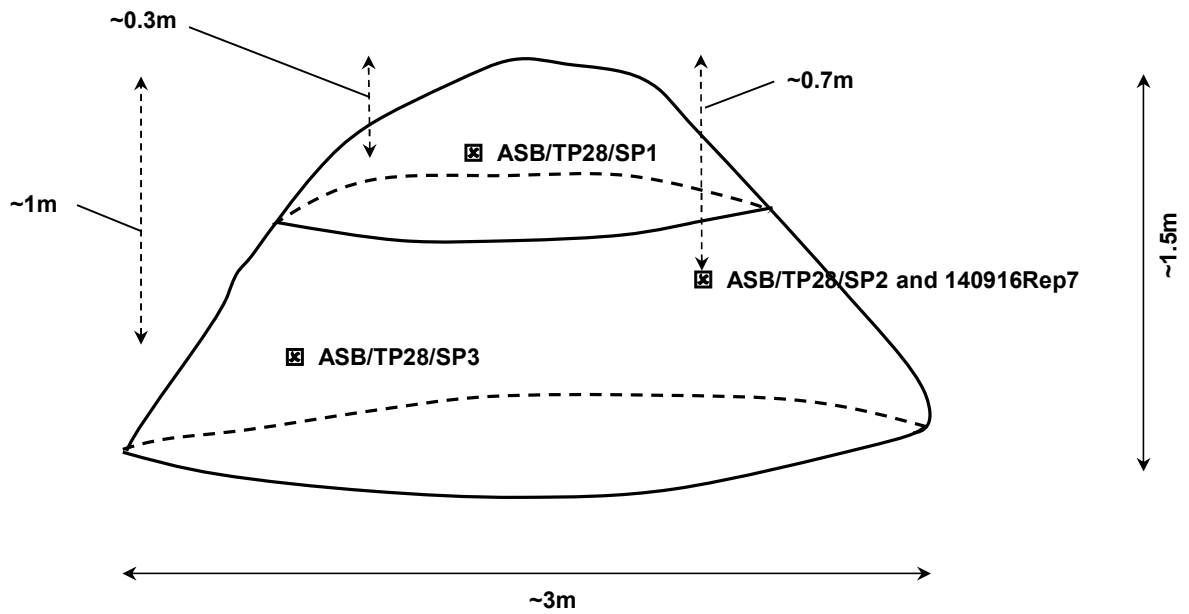
BORE No: GW/TP28
PROJECT No: 78156.02
DATE: 16/9/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
	0.3	SILTY GRAVELLY SAND: loose to medium dense, grey-brown, silty gravelly sand, dry.	- - -	(D)	0.1				Concrete	
		CLAYEY GRAVEL: well cemented, mottled red-brown and yellow-brown, clayey gravel (laterite), becoming weaker with depth, humid.	(D)	(D)	0.5				Bentonite Seal	
	1		(D)	(D)	1.0					
	2		(D)							
	2.8		(D)						Gravel Pack	
	3becoming uncemented gravelly clay, off-white with yellow-brown & red-brown mottling, laterite or weathered siltstone, damp.	(D)	(D)	3.0				Slotted Pipe	
	4		(D)							
	5		(D)	(D)	5.0				End Cap	
	5.5	Bore discontinued at 5.5m								

RIG: Landcruiser Mounted Rig **DRILLER:** R. Arbon **LOGGED:** A. Gane **CASING:**
TYPE OF BORING: 120mm diameter auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS: Location coordinates are in WGS84 Zone 52.

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	≻	Water seep
E	Environmental sample	≻	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test (s(50) (MPa)
		PL(D)	Point load diametral test (s(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)





Sketch of ASB Stockpile from TP28

Notes:

1. denotes approximate location of sample
2. Sketches are Not to Scale
3. Dimensions are approximate only
4. Stockpile volume estimated to be about 8m³ (no bulking factor) based on excavation dimensions.



