



*Lot 3002 Hardy Street, Denmark*

# **Remedial Action Plan**

**On behalf of  
Shire of Denmark**





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**Shire of Denmark**

Prepared By

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Vicki Davies  
Environmental Team Leader

Opus International Consultants (Australia) Pty  
Ltd  
Albany Office  
Frederick House, 70 - 74 Frederick Street  
PO Box 5236, Albany WA 6332  
Australia

Reviewed By

-----  
Jon English  
Associate Director - Environmental (UK)

Telephone: +61 8 9892 9600

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Approved for  
Release By

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Dr Danny Burkett  
Business Manager - Albany

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**ABBREVIATIONS**

ACM	Asbestos containing material
AF	Asbestos fines
ASLP	Australian Standard Leaching Procedures
BGL	Below ground level
BTEX	Benzene, toluene, ethylbenzene and xylene
BTEXN	Benzene, toluene, ethylbenzene, xylene and naphthalene
BH	Borehole
CEC	Cation exchange capacity
CLR11	Environment Agency Contaminated Land Report 11
CRC CARE	Cooperative Research Centre for Contamination Assessment and Remediation of the Environment
CSM	Conceptual Site Model
CT	Contaminant Thresholds
DEC	Department of Environment and Conservation
DER	Department of Environment Regulation
DQOs	Data quality objectives
DSI	Detailed Site Investigation
EILs	Ecological Investigation Levels
ESLs	Environmental Screening Levels
FA	Fibrous asbestos
HILs	Health Investigation Levels
HSLs	Health Screening Levels
LNAPL	Light non-phase aqueous liquid
MDD	Maximum dry density
NEPM	National Environment Protection Measures
OC	Organochlorine pesticides
OP	Organophosphorus pesticides
Opus	Opus International Consultants Limited Pty Ltd
QA	Quality Assurance
QC	Quality Control
PAHs	Polycyclic aromatic hydrocarbons
PCBs	Total polychlorinated biphenyls
PID	Photo-ionisation detector
PSD	Particle size distribution
RAP	Remedial Action Plan
ROA	Remedial Options Appraisal
SAP	Sampling and Analysis Plan
SAQP	Sampling and Analysis Quality Plan
SRV	Site Remediation and Validation
TP	Test Pit
TPH	Total petroleum hydrocarbon
TRH	Total recoverable hydrocarbon
UCL	Upper confidence limit
VOCs	Volatile organic compounds

# 1 Executive Summary

Opus International Consultants (Australia) Pty Ltd (Opus) have been engaged by the Shire Denmark to develop a Remedial Action Plan (RAP) for remediation of contaminated material at Lot 3002 Hardy Street, Denmark WA (“the Site”).

Lot 3002 was previously used as a Shire Depot by the Shire of Denmark when zoned as Reserve 34209 Lot 1024 Hardy Street. This site was used as a depot from 1964-65 to 1992 and had been subject to various potential contaminating activities. The Site is currently zoned Residential (Department of Planning 2015).

A “Report of a Known or Suspected Contaminated Site” (Form 1[r.6]) was submitted to the Department of Environment and Conservation (DEC) by Lionsville Denmark Inc. on 9 December 2010 subsequent to commencing excavation of the site for development of aged persons’ housing.

As at 29 August 2011 Lot 3002 Hardy Street was classified as “*Contaminated – remediation required*”.

At this stage development of aged persons’ housing has been put on hold until issues with contamination are resolved. The Shire of Denmark is now seeking to purchase the land from the State with the intention to remediate the site to a condition suitable for development of aged person’s housing. Amaroo Care Services Inc. has indicated to the Shire that, once remediated, they will purchase the land from the Shire to complete the development.

The remediation options assessed have been based on the findings of the Revised Detailed Site Investigation (DSI), Lot 3002 Hardy Street, Denmark prepared by Opus in 2015.

Uncontrolled Fill, buried Natural Topsoil and Natural Sand (where hydrocarbon impacted) have been identified via Tier 1 human health and ecological risk assessments to be potentially unsuitable for use from a human health and ecological protection perspective.

Risks to the receptors of relevant and possible pollutant linkages outlined in the revised CSM will be required to be mitigated. These are summarised as:

- Inhalation of vapours (indoor air) by future occupants;
- Root uptake/ direct contact with contaminants in the terrestrial ecosystem;
- Leaching of contaminants to groundwater and surface water (seasonal creekline to the east);
- Lateral and vertical migration of contaminated groundwater;
- Generation, migration and accumulation of ground gases inside properties leading to inhalation by occupants;
- Exposure of ground gases to construction workers during earthworks; and
- Aggressive attack by hydrocarbon contaminants on plastic building materials.

In addition:

- Uncontrolled fill may pose a risk to the structural integrity of buildings and associated infrastructure due to its unsuitable engineering properties i.e. decomposition of tree stumps may create underground voids; and
- Samples collected for asbestos analysis during the 2015 supplementary investigation did not detect presence of asbestos. However due to the nature of the Uncontrolled Fill identified there may be potential for risk of ‘pockets’ of asbestos containing material (ACM) to be located within the site.



The remediation objectives for Lot 3002 Hardy Street include the following:

- Break the relevant pollutant linkages for contaminants, identified in the conceptual site model, within:
  - Uncontrolled Fill;
  - Buried Natural Topsoil; and
  - Natural Sand (and Clay) (where hydrocarbon impacted).
- Provide a structurally sound site suitable for development of residential dwellings;
- Undertake site remediation works in a safe and sustainable manner with consideration for human health and ecological receptors.

It is considered that remediation of the site to break the relevant pollutant linkages will also address the possible pollutant linkages identified the Revised DSI (Opus 2015).

Remedial Targets have been developed for the clean-up of soil contamination and importation of clean fill at Lot 3002 Hardy Street and are based on the published Tier 1 generic assessment criteria presented in Tables 3-1 and 3-2.

The following scope of work has been undertaken for the purpose of the RAP for remediation of Lot 3002 Hardy Street, Denmark on behalf of the Shire of Denmark:

- Consult with the Department of Environment Regulation (DER) Contaminated Sites Branch;
- Develop procedures for implementation of the preferred remedial option (or combination of remedial options) identified in the ROA;
- Monitoring requirements;
- Risk management measures;
- Validation sampling;
- Reporting requirements for regulatory authorities

This RAP has been prepared in accordance with the requirements of DER guidelines, specifically *Assessment and Management of Contaminated Sites* (2014)

Based on the findings of the 2015 Revised DSI, the ROA and this RAP the following recommendations are proposed for the Shire of Denmark to undertake:

- Prepare a Health, Safety and Environment Plan (HSEP) prior to commencement of remedial works;
- Further investigation is required beneath the soil stockpile in the centre of the site as this overlies the former location of petrol and diesel fuel storage tanks. In addition, further investigation is also required on the land adjacent to the southern site boundary where materials are currently stockpiled and no access has been possible to date;
- Undertake remedial works in a safe manner that maximises the reuse of onsite material;
- Uncontrolled Fill and buried Natural Topsoil that is not structurally suitable shall be removed from the site and disposed of responsibly at a suitably permitted waste management facility;
- Based on the preferred remediation option by the Shire of Denmark the hydrocarbon contaminated proportion of the Uncontrolled Fill, an estimated volume of 2,500 m<sup>3</sup>, will not be screened and instead will be disposed of off-site by the Contractor in its entirety;
- Alternatively, if practical (and subject to favourable outcome of stakeholder consultation exercise), undertake ex situ bioremediation on a proportion of the hydrocarbon impacted soil;

- Assess whether an 80 m x 14 m size remediation pad (adjacent to the southern boundary) is practical given the Shires proposed design and sequencing of the remediation earthworks e.g. battered side slopes to the windrows will take up space, timeframes for remediation of the site etc.;
- Local government authority planning approval for undertaking bioremediation works onsite.
- Community consultation and notification will be required for surrounding residential properties prior to remediation site works;
- Upon removal of the full extent of the Uncontrolled Fill and the Natural Topsoil (Buried), samples of the natural soils should be collected and tested to demonstrate that the underlying soils are validated and structurally suitable for residential use;
- Actual waste classification is to be confirmed and agreed with the receiving landfill in advance of disposal;
- Replace deficit of fill with importation of certifiable clean fill, as per DER (2014) requirements, to provide a structurally sound site suitable for development of residential dwellings;
- Undertake all works, both on- and off-site, so as to minimise impact on the surrounding sensitive receptors including residences and the environment;
- If during the remediation earthworks, the ground conditions differ significantly from those encountered during the course of the investigations to date, including the discovery of any other odorous or visible contaminants, then this should be sampled, tested and dealt with appropriately;
- Undertaken pre, during and post site remediation groundwater quality monitoring;
- Proposed timeframes for remediation of the site is from August to December 2016; and
- On completion of the remediation earthworks a Site Remediation and Validation (SRV) report shall be prepared detailing the extent and effectiveness of the clean-up;
- The RAP and SRV are to be submitted to DER at completion of remedial works for reclassification of the site.

## 2 Introduction

### 2.1 Background

Opus have been engaged by the Shire Denmark to develop a RAP for remediation of contaminated material at Lot 3002 Hardy Street, Denmark WA.

Lot 3002 was previously used as a Shire Depot by the Shire of Denmark when zoned as Reserve 34209 Lot 1024 Hardy Street. This site was used as a depot from 1964-65 to 1992 and had been subject to various potential contaminating activities including: burial of waste; fuel storage in above ground and underground storage tanks; pesticide storage; and vehicle maintenance. Buildings were removed and activities associated with the maintenance of the site ceased when the site was vacated in 1982-84 and limited soil storage continued until 1992.

The Shire of Denmark transferred the land from its management to the State in 1997. The State, then, via the State Land Services transferred the management of the land to Lionsville Denmark Inc. for construction of aged persons' housing. A portion of Lot 3002 was also to be developed by Amaroo Care Services Inc.

However during site investigations for construction of sewer contaminated material, which was structurally unsuitable for construction, was intercepted and reported to the, then, Department of Environment and Conservation (DEC). On 24 January 2011 DEC classified the site as "*Possibly contaminated – investigation required*" (Appendix A).

A Detailed Site Investigation (DSI) was undertaken in 2011 by Opus on behalf of Lionsville Denmark Inc. Based on the findings of the DSI (Opus, 2011) the DEC reclassified the site, on 29 August 2011, as "*Contaminated – remediation required*" (Appendix A).

The development of aged persons' housing has been put on hold until issues with contamination are resolved.

In 2015 the DSI was revised (Opus 2015) based on new DER guidelines and supplementary site investigation.

The Shire of Denmark is now seeking to purchase the land from the State with the intention to remediate the site to a condition suitable for development of aged person's housing. Amaroo Care Services Inc. has indicated to the Shire that, once remediated, they will purchase the land from the Shire to complete the development.

Lionsville Denmark Inc. have confirmed to the Shire that Amaroo Care Services Inc. have taken over full responsibility for management of the units previously managed by Lionsville Denmark Inc and are no longer involved with the development of Lot 3002.

The remediation options assessed have been based on the findings of the Revised DSI, Lot 3002 Hardy Street, Denmark prepared by Opus in 2015.

## 2.2 Scope of Work

The following scope of work has been undertaken for the purpose of the RAP for remediation of Lot 3002 Hardy Street, Denmark on behalf of the Shire of Denmark:

- Consult with the Department of Environment Regulation (DER) Contaminated Sites Branch;
- Develop procedures for implementation of the preferred remedial option (or combination of remedial options) identified in the ROA;
- Monitoring requirements;
- Risk management measures;
- Validation sampling;
- Reporting requirements for regulatory authorities

This RAP has been prepared in accordance with the requirements of DER guidelines (DER 2014).

## 2.3 Site Identification and General Information

Site location:	Lot 3002 on Plan 45104, Hardy Street, Denmark WA
Number:	26 Hardy Street, Denmark WA
Reserve:	R34209
Certificate of Title:	LR3151/703 Refer to Appendix B
Land area:	8,907 m <sup>2</sup>
Current ownership:	Shire of Denmark
Locality Map:	Refer to Figure 2-1 and Appendix C
Local Government Authority:	Shire of Denmark
Town Planning Scheme:	Town Planning Scheme No. 3 (TPS3) gazetted on 25 March 1994
Current zoning:	Residential R20

Lot 3002 is located within the coordinate boundaries within the Shire of Denmark as outlined in Table 2-1. All coordinates are in GDA 1994 MGA Zone 50.

**Table 2-1: Co-ordinates of Lot 3002 Hardy Street, Denmark**

	<b>Easting (m)</b>	<b>Northing (m)</b>
NW corner	531 883	6 131 386
SW corner	531 729	6 131 341
NE corner	531 990	6 131 404
SE Corner	531 991	6 131 296

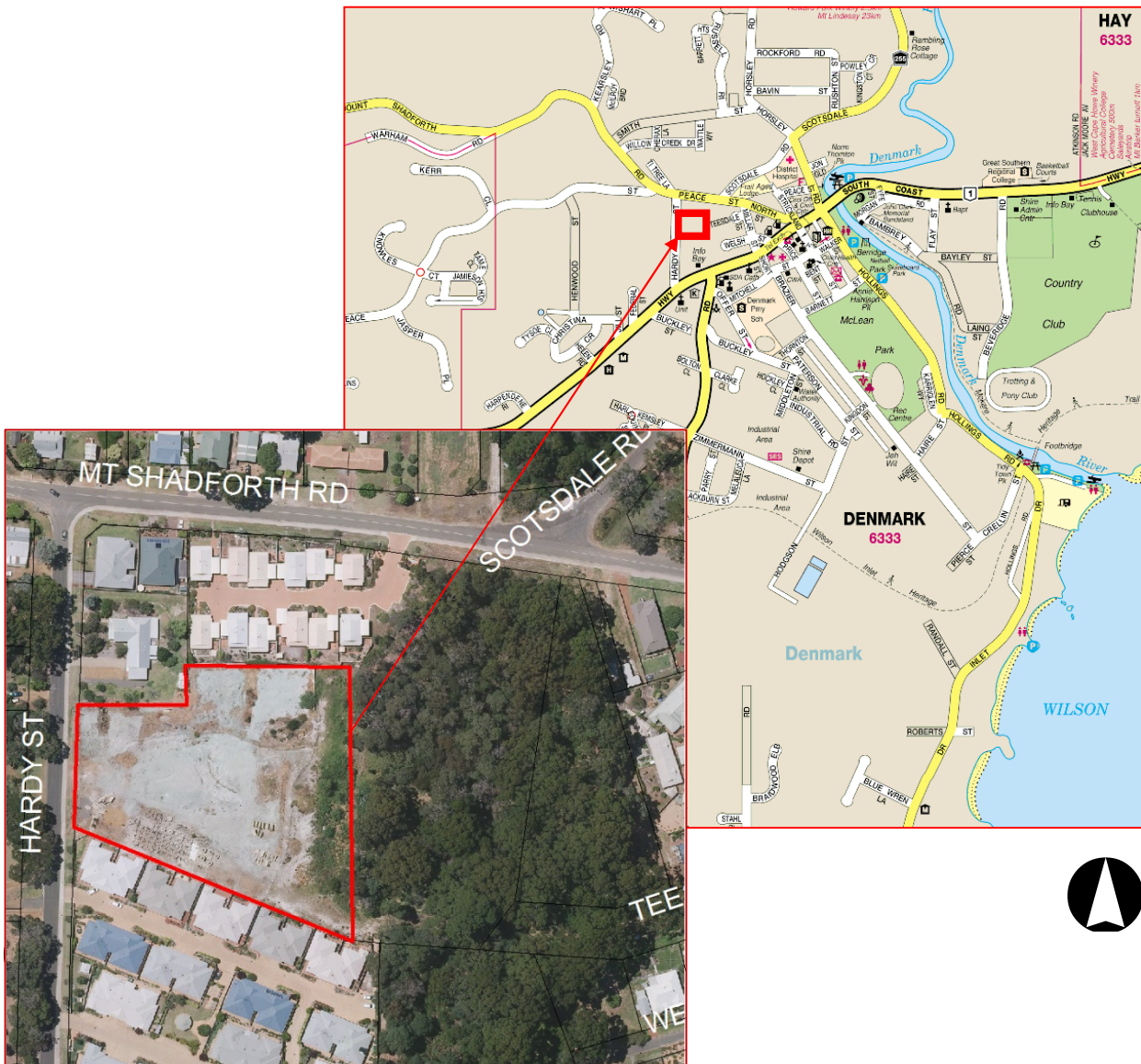


Figure 2-1: Locality Map of Lot 3002 Hardy Street, Denmark (not to scale).

## 2.4 Contaminated Site Classification

A “Report of a Known or Suspected Contaminated Site” (Form 1[r.6]) was submitted to the, then, Department of Environment and Conservation (DEC) by Lionsville Denmark Inc. on 9 December 2010.

DEC provided a Notice of a Classification of a Known or Suspected Contaminated Site given under Section 15 of the *Contaminated Sites Act 2003* with a classification of “Possibly contaminated – investigation required” on 24 January 2011. Restriction on Use included: “DEC recommends that further investigations and, if necessary, remedial works are completed before the site is redeveloped for residential use”.

Following submission of the DSI (Opus, 2011) to DEC the site was re-classified as “Contaminated – remediation required” as at 29 August 2011 with further information provided to DER in the Revised DSI (Opus 2015). Current Restriction on Use includes: “Further investigations and, remedial works are required before the site is redeveloped for residential use”.

DEC and DER correspondence has been provided in Appendix A.

## 2.5 Summary of Previous Investigations

### 2.5.1 Previous Investigations Pre-2011

Lot 3002 Hardy Street has been subject to a number of previous investigations, prior to the Opus DSI undertaken in 2011. The findings of these previous investigations are summarised in Table 2-2.

**Table 2-2: Summary of Previous Results for Lot 3002 Hardy Street, Denmark**

Previous Reports for Lot 3002 Hardy Street, Denmark	Summary of Previous Results
<p>Lionsville Aged Persons Homes Reserve 34209, Denmark.</p> <p>Prepared by Ayton, Talyor &amp; Burrell, April 1996</p> <p>[On site]</p>	<p>A report was developed by Ayton, Talyor &amp; Burrell to provide an overall concept plan for Stage 3 of the Lionsville Aged Persons Housing Complex. As a component of this report Wood &amp; Grieve Engineers completed a soil investigation for the site. This investigation reported that the “site is an old Council fill site which has had various quantities and quality of fill placed on it over the last 25 years”.</p> <p>The site was classified P in accordance with AS2870.1-1988, for sites containing fill. It was recommended that a minimum of 500 mm of clean sand fill should be placed over the site and footings should be designed in accordance with AS2870.1 – 1988 for a site classification P.</p>
<p>Lots bounded by Peace Street, Hardy Street and South Coast Highway, Environmental Review</p> <p>Prepared by Harrington Consultants in association with Ayton, Taylor &amp; Burrell and Wood &amp; Grieve Engineers, September 1997</p> <p>[On site and lots to the west/ north]</p>	<p>An Environmental Review was undertaken of lots bounded by Peace Street, Hardy Street and South Coast Highway for the proposed Rezoning Amendment 24 to Town Planning Scheme No. 3 by the Shire of Denmark. The purpose of the Environmental Review was to “confirm whether the land bounded by South Coast Highway, Hardy Street and Peace Street in Denmark was contaminated and whether this would also result in contamination of groundwater”. This review was requested by the Environmental Protection Authority as it was judged that the amendment may have a significant environmental impact.</p> <p>The review reported that “western portions of the site have largely been cleared and some landfill has occurred to create flat sites adjacent to Hardy Street. These areas have been used as a depot and storage sited by both Council and the Water Corporation. Uses included vehicle parking, maintenance and stockpiling of sand, gravel, blue metal and limestone for road making. Council advises that the land has not been used for waste disposal. Buildings were removed and activities associated with maintenance ceased and when the site was vacated in 1982-4, limited soil storage continued until 1992.”</p> <p>As a component of the Environmental Review a Health and Environmental Risk Assessment was undertaken by Harrington Consultants. During this assessment onsite soil and groundwater investigations were undertaken for contaminants. These investigations “reveal that the soils and water onsite are not contaminated and consequently no remedial action is required.” It is unknown, from the report, where exploratory boreholes were excavated across the site.</p>
<p>Water quality – Stormwater Discharge, Lionsville Housing Development, Lot 1024 Peace Street, Denmark</p> <p>Prepared by Shire of Denmark, January 2003</p> <p>[On site and lots to the west/ north]</p>	<p>One sample of water and one sample of sediment/sludge were collected from a subsoil drain discharge point at Lot 1024 Peace Street, Denmark.</p> <p>The samples were collected for chemical analysis following concerns about the quality of water and the presence of a red ochre substance transported in the water discharge.</p> <p>The analyst’s report from the Chemistry Centre, Department of Mineral and Petroleum Resources, advised that:</p> <ul style="list-style-type: none"> <li>• The solid material (sludge) is likely to be an iron oxide which is in solution and precipitates from solution when oxidising;</li> </ul>

Previous Reports for Lot 3002 Hardy Street, Denmark	Summary of Previous Results
	<ul style="list-style-type: none"> <li>• Although the water contained slightly elevated levels of iron, ammonia and hardeners it is of a quality suitable for drinking – with some treatment.</li> </ul> <p>It was concluded that the subsoil drainage water did not appear to present a public health or environmental hazard and could be discharged safely into the stormwater drainage system in the locality of the Lionsville Units.</p>
<p>Soil Conditions at Lot No 51 Hardy Street, Denmark</p> <p>Prepared by UTS Geotechnical, June 2004</p> <p>[Lot to the south]</p>	<p>Seven backhoe holes were excavated, spread over most of Lot 51 (Amaroo Village site). The site was found to be underlain by sands/sandy gravels, coffee rock and kaolinitic clays or sandy clays.</p> <p>Due to high kaolin content of soils the site was classified as ‘M’ according to AS2870.</p> <p>Some areas (adjacent to the southern boundary of Lot 3002) within the site were identified to contain deleterious material (0-500 mm BGL). It was recommended deleterious material was removed before the site was developed.</p>
<p>Lot 3002 Hardy Street, Site Visit Report</p> <p>Opus International Consultants, December 2010</p> <p>[On site]</p>	<p>A site visit was undertaken by Andrew Barker, Principal Project Engineer from Opus in Albany on 7th December 2010.</p> <p>In excavating the north east corner of the site, the Contractor had discovered unconsolidated fill material to a depth of around 2.0m. The fill material consisted of sand, gravel, clay, large laterite and granite boulders, building rubble such as concrete and bricks, metal and wire rope decomposed vegetative material and tree stumps. There was also some material with a strong hydrocarbon odour. Some of the tree stumps were of significant size and showing signs of rotting and decomposing. There was also evidence that the vegetative matter had decomposed into a peat like soil, high in organic content.</p> <p>The Contractor advised that he had undertaken some informal test pits across the remainder of the site to try and ascertain the extent of the fill material. He advised that the fill appeared to be spread across the majority of the site, however the depth of the fill varied. Generally the fill appears to be deepest in the north east corner, the depth to original soil generally reduces south and west across the site.</p> <p>Based on the site visit Opus strongly recommended that the site was not to be developed using the existing fill material. If the site was to be developed, it was recommended that the existing fill material be removed down to a suitable foundation level.</p> <p>Further advice was also recommended to be sought in relation to managing the waste/existing fill material. In general terms:</p> <ul style="list-style-type: none"> <li>• The material was recommended to be classified to DEC Contaminated Site Guidelines prior to removal off site.</li> <li>• The material should only be removed to an approved landfill site.</li> <li>• Further testing may be required prior to backfill to ensure contaminants do not present health risks on or beyond the site.</li> </ul>

## 2.5.2 Opus Detailed Site Investigation 2011

### 2.5.2.1 Soil Sampling Methodology

The 2011 DSI Sampling and Analysis Plan (SAP) is summarised as below:

- Advancement of 10 boreholes (ref: BH1 to BH10) by sonic drilling techniques to depths of between 0.35 m and 4.50 m below ground level (BGL);
- Advancement of 14 test pits (ref: TP1 to TP13 and TT9) located within nine trenches (ref: TT1 to TT9). The trenches/test pits were advanced by a mechanical excavator to depths of between 1.00m and 3.60 m BGL;
- Field headspace tests on recovered soil samples using a photo-ionisation detector (PID) to screen the soil for the presence of volatile organic compounds (VOCs); and
- Recovery of soil and water samples for chemical analysis in the laboratory including QA duplicate samples.