Photo of ASB Stockpile from TP28 (taken while sampling)



Sketch of ASB Stockpile Sampling Locations
Proposed Residential Subdivision
Lot 3 Freds Pass Road
Humpty Doo, Northern Territory

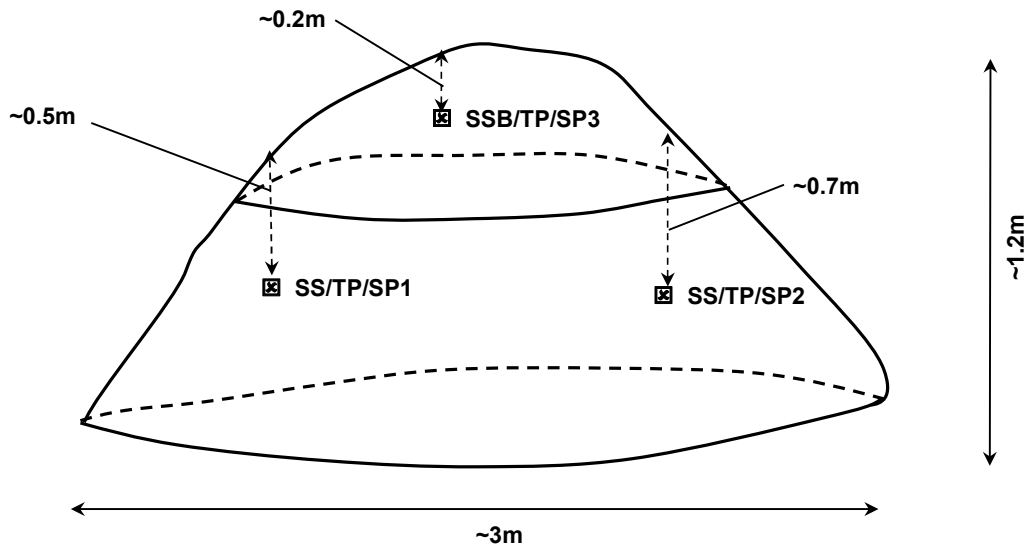
CLIENT: Mr Peter Poniris

Project 78156.02

Sketch 1

REV: 0

DATE: 7-Nov-16



Sketch of SS Stockpile

Notes:

1. denotes approximate location of sample
2. Sketches are Not to Scale
3. Dimensions are approximate only
4. Stockpile volume estimated to be about 8m³ (no bulking factor).



Photo of SS Stockpile near TP28 (taken while sampling)



Sketch of SS Stockpile Sampling Locations
Proposed Residential Subdivision
Lot 3 Freds Pass Road
Humpty Doo, Northern Territory

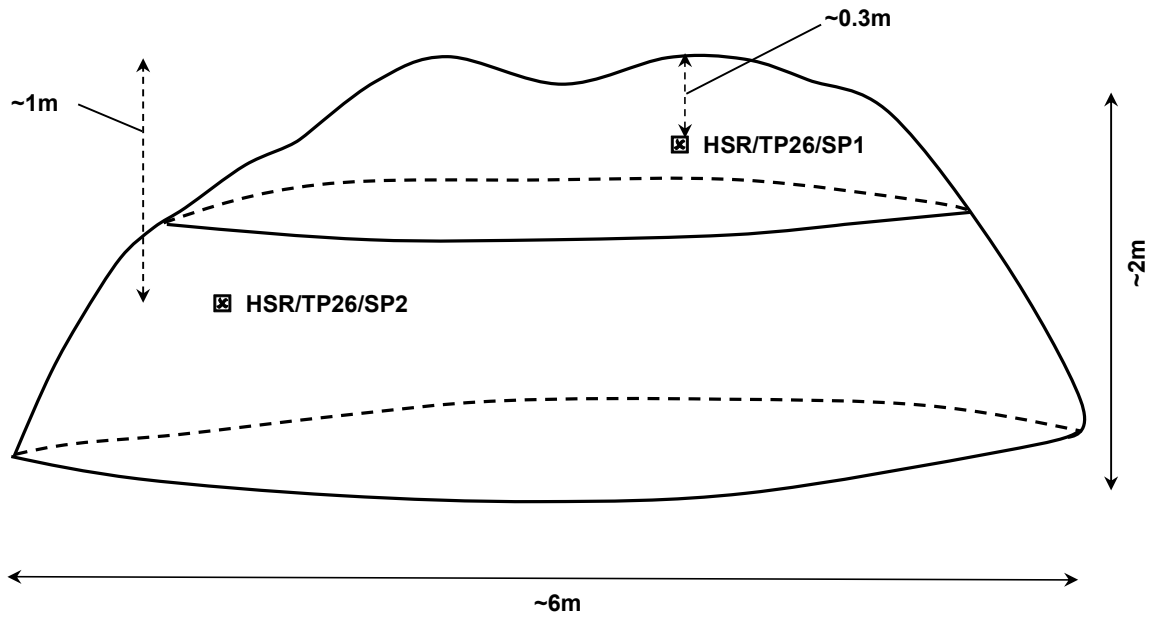
CLIENT: Mr Peter Poniris

Project 78156.02

Sketch 2

REV: 0

DATE: 7-Nov-16



Sketch of HSR Stockpile from TP26

Notes:

1. denotes approximate location of sample
2. Sketches are Not to Scale
3. Dimensions are approximate only
4. Stockpile volume estimated to be about 38m³ (no bulking factor) based on excavation dimensions.



Photo of HSR Stockpile from TP26 (taken while sampling)



Sketch of HSR Stockpile Sampling Locations
Proposed Residential Subdivision
Lot 3 Freds Pass Road
Humpty Doo, Northern Territory

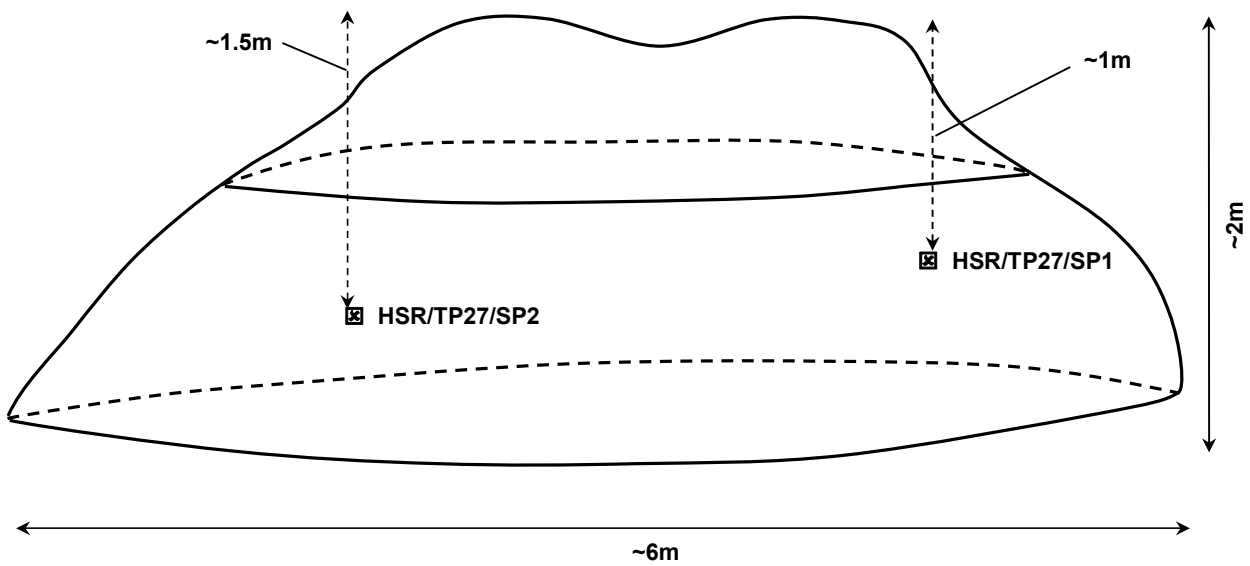
CLIENT: Mr Peter Poniris

Project 78156.02

Sketch 3

REV: 0

DATE: 7-Nov-16



Sketch of HSR Stockpile from TP27

Notes:

1. denotes approximate location of sample
2. Sketches are Not to Scale
3. Dimensions are approximate only
4. Stockpile volume estimated to be about 40m³ (no bulking factor) based on excavation dimensions.