### 2.5.2.2 Laboratory Analysis Programme

The following laboratory analysis was undertaken in the 2011 DSI based on the historical potential sources of contamination likely to be present at the site:

- Heavy metals including arsenic, cadmium, chromium, copper, lead, nickel, zinc and mercury;
- Total polychlorinated biphenyls (PCBs);
- Organochlorine pesticides (OC);
- Organophosphorus pesticides (OP);
- Phenolic compounds;
- Polycyclic aromatic hydrocarbons (PAHs).
- Total petroleum hydrocarbons (TPHs).
- Benzene, toluene, ethylbenzene and xylene (BTEX).

### 2.5.2.3 Soil Profile

The ground conditions encountered during the 2011 DSI are summarised in Table 2-3. Detailed exploratory borehole logs are included in the 2015 Revised DSI.

**Table 2-3: Summary of Soil Profile for Sample Logs for Lot 3002 Hardy Street, Denmark (April 2011)**

Material	Average Depth Below Ground Level	Min and Max Depth Below Ground Level
Grey sand (Recent Fill).	0 mm – 500 mm	0 mm and 1000 mm
Compacted laterite gravel.	500 mm – 1000 mm	400 mm and 1100 mm
Unconsolidated fill containing limestone rubble, concrete, bricks, pieces of metal drums, metal wire, bottles, number plates, tree stumps, trunks and branches, laterite and granite boulders, hydrocarbon impact soil. (Uncontrolled Fill)	500 mm – 1500 mm	0 mm and 3000 mm
Natural topsoil with organic matter generally 200mm in depth (buried).	1500 mm – 1700 mm	1000 mm and 3200 mm
Natural loamy sand	1700 mm –	1300 mm and 3500 mm
Natural clay (observed in 4 locations)	2400 mm –	1600 mm and 3500 mm



#### 2.5.2.4 Groundwater

Anecdotal reports suggest that an ill-defined surface water drainage line was previously present within Lot 3002 prior to filling of the site. This drainage line flowed from southwest to northeast across the site.

During the site investigation in April 2011 subsurface flows were found to daylight in pit which had been previously excavated in the northeast corner of Lot 3002. One water sample was collected at this location.

#### 2.5.2.5 Soil and Water Laboratory Analysis Results

The interpretation of the soil and water analysis results from the 2011 DSI is not reproduced below given that the assessment criteria used at the time was superseded in 2013. Consequently the chemical analysis results from the 2011 DSI have been reassessed together with the results of the supplementary investigation undertaken in 2015.

In general terms, the 2011 DSI indicated the following:

- Visual and olfactory evidence of hydrocarbon contamination in the northern central portion of the site, within the Uncontrolled Fill in BH1 and in the Uncontrolled Fill and underlying buried Natural Topsoil in TT7\_TP12;
- The identified contaminants of concern in the soil exceeding Health Investigation Levels (HILs) were petroleum hydrocarbons associated with the Uncontrolled Fill and any natural soil underlying the hydrocarbon impacted Uncontrolled Fill. The HILs were exceeded in BH1, TT1\_TP1, TT1\_TP2, TT1\_TP3, TT6\_TP10 and TT7\_TP12;
- Dieldrin and zinc in some samples of the Uncontrolled Fill exceeded the at the time;
- Phenols, PCBs, PAHs and BTEX concentrations in the soil were low; and
- The one water sample collected and analysis did not exceed the respective freshwater quality guideline levels at the time.

#### 2.5.2.6 Conclusions

The 2011 DSI identified unacceptably elevated levels of contamination in the form of petroleum hydrocarbons in the soil requiring remediation. Recommendations included:

- Removal of the all the Uncontrolled Fill and buried Natural Topsoil material from the site, given both the geotechnical unsuitability and petroleum hydrocarbon contamination;
- Removal of the Natural Sand underlying the Uncontrolled Fill where this was also impacted by hydrocarbon contamination; and
- Further investigation to better ascertain the lateral and vertical extent of the contaminated soil requiring remediation.

### 2.5.3 Opus Revised Detailed Site Investigation 2015

In May 2013 the contaminated land assessment framework changed significantly at national and state levels in Australia. The DSI was revised in 2015 to include findings of supplementary intrusive investigation together with a reassessment of the 2011 site investigation data in accordance with current DER (2014) guidelines.

The following data quality objectives (DQOs) were developed in order to satisfy the intended purpose of the supplementary site assessment works:

- Better characterise the apparent hotspot of unacceptable hydrocarbon contamination in BH1, TT1, TT6 and TT7;
- Assess anticipated waste classification of Uncontrolled Fill, the buried Natural Topsoil and Natural Sand (where hydrocarbon impacted for off-site disposal);
- Confirm field observations that the fill at the site is not contaminated by asbestos;
- Obtain additional data to enable derivation of site-specific Ecological Investigation Levels (EILs);
- Assess likely suitability of stockpiled soil (source of origin unknown) for re-use on site;
- Better determine the thickness of the Made Ground and the interface with the natural stratum.

#### 2.5.3.1 Soil Sampling Methodology

The 2015 Revised DSI SAP is summarised as below:

- Advancement of five test pits (ref: TP 14 to TP 18 inclusive) using a mechanical excavator to depths of between 0.95 m and 3.60 m BGL;
- Field headspace tests on recovered soil samples using a PID to screen the soil for the presence of VOCs; and
- Recovery of soil samples for chemical analysis in the laboratory including QA duplicate samples.

#### 2.5.3.2 Laboratory Analysis Programme

As part of the assessment for potential contamination at the site, soil samples were subjected to appropriate chemical analysis based on the findings of the desk study and site works. For consistency purposes with the 2011 DSI, this analysis was carried out at the NATA accredited laboratory of ALS Environmental in Perth.

##### (a) In Situ Soils

Previous testing of the in situ soils undertaken during the 2011 DSI has indicated that PAHs, phenols, PCBs and OP pesticides, were only present at or below detection limits at the site. Also low concentrations of OC pesticides were detected at levels which under current assessment criteria are considered to be suitable for use.

Consequently, the suite of testing for the supplementary investigation was focussed on metals and petroleum hydrocarbons. Cation exchange capacity (CEC) and pH values were also analysed to enable the calculation of site-specific EILs. Metals were considered to be a potential issue for landfill disposal waste classification purposes, hence testing for metals and their leachability was also completed.

The in situ soil samples were scheduled for laboratory analysis for the following determinands:

- Asbestos (soil plus any fragments of bulk ACM if encountered);
- Total metals – chromium, nickel, lead and zinc;
- Benzene, toluene, ethylbenzene, xylene and naphthalene (BTEXN);
- Total recoverable hydrocarbons (TRH), tested in four fractions in accordance with NEPM requirements C6-C40;
- Australian Standard Leaching Procedures (ASLP) soil leaching test;
- Leachable metals – chromium (total), chromium (hexavalent) and lead;
- pH value;
- CEC.

### **(b) Soil Stockpile**

The samples of the stockpiled soil were scheduled for laboratory analysis for the following determinands:

- Asbestos (soil plus any fragments of bulk ACM if encountered);
- Total metals – arsenic, cadmium, chromium, nickel, lead and zinc;
- BTEXN;
- TRH tested in four fractions in accordance with NEPM requirements C6-C40;
- PAHs;
- Total PCBs;
- OC and OP pesticides;

Additionally, to assess the stockpiled material suitability for use as fill material two samples were collected from the existing stockpile for the following geotechnical testing:

- Particle size distribution (PSD);
- Plastic index and linear shrinkage testing;
- Maximum dry density (MDD).

### **(c) Water Samples**

Only groundwater seepages were encountered during the excavation, logging and sampling of the test pits during the 2015 supplementary investigation. Therefore no water samples were collected and analysed in the laboratory.

## 2.5.4 Tier 1 Risk Assessment

The soil and water chemical analysis data from both the 2011 DSI and 2015 supplementary investigation has been subjected to a Tier 1 risk assessment as per DER (2014) guidelines. Site specific EILs and generic HILs have been outlined in Section 13 of the Revised DSI (Opus 2015). A summary of the **individual** results that exceeded the EILs and HILs is shown in Table 2-4.

**Table 2-4: Summary of Soil Samples which Exceed Tier 1 Investigation and Screening Levels**

Sample ID	Sample Depth mm BGL	Soil Types	Determinand	Concentration Detected (mg/kg)	Tier 1 Assessment Criteria (mg/kg) (DER,2014)	Source of Assessment Criteria Exceeded
BH1 3000mm	3000- 3200 mm	Uncontrolled Fill	F3	<b>360</b>	300	ESL
TT1_TP1 1400mm	1400- 2100 mm	Natural sand	F3	<b>400</b>	300	ESL
TT1_TP3 800mm (Control 7 April)	800- 1200 mm	Uncontrolled Fill	F3	<b>620</b> <b>(650)</b>	300	ESL
TT7_TP12 2000mm	2000- 3000 mm	Natural topsoil – impacted by hydrocarbon - odour	F3	<b>1620</b>	300	ESL
TP14 3300 mm	3300 – 3600 mm	Natural sand	F3	<b>350</b>	300	ESL
TT1_TP1 1400mm	1400- 2100 mm	Natural sand	F2*	<b>540</b>	120	ESL
					240^	HSL vap
TT1_TP3 800mm (Control 7 April)	800- 1200 mm	Uncontrolled Fill	F2*	<b>100</b> <b>(140)</b>	120	ESL (duplicate only)
					110#	HSL vap (duplicate only)
TT7_TP12 2000mm	2000- 300 mm	Natural topsoil – impacted by hydrocarbon - odour	F2*	<b>120</b>	120	Equals ESL
TT4_TP7 2500mm	2000- 3000 mm	Uncontrolled Fill	Zinc	<b>243</b>	230	EIL
TT6_TP10 700mm	700- 1100 mm	Uncontrolled Fill	Zinc	<b>287</b>	230	EIL
TP15 1800	1800- 2400 mm	Uncontrolled Fill	Zinc	<b>321</b>	230	EIL

Table 7 Notes: Quality Control (QC) duplicate soil sample results in bracket

F2 = >C10 - C16 fraction minus naphthalene

F3 = >C16 –C34 fraction

^ HIL based on 1 to 2 m deep sample in sand

# HIL based on 0 to 1 m deep sample in sand

Several samples were also collected for asbestos analysis for fibrous asbestos (FA) and asbestos fines (AF), and this testing did not detect asbestos in any of the samples. Additionally, no bulk items of suspected ACMs were observed during the site investigations.

The Shire of Denmark have indicated that no asbestos buildings were demolished on site when the depot was closed and it is unlikely that asbestos was buried on site during the life of the depot.

Refer to the Opus 2015 Revised DSI for details regarding statistical analysis of metals.

#### **2.5.4.1 Human Health Risk Assessment**

The results of the petroleum hydrocarbon analysis have been compared directly to the respective Health Screening Levels (HSLs) and Management Limits.

Of 59 samples (44 in 2011 and 15 in 2015) analysed for TRH, two samples exceeded the HSL for F2 (C10–C16 fraction minus naphthalene) relating to vapour intrusion. No other Tier 1 HSL was exceeded in the samples analysed.

The two samples exceeding the HSL for vapour intrusion were both encountered in trial trench 1, in TP1 and TP3 respectively. These were samples of buried Natural Topsoil (TP1) and Natural Sand (TP3).

The results of the metals analysis have been subjected to statistical analysis with the exposure area used based on the various categories of soil types encountered during the investigation. The statistical assessment indicates that the 95 % upper confidence limit (UCL) of the arithmetic mean for all the soil types does not exceed the respective HILs. Therefore the metal concentrations in the soil are not considered to present a significant risk to human health for the proposed residential use.

#### **2.5.4.2 Ecological Risk Assessment**

Site specific Environmental Screening Levels (ESLs) have been outlined in Section 13 of the Revised DSI (Opus 2015). The results of the petroleum hydrocarbon analysis have been compared directly to the respective ESLs.

Of the 59 samples (44 in 2011 and 15 in 2015) analysed for TRH, five results exceeded the ESL for F3 (C16-C34 fraction) and two results exceed ESL for F2 (C10 – C16 fraction minus naphthalene). The exceedances of the ESLs were recorded in BH1, trial trench 1 (TP1 and TP3), trial trench 7 (TP12) and TP14.

The two results that exceeded ESL for F2 were recorded in TP3 and TP12, were the same soil samples that exceeded the ESL for F3. The soil material types exhibiting the elevated TPH concentrations comprised samples of the Uncontrolled Fill, buried Natural Topsoil and the Natural Sand.

The results of the metals analysis have been subjected to statistical analysis with the exposure area used based on the various categories of soil types encountered during the investigation. Whilst three samples of the Uncontrolled Fill exceeded the EIL for zinc, the statistical assessment indicates that the 95 % UCL for zinc of 156 mg/kg did not exceed the EIL of 230 mg/kg. The 95 % UCL for all the other soil types did not exceed the respective EILs. Therefore the metal concentrations in the soil are not considered to present a significant risk to the terrestrial ecosystem.

### 2.5.4.3 Water Sample Results

The results for the one sample of water tested have been compared directly to the both the assessment levels for water for fresh water values and in their absence drinking water guideline values. The results indicate that none of the determinands exceed the respective assessment levels (Opus 2015). It should be noted however that the limit of reporting for the pesticides is much higher than the assessment level itself.

### 2.5.5 Landfill Waste Classification

Given the potential requirement to dispose of the Uncontrolled Fill, Natural Topsoil (Buried) and Natural Sand materials off-site to landfill, the soil results have been compared to the waste classification criteria detailed in the DEC *Landfill Waste Classification and Waste Definitions 1996* (as amended December 2009).

The total soil results have been compared to the Contaminant Thresholds (CT) values in Table 2-5. All results are below CT1 Class 1 values with the exception of chromium and lead. In the case of chromium, the CT values are based on hexavalent chromium, whereas the majority of the laboratory data recovered is for total chromium so the results are not directly comparable.

**Table 2-5: Soil Results compared to Contaminant Thresholds for Landfill Waste Classification**

Soil Type	CT1 Class 1 (mg/kg)		Concentration Range Recorded (mg/kg)		No of Samples Tested	No. of Samplers Exceeding CT1	
	Chromium (hexavalent)	Lead	Chromium (total)	Lead		Chromium (total)	Lead
Uncontrolled Fill	10	2	<2-65	<5-205	21	13	19
Natural Topsoil			<2-18	<5-6	5	2	1
Natural Sand			<2-9	<5-12	17	0	8

Given that the CT values are based upon hexavalent rather than total chromium results, four soil samples of Uncontrolled Fill were analysed for both total and hexavalent chromium. The results of this analysis are summarised in Table 2-6 and indicate that the chromium present in the soil is likely to be the trivalent form (chromium III) rather than the more toxic hexavalent form (chromium VI).

**Table 2-6: Comparison of Soil Results for Total and Hexavalent Chromium for Waste Classification**

Sample Ref.	CT1 Class 1 (mg/kg)	Total Soil Concentrations Recorded (mg/kg)	
	Chromium (VI)	Chromium (total)	Chromium (VI)
TP17 0.4-0.6m	10	10	<0.5
TP14 1.4-2.0m		15	<0.5
TP14 2.1-2.3m		26	<0.5
TP15 1.1-1.8m		20	<0.5

Where CT1 Class 1 criteria are exceeded, the DEC waste classification guidelines require that leachable concentrations are determined using the ASLP soil leaching test protocols.

Soil leachate analysis for hexavalent chromium and lead was carried out on four soil samples of Uncontrolled Fill and the results of this are compared to the respective Leachable Concentration ASLP1 and Concentration Limit CL1 for Class 1 waste (Table 2-7).

**Table 2-7: Comparison of Results to Leachable Concentrations (ASLP1) and Concentration Limits (CL1)**

Sample Ref	Leachable Conc. ASLP1 (mg/l)		Conc. Limit CL1 (mg/kg)		Total Soil Conc. Recorded (mg/kg)		Soil Leachate Conc. Recorded (mg/l)	
	Cr (VI)	Pb	Cr (VI)	Pb	Cr (VI)	Pb	Cr (VI)	Pb
TP17 0.4-0.6m	0.5	0.1	500	1500	<0.5	9	<0.01	<0.01
TP14 1.4-2.0m					<0.5	62	<0.01	0.02
TP14 2.1-2.3m					<0.5	10	<0.01	<0.01
TP15 1.1-1.8m					<0.5	205	<0.02	<b>0.22</b>

None of the chromium (VI) soil results exceed either the ASLP1 or CL1. Only one of the three lead results exceeds the ASLP1 of 0.1 mg/l with 0.22 mg/l detected, but this is below the ASLP3 value of 5 mg/l. It should be noted that ASLP2 for lead is 0.1 mg/l, therefore is the same as ASLP1.

The above results indicate that three out of the four samples are likely to be classified as Class 1 waste, with only the sample from TP15 1.1-1.8 m classified as Class III waste.

In addition to the metals, Concentration Limits (CL1) are also prescribed for petroleum hydrocarbons and these have been compared to the TRH results recorded in Table 2-8.

**Table 2-8: Comparison of TRH Results to Concentration Limits (CL1)**

Soil Type	CL1 Class 1 (mg/kg)		Concentration Range Recorded (mg/kg)		No of Samples Tested	No. of Samplers Exceeding CL1	
	C16-C35 aromatics	C10-C35 aliphatics	C16-C34 aliphatics & aromatics	C10-C40 aliphatics & aromatics		C16-C34 aliphatics & aromatics	C10-C40 aliphatics & aromatics
Uncontrolled Fill	450	28,000	<100-1620	<50-2880	59	<b>3*</b>	0
Natural Topsoil							
Natural Sand							

Note: \* = potential exceedance of CL1 for C16-C35 aromatic fraction.

The CL1 carbon fractions are not directly comparable to the carbon fractions analysed in the TRH NEPM method. Where direct comparison is possible, the C10-C40 results do not exceed the CL1 for C10-C35 aliphatics. In the case of the C16-C34 results, three samples potentially exceed the CL1 for the C16-C35 aromatic fraction, but in the absence of further more detailed analysis to split the results into aliphatic and aromatic components, it is unclear whether this CL1 is actually exceeded or not.

### 2.5.6 Significance of the Contamination Identified

The combined findings of the 2011 DSI and 2015 supplementary investigation indicate that:

- Soil in the central and northern portion of the site is impacted by petroleum hydrocarbon contamination, exceeding human health screening levels for vapour intrusion into buildings and also ecological screening levels;
- Petroleum hydrocarbon impacted soils include the Uncontrolled Fill, the buried Natural Topsoil and the Natural Sand;
- The greatest hydrocarbon contamination appears to be located in the central, northern and eastern portions of the lot and may have been from drums or dumping on the ground over time;
- Uncontrolled Fill was also found to contain elevated zinc concentrations above ecological investigation levels in isolated locations, however, statistical analysis of all the zinc results for the Uncontrolled Fill, indicates that these are not significantly elevated overall;
- The Uncontrolled Fill and buried Natural Topsoil is not considered to be a suitable material from a geotechnical engineering requirement;
- It is provisionally considered that most of the hydrocarbon impacted Uncontrolled Fill, Natural Topsoil and Natural Sand can be disposed of to a Class 1 landfill as contaminated solid waste that meets the waste acceptance criteria for Class I landfills.
- A potential alternative to disposal to landfill is bioremediation of the hydrocarbon contamination at a soil treatment facility, although this alone will not improve the engineering properties of the soil. Bioremediation at an off-site location is considered likely to represent a prescribed process requiring a works approval in accordance with the *Environmental Protection Act 1986*;
- Based on the laboratory testing results, the Recent Fill material is considered to be suitable for the proposed residential use on-site.
- Four samples were tested from the stockpiled fill material, and no determinands analysed exceeded the health and ecological investigation/screening levels and on this basis is considered to be suitable for the proposed residential use.