Photo of HSR Stockpile from TP27 (taken while sampling)



Sketch of HSR Stockpile Sampling Locations
Proposed Residential Subdivision
Lot 3 Freds Pass Road
Humpty Doo, Northern Territory

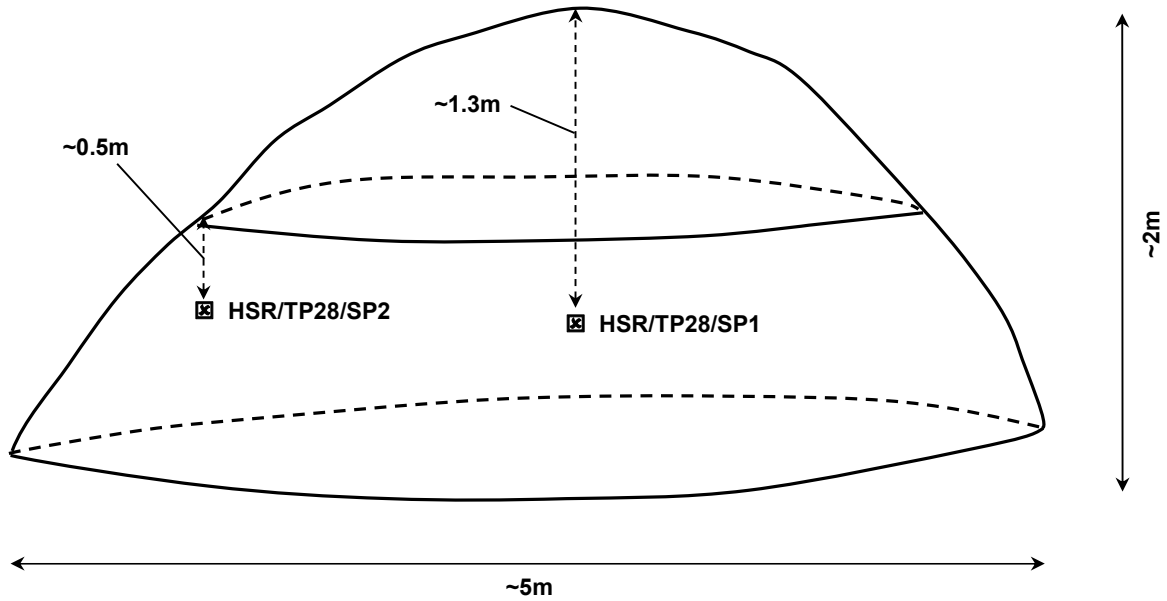
CLIENT: Mr Peter Poniris

Project 78156.02

Sketch 4

REV: 0

DATE: 7-Nov-16



Sketch of HSR Stockpile from TP28

Notes:

1. ☒ denotes approximate location of sample
2. Sketches are Not to Scale
3. Dimensions are approximate only
4. Stockpile volume estimated to be about 38m³ (no bulking factor) based on excavation dimensions.



Photo of HSR Stockpile from TP28 (taken while sampling)



Sketch of HSR Stockpile Sampling Locations
Proposed Residential Subdivision
Lot 3 Freds Pass Road
Humpty Doo, Northern Territory