It is recommended that:

- Actual waste classification is confirmed and agreed with the receiving landfill in advance of disposal. It should be noted that further soil sampling and analysis may be required by the receiving landfill site in order to confirm the waste classification;
- Uncontrolled Fill and buried Natural Topsoil is removed from the site and replaced by certifiably clean engineered fill material;
- Hydrocarbon impacted Natural Sand is also removed from the site at the same time as the Uncontrolled Fill and buried Natural Topsoil;
- Following removal of the hydrocarbon impacted material, the residual Natural Sand materials are considered likely to be suitable for the proposed residential use;
- Other remedial options (in addition to excavation and off-site disposal of the hydrocarbon contaminated soil) could be considered, such as on-site treatment technologies by a range of processes including bioremediation. The potential viability of other remediation methods should be undertaken as a remedial options appraisal exercise.

### 2.5.7 Site Plan – Extent of Contamination

Mapping has been developed to indicate the extent of Uncontrolled Fill and soil contamination exceeding selected assessment levels for each sampling depth (Appendix D).



## 2.6 2015 Revised Conceptual Site Model

### 2.6.1 Potential Sources of Contamination

The following potential on-site sources of ground contamination were identified in Table 2-9 as part of the DSI.

**Table 2-9: Potential Contamination Associated with Activities Previously Undertaken On-site**

Source	Activity	Potential Contaminants
Off site	Previous importation of Made Ground to the site to raise ground levels	Unknown
Former Shire Depot	Demolition of former buildings if carried out in an uncontrolled manner	Metals, PAHs and asbestos
	Bulk Storage of materials during its operation life such as storage of bitumen	PAHs
	Spills and leakages of petroleum hydrocarbons in above and/or below ground tanks and drums during its operational life	TPH, BTEX and PAHs
	Storage of pesticides, insecticides and herbicides during its operational life	Pesticides, insecticides and herbicides
	Maintenance of vehicles, such as lubricating oils, metals, asbestos from brake shoes and acids from batteries etc	TPH, BTEX, PAHs and asbestos
	Burial of waste on site, including drums, tins, wire, hydrocarbons and possibly vehicles	Potential contaminants of concern are wide ranging and could include metals, PAHs, TPH, BTEX, chlorinated solvents and asbestos
	Ground gases generated by biodegradable material buried at the site including timber, tree stump and vegetation. Also hydrocarbon vapours from any fuel spillages / tank leakages	Potential ground gases include methane (flammable and asphyxiant), carbon dioxide (asphyxiant) and hydrocarbon vapours

No significant potential off-site sources of contamination have been identified given that the surrounding land is currently predominantly residential and recreational. The former use of the surrounding land as part of the Shire Depot is likely to have comprised similar activities to that carried out on the site and resulted in similar sources of contamination as that on site. On site sources of contamination are therefore considered likely to be more significant than off-site sources.

### 2.6.2 Receptors of Contamination and Migration Pathways

Receptors are defined as human or non-human organisms that have the potential to experience adverse effects from direct or indirect exposure to contaminated material. Ecological receptors include flora and fauna and their terrestrial and aquatic habitats, such as surface watercourses and the groundwater that supplies them.

Migration pathways are defined as the courses chemicals take from a source to an exposed organism or receptor. The exposure pathway can be direct (i.e. stays within the same exposure media) or indirect transport from one medium to another takes place.

The following potential human health and ecological receptors were identified as part of the DSI:

- Future residents and staff of the proposed aged persons home;
- Terrestrial ecosystem (including flora, fauna, biota, predators);
- Karri and Marri trees and other native vegetation in the adjacent reserve;
- Site construction and maintenance workers;
- Groundwater underlying the site at shallow depth;
- Surface water associated with the seasonal creekline to the east;
- Building materials.

Potential migration pathways identified during the DSI are outlined in Table 2-10.

**Table 2-10: Potential Migration Pathways**

Potential Pathway	Risk
Inhalation	Human health can potentially be at risk from breathing dust and vapours from contaminated soil in the outdoor air and also the inhalation of fugitive dust inside buildings. Vapours from contaminated soil and groundwater can also migrate into buildings and be inhaled by the occupants.
Ingestion	Human health can be potentially at risk from eating and swallowing contaminated soil and groundwater. Ingestion can also occur by deliberately eating contaminated soil or indirectly by eating and smoking with dirty hands etc., or by ingestion of fugitive dust.
Dermal Contact	Human health can be potentially at risk from direct skin contact with contaminated soil and groundwater causing skin conditions such as dermatitis and also dermal contact with fugitive dust inside buildings. Certain contaminants can be absorbed into the body through the skin or enter directly through open cuts and abrasions.
Uptake by Plants, Vegetables and Fruit	Some contaminants may be toxic to plants (phytotoxic) but not necessarily to human health at the same concentrations. Also plants may uptake contaminants through their roots, which in the case of home-grown vegetables and fruit may be later consumed by humans. Contaminated soil adhered to vegetables and fruit can also be potentially ingested if not properly washed before consumption. Plant growth can also be adversely affected by ground gases.
Leaching	Infiltration of water through soil can leach out soluble contaminants resulting in groundwater pollution.
Migration of Contaminated Water	Depending on the permeability of ground conditions and any other man-made voids or preferential pathways, contaminated groundwater can potentially migrate laterally or vertically impacting adjacent surface and groundwater.
Leaking Tanks, Pipelines and Drains	Where cracks in tanks, pipelines and drains are present any contaminants such as hydrocarbons or contaminated drainage can escape and impact the surrounding soil and groundwater.
Migration of Ground / Hydrocarbon Vapours	Ground gases or volatile hydrocarbon vapours may migrate laterally or vertically through permeable or voided ground and accumulate within unprotected buildings.
Aggressive Attack	Some buildings and materials can be damaged by direct contact with aggressive ground condition, for example sulphate attack on concrete and hydrocarbon attack on plastics.

### 2.6.3 Pollutant Linkages

The term **relevant pollutant linkage** is defined as one that has been identified through risk assessment as representing unacceptable risks to human health or to ecological receptors. Where a relevant pollutant linkage has been identified above remediation is considered necessary in order to break the pathway between the contamination source, migration pathway and the receptor.

The term **possible pollutant linkage** is defined as one that has the potential to represent unacceptable risks to human health or to ecological receptors but has not been identified through risk assessment. Where a possible pollutant linkage has been identified above, further investigation and risk assessment may be required (as indicated by \* above) to establish whether a relevant pollutant linkage exists.

The findings of the DSI indicate that the following pollutant linkages outlined in Table 2-11 exist or do not exist, assuming the proposed residential development.

**Table 2-11: Pollutants Linkages**

Source	Pathway	Receptor	Possible Pollutant Linkage	Relevant Pollutant Linkage
Recent Fill	Ingestion Dermal contact Inhalation particulates	Future occupants	No	
		Construction workers	No	
Uncontrolled Fill	Ingestion Dermal contact Inhalation particulates	Future occupants	No	
		Construction workers	No	
Uncontrolled Fill	Inhalation of vapours (indoor air)	Future occupants		Yes <sup>#</sup>
		Construction workers	Yes	
Natural Topsoil (Buried)	Ingestion Dermal contact Inhalation particulates	Future occupants	No	
		Construction workers	No	
Natural Topsoil (Buried)	Inhalation of vapours (indoor air)	Future occupants	Yes* <sup>#</sup>	
		Construction workers	Yes	
Natural Sand (and Clay)	Ingestion Dermal contact Inhalation particulates	Future occupants	No	
		Construction workers	No	
Natural Sand (and Clay)	Inhalation of vapours (indoor air)	Future occupants		Yes <sup>#</sup>
		Construction workers	Yes	
Recent Fill	Root uptake	Terrestrial ecosystem	No	
		Trees and other vegetation in nearby reserve	No	
Uncontrolled Fill Natural Topsoil (Buried) Natural Sand (and Clay)	Root uptake/direct toxicity	Terrestrial ecosystem  Trees and other vegetation in nearby reserve	No	Yes <sup>#</sup>

Source	Pathway	Receptor	Possible Pollutant Linkage	Relevant Pollutant Linkage
Uncontrolled Fill Natural Topsoil (Buried) Natural Sand	Leaching	Groundwater  Surface water – seasonal creekline to the east	Yes*#	Yes#
Uncontrolled Fill Natural Topsoil (Buried) Natural Sand	Aggressive attack	Building materials	Yes*#	
Contaminated groundwater	Ingestion Dermal contact	Construction workers	No	
Contaminated groundwater	Inhalation (indoor air)	Future occupants  Neighbouring occupants	No*  No*	
Contaminated groundwater	Lateral and vertical migration via strata	Groundwater  Surface water – seasonal creekline to the east	No*  No*	
Contaminated groundwater	Lateral and vertical migration via man made pathways	Groundwater  Surface water – seasonal creekline to the east	No*  No*	
Contaminated groundwater	Aggressive attack	Building materials	No*	
Ground gases (on-site and off-site)	Generation, migration and accumulation inside properties  Exposure during earthworks	Future occupants  Construction workers	Yes*  Yes*	

\* - further site investigation would be required to prove pollutant linkage.

# - hydrocarbon impacted soils only are unsuitable

## 2.6.4 Pollutant Linkages and Requirements for Remediation

### 2.6.4.1 Relevant Pollutant Linkages

Relevant pollutant linkages include contaminants from the following sources:

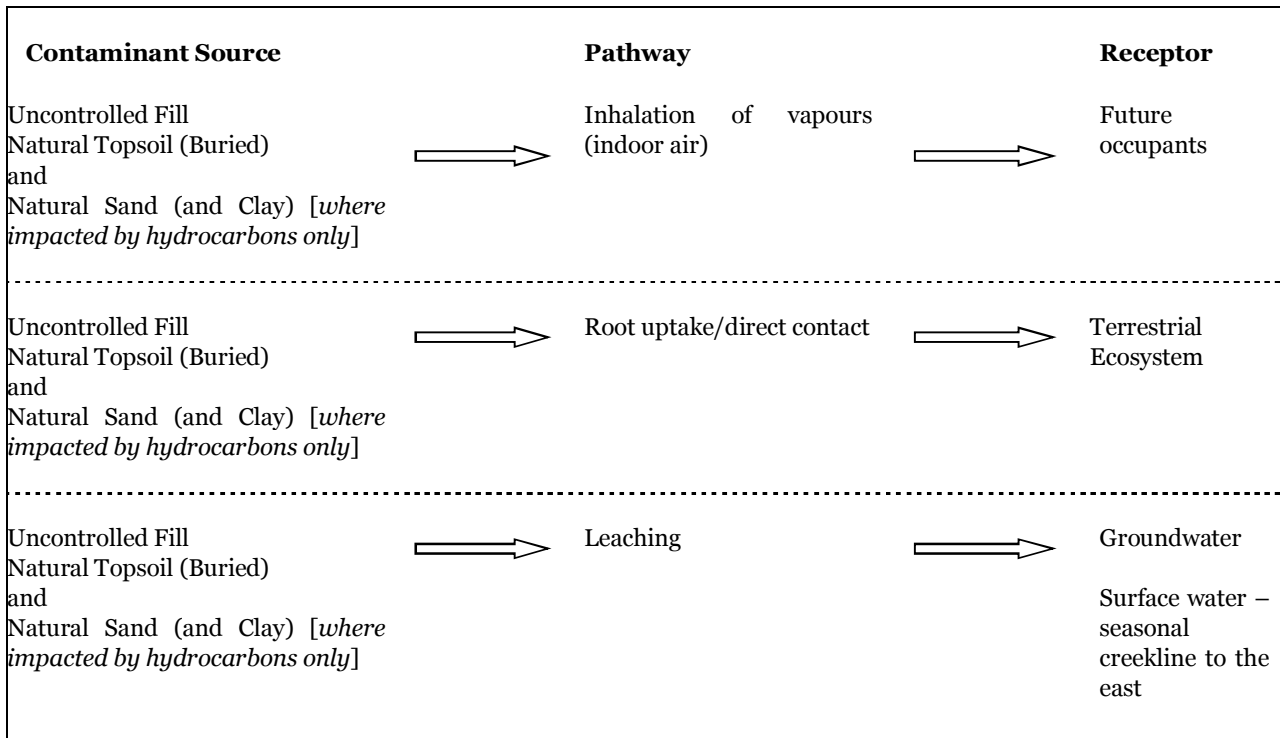
- Uncontrolled Fill;
- Buried Natural Topsoil; and
- Natural Sand (and Clay) where hydrocarbon impacted.

The Uncontrolled Fill and the buried Natural Topsoil (where hydrocarbon impacted) has been proven via a Tier 1 human health risk assessment to be potentially unsuitable for use due to the presence of elevated F2 (C10–C16 fraction minus naphthalene) concentrations.

The Uncontrolled Fill, buried Natural Topsoil and Natural Soil (where hydrocarbon impacted) has also been indicated via Tier 1 ecological risk assessment to present a potentially unacceptable risk to

the terrestrial ecosystem, including groundwater and surface water, due to the presence of elevated F2 and F3 (C16-C34 fraction).

Figure 2-2 represents the contaminant source, pathway and receptors for the relevant pollutant linkages.



**Figure 2-2: Relevant Pollutant Linkages**

Further Tier 2 risk assessment is not considered warranted as the preference of the proponent is to remove the unsuitable Uncontrolled Fill and Natural Topsoil (Buried) as it also has undesirable engineering properties. These materials together with any hydrocarbon impacted Natural Sand (and Clay) should also be remediated.

The proposed removal and off-site disposal of the Uncontrolled Fill, Natural Topsoil (Buried) and the hydrocarbon impacted Natural Sand will break the pollutant and linkage and protect future occupants of the aged persons’ housing.

It will be necessary to excavate and remove the overlying Recent Fill in a careful manner (so as not to cross contaminate it with the uncontrolled fill) and stockpile this material for future reuse. These works should be monitored full time on site by a suitably qualified Engineer. Upon removal of the full extent of the Uncontrolled Fill and the Natural Topsoil (Buried), samples of the natural soils should be collected and tested to demonstrate that the underlying soils are suitable for residential use.

**2.6.4.2 Possible Pollutant Linkages**

Possible pollutant linkages include, but may not be limited to, the following sources:

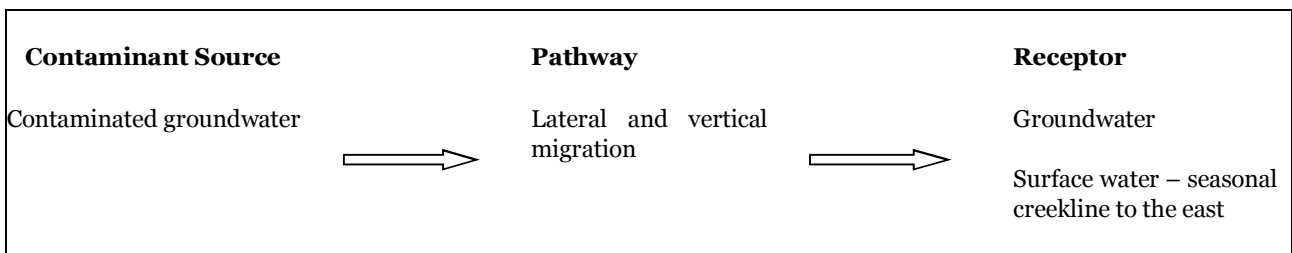
- Contaminated groundwater;
- Ground gases (on-site and off-site); and
- Hydrocarbon impacted soil

**Contaminated Groundwater**

No elevated dissolved concentrations of contaminants were detected in the groundwater during the DSI. However, it should be noted that only one water sample was collected and analysed from the open pit in the northeast of the site, which may not be representative of groundwater quality across the site.

Should visual and olfactory evidence of groundwater contamination be encountered during the removal of the unsuitable soils, then the quality of this water should be assessed and dealt with appropriately during these works. It is also considered prudent during the removal of the unsuitable soils to monitor of groundwater within the seasonal creek line (upstream and downstream of Lot 3002) located to the east of the site in Lot 3003 (Figure 2-3).

Again the removal of the unsuitable Uncontrolled Fill and the Natural Topsoil (Buried) will also remove the future source of pollution of the groundwater and surface water.



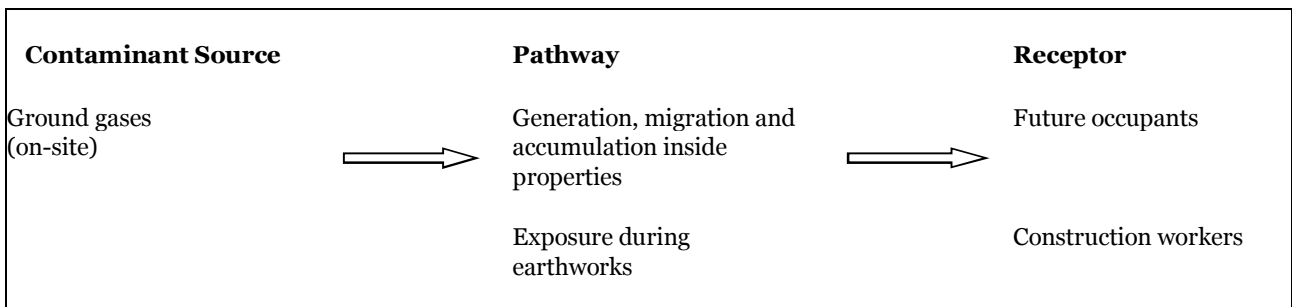
**Figure 2-3: Possible Pollutant Linkage Associated with Contaminated Groundwater**

**Ground Gases**

The Uncontrolled Fill and the Natural Topsoil (Buried) is considered to represent a potential source of methane and carbon dioxide ground gas, due to the presence of biodegradable materials, such as wood, tree trunks, vegetation and hydrocarbons (Figure 2-4).

Whilst no specific investigation or gas monitoring has been undertaken as part of the DSI, the removal of the full extent of the Uncontrolled Fill and the Natural Topsoil (Buried) will remove the potential on-site source of the ground gas and therefore mitigate the risk.

The Shire of Denmark has confirmed that the surrounding land was not used as a landfill. It is therefore assumed that only potential on-site sources of ground gas exist.

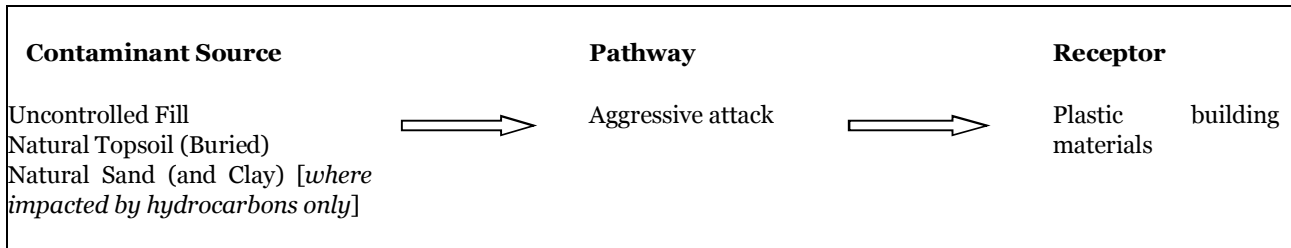


**Figure 2-4: Possible Pollutant Linkage Associated with Ground Gases**

## Hydrocarbon Impacted Soils

Certain hydrocarbons (particularly aromatic compounds) can permeate plastic water pipes and taint drinking water supplies. Other hydrocarbons can cause aggressive attack to plastic building materials (Figure 2-5).

However, the removal of the unsuitable Uncontrolled Fill, Natural Topsoil (Buried) and Natural Sand will also remove the source of hydrocarbons which could cause aggressive attack to plastic building materials.



**Figure 2-5: Possible Pollutant Linkage Associated with Hydrocarbon Impacted Soils**

## 2.7 Extent of Remediation Required

Uncontrolled Fill, buried Natural Topsoil and Natural Sand (where hydrocarbon impacted) have been identified via Tier 1 human health and ecological risk assessments to be potentially unsuitable for use from a human health and ecological protection perspective.

Risks to the receptors of relevant and possible pollutant linkages outlined in the revised CSM (Section 2.6) will be required to be mitigated. These are summarised as:

- Inhalation of vapours (indoor air) by future occupants;
- Root uptake/ direct contact with contaminants in the terrestrial ecosystem;
- Leaching of contaminants to groundwater and surface water (seasonal creekline to the east);
- Lateral and vertical migration of contaminated groundwater;
- Generation, migration and accumulation of ground gases inside properties leading to inhalation by occupants;
- Exposure of ground gases to construction workers during earthworks; and
- Aggressive attack by hydrocarbon contaminants on plastic building materials.

In addition:

- Uncontrolled fill may pose a risk to the structural integrity of buildings and associated infrastructure due to its unsuitable engineering properties i.e. decomposition of tree stumps may create underground voids; and
- Samples collected for asbestos analysis during the 2015 supplementary investigation did not detect presence of asbestos. However due to the nature of the Uncontrolled Fill identified there may be potential for risk of ‘pockets’ of ACM to be located within the site.