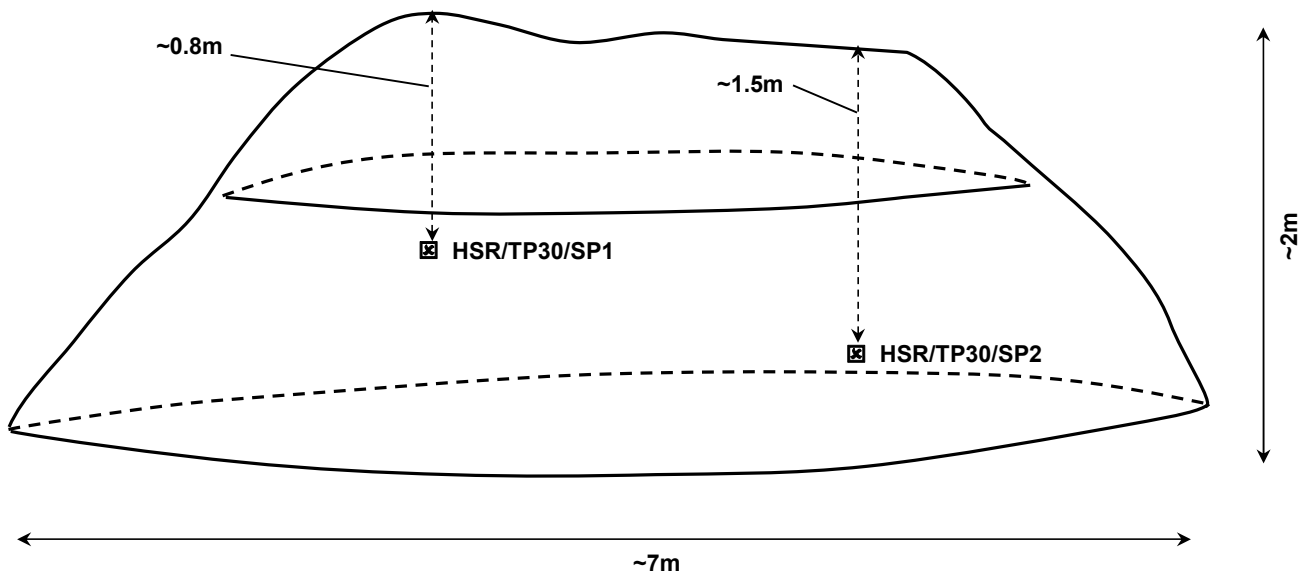
CLIENT: Mr Peter Poniris

Project 78156.02

Sketch 5

REV: 0

DATE: 7-Nov-16



Sketch of HSR Stockpile from TP30

Notes:

1. ☒ denotes approximate location of sample
2. Sketches are Not to Scale
3. Dimensions are approximate only
4. Stockpile volume estimated to be about 41m³ (no bulking factor) based on excavation dimensions.



Photo of HSR Stockpile from TP30 (taken while sampling)



Sketch of HSR Stockpile Sampling Locations
Proposed Residential Subdivision
Lot 3 Freds Pass Road