Given that the Uncontrolled Fill and buried Natural Topsoil also has undesirable engineering properties, Opus understands that it is the preference of the Shire of Denmark that these materials, together with any hydrocarbon impacted Natural Sand, are excavated and removed from the site.

It will be necessary to excavate and remove the overlying uncontaminated Recent Fill in a careful manner and stockpile this material for future reuse. These remediation earthworks should be monitored full time on site by a suitably qualified Engineer to ensure that the different material types are properly segregated and that the full extent of the contaminated materials are removed.

Upon removal of the full extent of the Uncontrolled Fill, Natural Topsoil (Buried) and hydrocarbon impacted Natural Sand, samples of the natural soils should be collected and tested by the Engineer to demonstrate that the underlying soils are suitable for residential use.

Based on the combined findings of the 2011 DSI and 2015 supplementary investigation the approximate quantities of unsuitable materials required to be removed are outlined in Table 2-12.

**Table 2-12: Approximate Material Quantities**

Material	Approximate Quantity	Description	Proposed Action
Recent Fill	3,600 m <sup>3</sup>	Overlying the unsuitable materials to be removed Uncontaminated grey sand Average depth 0 – 500 mm BGL Maximum depth: surface level to 1000 mm	Likely to be suitable for reuse on site
Compacted laterite gravel		Average depth 500 – 1000 mm BGL Minimum to maximum extent 400 mm – 1100 mm	Where uncontaminated reuse as replacement fill if it has structurally sound engineering properties for residential development
Uncontrolled Fill	8,400 m <sup>3</sup> (2,500 m <sup>3</sup> )	Unsuitable engineering properties for construction of residential dwellings (It is estimated that approximately 2,500 m <sup>3</sup> of the Uncontrolled Fill is contaminated by petroleum hydrocarbons)	Requires excavation, sorting, remediation and replacement with certified clean fill which has structurally sound engineering properties for residential development
Buried Natural Topsoil		Contaminated and unsuitable engineering properties for construction of residential dwellings	Requires excavation, sorting, remediation and replacement with certified clean fill which has structurally sound engineering properties for residential development
Natural Sand (and clay) – where hydrocarbon impacted only		Hydrocarbon impacted	Requires excavation, remediation and replacement with certified clean fill which has structurally sound engineering properties for residential development
Original stockpiled fill material	1,875 m <sup>3</sup>	Based on the results of the Tier 1 Assessment and geotechnical laboratory results (Opus 2015) the stockpiled fill material is considered to be suitable for the proposed residential use	Use as replacement fill
New stockpiled fill material sourced from Wilson Inlet cut	920 m <sup>3</sup>	Suitable for backfill based on the Remedial Targets in Table 3-1	Use as replacement fill



There will be a possible requirement to import approximately 6,500 m<sup>3</sup> of clean fill in order to fill the site to the current ground level. It should be appreciated that the above estimated quantities are very approximate as there is no topographic survey and the exploratory positions have not been accurately surveyed. The above volumes of materials are as measured in the ground and make no allowance for bulking upon excavation.

The Shire of Denmark's proposed timeframe for remediation of the site is from August to December 2016.

## 3 Remediation Objectives

### 3.1 Objectives

The remediation objectives for Lot 3002 Hardy Street include the following:

- Break the relevant pollutant linkages for contaminants, identified in the conceptual site model, within:
  - Uncontrolled Fill;
  - Buried Natural Topsoil; and
  - Natural Sand (and Clay) (where hydrocarbon impacted).
- Provide a structurally sound site suitable for construction of residential dwellings and associated infrastructure;
- Undertake site remediation works in a safe and sustainable manner with consideration for human health and ecological receptors.

It is considered that remediation of the site to break the relevant pollutant linkages will also address the possible pollutant linkages identified in Section 2.6.4.2.

### 3.2 Remedial Targets

The remedial targets applicable to for the clean-up of soil contamination at Lot 3002 Hardy Street are based on the published Tier 1 generic assessment criteria presented in Tables 3-1 and 3.2.

**Table 3-1: Remedial Targets for the Importation of Clean Soil to the Site**

Determinands	Maximum Acceptable Soil Concentration (mg/kg unless otherwise stated)	Source of Remediation Criteria
<b>Metals</b>		
Arsenic	100	EIL & HIL
Cadmium	20	HIL
Chromium (total)	100	HIL
Copper	95	EIL
Lead	300	HIL
Mercury	40	HIL
Nickel	30	EIL
Zinc	230	EIL
<b>Organics (% SOM)</b>		
Benzene	0.5	HSL
Toluene	85	ESL
Ethylbenzene	55	HSL
Xylenes	40	HSL
TRH C <sub>6</sub> -C <sub>10</sub> (F1)	45	HSL
TRH C <sub>10</sub> -C <sub>16</sub> (F2)	110	HSL
TRH C <sub>16</sub> -C <sub>34</sub> (F3)	300	ESL

Determinands	Maximum Acceptable Soil Concentration (mg/kg unless otherwise stated)	Source of Remediation Criteria
TPH C <sub>34</sub> -C <sub>40</sub> (F4)	2800	ESL
Naphthalene	3	HSL
Benzo(a)pyrene	0.7	ESL
Carcinogenic PAHs (TEQ)	3	HIL
Total PAHs	300	HIL
Phenols	3000	HIL
Aldrin & Dieldrin	6	HIL
DDT, DDD & DDE	180	EIL
Trans Chlordane	50	HIL
<b>Others</b>		
Asbestos (all forms)	<0.001	WA Guidelines

Notes:

1. EIL = Environmental Investigation Level where ABC = 0, pH = 7, CEC= 5 & CLAY =1 (NEPM Table 1B (1 to 5))
2. ESL = Environmental Screening Level for TPH fractions for coarse soil texture (NEPM Table 1B (6))
3. HIL = Health Investigation Level for residential use with gardens (NEPM Table 1A (1))
4. HSL = Health Screening Level for vapour intrusion, based on a sand soil type (0-<1m depth) for low density residential use (NEPM Schedule B12 Table 1A (3)).
5. WA Guidelines = Western Australia Department of Health Guidelines for the Assessment, Remediation and Management of Asbestos-Contaminated Sites in Western Australia – May 2009
6. The above acceptance criteria are based upon either maximum soil concentrations or alternatively 95% Upper Confidence Levels (apart from asbestos).

**Table 3-2: Remedial Targets for the Retention of Soil following Removal of the Contaminated Soil and the Reuse of Site Derived Soil**

Determinands	Maximum Acceptable Soil Concentration (mg/kg unless otherwise stated)	Source of Remediation Criteria
<b>Organics (% SOM)</b>		
TRH C <sub>6</sub> -C <sub>10</sub> (F1)	45	HSL
TRH C <sub>10</sub> -C <sub>16</sub> (F2)	110	HSL
TRH C <sub>16</sub> -C <sub>34</sub> (F3)	300	ESL
TPH C <sub>34</sub> -C <sub>40</sub> (F4)	2800	ESL
<b>Others</b>		
Asbestos (all forms)	<0.001	WA Guidelines

Notes:

1. ESL = Environmental Screening Level for TPH fractions for coarse soil texture (NEPM Table 1B (6))
2. HSL = Health Screening Level for vapour intrusion, based on a sand soil type (0-<1m depth) for low density residential use (NEPM Schedule B12 Table 1A (3)).
3. WA Guidelines = Western Australia Department of Health Guidelines for the Assessment, Remediation and Management of Asbestos-Contaminated Sites in Western Australia – May 2009
4. The above acceptance criteria are based upon either maximum soil concentrations or alternatively 95% Upper Confidence Levels (apart from asbestos).

## 4 Remedial Options Appraisal

### 4.1 Background

A **remedial option** is a means of reducing or controlling the health or environmental risks associated with a particular contaminant linkage. A **remedial action plan** (RAP) is a plan that involves one or more remedial options to reduce or control the risks from all significant contaminant linkages associated with the site.

A National Framework for Remediation and Management of Contaminated Sites in Australia is currently being developed through the Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC CARE). However, at this time no detailed national guidance on the evaluation of a wide range remedial options has been published. CRC CARE has published guidance on evaluating remedial options for specific clean-up technologies, such as Technical Report 18 '*Selecting and assessing strategies for remediation of light non-phase aqueous liquid (LNAPL) in soils and aquifers*' 2010. Opus has made reference to Technical Report 18, but as LNAPL not been identified at the Hardy Street site, this guidance is of limited applicability.

The DER guidelines (DER 2014) provides limited guidance on the evaluation of remedial options. The DER suggest that the following considerations should be taken into account when evaluating the potential applicability of available remedial for a particular site:

- The preferred hierarchy for site clean-up and/or management as described in Principle 16 of the NEPM;
- Environmental setting and surrounding land uses;
- Technical constraints – technical ability to remove, destroy or reduce (treat), contain or manage the substance(s) causing contamination and restore the relevant environmental values;
- Logistical constraints, such as site access, availability of materials and infrastructure and waste disposal;
- Site management issues that may arise from the preferred method(s);
- Acceptability of preferred method(s) to stakeholders, particularly owners of affected sites and neighbours;
- Sustainability, including waste minimisation.

In the absence of detailed national or state guidance on the evaluation of remedial options, reference has been made to the following international guidance:

- Environment Agency Contaminated Land Report 11 '*Model procedures for the management of land contamination*' 2004 (UK); and
- Federal Remediation Technologies Roundtable (FRTR) Remediation Technologies Screening Matrix, Version 4.0 (USA).

The Environment Agency Contaminated Land Report 11 (CLR11) recommends that prior to finalising the RAP and commencing remediation at a site, a remedial options appraisal (ROA) is undertaken. Options appraisal is the process of evaluating feasible remediation options and determining the most appropriate remediation strategy for the site.

## 4.2 Potential Remedial Options and Applicability

Reference has been made to Remediation Option Applicability Matrix: Organic Substances from CLR11. The various potentially applicable remediation options available are characterised into six categories in CLR 11:

- Civil engineering methods;
- Biological treatment methods;
- Chemical treatment methods;
- Physical treatment methods;
- Stabilisation and solidification treatment methods;
- Thermal treatment methods.

According to the matrix, the following remedial options in Table 3-1 below have potential applicability for the remediation of the hydrocarbon impacted soil at the Hardy Street site.

Consideration has been made for whether the remediation options are potentially applicable for the site-specific circumstances at Lot 3002 Hardy Street and if remediation of the hydrocarbon impacted soils could be undertaken within the proposed timeframes (Table 4-1).

**Table 4-1: Remediation Option Applicability Matrix**

Remedial Option	Applicability	Main Strengths	Main Weaknesses
<b>Civil Engineering Methods</b>			
Excavation and off-site disposal	✓	<ul style="list-style-type: none"> <li>• Total removal of contaminated material</li> <li>• Can be completed in fast timeframes</li> <li>• Suitable for shallow unsaturated zone</li> <li>• Suitable for both cohesive &amp; granular materials</li> <li>• Good opportunity to remove other contaminants to achieve structurally sound site for construction</li> <li>• Some suitable stockpiled soil exists on site for back filling the excavation</li> </ul>	<ul style="list-style-type: none"> <li>• Landfill rates may make this prohibitively expensive</li> <li>• Low sustainability</li> <li>• Replacement clean soil required to be imported and placed</li> </ul>
Excavation and off-site biological treatment (treated soil returned to site for reuse)	✓	<ul style="list-style-type: none"> <li>• Above average applicability for hydrocarbon fuels in soil</li> <li>• Moderate cost</li> <li>• Moderately sustainable given vehicle movements to/from site to off-site treatment location.</li> <li>• Opportunity to remove geotechnical unsuitable materials from the ground</li> </ul>	<ul style="list-style-type: none"> <li>• Results in partial treatment of contamination rather than complete treatment to background concentrations</li> <li>• Medium to long timescales several weeks</li> <li>• Availability of suitable off-site treatment facilities and suitably experienced contractors</li> <li>• Geotechnical unsuitable materials will still need to be disposed of off-site.</li> </ul>

Remedial Option	Applicability	Main Strengths	Main Weaknesses
Containment – cover systems	x	<ul style="list-style-type: none"> <li>• Breaks the root uptake/direct contact exposure pathway</li> <li>• Low cost compared to removal</li> <li>• Sustainable method</li> <li>• Short timescale</li> </ul>	<ul style="list-style-type: none"> <li>• Does not break the inhalation in indoor air pathway</li> <li>• Does not break the leaching to groundwater pathway</li> <li>• Does not treat/ remove source of contaminated material</li> <li>• Does not address structural issues</li> </ul>
Containment – in ground barriers	x	<ul style="list-style-type: none"> <li>• Basal liner barrier would break the leaching to groundwater pathway</li> </ul>	<ul style="list-style-type: none"> <li>• Only appropriate to prevent downward and vertical migration of contamination</li> <li>• Does not treat/ remove source of contaminated material</li> <li>• Extensive earthworks required to install a basal liner</li> </ul>
<b>Biological Methods</b>			
Biopiles (ex situ)	x	<ul style="list-style-type: none"> <li>• Above average applicability for hydrocarbon fuels in soil</li> <li>• Low to moderate cost</li> <li>• Relatively sustainable</li> <li>• Opportunity to remove geotechnical unsuitable materials from the ground</li> </ul>	<ul style="list-style-type: none"> <li>• Results in partial treatment of contamination rather than complete treatment to background concentrations</li> <li>• Large area of land required for treatment</li> <li>• Could be used to treat a portion of the hydrocarbon impacted soil onsite without need for DER Works Approval application</li> <li>• Dependent upon a satisfactory outcome of consultation with regulatory authorities and nearby owners and occupiers</li> <li>• Mechanical aeration, moisture content and nutrient regulation required</li> <li>• Design and operational requirements of biopiles are considered prohibitively complicated for the Shire of Denmark to implement in house</li> <li>• Medium to long timescales several weeks</li> <li>• Local planning approval may be required</li> </ul>

Remedial Option	Applicability	Main Strengths	Main Weaknesses
Windrow turning (ex situ)	✓	<ul style="list-style-type: none"> <li>• Above average applicability for hydrocarbon fuels in soil</li> <li>• Low cost</li> <li>• Very sustainable as low energy costs</li> <li>• Opportunity to remove geotechnical unsuitable materials from the ground</li> </ul>	<ul style="list-style-type: none"> <li>• Results in partial treatment of contamination rather than complete treatment to background concentrations</li> <li>• Large area of land required for treatment</li> <li>• Could be used to treat a portion of the hydrocarbon impacted soil onsite without need for DER Works Approval application</li> <li>• Dependent upon a satisfactory outcome of consultation with regulatory authorities and nearby owners and occupiers</li> <li>• Long timescales several weeks to months depending on level of contamination and remediation intensity</li> <li>• Weekly turning, moisture and nutrient control</li> <li>• Local planning approval may be required</li> </ul>
Landfarming (ex situ)	✘	<ul style="list-style-type: none"> <li>• Above average applicability for hydrocarbon fuels in soil</li> <li>• Low cost</li> <li>• Very sustainable as low energy costs</li> <li>• Opportunity to remove geotechnical unsuitable materials from the ground</li> </ul>	<ul style="list-style-type: none"> <li>• Results in partial treatment of contamination rather than complete treatment to background concentrations</li> <li>• Very large area of land required for treatment. The area of land required for landfarming makes this option unfeasible for on-site remediation</li> <li>• No requirement for DER Works Approval application for on-site treatment</li> <li>• Dependent upon a satisfactory outcome of consultation with regulatory authorities and nearby owners and occupiers</li> <li>• Long timescales several weeks to months depending on level of contamination and remediation intensity</li> <li>• Regular tilling, moisture and nutrient control</li> <li>• Local planning approval may be required</li> </ul>

Remedial Option	Applicability	Main Strengths	Main Weaknesses
Bioventing (in situ)	x	<ul style="list-style-type: none"> <li>• Above average applicability for hydrocarbon fuels in soil</li> <li>• Low cost to moderate cost</li> <li>• Relatively sustainable</li> </ul>	<ul style="list-style-type: none"> <li>• Results in partial treatment of contamination rather than complete treatment to background concentrations</li> <li>• Long timescales several months</li> <li>• No opportunity to remove geotechnical unsuitable materials from the ground</li> </ul>
<b>Chemical Methods</b>			
Soil flushing (ex situ) / Solvent extraction (in situ)	x	<ul style="list-style-type: none"> <li>• Average applicability for hydrocarbon fuels in soil</li> <li>• Short timescales</li> </ul>	<ul style="list-style-type: none"> <li>• Results in partial treatment of contamination rather than complete treatment to background concentrations</li> <li>• Expensive</li> <li>• Limited commercial availability</li> </ul>
In situ chemical oxidation	x	<ul style="list-style-type: none"> <li>• Below average applicability for hydrocarbon fuels in soil</li> <li>• Short timescales</li> </ul>	<ul style="list-style-type: none"> <li>• Results in partial treatment of contamination rather than complete treatment to background concentrations</li> <li>• Expensive</li> <li>• Limited commercial availability</li> </ul>
<b>Physical Methods</b>			
Soil vapour extraction (in situ)	x	<ul style="list-style-type: none"> <li>• Hydrocarbon contaminated material is insufficiently volatile for SVE</li> <li>• Sustainable method</li> <li>• Applicable as part of a treatment train</li> </ul>	<ul style="list-style-type: none"> <li>• Results in partial treatment of contamination rather than complete treatment to background concentrations</li> <li>• Contaminated off gas requires collection, treatment and disposal</li> <li>• Long timescales</li> </ul>
Soil washing (ex situ)	x	<ul style="list-style-type: none"> <li>• Average applicability for treatment of hydrocarbon fuels</li> <li>• Sustainable method</li> </ul>	<ul style="list-style-type: none"> <li>• Results in partial treatment of contamination rather than complete treatment to background concentrations</li> <li>• Large area of land required for treatment</li> <li>• Wastewater generated that requires treatment and disposal</li> <li>• Limited commercial availability</li> </ul>



Remedial Option	Applicability	Main Strengths	Main Weaknesses
<b>Stabilisation and Solidification Methods</b>			
Hydraulic binders (e.g. cement) (in situ or ex situ)	✘	<ul style="list-style-type: none"> <li>• Below average applicability for treatment of hydrocarbons</li> </ul>	<ul style="list-style-type: none"> <li>• Results in a volume expansion of material</li> <li>• Treated material becomes hard like cement so difficult to excavate and work with</li> <li>• Expensive</li> </ul>
<b>Thermal Methods</b>			
Incineration (ex situ)	✘	<ul style="list-style-type: none"> <li>• Total removal of contaminated material</li> <li>• Can be completed in fast timeframes</li> </ul>	<ul style="list-style-type: none"> <li>• Cost of incineration may make this prohibitively expensive</li> <li>• Ash requires disposal after incineration</li> <li>• Low sustainability</li> <li>• Replacement clean soil required to be imported and placed</li> </ul>
Steam injection/ Electrical resistance heating/ Radio frequency and microwave heating (ex situ)	✘	<ul style="list-style-type: none"> <li>• Above average applicability for treatment of hydrocarbons</li> </ul>	<ul style="list-style-type: none"> <li>• Low sustainability regarding energy use</li> <li>• Expensive</li> <li>• Results in partial treatment of contamination rather than complete treatment to background concentrations</li> <li>• Limited commercial availability</li> </ul>

### 4.3 Evaluation of Shortlisted Remedial Options

As one of the objectives of is to provide structurally sound soils for construction of dwellings at the site it is considered that active remediation, rather than onsite management, of contamination is appropriate.

The following remediation options have been shortlisted and a detailed evaluation of options is provided in Table 4-2:

- Do nothing;
- Excavation and off-site disposal;
- Excavation and off-site bioremediation with treated material returned to site; and
- Ex situ bioremediation undertaken on site (e.g. biopiles or windrows).

With regards to the potential application of bioremediation, the Contaminated Sites Guidelines (DER 2014) states:

*“Bioremediation, when appropriately managed, can be an environmentally sound and cost effective method of treating contaminated soils containing certain organic compounds.”*

However, in relation to ex situ bioremediation, the guidelines state:

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*“The location and construction of bioremediation facilities should be carefully considered to avoid negatively impacting the surrounding environment and the community. Guidance on site selection and other considerations for establishing and managing a bioremediation facility is provided in Best Practice Note: Landfarming published by New South Wales Environment Protection Authority (NSW EPA 2014).*

*Bioremediation facilities should incorporate contemporary emission and control systems. DER expects that effective stakeholder engagement will be undertaken by proponents prior to constructing a bioremediation facility. It is generally not advisable to construct bioremediation facilities in close proximity to sensitive land uses such as residential areas, child care centres, schools or public open spaces or sensitive environmental receptors.”*

It is understood the following evaluation of the options has been undertaken on the basis that, for active remediation of the site, the Shire of Denmark will seek to purchase Lot 3002 from the State and that Amaroo Care Services Inc. will purchase the site once remediated.

Table 4-2: Detailed Evaluation of Options

Remedial Option	Location	Description	Opportunities/ Constraints			Net Outcome
			Environmental	Economic	Social	
<b>Do nothing</b>						
No remediation undertaken	<b>Lot 3002 Hardy Street, Denmark</b>	Contaminated materials to remain in situ untreated	Human health and Ecological risk due to in situ contamination and potential offsite contamination downslope to surrounding reserve, residential properties and ultimately to the Denmark River.  Requirements as per the <i>Contaminated Sites Act 2003</i> .	In its current state the site is considered to be structurally unsuitable for construction of infrastructure  As a vacant lot there would be no generation of rates income  No costs associated with remediation works (excavation and replacement fill)  Costs: <ul style="list-style-type: none"> <li>- Loan taken over from Lionsville Denmark Inc. – existing debt acquisition</li> <li>- Ongoing water rates, temporary fencing and dust suppression</li> </ul>	Vacant lot unattractive to surrounding residences, possibly effecting property values  No remediation of the site would:  <i>“Deny the community the opportunity of making use of a highly valuable and strategic lot highly suitable for the intended purpose of the senior citizens centre and additional 24 seniors’ units.</i>  <i>Council continues to receive complaints in relation to dust and water coming from the site causing inconvenience and consternation to neighbours.</i>  <i>The proposed Senior Citizens Facility would be available not just to the residents of Amaroo but to the seniors of Denmark in general.”</i> (Shire of Denmark 2012)	No economic benefit from vacant land  Unacceptable risk to human health and ecological protection for any future development on site and also down slope groundwater bore users, creekline and ultimately Denmark River
<b>Excavation and off-site disposal</b>						
Excavation and offsite disposal to landfill  Replacement with certified clean fill suitable for construction of residential dwellings	Shire of Denmark <b>McIntosh Road Waste Transfer Station Facility</b>  46 McIntosh Road, Denmark  Being Lot 7397 on Plan 193805  DER Licence: L6862/1997/11	Located approx. 6 km from Lot 3002  Class I inert landfill site	The geotechnically unsuitable materials will need to be segregated and disposed of at alternative facilities.  The buried tree stumps would be burnt at the McIntosh Road site.  The metal content can potentially be recycled.  The brick and concrete could potentially be recycled or disposed of as Class I waste if it cannot be used as daily cover.  Excavated material may need to be mixed with clean fill to reduce concentrations to Class I levels.	No fees for disposal of Class I material that can be used as daily cover.  However this site does not accept enough waste input to warrant that much daily cover material to be stored on site  Costs: <ul style="list-style-type: none"> <li>- Excavation costs</li> <li>- Transport costs to landfill (empty truck on return run to Denmark)</li> <li>- Water rates, temporary fencing and dust suppression during site remediation works</li> <li>- Cost purchase and transport of addition replacement fill material to site</li> <li>- Laboratory analysis of soil samples to validate Class I levels</li> </ul>	Dust and water generation off site may cause issues for neighbouring properties during earthworks at Lot 3002  Disposal site already a waste facility so unlikely to have social issues	Lowest transportation costs however there is limited requirement for cover material at this site

Remedial Option	Location	Description	Opportunities/ Constraints			Net Outcome
			Environmental	Economic	Social	
	<p>Shire of Plantagenet</p> <p><b>Mount Barker Waste Management Facility</b></p> <p>O'Neill Road, Mount Barker</p> <p>Being Crown Reserve 23969</p> <p>DER Licence: L7026/1997/14</p>	<p>Located approx. 65 km from Lot 3002</p> <p>Class II or Class III putrescible landfill site</p>	<p>The geotechnically unsuitable materials will need to be segregated and disposed of at alternative facilities.</p> <p>The buried tree stumps would be burnt.</p> <p>The metal content can potentially be recycled.</p> <p>The brick and concrete could potentially be recycled or disposed of as Class I waste if it cannot be used as daily cover.</p> <p>Emissions from transport via truck higher than compared to a closer site.</p> <p>Excavated material may need to be mixed with clean fill to reduce concentrations to Class I levels.</p>	<p>No fees for Class I material that can be used as daily cover – Shire of Plantagenet require additional cover material</p> <p>Costs:</p> <ul style="list-style-type: none"> <li>- Excavation costs</li> <li>- Transport costs to landfill</li> <li>- Clean replacement fill can be purchased from the Waste Management Facility site (full truck on return run to Hardy Street, Denmark)</li> <li>- Water rates, temporary fencing and dust suppression during site remediation works</li> <li>- Laboratory analysis of soil samples to validate Class I levels</li> </ul>	<p>Dust and water generation off site may cause issues for neighbouring properties during earthworks at Lot 3002</p> <p>Disposal site already a waste facility so unlikely to have social issues</p>	<p>Highest transportation costs however this is offset against no landfill fees and full return load of replacement fill</p>
	<p>City of Albany</p> <p><b>Albany Refuse Site</b></p> <p>37 Maxwell Street, Mount Melville</p> <p>Being Lot 1135 on Plan 208775 and Lot 202 on Plan 76615</p> <p>DER Licence: L6925/1997/9</p>	<p>Located approx. 52 km from Lot 3002</p> <p>Class II or Class III putrescible landfill site</p>	<p>The geotechnically unsuitable materials will need to be segregated and disposed of at alternative facilities.</p> <p>The buried tree stumps would be burnt at the Bakers Junction site.</p> <p>The metal content can potentially be recycled.</p> <p>The brick and concrete could potentially be recycled or disposed of as Class I waste if it cannot be used as daily cover.</p> <p>Emissions from transport via truck higher than compared to a closer site.</p> <p>Excavated material may need to be mixed with clean fill to reduce concentrations to Class I levels.</p>	<p>Costs:</p> <ul style="list-style-type: none"> <li>- Excavation costs</li> <li>- Transport costs to landfill (empty truck on return run to Denmark)</li> <li>- Water rates, temporary fencing and dust suppression during site remediation works</li> <li>- Contaminated Solid Waste (DER approved) \$200/ tonne</li> <li>- Cost purchase and transport of addition replacement fill material to site</li> <li>- Laboratory analysis of soil samples to validate Class I levels</li> </ul>	<p>Dust and water generation off site may cause issues for neighbouring properties during earthworks at Lot 3002</p> <p>Disposal site already a waste facility so unlikely to have social issues</p>	<p>Highest transportation costs and landfill fees</p>

Remedial Option	Location	Description	Opportunities/ Constraints			Net Outcome
			Environmental	Economic	Social	
	<p><b>Denmark Air Park</b></p> <p>22 Wrightson Road</p> <p>Reserve 41390 Being Lot 8027 on Plan 194711</p>	<p>Located approx. 6 km from Lot 3002</p> <p>Mix geotechnically suitable material, excavated from Lot 3002 at the Air Park site, with clean material for reuse as fill for hangars and internal roads</p> <p>4,000 m<sup>2</sup> of paved area required for mixing and storage</p>	<p>The geotechnically unsuitable materials will need to be segregated and disposed of at alternative facilities.</p> <p>The buried tree stumps would be transported to and burnt at the McIntosh Road site.</p> <p>The metal content can potentially be recycled.</p> <p>The brick and concrete could potentially be recycled or disposed of as Class I waste if it cannot be used as daily cover.</p> <p>Excavated material may need to be mixed with clean fill to reduce concentrations to Class I levels for use within the Air Park as fill.</p> <p>Leachate collection required.</p> <p>Denmark Agriculture School pasture land down slope of the airport.</p> <p>DER Works Approval (to construct) and licence (to operate) for a Class I site required.</p> <p>Temporary hardstand, bunding and stormwater control required for mixing soils onsite.</p> <p>Site clean-up requirements.</p>	<p>Costs:</p> <ul style="list-style-type: none"> <li>- Excavation costs</li> <li>- Transportation costs – possibility of clean fill being obtained from the Air Park site (full truck on return run to Hardy Street, Denmark)</li> <li>- Water rates, temporary fencing and dust suppression during site remediation works</li> <li>- Civil design and Environmental Consultants costs to develop DER Works Approval for Class I landfill</li> <li>- DER Works Approval fees</li> <li>- Capital costs (temporary hardstand, bunding and stormwater control etc.)</li> <li>- Cost purchase and transport of addition replacement fill material to site</li> <li>- Laboratory analysis of soil samples to validate Class I levels</li> </ul>	<p>Dust and water generation off site may cause issues for neighbouring properties during earthworks at Lot 3002</p> <p>Airport Association generally supportive of mixing contaminated soil on a hardstand at the airport</p> <p>Concerned that the area becoming a long term storage area</p>	<p>DER Works Approval (to construct) and licence (to operate) for a Class I site required</p> <p>Formal comment from DER would be required regarding Works Approval and Licencing requirements or approvals via an alternative mechanism</p>
<b>Excavation and off-site bioremediation</b>						
Airport - Bioremediation	<p><b>Denmark Air Park</b></p> <p>22 Wrightson Road</p> <p>Reserve 41390 Being Lot 8027 on Plan 194711</p>	<p>Located approx. 6 km from Lot 3002</p> <p>Carefully segregate contaminated material and geotechnically unsuitable material from uncontaminated soil</p> <p>Mix material, excavated from Lot 3002 at the Air Park site, for bioremediation of soils over time</p> <p>4,000 m<sup>2</sup> of paved area required for mixing and storage</p> <p>Reuse treated and uncontaminated soil as replacement fill</p> <p>Deficit of back fill would be required to be purchased</p>	<p>The geotechnically unsuitable materials will need to be segregated and disposed of at alternative facilities.</p> <p>The buried tree stumps would be burnt at the McIntosh Road site.</p> <p>The metal content can potentially be recycled.</p> <p>The brick and concrete could potentially be recycled or disposed of as Class I waste.</p> <p>DER Works Approval (to construct) and licence (to operate) for Category 67A Premises (compost manufacturing and soil blending).</p> <p>Temporary hardstand, bunding and leachate required for turning contaminated material onsite.</p> <p>Denmark Agriculture School pasture land down slope of the airport.</p> <p>Site clean-up requirements.</p> <p>Time scales for bioremediation of hydrocarbons likely to be prohibitively slow.</p> <p>Good sustainability option with regard to reuse of materials</p>	<p>Costs:</p> <ul style="list-style-type: none"> <li>- Transportation costs – possibility of clean fill being obtained from the Air Park site (full truck on return run to Hardy Street, Denmark)</li> <li>- Civil and Environmental Consultants costs to develop DER Works Approval for Category 67A Premises (compost manufacturing and soil blending)</li> <li>- DER Works Approval fees</li> <li>- Capital works costs for temporary hardstand, bunding and leachate collection</li> <li>- Purchase cost of replacement fill</li> </ul>	<p>Airport Association generally supportive of mixing contaminated soil on a hardstand at the airport</p> <p>Concerned that the area becoming a long term storage area</p>	<p>DER Works Approval (to construct) and licence (to operate) for Category 67A Premises (compost manufacturing and soil blending)</p> <p>Formal comment from DER would be required regarding Works Approval and Licencing requirements or approvals via an alternative mechanism</p> <p>Timeframes for treatment may not meet Shire's requirements</p> <p>Excavation and reuse of appropriate uncontaminated material could be used as part of the treatment train</p>

Remedial Option	Location	Description	Opportunities/ Constraints			Net Outcome
			Environmental	Economic	Social	
Excavation and off-site treatment of soil by bioremediation, with treated soil reused at disused gravel pit for site rehabilitation  Replacement with certified clean fill suitable for construction of residential dwellings	<b>Disused gravel pit Sunny Glen Road, Denmark</b>	<p>Located approx. 10 km from Lot 3002</p> <p>Carefully segregate contaminated material and geotechnically unsuitable material from uncontaminated soil</p> <p>Mix material, excavated from Lot 3002 at the former gravel pit site, for bioremediation of soils over time</p> <p>Reuse treated and uncontaminated soil as replacement fill</p> <p>Deficit of back fill would be required to be purchased</p>	<p>The geotechnically unsuitable materials will need to be segregated and disposed of at alternative facilities.</p> <p>The buried tree stumps would be burnt at the McIntosh Road site.</p> <p>The metal content can potentially be recycled.</p> <p>The brick and concrete could potentially be recycled or disposed of as Class I waste.</p> <p>DER Works Approval (to construct) and licence (to operate) for Category 67A Premises (compost manufacturing and soil blending).</p> <p>Temporary hardstand, bunding and leachate required for turning contaminated material.</p> <p>Reuse treated material within the former gravel pit site as a component of site rehabilitation – this would be subject to the general provisions of the EP Act.</p> <p>Risk of contaminating a “clean” site.</p> <p>Tree trunks and stumps could be used as habitat within the rehabilitation works.</p> <p>Good sustainability option with regard to reuse of materials</p>	<p>Costs:</p> <ul style="list-style-type: none"> <li>- Transportation costs</li> <li>- Civil and Environmental Consultants costs to develop DER Works Approval for Category 67A Premises (compost manufacturing and soil blending)</li> <li>- DER Works Approval fees</li> <li>- Capital works costs for temporary hardstand, bunding and leachate collection</li> <li>- Purchase cost and transport of addition replacement fill material to site</li> </ul>	<p>Dust and water generation offsite unlikely to cause an issue for neighbouring property</p>	<p>DER Works Approval (to construct) and licence (to operate) for Category 67A Premises (compost manufacturing and soil blending)</p> <p>Low cost for treatment and reuse</p> <p>Formal comment from DER would be required regarding Works Approval and Licencing requirements or approvals via an alternative mechanism</p> <p>Excavation and reuse of appropriate uncontaminated material could be used as part of the treatment train</p>
<b>Excavation and ex situ bioremediation undertaken on-site</b>						
Excavation and ex situ bioremediation undertaken on-site using windrows	<b>Lot 3002 Hardy Street, Denmark</b>	<p>Carefully segregate contaminated material and geotechnically unsuitable material from uncontaminated soil</p> <p>Mix material excavated from Lot 3002 with soil amendments (added bacteria, fungi etc.) aerate and control pH, moisture, nutrient and temperature levels, on site for bioremediation of soils over time</p> <p>Reuse treated and uncontaminated soil as replacement fill</p> <p>Deficit of back fill would be required to be purchased</p>	<p>The geotechnically unsuitable materials will need to be segregated and disposed of at alternative facilities.</p> <p>The buried tree stumps would be burnt at the McIntosh Road site.</p> <p>The metal content can potentially be recycled.</p> <p>The brick and concrete could potentially be recycled or disposed of as Class I waste.</p> <p>Ex situ bioremediation of hydrocarbon impacted soil can be undertaken on the site of origin without the requirement for a works approval or pollution prevention licence under the <i>Environmental Protection Act 1986</i> (EP Act).</p> <p>Limited space available for soil treatment within Lot 3002</p> <p>Temporary hardstand, bunding and leachate required for turning contaminated material.</p> <p>The space limitations dictate that the time scales are likely to be prohibitively slow for ex situ bioremediation of extensive quantities of hydrocarbon contaminated soil.</p> <p>Risk of recontamination of previously remediated areas within the site.</p> <p>Low transport emissions and good sustainability option with regard to reuse of materials</p> <p>DER guidelines generally do not advise construction and operation of bioremediation facilities in in close proximity to residential areas</p>	<p>Low cost</p> <p>Costs:</p> <ul style="list-style-type: none"> <li>- Capital works costs for temporary hardstand, bunding and leachate collection</li> <li>- Cost purchase and transport of additional replacement fill material to site</li> <li>- Laboratory analysis of soil samples to validate Class I levels or Remedial Targets for reuse on site</li> <li>- Machine for turning windrow over a long period of time</li> <li>- Material to cover windrow to prevent stormwater ingress and control dust</li> </ul>	<p>DER consider it generally not advisable to undertake bioremediation in closer proximity to residential areas</p> <p>Dust, odour and water generation offsite may cause issues for neighbouring properties during earthworks</p> <p>Effective stakeholder engagement required with nearby residents – detailed community consultation would be required prior to undertaking bioremediation onsite</p> <p>Local Government planning approval may be required</p>	<p>Low cost</p> <p>May be a suitable option for a portion of the hydrocarbon impacted sieved uncontrolled fill – with low levels of contamination</p> <p>Dust and odour may be an issue for neighbouring properties</p> <p>Timeframes for treatment may not meet Shire’s requirements</p> <p>Excavation and reuse of appropriate uncontaminated material could be used as part of the treatment train</p> <p>Shire of Denmark very keen to pursue this ex situ bioremediation option</p>

## 4.4 Consideration of NEPM Preferred Remediation Hierarchy

The short listed remedial options have also be considered with respect to the preferred hierarchy of options for remediation are outlined in the DER (2014) guidelines as per the following (Table 4-3), based on Principle 16 of the NEPM:

**Table 4-3: Comments on Preferred Hierarchy Options for Remediation of Lot 3002 Hardy Street**

Preferred Hierarchy Options for Remediation*	Comment with regard to Remediation of Lot 3002
<i>On-site treatment of the contamination so that it is destroyed or the associated risk is reduced to an acceptable level</i>	<p>Ex situ bioremediation of hydrocarbon contamination on-site has only limited potential due to the limited space available. Dust, odour and water generation offsite which may cause issues for neighbouring properties.</p> <p>It is the preferred option of the Shire of Denmark for sustainability and economic reasons.</p> <p>Materials that are unsuitable from a geotechnical perspective (e.g. tree trunks, metal and buried topsoil) can be removed during excavation works and disposed of off-site.</p> <p>This option may be suitable for small quantities of material with low hydrocarbon levels. A treatability study would be beneficial in assessing the effectiveness of this option. Also need to determine if sufficient area is available onsite for stockpiling of soil during remediation works.</p>
<i>Off-site treatment of excavated soil, so that the contamination is destroyed or the associated risk is reduced to an acceptable level, after which soil is returned to the site</i>	<p>Off-site treatment of excavated soil, via bioremediation, may reduce hydrocarbon to an acceptable level.</p> <p>Materials that are unsuitable from a geotechnical perspective (e.g. tree trunks, metal and buried topsoil) can be removed during excavation works and disposed of off-site.</p> <p>There would be double handling of material and transport costs and likely requirement for DER Works Approval for capital construction and Licence to operate.</p>
<i>If the above options are not practicable</i>	
<i>Consolidation and isolation of the soil on site by containment with a properly designed barrier</i>	<p>Containment of contaminated material on-site is considered inappropriate as it will not break all relevant pollutant linkages, such as the inhalation in indoor air pathway and the leaching to groundwater pathway</p> <p>There is also the need to remove structurally unsound material within Uncontrolled Fill.</p>
<i>Removal of contaminated material to an approved site or facility, followed, where necessary, by replacement with appropriate material</i>	<p>Removal of contaminated material to an approved site followed by replacement with appropriate material is considered the most practical option given the Shire of Denmark's timeframe constraints.</p> <p>Additionally this option also meets the Shire of Plantagenet's requirement for landfill cover.</p>
<i>Where the assessment indicates remediation would have no net environmental benefit or would have not a net adverse environmental effect, implementation of an appropriate management strategy</i>	<p>Active remediation of the site is required to remove contamination and structurally unsound soils which is considered likely to result in a net environmental benefit.</p>

Note \* = the hierarchy in Table 17 is presented in order of decreasing preference

## 4.5 Rationale for Selected Remediation Approach

In order to meet the objectives for remediation, based on the detailed evaluation of remediation options, the preferred option of the Shire of Denmark for active remediation of Lot 3002 is a combination of:

- Excavation of contaminated and geotechnically unsuitable materials;
- Careful segregation of “clean” suitable material and reuse as replacement fill;
- Segregation of the contaminated and unsuitable materials into different waste categories (e.g. tree stumps, metal, rocks, concrete);
- Chemical analysis of excavated soil to determine if it meets remedial targets or requires waste classification for off-site disposal;
- Onsite ex situ bioremediation of soil of hydrocarbon impacted soil where it can be practically be achieved (subject to a satisfactory outcome of the stakeholder engagement exercise);
- Removal of contaminated and unsuitable material to the Shire of Plantagenet’s Mount Barker Waste Management Facility; and
- Followed by replacement with structurally sound and certifiably clean soil to existing surface levels.

It is considered that remediation of the site will break relevant and possible pollutant linkages associated with the contamination identified on-site.



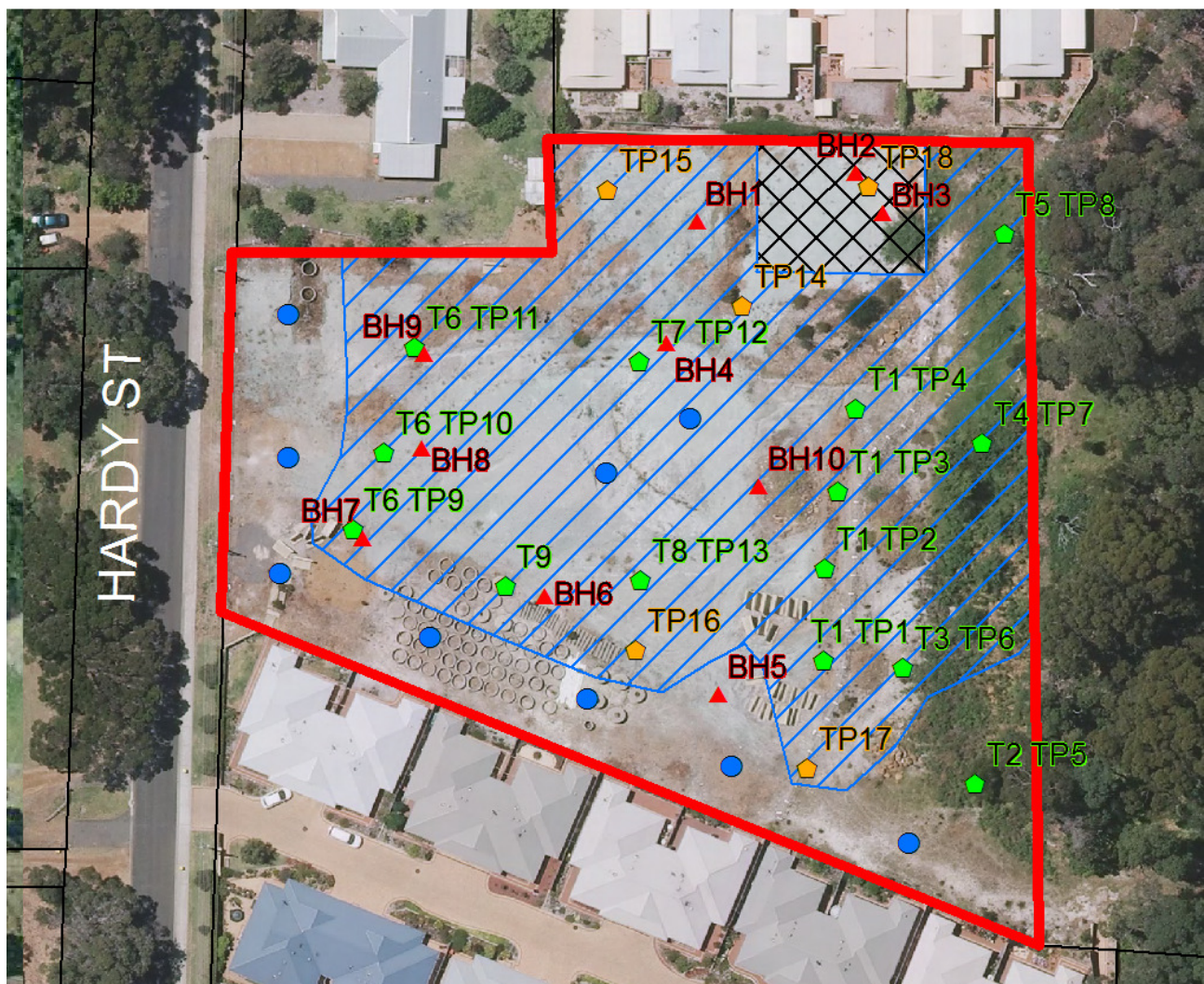
## 5 Further Investigation in Previously Inaccessible Areas

### 5.1 Method

Prior to commencing the remediation work, further investigation is required in areas that were previously inaccessible at the time of the DSI. The objectives of the further investigation is to characterise the soil and determine whether the Uncontrolled Fill is present:

- Beneath the central stockpile where two underground petrol and diesel storage tanks and bowsers were historically located;
- Beneath the stored materials adjacent to the southern boundary, where a former maintenance shed and workshop were historically located;
- Adjacent to the western boundary.