Humpty Doo, Northern Territory

CLIENT: Mr Peter Poniris

Project 78156.02

Sketch 6

REV: 0

DATE: 7-Nov-16

Project: VALIDATION ASSESSMENT	Project No: 78156.02
Operator: MR PETER POWIRIS	Date: 25/10/16
Location: LOT 3 FOODS PASS Rd HEMPY DOO, NT	Inspection No: 001

Area inspected:

ALL OF MD ZONE

Proving Method(s) and Equipment:

VISUAL

Details of Inspection:

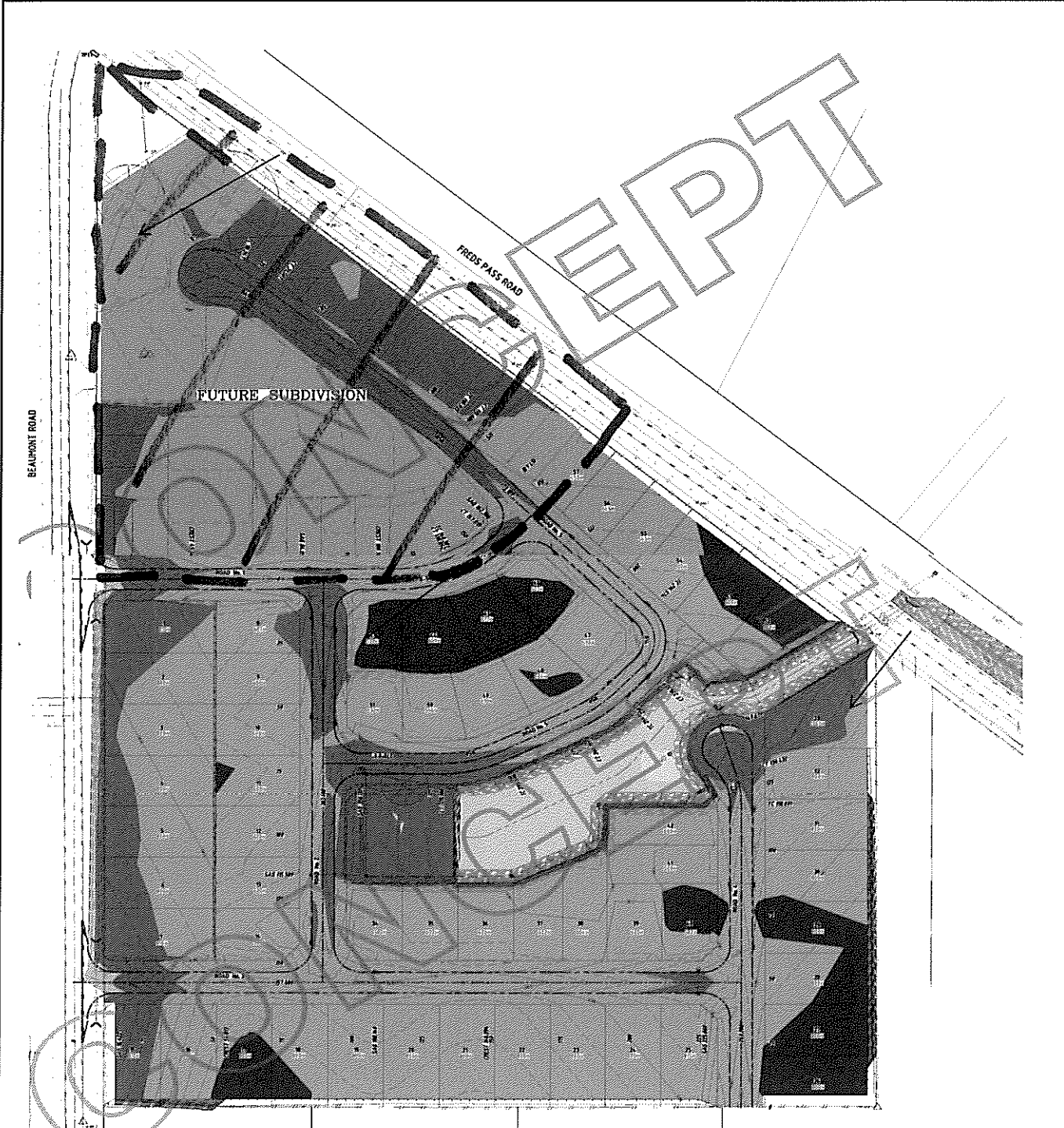
**ENTIRE MD ZONE CLEARED OF TOPSOIL.
SOME WINROWS MATERIAL STILL TO
BE MOVED FROM SITE TO STOCKPILING
AREA.**

Extent of Stripping shown on attached Plan:	Yes <input checked="" type="checkbox"/>	No <input type="checkbox"/>
Extent of Stripping shown on Master Plan:	Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>
Is reinspection required?	Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>

If "yes"; where?

Inspected by: R. ARBON	Date: 25/10/16
-------------------------------	-----------------------


Distribution	
PM:	Date:
LEM:	Date:
File:	Date:

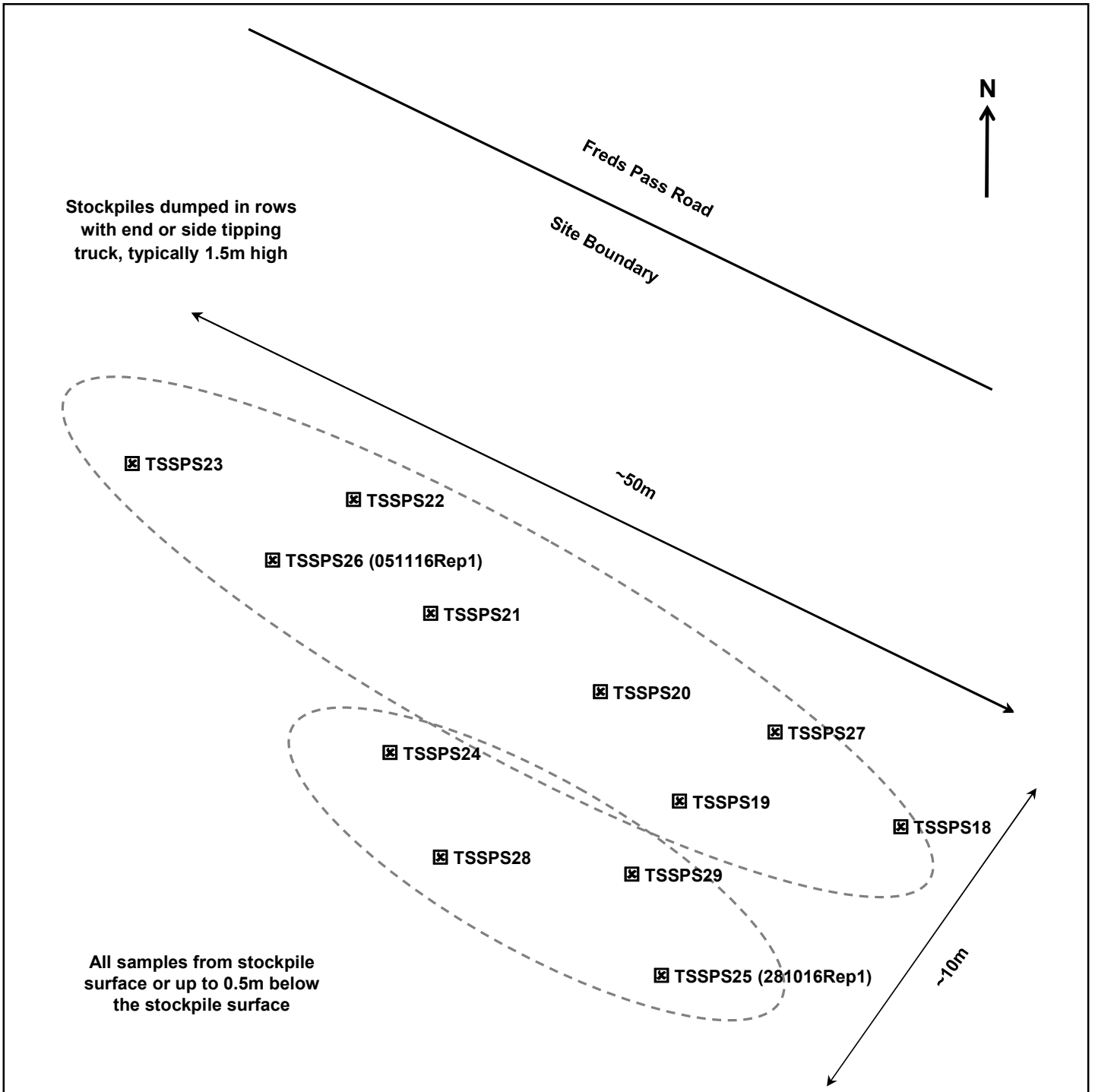


Proposed cut/fill depths

- Fill 0-0.5 m
- Fill 0.5-1.0 m
- Fill 1.0-1.5 m
- Fill 1.5-2.0 m
- Cut 0-0.5 m
- Cut 0.5-1.0 m

Not to Scale

 Douglas Partners Geotechnics Environment Groundwater	Earthworks Plan Overlay Proposed Residential Subdivision Lot 3 Freds Pass Road Humpty Doo, NT	Project 78156.01
		DRAWING: 4
		REV: 0
	CLIENT: Tolinchlo Pty Ltd	DATE: 5-Apr-16



Plan View of Topsoil Stockpiles

Notes:

1. ☒ denotes approximate location of sample
2. Sketches are Not to Scale
3. Dimensions are approximate only
4. Total volume of stockpiles estimated to be about 400 to 700m³ (no bulking factor) based on site area and depth of stripping.


	Sketch of Topsoil Stockpile Sampling Locations		Project	78156.02
	Proposed Residential Subdivision		Sketch 7	
	Lot 3 Freds Pass Road		REV:	0
	Humpty Doo, Northern Territory		DATE:	7-Nov-16
CLIENT:		Mr Peter Poniris		



Photo 1: Windrow of topsoil, prior to removal from MD Zone



Photo 2: Windrows of topsoil, prior to removal from MD Zone



Project No.
78156.02

Site Photographs

Photo Date:
[See Photo](#)

Remediation and Validation - MD Zone

Client: Mr Peter Poniris



Photo 3: Location of Water Tank, Slab and Shed



Photo 4: Tying on the MD site



Project No.
78156.02

Site Photographs

Photo Date:
[See Photo](#)

Remediation and Validation - MD Zone
Client: Mr Peter Poniris



Photo 5: Tying on the MD site. Ponding water due to rain in foreground.