The further investigation works are to be undertaken by the advancement of nine test pits excavated using a backhoe excavator at the locations indicated in blue circles on Figure 6 below:



**Legend**

- Further Testing Required
- 2015 Test\_Pits\_Updated
- Site location
- 6 April 2011
- 7 April 2011
- ▨ Approximate area of uncontrolled fill
- ▩ Previously excavated and partially filled



**Figure 5-1: Previous and Proposed Soil Sample Locations within the Site (Not to scale) (Source Landgate)**

## 5.2 Summary of Further Investigation Sampling and Analysis Quality Plan (SAQP)

The Sampling and Analysis Quality Plan (SAQP) for the further investigation works is enclosed in Appendix E and is summarised below.

### 5.2.1 Soil Sampling

It is anticipated that the test pits will be excavated through the full depth of the Uncontrolled Fill terminating in the Natural Sand (and clay). The test pits are not expected to penetrate the full depth of the Natural Sand (and clay) and will stop at where (based on field observations) the Natural Sand (and clay) appears to be uncontaminated.

All soil samples analysed will be subject to on-site field testing to screen the soil samples for the presence of volatile organic compounds (VOCs) using a hand-held photo-ionization detector (PID).

Soil samples will be collected at the following frequency:

- At each and every change in the fill or natural soil strata;
- Where material is homogenous samples will be collected at a minimum depth of every 0.5 m;
- Additional samples will be collected should visual or olfactory evidence of contamination be observed;
- In the capillary zone immediately above the water table (if encountered)
- The first sample of natural soil will be collected at the boundary with the fill;

Where suspected asbestos containing material (ACM) is encountered as a bulk item in fill it should be sampled and surrounding soil collected as a separate sample to assess whether asbestos is present in the fill as free fibres

### 5.2.2 Soil Analysis

Selected soil samples will be scheduled for chemical analysis at the laboratory of ALS for the following determinands:

- Metals
- PCBs
- OC/OP Pesticides
- PAHs
- Phenols
- Total Recoverable Hydrocarbons NEPM 2013 Fractions
- BTEX
- Asbestos

Blind replications (control) samples will be collected and analysed as detailed in the appended SAQP.

## 6 Remedial Method

The following remedial method has been developed in consultation with the Shire of Denmark. A plan of the Site remedial works is included in Appendix F.

### 6.1 Site Preparation Requirements

Prior to undertaking site works all site staff shall undergo an induction of the Operational Site Management Plan (Section 7.4) for the remedial works.

Prior to excavation works the Shire will carry out the following site preparation works:

- Notify the community and surrounding residents of when remediation works will commence, how long they will continue, expected days and hours of operation;
- Identify, isolate and protect any underground services at the site;
- Identify and protect from damage groundwater monitoring boreholes MB1, MB2 and MB3;
- Remove green waste, just prior each excavation to minimise dust, and dispose to a DER licenced facility approved to accept green waste;
- Remove rocks and waste concrete located at the surface of the site to McIntosh Road waste facility;
- Install security and wind fencing (dust control measure) on the western, northern and eastern boundaries of the site;
- Install sediment control measures (silt fence) on the northern and eastern (adjacent to creekline vegetation) boundaries of the site;
- Install warning sign at site entrance;
- Move and stack concrete stormwater infrastructure and retaining walls to the south east corner of the site so that it does not impede site remediation works.

### 6.2 Excavation and Segregation of Materials

The remedial works comprise the careful excavation and segregation of different material types and disposal off-site of structurally unsuitable materials (such as concrete, brick, rock, metal, tree stumps, topsoil etc.) and hydrocarbon contaminated materials.

The structurally unsuitable materials are present within the Uncontrolled Fill and Buried Topsoil at the site. The hydrocarbon contaminated material is generally present within a proportion of the Uncontrolled Fill, but also extends into the Natural Sand (and Clay) in some locations.

The estimated volume of Uncontrolled Fill requiring remediation is approximately 8,400 m<sup>3</sup>, of which approximately 2,500 m<sup>3</sup> is considered likely to be hydrocarbon impacted.

Excavation and segregation of materials shall include, but may not be limited to, the following:

- The Contractor shall carefully and selectively excavate the near surface soils suitable soil (Recent Fill) and store these separately in designated stockpiles on-site for potential re-use on site (subject to confirmatory testing);
- Once the Recent Fill has been excavated and stockpiled the Uncontrolled Fill shall be carefully excavated and the different material types segregated;
- The Shire of Denmark propose to screen the proportion of Uncontrolled Fill that is not impacted by hydrocarbon contamination, to remove structurally unsuitable material (such

as concrete, brick, rock, metal, tree stumps etc.) with the uncontaminated fines content stockpiled separately and potentially reused to backfill the remediation excavation;

- The estimated volume of uncontaminated Uncontrolled Fill to be screened is approximately 5,900 m<sup>3</sup>;
- The hydrocarbon contaminated proportion of the Uncontrolled Fill, an estimated volume of 2,500 m<sup>3</sup> will not be screened and instead will be disposed of off-site by the Contractor in its entirety or alternatively a portion of screened hydrocarbon contaminated soil may be subjected to ex situ bioremediation onsite (Section 6.3);
- The Contractor shall excavate and segregate of the full extent of the Uncontrolled Fill, together with other fill materials (such as Laterite Gravel) and the Buried Topsoil, terminating the excavation in uncontaminated Natural Sand (and Clay) soils;
- The hydrocarbon contaminated soils should be carefully excavated with care taken during any earthworks to prevent the cross contamination with other uncontaminated fill and natural soils;
- The excavation of the hydrocarbon impacted soils will be supervised and verified on a full time basis by the Supervising Engineer;
- All excavated materials shall be segregated into different material types and stockpiled pending disposal off-site or reuse on the site;
- Where hydrocarbon contaminated soils are stockpiled pending disposal off-site the Contractor shall take appropriate measures to prevent cross contamination of the underlying ground and the generation of contaminated surface water run-off;
- Potential mitigation measures could include the provision of a suitably thick polythene membrane laid onto the ground surface and/or a sacrificial clean soil separating layer to protect the underlying uncontaminated clean soils from cross contamination with the stockpiled soils;
- Other potential mitigation measures could include covering the stockpile with thick polythene sheeting or acrylic sealant (if suitable with regard to potential cross contamination of soil) to restrict infiltration of precipitation and subsequent run-off generation;
- The Contractor shall be responsible for protecting the stability of the excavations and controlling the ingress of groundwater and stormwater into the excavation;
- If light non-aqueous phase liquids (LNAPL) are encountered in the earthworks they are to be controlled as necessary and recovered by the use of oleophilic blankets or mopping options to clear up spills or minor seepages;
- On completion of the removal of the Uncontrolled Fill, the Buried Topsoil and the hydrocarbon contaminated Natural Sand (and Clay), the Environmental Officer shall collect samples of the underlying natural soils in order to verify that the removal works have been successful;
- If the remedial targets are exceeded then further excavation will be required with subsequent validation sampling and testing until the remedial targets are achieved;
- Validation testing will also be undertaken by the Environmental Officer on the stockpiled materials (Recent Fill and the uncontaminated Uncontrolled Fill fines) to confirm their suitability for reuse in backfilling the remediation excavation, in accordance with Section 8.2 of this report.

## 6.3 On-site Bioremediation Using Windrows

### 6.3.1 Practicalities of Ex Situ Bioremediation

Subject to the findings of the further investigation not detecting any contaminated material or uncontrolled fill on the area of land adjacent to the southern boundary, then this area of site (hatched in yellow on the Remedial Works Site Plan in Appendix F) can potentially be used as a low permeability pad upon which the ex situ bioremediation works can be performed.

Typical dimensions of windrows are 3-4 m in width, 2 m in height and of any length. The yellow hatched area on the Remedial Works Site Plan is approximately 80 m x 14 m in area (1,120 m<sup>2</sup>). Allowing for 5 m clearance on all sides of the windrow for the excavator, it is envisaged that one 70 m long x 4 m wide x 2 m high windrow could be practically accommodated in this area. Assuming that the windrow has 45° sloping sides, it is estimated that a maximum of approximately 280 m<sup>3</sup> of hydrocarbon contaminated soil could be bioremediated at any one time in the available land space.

It is recommended that the Shire of Denmark consider whether allocating 1,120 m<sup>2</sup> of the overall site area presents any practical constraints to the design and sequencing of the remediation earthworks.

The Environment Agency Data Sheet indicates timescales of between 2-12 months for bioremediation using windrows to be completed. This is dependent on a number of factors, including how heavily contaminated the soil is in the first place and how low the remedial targets are. At Lot 3002 Hardy Street the bioremediation needs to reduce the hydrocarbon concentrations in the soil as indicated in Table 6.1 below:

**Table 6.1 Maximum soil concentrations compared to the soil remedial targets**

Determinands	Maximum Soil Concentration (mg/kg)	Soil Remedial Target (mg/kg)	% Reduction
Total recoverable hydrocarbons C10-C16 (F2)	540	110	80
Total recoverable hydrocarbons C16-C34 (F3)	1620	300	81

Consultation with a specialist remediation contractor suggests that based on the maximum recorded concentrations recorded to date, the approximate timescales required to bioremediate the soil to the remedial targets is somewhere between 20 and 50 weeks.

If the Shire was to bioremediate, all the 2,500 m<sup>3</sup> of hydrocarbon contaminated soil and there is only space to remediate 280 m<sup>3</sup> at a time, then the likely timescales for ex situ bioremediation are as follows:

- Based on 20 weeks to achieve the soil remedial targets (plus 4 weeks for lab testing and changeover) then the anticipated total duration would be approx. 216 weeks (i.e. 4.2 years).
- Based on 50 weeks to achieve the soil remedial targets (plus 4 weeks for lab testing and changeover) then the anticipated total duration would be approx. 486 weeks (i.e. 9.3 years).

Consequently in a remediation contract period of say 12 months it is likely only going to be possible to bioremediate between 280 m<sup>3</sup> and 560 m<sup>3</sup> of hydrocarbon contaminated soil.

Obviously if the available treatment area at the site increased, then it would be possible to shorten the duration of the remediation works considerably.

Also if the soil subjected to bioremediation consists of the least hydrocarbon contaminated materials on the site (as opposed to the greatest contaminated material), then the timescales for bioremediation are likely to be lesser that quoted above.

As discussed elsewhere the viability of undertaking ex situ bioremediation on-site is subject to a satisfactory outcome of the stakeholder consultation process. This is particularly relevant given that the DER does not generally consider bioremediation appropriate in close proximity to residential properties.

### 6.3.2 Ex Situ Bioremediation Treatability Study

Both the Environment Agency Data Sheet and NSW Best Practice Note recommend treatability or pilot scale trials to demonstrate that the ex situ bioremediation method is going to be successful in achieving the required soil remedial targets before embarking upon full scale remediation.

The Shire of Denmark may wish to consider undertaking a laboratory Treatability Study or a pilot scale treatability trials in accordance with the above guidance. Alternatively instead of undertaking a treatability study, the Shire of Denmark may wish to proceed straight to full scale remediation, given that the limited area of the remediation pad is only capable to treating 280 m<sup>3</sup> at any one time.

### 6.3.3 Methodology for Ex Situ Bioremediation by Windrows

The ex situ bioremediation of hydrocarbon contaminated soil on-site will, as a minimum, be subject to the following methodology and environmental controls:

- Construction of a low permeability pad upon which the windrows will be placed and turned. This will be constructed from compacted clay and/or a HDPE geomembrane with a permeability of less than 10<sup>-9</sup> m/s, with a suitable depth of sacrificial material above to protect it during excavation and mechanical aeration of the soil;
- The pad will need to have a minimum gradient of 2% so that any accumulated rainfall drains to a collection sump. The collection sump needs to have sufficient volume to contain expected quantity of surface water based on local meteorological conditions and the size of the pad;
- Collected rainfall from the sump will be recirculated over the windrows to help maintain optimum moisture content. Any excess accumulated stormwater will need to be disposed of off-site to an appropriate facility e.g. tanked off-site or discharged to sewer under a consent;
- The windrow will be 70 m in length and 4 m width with a maximum height of 2 m, giving an approximate volume of 280 m<sup>3</sup>, assuming 45° slopes. It will be necessary to add and mix fertilizer (nitrogen, phosphorous and potassium) and animal manure (e.g. chicken) to the soil to provide adequate nutrients;
- The windrows will be mechanically aerated every week using a 360 excavator. Preferably the excavator will be fitted with an ALLU bucket to breakdown clumps in the soil to increase the surface area of the material available for treatment;
- During the weekly mechanical aeration, the moisture content of the windrow can be maintained at optimum conditions (between 40-85%) and nutrients added where required;
- The windrows will be covered with a polypropylene geomembrane cover to minimise infiltration of precipitation and the generation of contaminated run-off. The cover will also minimise windblown dust from the site;
- Performance monitoring of the bioremediation process will need to be undertaken to determine progress. This may include the following:
  - » Sampling and chemical analysis of soil for TRH for comparison with the soil remedial targets;

- » Environmental parameters in the soil pile e.g. oxygen and carbon dioxide concentrations, moisture content, nutrient balance, temperature, pH and microbial population density;
- On completion of the remediation works, validation sampling of the soil within the windrows will be required. It is proposed that validation samples will be collected and analysed at frequency of one per 25 m<sup>3</sup> of soil being treated. This is in line with the minimum recommended number of samples for the initial assessment of stockpiles in Table 4 of Schedule B3 of the NEPM;
- The soil samples will be analysed for Total Recoverable Hydrocarbons NEPM 2013 Fractions at the laboratory of ALS. Blind replications (control) samples will be collected and analysed as detailed in the appended SAQP;
- In order for the soil to be deemed to have been successfully remediated, all of the individual soil results (or alternatively 95% of the upper confidence level) will need to be below the agreed Remedial Targets;
- Special controls to collect and treat volatile vapours emitted from the windrows is not anticipated as being necessary, given that the hydrocarbons detected in the soil to date are not particularly volatile (i.e. carbon range C10-C34).

#### **6.4 Placement of Clean Fill in the Excavation**

Following receipt of the laboratory results of the soil sampling at the base of the excavation and approval by the Supervising Engineer that the full extent of the contaminated material has been removed, the excavation shall be backfilled with chemically suitable site derived or imported Clean Fill.

Before use the chemically suitable site derived or imported Clean Fill will be sampled and tested to confirm that it is uncontaminated in accordance with the requirements of the Section 8.2 and 8.3 of this report.

The Supervising Engineer shall ensure that replacement fill is placed and compacted in a manner that is suitable for construction of buildings and associated infrastructure within the Site. Once the Site is remediated and filled to original ground level, a layer of hydro mulch or seeded topsoil is recommended to minimise offsite dust emissions.

#### **6.5 Disposal of Materials Off-site**

All contaminated and geotechnically unsuitable materials arising from the remediation earthworks are to be disposed off-site to a suitably permitted waste management facility. Loading of vehicles shall be performed in an organised manner so as to prevent the spread of contaminants. All vehicles are to be sheeted and 'clean', prior to leaving site. The Contractor shall take all reasonable and applicable measures to prevent the escape of material during transportation.

The Opus 2015 DSI provisionally considered that most of the hydrocarbon impacted Uncontrolled Fill, Natural Topsoil and Natural Sand can be disposed of to a Class I landfill as contaminated solid waste that meets the waste acceptance criteria for Class I landfills. The Contractor shall be responsible for classifying the different categories of waste for disposal in discussion with the receiving waste management facility.

Prior to any removal of contaminated materials, the Contractor shall supply the Supervising Engineer with details of the proposed receiving waste disposal site. The Contractor shall ensure that sufficient information (including laboratory results of soil testing) is provided to the receiving waste disposal site prior to site works for waste classification purposes. On completion of disposal of the contaminated materials, the Contractor shall provide the Supervising Engineer with copies of all the waste consignment notes.

At no time is excavation water to be discharged off site without the prior consent of the Site Manager.

## 6.6 Unforeseen Ground Conditions

During remediation of the site, should ground conditions differ significantly from those encountered during the DSI investigations, then works should be suspended immediately and the Site Manager notified. An assessment of the new materials encountered shall then be made by the Environmental Officer and no further works carried out until a plan for dealing with the suspected contamination has been developed and agreed to by the Environmental Officer, the Shire of Denmark and the DER.



## 7 General Requirements for Site Remediation

### 7.1 Limitations

The scope of the proposed site remediation works shall be considered provisional until approval of this document by the Shire of Denmark.

### 7.2 Regulatory Compliance Requirements

It is understood that, under the *Environmental Protection Act 1986*, a DER Works Approval application is not required for remedial works undertaken on the site on which contamination has originated (DER 2014).

Regulatory compliance requirements for remediation of the site may include, but are limited to, the following which have been addressed in Section 5.5:

- Legislation and subsidiary legislation:
  - *Contaminated Sites Act 2003*;
    - *Contaminated Sites Regulations 2006*;
  - *Environmental Protection Act 1986*;
    - *Environmental Protection (Controlled Waste) Regulations 2004*;
    - *Environmental Protection (Noise) Regulations 1997*;
    - *Environmental Protection (Unauthorised Discharge) Regulations 2004*;
  - *Occupational Safety and Health Act 1984*;
    - *Occupational Safety and Health Regulations 1996*;
- Australian Standards and Guidelines:
  - *AS 2436-2010 Guide to noise and vibration control on construction, demolition and maintenance sites*;
  - *A guideline for managing the impacts of dust and associated contaminants from land development sites, contaminated sites remediation and other related activities* (DEC 2011);
  - *Australian Guidelines for Water Quality Monitoring and Reporting* (ANZECC & ARMCANZ 2000);
  - *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC & ARMCANZ 2000);
  - *Guidelines for the Assessment, Remediation and Management of Asbestos-Contaminated Sites in Western Australia* May 2009;
  - *Landfill Waste Classification and Waste Definitions 1996 (As amended December 2009)*.

### 7.3 Stakeholders

The following stakeholders have been identified regarding remediation of the site:

- Shire of Denmark – who are responsible for remediation of the site;
- Shire of Plantagenet – have agreed to accept waste material at the Mount Baker Waste Management Facility (Appendix G);
- Amaroo Care Services Pty Ltd – have agreed in principle to purchase Lot 3002 Hardy Street once the site has been remediated and is in a condition suitable for construction of residential buildings;
- DER – as the regulating authority
- Surrounding residents – may be directly impacted due to noise, dust etc during remediation works.

### 7.4 Operational Phase Site Management Plan

Table 7-1 outlines management actions (but may not be limited to) proposed to mitigate impact of operational site works.

Remedial works shall be carried out with the minimum amount of disturbance and inconvenience to the neighbouring occupants and the general public.

The Shire of Denmark and/or the Contractor shall take all measures necessary to minimise potential adverse impacts on the local environment.

Please note that the following Operational Phase Site Management Plan is not a site safety management plan and the Shire of Denmark shall develop a Health, Safety and Environmental Plan prior to commencement of remedial works.

All documentation is to be supplied to the Shire of Denmark Site Manager in a central location, and a detailed site activities log is to be kept, for inspection and reporting purposes (Section 8.6).