Photo 6: Forming a drain to the east end of the site during mixing to allow rainfall to runoff more effectively



Project No.
78156.02

Site Photographs

Photo Date:
[See Photo](#)

Remediation and Validation - MD Zone
Client: Mr Peter Poniris



Photo 7: Example of tyning in two directions where shallow laterite was encountered



Photo 8: Finished surface after re-compaction



Project No.
78156.02

Site Photographs

Photo Date:
[See Photo](#)

Remediation and Validation - MD Zone
Client: Mr Peter Poniris

Asbestos Clearance Certificate

ASBESTOS CLEARANCE INSPECTION DETAILS

This Clearance Certificate has been prepared by Northern Trade Solutions to the strictest controls provided in The Act, The Regulations, Codes of Practices and Australian Standards. Northern Trade Solutions has in the best interest provided all details to the company's professional and practical knowledge for this Asbestos Clearance Certificate in the details listed below.

1. Client details	
Name of client:	Peter Ponaris Faith Constructions
Client contact details:	0418 894 582
2. Removal work details	
Date removal work carried out:	20.09.2016
Site address where removal work is being carried out:	110 Freds Pass Road Humpty Doo
Details of the specific asbestos removal work area(s):	Removed 10cubic meters of Asbestos affected soil All Asbestos removed
Name of licensed asbestos removalist:	Northern Trade Solutions Licence number 37309 Nathan Bingham, David Smith
Name and contact details of licensed asbestos removalist supervisor (if different to removalist):	Tracy Allen
3. Inspection details	
Name of Assessor/competent Person	Gerry Koukouvas
Address of Assessor/Competent Person	15 Mel Rd Berrimah
Phone Number of Assessor/Competent person	0459 035 600
Date of clearance inspection:	20.09.2016
Time of clearance inspection:	5.15pm

Asbestos Clearance Certificate

4. Asbestos removal documentation	Yes	No
Do you have a copy of the asbestos removal SWMs?	✓	
Do you have a copy of the notification form?	✓	
Is the removal work consistent with the control plan and the notification form? (e.g. use of enclosures, decontamination facilities, waste facilities)	✓	

5. Visual Inspection	Yes	No
Inspection of the specific area detailed in section 2 <u>did not find visible asbestos</u> remaining as a result of the asbestos removal work carried out.	✓	
Is air monitoring required		✓
Can the area be reoccupied?	✓	
Has additional information been attached? (e.g. photos, drawings, plans)		✓

6. Air Monitoring	Yes	No
Air monitoring was carried out as part of the clearance inspection. <u>The result was below 0.01 f/ml.</u>		✓
Has the air monitoring sample been analysed by a NATA-accredited laboratory?	N.A.	
Is the air monitoring report attached?	N.A.	
Can the area be reoccupied?	✓	

Note: Where asbestos removal work requires a Class A licence, an independent licensed asbestos assessor must carry out the clearance inspection and complete clearance certificate if satisfied that the area is safe to reoccupy.



2



Asbestos Clearance Certificate

CLEARANCE DECLARATION

I declare that:

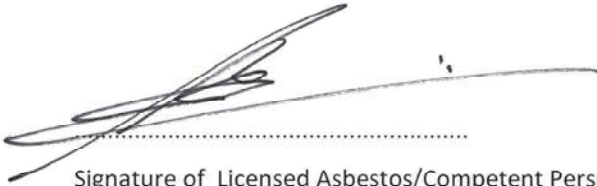
- the former enclosure, asbestos removal work area and the surrounding area are free from any visible asbestos
- the transit route and waste routes are free from any asbestos,
- all asbestos in the scope of the removal work has been removed and any known asbestos is intact.

.....Gerry Koukouvas.....

Name of Northern Trade Solutions Licensed Asbestos Supervisor/Competent Person

.....NTWS-AA-45196.....

Northern Trade Solutions Competent Person Licence number (if applicable)



.....

Signature of Licensed Asbestos/Competent Person

18th February 2016

Dear Sir,

Currently I am the authorised Tenement Manager for Earthworks NT Pty Ltd with the Northern Territory Titles Division.

Earthworks NT Pty Ltd Fill for the proposed sub division at Humpty Doo will be supplied from EWNT s approved Sunday Creek Extractive leases EMP's 22804, 1331, 27676, 22804, 27786 and 1316.

All of the above leases have an approved Mine Management Plan in place and are Virgin Ground

Yours faithfully,



Pedro Kastellorizos
Managing Director
Kastellco Geological Consultancy & Tenement Management
Mobile Number: 0427 482787