Table 7-1: Operational Phase Site Management Plan

Management Aspect	Legislation & Guidelines	Potential Impacts	Management Action	Monitoring / Frequency	Performance Targets	Contingency Measures	Responsibility
Site Security	<i>Occupational Safety and Health Act 1984</i>	<ul style="list-style-type: none"> <li>Unauthorised access to the site by the public</li> <li>Risk of harm to public due falls, exposure to contaminants, machinery etc</li> </ul>	<ul style="list-style-type: none"> <li>Shire of Denmark to develop a Health, Safety and Environmental Plan prior to commencement of remedial works</li> <li>The site should be securely fenced from the general public to prevent unauthorised access or trespassing.</li> <li>Any excavations should be fenced off and labelled</li> <li>Appropriate signage and security clearance procedures implemented at the site entrance</li> </ul>	<ul style="list-style-type: none"> <li>Installation prior to and maintained throughout works</li> <li>Daily observation</li> <li>Record all incidences in the Site Records File</li> </ul>	<ul style="list-style-type: none"> <li>Fencing intact for the duration of remedial works</li> </ul>	<ul style="list-style-type: none"> <li>Repair/ reinstall fencing as required</li> </ul>	<ul style="list-style-type: none"> <li>Site Manager</li> <li>Site Supervisor</li> </ul>
Stormwater	<i>Environmental Protection Act 1986</i> <i>Environmental Protection (Unauthorised Discharge) Regulations 2004</i> <i>Australian Guidelines for Water Quality Monitoring and Reporting (ANZECC &amp; ARMCANZ 2000)</i> <i>Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC &amp; ARMCANZ 2000)</i>	<ul style="list-style-type: none"> <li>Degradation of water quality and vegetation within the creekline to the east of the site, through release of nutrients, sediment or hydrocarbons from direct runoff and stormwater during remedial activities</li> <li>Excessive retention of stormwater in excavation may cause a land slip impacting on downslope residential properties</li> </ul>	<ul style="list-style-type: none"> <li>Regularly check weather conditions and minimise works during heavy rainfall events</li> <li>Divert upstream uncontaminated stormwater around or through the work areas without mixing with contaminated site water using appropriately sized, stable diversion drains, banks or bunds</li> <li>Install stormwater diversion drains around each open excavation to prevent stormwater ingress</li> <li>Minimise clearing and the extent and duration of land that is bare of vegetation at any one time;</li> </ul>	<ul style="list-style-type: none"> <li>Stormwater control measures installed prior to commencement of works</li> <li>Daily inspection of stormwater control measures throughout works</li> <li>Photographs of site works</li> <li>Record all environmental incidences and complaints in the Site Records File</li> </ul>	<ul style="list-style-type: none"> <li>No direct discharge of stormwater offsite</li> <li>No complaints from surrounding residents regarding sediment or additional stormwater entering properties</li> </ul>	<ul style="list-style-type: none"> <li>If stormwater diversion drains fail, reinstall as required</li> <li>If water is discharged to stormwater system or surface waters it must meet the <i>Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC &amp; ARMCANZ 2000)</i></li> <li>If these guidelines cannot be met then stormwater must either be discharge to sewer, with approval from Water Corporation, or disposed to a DER Licenced liquid waste facility</li> </ul>	<ul style="list-style-type: none"> <li>Site Manager</li> <li>Site Supervisor</li> </ul>
Stockpiling Soil	<i>Landfill Waste Classification and Waste Definitions 1996 (As amended December 2009)</i>	<ul style="list-style-type: none"> <li>Poor segregation of materials onsite increasing the volume of material to be disposed to landfill</li> <li>Thereby increasing volume of replacement fill required</li> </ul>	<ul style="list-style-type: none"> <li>Onsite soil movement shall be kept to a minimum and shall be documented</li> <li>Stockpiles of site derived Recent Fill will be kept separate and distinguishable from any other stockpiles of site derived Uncontrolled Fill or imported soil</li> <li>Where required fence and label stockpiles to keep track of material types and prevent cross-contamination</li> <li>Stockpiles will be positioned on the southern boundary of the Site upslope from the excavation area to prevent run-off from the excavation area cross-contaminating stockpiles</li> <li>The time that stockpiles are present onsite shall be minimised so far as practicable</li> <li>Stockpiles in place for more than one month shall be covered with soil stabilisation material</li> </ul>	<ul style="list-style-type: none"> <li>Throughout works</li> <li>Daily observations</li> <li>Photographs of site works</li> <li>Record dates, locations and material type, test results of stockpiles in a central site records file</li> <li>Record all environmental incidences in the Site Records File</li> </ul>	<ul style="list-style-type: none"> <li>Minimise cross contamination and maximise reuse of carefully stockpiled soil</li> </ul>	<ul style="list-style-type: none"> <li>Sample as per the SQAP</li> <li>If sample results are variable across a number of stockpiles of similar material i.e. Recent Fill repeat sampling and analysis</li> <li>If stockpiles are not recorded accurately repeat sampling as required, to obtain accurate information for each particular stockpile</li> </ul>	<ul style="list-style-type: none"> <li>Site Manager</li> <li>Site Supervisor</li> <li>Environmental Officer</li> </ul>

Management Aspect	Legislation & Guidelines	Potential Impacts	Management Action	Monitoring / Frequency	Performance Targets	Contingency Measures	Responsibility
Ex Situ On-site Bioremediation	<i>Environmental Protection Act 1986</i> <i>Environmental Protection (Unauthorised Discharge) Regulations 2004</i>	<ul style="list-style-type: none"> <li>Degradation of ground and surface water quality and vegetation within the creekline to the east of the site, through release of nutrients, sediment or hydrocarbons from direct runoff and stormwater during remedial activities</li> <li>Poor segregation of materials onsite increasing the volume of material to be disposed to landfill. Thereby increasing volume of replacement fill required</li> <li>Exposure of site staff and surrounding residents to contaminated material</li> </ul>	<ul style="list-style-type: none"> <li>Undertake a small scale treatability study to determine if the proposed bioremediation will be successful</li> <li>Divert upstream uncontaminated stormwater around or through the work areas without mixing with contaminated site water using appropriately sized, stable diversion drains, banks or bunds</li> <li>Place stockpile over an area yet to be remediated to prevent recontamination of remediated areas within the site</li> <li>Construct stockpile on an impermeable liner (e.g. clay layer or HDPE membrane) and a sacrificial layer of clean soil</li> <li>Soil base slopes in one direction for channelling leachate to a single leachate collection sump</li> <li>Leachate collection in a bunded area</li> <li>Recycle leachate over stockpile (without creating runoff) to maintain moisture levels</li> <li>Cover soil to prevent infiltration of stormwater and the generation of windblown dust</li> <li>Waste soil shall not be removed from site for disposal at a DER approved landfill prior to waste classification</li> <li>Reuse of soil on-site shall not be undertaken until laboratory analysis confirms it meets Remedial Targets</li> </ul>	<ul style="list-style-type: none"> <li>Throughout works</li> <li>Daily observations</li> <li>Photographs of site works</li> <li>Record dates, locations and material type, test results of stockpiles in a central site records file</li> <li>Record all environmental incidences in the Site Records File</li> </ul>	<ul style="list-style-type: none"> <li>No complaints from surrounding residents</li> <li>Remedial Targets for reuse are met</li> <li>No unauthorised discharge offsite</li> </ul>	<ul style="list-style-type: none"> <li>If Remedial Targets are not met within the specified period of time for the Treatability Study dispose to landfill</li> </ul>	<ul style="list-style-type: none"> <li>Site Manager</li> <li>Site Supervisor</li> <li>Environmental Officer</li> </ul>
Waste Soil	<i>Landfill Waste Classification and Waste Definitions 1996 (As amended December 2009)</i> <i>Occupational Safety and Health Act 1984</i>	<ul style="list-style-type: none"> <li>Poor segregation of materials onsite increasing the volume of material to be disposed to landfill. Thereby increasing volume of replacement fill required</li> <li>Exposure of site staff to contaminated material</li> </ul>	<ul style="list-style-type: none"> <li>Waste soil shall not be removed from site for disposal at a DER approved landfill prior to waste classification</li> <li>All disposal receipts for all soil and waste material removed off site shall be retained by the Contractor and provided to the Shire of Denmark Site Manager for inclusion in the Site Validation Report</li> <li>In addition to waste classification soil samples for disposal to landfill shall also be tested for presence of asbestos</li> <li>Site staff should be aware of the potentially contaminated nature of some of the Made Ground materials at the site and a high standard of health and safety awareness should be adopted in order to protect the health of workers and the general public</li> <li>Shire of Denmark to develop a Health, Safety and Environmental Plan prior to commencement of remedial works</li> </ul>	<ul style="list-style-type: none"> <li>As required prior to disposal of waste soil off site throughout works</li> <li>Photographs of site works</li> <li>Record dates, locations and material type, test results of stockpiles in a central site records file</li> <li>Transport volumes</li> <li>Landfill delivery receipts</li> <li>Record all environmental incidences and complaints in the Site Records File</li> </ul>	<ul style="list-style-type: none"> <li>Minimise waste soil to be disposed offsite</li> <li>No complaints from surrounding residents regarding waste soil</li> </ul>	<ul style="list-style-type: none"> <li>If sample results are significantly different across a number of stockpile repeat sampling and analysis</li> <li>If asbestos is identified all excavation works shall cease and management strategies be developed by Shire of Denmark in consultation with DER Contaminated Sites Branch</li> </ul>	<ul style="list-style-type: none"> <li>Site Manager</li> <li>Site Supervisor</li> <li>Environmental Officer</li> </ul>

Management Aspect	Legislation & Guidelines	Potential Impacts	Management Action	Monitoring / Frequency	Performance Targets	Contingency Measures	Responsibility
Erosion and Sediment Control	<i>Environmental Protection Act 1986</i> <i>Environmental Protection (Unauthorised Discharge) Regulations 2004</i>	<ul style="list-style-type: none"> <li>Degradation of water quality and vegetation within the creek line to the east of the site, through sediment deposition during remedial activities</li> </ul>	<ul style="list-style-type: none"> <li>Sediment run-off controls shall be installed and functional prior to commencement of remedial works</li> <li>All erosion and sediment control measures shall be maintained throughout the duration of remedial works and shall only be removed once the work area has been effectively stabilised</li> <li>Silt fencing or similar devices shall be installed on the downslope side of all disturbed areas and stockpiled or loose material</li> <li>Excavation works shall not be undertaken during heavy rain</li> <li>All sediment control measures shall be maintain during works and inspected after rain events to ensure they are functioning properly</li> <li>Care shall be taken to ensure that no significant amounts of sediment are allowed to enter stormwater drains and surface water courses</li> <li>Minimise extent of clearing and duration of land that is bare of vegetation at any one time</li> <li>Road sweeping may be required to prevent soils being transported on Hardy Street to the stormwater system</li> <li>All loads being transported off site shall be covered</li> <li>All stockpiles shall be adequately protected from erosion by diversion drains and bunds as required</li> <li>Avoid use of sediment control measures that will introduce weed species into adjacent vegetation i.e.hay bales</li> <li>Wheel cleaning and road sweeping may be required in wet weather conditions to prevent contaminated soils being transported on the roads around the site</li> </ul>	<ul style="list-style-type: none"> <li>Erosion and sediment control measures installed prior to commencement of works</li> <li>Daily inspection of erosion and sediment control measures throughout works</li> <li>Photographs of site works</li> <li>Record all environmental incidences and complaints in the Site Records File</li> </ul>	<ul style="list-style-type: none"> <li>No sediment discharged from site</li> <li>No off site erosion</li> <li>No complaints from surrounding residents regarding sediment entering properties</li> </ul>	<ul style="list-style-type: none"> <li>If during the course of works, the proposed controls are deemed to be inadequate or are not performing in a manner that protects the receiving waters within or adjacent to the works area from increased sedimentation, implementation of alternative or additional measures may occur subject to approval of the Site Supervisor</li> <li>Erosion and sediment control devices shall be cleaned out, repaired and replaced as required to ensure continued effectiveness.</li> </ul>	<ul style="list-style-type: none"> <li>Site Manager</li> <li>Site Supervisor</li> </ul>
Excavation	<i>Occupational Safety and Health Act 1984</i> Safety guidance is provided in the Code of Practice Excavation Government of Western Australia Commission for Occupational Safety and Health 2005	<ul style="list-style-type: none"> <li>Risk of harm to public and site staff due falls, collapse of excavations etc</li> </ul>	<ul style="list-style-type: none"> <li>Shire of Denmark to develop a Health, Safety and Environmental Plan prior to commencement of remedial works</li> <li>The site should be securely fenced from the general public to prevent unauthorised access or trespassing.</li> <li>All excavations should be fenced off and labelled</li> <li>No person should enter an excavation if the depth is greater than 1.0 m depth.</li> <li>Care should be taken when standing close to the edge of the open excavations in case the side walls collapse during excavation, particularly below the water table.</li> </ul>	<ul style="list-style-type: none"> <li>Daily inspections of the site shall be undertaken by the Supervisor throughout works</li> <li>Record all environmental incidences and complaints in the Site Records File</li> </ul>	<ul style="list-style-type: none"> <li>No complaints from surrounding residents</li> </ul>		<ul style="list-style-type: none"> <li>Site Manager</li> <li>Site Supervisor</li> </ul>

Management Aspect	Legislation & Guidelines	Potential Impacts	Management Action	Monitoring / Frequency	Performance Targets	Contingency Measures	Responsibility
Noise and Vibration	<i>Environmental Protection Act 1986</i> <i>Environmental Protection (Noise) Regulations 1997</i> – sets limits on noise emissions AS 2436-2010 Guide to noise and vibration control on construction, demolition and maintenance sites	<ul style="list-style-type: none"> <li>Excessive noise and vibration emission from site due to operation of machinery may have the potential to generate noise and cause nuisance to nearby sensitive receptors such as residential dwellings</li> </ul>	<ul style="list-style-type: none"> <li>Operations undertaken between the 0700 hours and 1900 hours on any day which is not a Sunday or public holiday</li> <li>Site staff to be considerate of people who live nearby so they are not subjected to unnecessary noise or vibration</li> <li>Site induction training to take all necessary steps to minimise noise and vibration</li> <li>Use equipment on the premises that is the quietest reasonably available</li> <li>Where appropriate use alternative safe system of work to traditional reversing or warning alarms</li> <li>Regularly maintain all equipment and vehicles and attend promptly to any loose parts, rattling covers, worn bearings and broken components. This should be addressed through a regular maintenance schedule and correct staff training</li> <li>Notify community prior to works commencing</li> <li>Advise all residents within a noise sensitive area of the time, duration and purpose of the works a minimum of 48 hours before work is scheduled to occur</li> </ul>	<ul style="list-style-type: none"> <li>Daily inspections of the site shall be undertaken by the Supervisor to assess vibration and noise generation</li> <li>All plant operators shall continuously monitor noise generation</li> <li>Record all environmental incidences and complaints in the Site Records File</li> </ul>	<ul style="list-style-type: none"> <li>No complaints from surrounding residents regarding noise and vibration</li> </ul>	<ul style="list-style-type: none"> <li>If a number of complaints are received by the Shire regarding noise generated by the site works the Site Supervisor shall undertake corrective actions to address the complaints so far as practicable and in a timely manner</li> </ul>	<ul style="list-style-type: none"> <li>Site Manager</li> <li>Site Supervisor</li> </ul>
Wind-borne Dust	<i>Environmental Protection Act 1986</i> <i>A guideline for managing the impacts of dust and associated contaminants from land development sites, contaminated sites remediation and other related activities</i> (DEC 2011)	<ul style="list-style-type: none"> <li>Remediation works may generate offsite dust emissions (contaminated and uncontaminated)</li> <li>Sensitive receptors such as surrounding residents and vegetation to the east of the Site may be exposed to dust which impact on health and environmental aspects</li> </ul>	<ul style="list-style-type: none"> <li>Limit vehicle access onto the site</li> <li>Regularly check weather conditions and minimise works during dry and windy conditions</li> <li>Remove green waste from surface just prior to commencing new excavation</li> <li>Use a water truck with atomised sprays to dampen dust during excavation</li> <li>The method for dampening should not cause pooling or run-off of contaminated water that would discharge into surface water bodies or the stormwater network</li> <li>The application of water does not induce soil erosion</li> <li>During creation, stockpiles will be dampened during windy conditions to minimise dust generation</li> <li>Stockpiles in place for a significant length of time shall be covered with soil stabilisation material</li> </ul>	<ul style="list-style-type: none"> <li>Daily inspections of the work area shall be undertaken by the Site Supervisor to assess dust generation potential</li> <li>Record all environmental incidences and complaints in the Site Records File</li> <li>All plant operators shall continuously monitor dust generation and report excessive dust to the Site Supervisor</li> </ul>	<ul style="list-style-type: none"> <li>No offsite dust emissions</li> <li>No complaints from surrounding residents regarding dust</li> </ul>	<ul style="list-style-type: none"> <li>Cease excavation works during Bureau of Meteorology Strong Wind and Gale warnings</li> <li>If a number of complaints are received by the Shire regarding dust generated by the site works the Site Supervisor shall undertake corrective actions to address the complaints so far as practicable and in a timely manner</li> <li>If dust continues to be an issue, cover stockpiles with suitable material to prevent offsite dust emissions</li> </ul>	<ul style="list-style-type: none"> <li>Site Manager</li> <li>Site Supervisor</li> </ul>
Odour	<i>Environmental Protection Act 1986</i>	<ul style="list-style-type: none"> <li>Odour emissions from machinery and excavation of Uncontrolled Fill may impact on the amenity of surrounding residential dwellings</li> </ul>	<ul style="list-style-type: none"> <li>Measures to suppress the emission of odour</li> <li>Regularly maintain all equipment and vehicles and attend promptly to excessive exhaust emissions. This should be addressed through a regular maintenance schedule and correct staff training</li> </ul>	<ul style="list-style-type: none"> <li>Daily inspections of the work area shall be undertaken by the Site Supervisor to assess odour generation potential</li> <li>Record all environmental incidences and complaints in the Site Records File</li> <li>All plant operators shall continuously monitor odour generation and report excessive odour to the Site Supervisor</li> </ul>	<ul style="list-style-type: none"> <li>No offsite odour emissions</li> <li>No complaints from surrounding residents regarding odour</li> </ul>	<ul style="list-style-type: none"> <li>If a number of complaints are received by the Shire regarding odour generated by the site works the Site Supervisor shall undertake corrective actions to address the complaints so far as practicable and in a timely manner</li> </ul>	<ul style="list-style-type: none"> <li>Site Manager</li> <li>Site Supervisor</li> </ul>

Management Aspect	Legislation & Guidelines	Potential Impacts	Management Action	Monitoring / Frequency	Performance Targets	Contingency Measures	Responsibility
Transportation	<i>Environmental Protection Act 1986</i> <i>Environmental Protection (Controlled Waste) Regulations 2004</i>	<ul style="list-style-type: none"> <li>Spillage of contaminated material</li> </ul>	<ul style="list-style-type: none"> <li>All vehicles loads are to be covered and vehicles 'clean', prior to leaving site</li> <li>Where hazardous waste is to be removed from the site, the waste must only be transported as per <i>Environmental Protection (Controlled Waste) Regulations 2004</i></li> <li>Waste tracking documentation must be completed upon dispatch of the waste off-site and records kept on file</li> </ul>	<ul style="list-style-type: none"> <li>Daily inspections of transport vehicles to undertaken by the Site Supervisor</li> <li>Record all environmental incidences and complaints in the Site Records File</li> </ul>	<ul style="list-style-type: none"> <li>No spills when transporting material offsite</li> <li>No complaints regarding spillage of materials offsite</li> </ul>	<ul style="list-style-type: none"> <li>Any leakage or spillage of hazardous substances or material removed offsite will trigger immediate spill response and clean up procedures, and repair and improvement of transportation</li> </ul>	<ul style="list-style-type: none"> <li>Site Manager</li> <li>Site Supervisor</li> </ul>
Chemical/ Equipment Storage	<i>Environmental Protection Act 1986</i> <i>Environmental Protection (Unauthorised Discharge) Regulations 2004</i>	<ul style="list-style-type: none"> <li>The spillage or leakage of hazardous substances used, stored or disposed of during maintenance works has the potential to contaminate soils, surface waters and groundwater impacting on vegetation, fauna, soil and water quality</li> </ul>	<ul style="list-style-type: none"> <li>Shire of Denmark to develop a Health, Safety and Environmental Plan prior to commencement of remedial works</li> <li>If stored on site any temporary storage of chemicals, fuels and oils will be double skinned tanks or bunded tanks (capable of containing at least 110% of the tank volume) to minimise any potential spillages</li> <li>Hazardous substances (including dangerous goods and hazardous materials) present inherent environmental risks in storage, use and disposal. Wherever possible, non-hazardous alternatives shall be used.</li> <li>Only the minimum essential stocks of items such as chemicals and fuels are to be stored on site at any one time.</li> <li>All hazardous substances and materials must be stored and transported in accordance with their Material Safety Data Sheets (MSDS) and relevant Australian Standards and Dangerous Goods regulations.</li> <li>On-site refuelling must not occur within 50m of a watercourse or drainage line and shall be undertaken in bunded and sealed areas in a manner to prevent spillage through appropriate handling and storage of fuels.</li> <li>Onsite refuelling is to be supervised at all times and all hoses are to be fitted with a stop valve at the nozzle end.</li> <li>Spill kits shall be kept on site at all times. Spill kits are to be located where hazardous substances are stored and used. All site personnel (including contractors) are to be trained in the use of spill kits.</li> <li>Hazardous substances and materials must only be handled by trained personnel and in accordance with MSDS.</li> <li>If any potentially dangerous wastes i.e. other than those documented in the Revised DSI (Opus 2015) i.e. asbestos, are encountered during the works, the location and details of the waste must be reported to the Supervisor</li> </ul>	<ul style="list-style-type: none"> <li>Daily inspections of the site shall be undertaken by the Supervisor to ensure hazardous substances are being stored and used in accordance with the HSEP and applicable MSDS</li> <li>Record all environmental incidences and complaints in the Site Records File</li> </ul>	<ul style="list-style-type: none"> <li>No complaints from surrounding residents</li> </ul>	<ul style="list-style-type: none"> <li>If asbestos or other hazardous substance is identified all excavation works shall cease and management strategies be developed by Shire of Denmark in consultation with DER Contaminated Sites Branch</li> <li>Any leakage or spillage of hazardous substances will trigger immediate spill response and clean up procedures, and repair and improvement of storage areas and, or equipment</li> <li>Where the storage or handling of hazardous substances does not comply with the HSEP, additional training shall be provided to site personnel involved</li> <li>Any complaint or environmental incident will trigger corrective actions immediately</li> <li>All corrective actions shall be approved by the Site Manager and shall be developed in consultation with relevant regulatory authorities where appropriate.</li> </ul>	<ul style="list-style-type: none"> <li>Site Manager</li> <li>Site Supervisor</li> </ul>

## 7.5 Responsibilities and Contract Details of Site Personnel

This RAP is prepared for the specific use of the following parties, who are referred to in this document as:

- Site Manager – Shire of Denmark;
- Site Supervisor – Shire of Denmark;
- Contractor – Shire of Denmark with subcontractors and own plant;
- Supervising Engineer – Shire of Denmark;
- Environmental Officer – Opus.

The Contractor shall provide a competent representative on site for the duration of the remediation works to liaise with the Shire of Denmark Project Manager. The representative shall be responsible for appropriate supervision of remedial activities to ensure works are carried out in accordance with the DER approved Remedial Action Plan.

The responsibilities of the Environmental Officer are restricted to the independent monitoring of the works in terms of compliance with this RAP, carrying out validation testing, liaison with Regulators and reporting.

The Environmental Officer has no responsibility for direct instruction of the Contractor, or measurement and administration under the contract. The Environmental Officer will report to the Shire of Denmark who is the client.

Table 7-2 outlines responsibilities and contact details for site personnel during works.

**Table 7-2: Contact Details of Site Personnel**

Organisation	Name	Role	Role in Project	Contact Details
Shire of Denmark 953 South Coast Highway PO Box 183 Denmark WA 6333 T: (08) 9848 0300	Gregg Harwood	Director of Community and Regulatory Services	Project Manager / Site Manager	M: 0418 732 197 E: <a href="mailto:dcrs@denmark.wa.gov.au">dcrs@denmark.wa.gov.au</a>
	Lee Shelley	Health and Building Project Officer  Site Attendant	Site Supervisor  Waste delivery at McIntosh Road Waste Management Facility	M: 0416 476 933 E: <a href="mailto:health3@denmark.wa.gov.au">health3@denmark.wa.gov.au</a>
	Ryan Harding	Health and Building Project Officer	Site Supervisor	M: 0409 570 136 E: <a href="mailto:health2@denmark.wa.gov.au">health2@denmark.wa.gov.au</a>
	Gilbert Arlandoo	Director of Infrastructure Services	Supervising Engineer	M: 0427 448 603 E: <a href="mailto:engineer1@denmark.wa.gov.au">engineer1@denmark.wa.gov.au</a>
	Clint Daw	Technical Officer	Supervising Engineer	
Shire of Plantagenet	Dominic Le Cerf	Manager Works and Services	Managing waste delivery	T: (08) 9892 1139 E: <a href="mailto:dlecerf@plantagenet.wa.gov.au">dlecerf@plantagenet.wa.gov.au</a>



Organisation	Name	Role	Role in Project	Contact Details
Langton Road Mount Barker WA 6324 T (08) 9892 1111	Barry Hinds	Assistant Works Supervisor/ Waste	Waste delivery at Mount Barker Waste Management Facility	M: 0437 289 796
Contractor	Shire of Denmark with subcontractors and own plant  Gregg Harwood	Director of Community and Regulatory Services	Earthworks and transport of waste material for recovery or disposal	M: 0418 732 197  E: <a href="mailto:dcrs@denmark.wa.gov.au">dcrs@denmark.wa.gov.au</a>
Opus International Consultants  70-74 Frederick Street, Albany WA 6332	Vicki Davies	Environmental Team Leader	Environmental Officer  Soil and groundwater sampling for verification of remedial works	M: 0427 915 726  E: <a href="mailto:vicki.davies@opus.com.au">vicki.davies@opus.com.au</a>
	Will White	Senior Environmental Consultant	Environmental Officer  Soil and groundwater sampling for verification of remedial works	M: 0431 364 788  E: <a href="mailto:will.white@opus.com.au">will.white@opus.com.au</a>

## 7.6 Complaints

Any complaints relating directly to the remediation works shall be recorded in a complaints register and dealt with immediately by the Contractor. The Contractor shall, without delay, inform the Shire of Denmark Project Manager of any and all such occurrences and of the subsequent actions taken to ensure appropriate measures are put in place to rectify the nuisance and prevent further occurrences or similar complaints.

## 7.7 Health and Safety

The Contractor shall be responsible for ensuring the remedial works are carried out in full compliance with the appropriate health and safety legislation, guidance documents and approved Codes of Practice, Australian Standards and Australian/ New Zealand Standards including, but not limited to:

- AS 2436-2010 Guide to noise and vibration control on construction, demolition and maintenance sites;
- *Environmental Protection (Noise) Regulations 1997*;
- *Guidelines for the Assessment, Remediation and Management of Asbestos – Contaminated Sites in Western Australia – May 2009* (DoH 2009) gazetted under the *Contaminated Sites Act 2003* in 2010;
- *Occupational Safety and Health Act 1984*;
- *Occupational Safety and Health Regulations 1996*;

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A Health Safety and Environment Plan (HSEP) for the remedial works shall be developed by the Shire of Denmark. No works will be permitted until an adequate plan has been submitted to, and approved by, the Shire of Denmark Project Manager.

### **7.8 Remediation Schedule and Hours of Operation**

Timeframes for remediation of the site is from August to December 2016. Operations will be undertaken between the 0700 hours and 1900 hours on any day which is not a Sunday or public holiday.

## 8 Site Validation Plan

### 8.1 Validating the Removal of Contaminated Soil

The removal of the unsuitable Uncontrolled Fill, Buried Natural Topsoil and hydrocarbon impacted Natural Sand (and clay) will require inspection and testing by the Environmental Officer and reported to the Supervising Engineer to validate the success of the remedial works.

Validation will include, but may not be limited to, the following:

- Samples of soil from the base of the excavation will be collected to verify that the full extent of the hydrocarbon contaminated material has been removed;
- Samples of soil from the windrows on completion of the ex situ on-site bioremediation and any reuse of excavated material on-site;
- The soil samples will be collected on an approximate grid spacing of 20 m and submitted to the laboratory of ALS and tested for the determinands in **Table 3-2**;
- Based on the currently known site area where unsuitable materials are present it is estimated that approximately 18 validation soil samples will be required as per Appendix F;
- The laboratory results shall be compared to the remediation criteria contained in **Table 3-2** of this document;
- If all the determinands are below the specified remediation criteria, then the soils will be considered to be acceptable. If any of the determinands exceed the specified remediation criteria then further remediation will be required; and
- The excavation shall not be backfilled until the Supervising Engineer has verified the successful removal of the full depth of unsuitable materials and confirmed that the backfill materials are suitable for use.

### 8.2 Validating the Placement of Site Derived Soil

#### 8.2.1 Existing Stockpiled Materials

Two sources of stockpiled material have been stored on site for possible reuse as backfill for the remediation excavation. Source and validation sampling results previously undertaken have been summarised in Table 8-1.

**Table 8-1: Replacement Fill Quantities, Source and Previous Sampling**

Source	Approximate Volume	Date of Validation Sampling	Number of Samples	Additional Validation Recommended Based on DEC 2009 Sampling Rates
Nigel Palmer Earthmoving – McIntosh Road Pit	1,875 m <sup>3</sup>	29/07/15	4	4
		9/05/16	3	
Wilson Inlet cut	920 m <sup>3</sup>	9/05/16	5	3

### 8.2.1.1 McIntosh Road Pit Source

The results of the samples analysed from the McIntosh Road Pit source collected in 2015 (Opus 2015) and 2016 (Appendix H) indicate this stockpiled material is chemically suitable for reuse to backfill the remediation excavation.

Given that the volume of the stockpile is approximately 1,875 m<sup>3</sup> it is recommended that further sampling and analysis is undertaken, as per DEC (2009) guidelines for sampling rates, to verify that the remainder of the stockpile not sampled and tested previously continues to be chemically suitable for use.

Given that seven samples from the near the outside of the stockpile have been sampled and analysed to date it is proposed that approximately 1,200 m<sup>3</sup> can be used as backfill and the remainder of the centre of the stockpile is verified.

No greater volume than 1,200 m<sup>3</sup> of the existing stockpiled material may be reused to backfill the excavation without validation.

### 8.2.1.2 Wilson Inlet Cut Source

Five samples were collected in May 2016 from the new stockpiled material onsite and results indicate that this material is chemically suitable for reuse as backfill for the determinands in **Table 3-1**.

Acid Sulfate Soil (ASS) and Total Soluble Salts (TSS) were also analysed due to the source location from a marine environment.

ASS field tests for soil pH and pH<sub>FOX</sub> levels were greater than 4 and a slight reaction rate and indicated a low risk of ASS presence (DER 2015).

Results for TSS were 5,000 to 5,060 mg/kg therefore concrete infrastructure installed onsite shall be suitable for this level of salinity, to the satisfaction of the Shire of Denmark Supervising Engineer.

The approximate volume of this stockpile is 920 m<sup>3</sup> and therefore a further 3 samples are recommended for this material prior to reuse.

### 8.2.1.3 Further Validation of Stockpiled Replacement Fill Onsite

Composite samples of soil, as per the additional sampling requirements in Table 8-1, will be collected from the replacement fill stockpiles by the Environmental Officer and submitted to the laboratory of ALS and tested for the determinands in **Table 3-1**. The laboratory results shall be compared to the remediation criteria contained in **Table 3-1** of this document.

If all the determinands (or alternatively 95% upper confidence limits) are below the specified remediation criteria, then the soils will be considered to be acceptable.

If any of the determinands (or alternatively 95% upper confidence limits) exceed the specified remediation criteria then the stockpiled material will be considered unsuitable for use and will need to be removed off-site.

The Supervising Engineer is responsible for ensuring the replacement fill is structurally sound for construction of buildings.

## 8.2.2 Site Derived Recent Fill

The Opus DSI 2015 report indicated that the site derived Recent Fill is chemically suitable for reuse to backfill the remediation excavation. However, given that the Recent Fill is present near surface it will be necessary to carefully excavate and segregate this material and temporarily stockpile the material separately pending reuse to backfill the remediation excavation.

In order to verify that the stockpiled Recent Fill has not been subjected to cross contamination during excavation and handling before reuse onsite, validation will include, but may not be limited to, the following:

- Sampling based on a frequency of one validation sample per 200 m<sup>3</sup> of Recent Fill reused;
- Based on an anticipated volume of Recent Fill of 3,600 m<sup>3</sup>, it is estimated that approximately 18 validation soil samples will be required;
- Composite samples of the stockpiled Recent Fill will be collected by the Environmental Officer and submitted to the laboratory of ALS and tested for the determinands in **Table 3-2**;
- The laboratory results shall be compared to the remediation criteria contained in **Table 3-2** of this document;
- If all the determinands (or alternatively 95% upper confidence limits) are below the specified remediation criteria, then the soils will be considered to be acceptable;
- If any of the determinands (or alternatively 95% upper confidence limits) exceed the specified remediation criteria then the affected portion of the stockpiled Recent Fill will be considered unsuitable for use and will need to be removed off-site.
- The Recent Fill material must not be reused to backfill the excavation without validation.
- The Supervising Engineer is responsible for ensuring replacement fill is structurally sound for construction of buildings.

### 8.2.3 Site Derived Screened Uncontrolled Fill

The Uncontrolled Fill is being remediated because it is geotechnically unsuitable for the proposed redevelopment of the site and also because a proportion of the Uncontrolled Fill is contaminated by petroleum hydrocarbons.

It is the intention of The Shire of Denmark to screen the proportion of Uncontrolled Fill that is not impacted by hydrocarbon contamination to remove structurally unsuitable material (such as concrete, brick, rock, metal, tree stumps etc.) and reuse the uncontaminated fines to backfill the remediation excavation.

The hydrocarbon contaminated proportion of the Uncontrolled Fill, an estimated volume of 2,500 m<sup>3</sup> will not be screened and instead will be disposed of off-site by the Contractor in its entirety or alternatively a portion of screened hydrocarbon contaminated soil may be subjected to ex situ bioremediation onsite (Section 6.3).

Material destined for offsite disposal will be sampled and analysed for Waste Classification as per Section 8.2.3.2.

#### 8.2.3.1 Validation for Reuse Onsite

Following selective excavation, screening and stockpiling of the uncontaminated Uncontrolled Fill, validation sampling and testing is required to verify that the fines are chemically suitable for reuse to backfill the excavation.

The estimated volume of Uncontrolled Fill requiring remediation is approximately 8,400 m<sup>3</sup>, of which approximately 2,500 m<sup>3</sup> is considered likely to be hydrocarbon impacted (Appendix D). Therefore potentially 5,900 m<sup>3</sup> is likely to be non-hydrocarbon impacted and suitable for screening.

Please note that this volume may be increased following the additional further testing required as per Section 5.

As an additional precaution the uncontaminated Uncontrolled Fill fines will not be placed within the 1.0 m of the final ground surface.

In order to verify that the screened fines have not been cross contaminated during excavation and handling before reuse on site, it is necessary to undertake validation sampling based on a frequency as per the DEC (2009) guidelines for sampling stockpiles.

Composite samples of the uncontaminated Uncontrolled Fill screened fines will be collected by the Environmental Officer and submitted to the laboratory of ALS and tested for the determinands in **Table 3-2**. The laboratory results shall be compared to the remediation criteria contained in **Table 3-2** of this document. If all the determinands (or alternatively 95% upper confidence limits) are below the specified remediation criteria, then the soils will be considered to be acceptable.

If any of the determinands (or alternatively 95% upper confidence limits) exceed the specified remediation criteria then the affected portion of the stockpiled Recent Fill will be considered unsuitable for use and will need to be removed off-site.

The Supervising Engineer is responsible for ensuring replacement fill is structurally sound for construction of buildings.

#### **8.2.3.2 Waste Classification**

Hydrocarbon impacted Uncontrolled Fill and screened fines that do not meet Remedial Targets for reuse onsite the stockpiled material will be sampled for laboratory analysis for waste classification for disposal to landfill as per DEC (2009) recommendations for analytes and sampling rates.

Material to be removed offsite and disposed to landfill shall be classified prior to removal from the Site.

Analysis results shall be provided to the receiving landfill (Mount Barker Waste Management facility – Class I and II classified waste) for their approval prior to accepting waste material.

In the event that Class III waste is identified an alternative DER approved landfill site will be sourced or soil will be remediated on-site to meet Class II landfill requirements.

### **8.3 Validating the Placement of Imported Clean Fill**

If there is a shortfall of backfill material it will be necessary to import Clean Fill to the site. The Clean Fill should meet the requirement of the DER 'Material guideline: Clean fill' (DER 2014).

The Clean Fill shall be obtained wherever possible from a single source (preferably), which has been inspected, tested, validated and approved in advance by the Environmental Officer.

For each proposed source of Clean Fill to be used on the site, a minimum of three representative samples of each material will be collected by the Environmental Officer during the inspection of the source and tested to demonstrate that the source is suitable for residential use with plant uptake. The purpose of the inspection is to ensure that the proposed source comprises chemically inert material with limited potential for contamination to be incorporated.

The soil samples from the proposed sources of imported Clean Fill shall be submitted to the laboratory by the Environmental Officer and tested for the full range of contaminants listed in **Table 3-1** of this document. The results of the laboratory testing shall be compared to the remediation criteria also listed in **Table 3-1**. If one of the determinants (or alternatively 95% upper confidence limits) exceeds the specified acceptance criteria, then the proposed source of the soil shall be rejected.

In order to demonstrate the continued suitability of the source of the Clean Fill it is necessary to collect and analyse additional samples, where the quantity imported exceeds 600 m<sup>3</sup>. As the Clean Fill should meet the DER material guidelines validation testing at a frequency of 1 sample/ 1,000 m<sup>3</sup> is considered appropriate.

No source of Clean Fill material should be imported to site without validation. The Supervising Engineer is responsible for ensuring replacement fill is structurally sound for construction of buildings.

### 8.4 Groundwater Monitoring During and After Works

Three groundwater monitoring bores (Figure 8-1) were installed 26 April 2016. MB1 was installed upslope of the contaminated material, MB2 adjacent to previously identified contaminants and MB3 downslope of the site. Initial groundwater monitoring was undertaken by Opus, on behalf of the Shire of Denmark, on 9 May 2016 to investigate background contaminant levels.

A summary of groundwater quality result for pre-remedial site works is included in Appendix H.



**Legend**

- Site location
- Monitoring Bore Locations



**Figure 8-1: Approximate Monitoring Bore Locations (Not to scale) (Source Landgate)**

## 8.5 Summary of Site Validation Sampling and Analysis Quality Plan (SAQP)

The Sampling and Analysis Quality Plan (SAQP) for the validation of remedial works is enclosed in Appendix I and is summarised below.

### 8.5.1 Soil Sampling

It is anticipated areas of the site requiring remediation will be excavated through the full depth of the Uncontrolled Fill terminating in the natural sand. Excavation is not expected to penetrate the full depth of the natural sand and will stop at where (based on field observations) the natural sand appears to be uncontaminated.

All soil samples analysed will be subject to on-site field testing to screen the soil samples for the presence of volatile organic compounds (VOCs) using a hand-held photo-ionization detector (PID).

Where suspected asbestos containing material (ACM) is encountered as a bulk item in fill it should be sampled and surrounding soil collected as a separate sample to assess whether asbestos is present in the fill as free fibres.

Soil samples will be collected for validation against determinands in **Table 3-1** for the following:

- Further validation of stockpiled replacement fill located onsite; and
- Imported Clean Fill.

Soil samples will be collected for validation against determinands in **Table 3-2** for the following:

- In situ Natural Sand (and clay) following removal of contaminated material;
- Site derived Recent Fill;
- Site derived Screened Uncontrolled Fill;
- Bioremediated soil

Soil samples will be collected for waste classification as per DEC (2009) guidelines for the following:

- Site derived material that fails to meet Remedial Targets in Table 3-2.

Soil samples will be collected as per the rates outlined in Section 8 and have been summarised in Appendix I.

### 8.5.2 Soil Analysis

Selected soil samples will be scheduled for chemical analysis at the laboratory of ALS for the following determinands as per **Table 3-1**:

- Metals;
- PCBs;
- OC/OP Pesticides;
- PAHs;
- Phenols;
- Total Recoverable Hydrocarbons NEPM 2013 Fractions;
- BTEX;
- Asbestos



Selected soil samples will be scheduled for chemical analysis at the laboratory of ALS for the following determinands as per **Table 3-2**:

- Total Recoverable Hydrocarbons NEPM 2013 Fractions; and
- Asbestos.

Soil samples collected for waste classification will be analysed based on the previous characterisation of the site contaminants and requirements of Tables 3, 4 and 5 of the DEC (2009) guidelines.

Field and laboratory QC/QA will be undertaken as detailed in Appendix E.

### 8.5.3 Groundwater Sampling

Groundwater sampling will continue to be undertaken during and post remedial works at MB1, MB2 and MB3. Timeframes for monitoring will be dependent on the works schedule.

Groundwater sampling will be undertaken using a low flow pump, water quality meter and water level meter. Sampling and preservation of samples will be undertaken as per AS/NZS 5667:1998 Part 1 and 11.

It should be noted that groundwater monitoring borehole MB2 is located with the area of the remediation excavation and will be destroyed during the remediation works. It is therefore proposed that the groundwater sampling is undertaken at an early stage during the remediation works, before such a time that MB2 is destroyed.

Standard forms for groundwater monitoring are included in Appendix J.

### 8.5.4 Groundwater Analysis

Standing groundwater level will be measured prior to purging the monitoring bores.

Field groundwater quality measurements will include the following:

- pH;
- Dissolved oxygen;
- Total dissolved salts;
- Electrical conductivity; and
- Temperature.

Groundwater samples will be scheduled for chemical analysis at the laboratory of ALS for the following determinands:

- Dissolved metals;
- Total mercury;
- PCBs;
- OC/OP Pesticides;
- PAHs;
- Phenols;
- TPH; and
- BTEX.

Field and laboratory QC/QA will be undertaken as detailed in Appendix E.

## 8.6 Site Remediation and Validation Reporting

Records and photographs of all site remediation works and validation should be kept and supplied to the Shire of Denmark for collation in a Site Remediation and Validation (SRV) report at completion of works for submission to the DER Contaminated Sites Branch. This report shall include but may not be limited to the following as per DER (2014) guidance:

- Remediation works undertaken;
- Evaluation of soil validation results and comparison with remedial objectives and targets;
- Evaluation of Treatability Study;
- Evaluation of groundwater monitoring results;
- Any revision to the CSM and any uncertainties in the remediation outcomes;
- Deviations from the RAP;
- Recommendations for further site remediation or management (if required);
- Any restrictions for future use of the site;
- Documentation of all off-site disposal of waste materials i.e. transport dockets, landfill receipts;
- Documentation of all imported replacement fill i.e. source and certification of quality; and
- Any approvals or licences obtained from regulatory authorities to complete the remediation works.

## 9 Recommendations

Based on the findings of the 2015 Revised DSI, the ROA and this RAP the following recommendations are proposed for the Shire of Denmark to undertake:

- Prepare a Health, Safety and Environment Plan (HSEP) prior to commencement of remedial works;
- Further investigation is required beneath the soil stockpile in the centre of the site as this overlies the former location of petrol and diesel fuel storage tanks. In addition, further investigation is also required on the land adjacent to the southern site boundary where materials are currently stockpiled and no access has been possible to date;
- Undertake remedial works in a safe manner that maximises the reuse of onsite material;
- Uncontrolled Fill and buried Natural Topsoil that is not structurally suitable shall be removed from the site and disposed of responsibly at a suitably permitted waste management facility;
- Based on the preferred remediation option by the Shire of Denmark the hydrocarbon contaminated proportion of the Uncontrolled Fill, an estimated volume of 2,500 m<sup>3</sup>, will not be screened and instead will be disposed of off-site by the Contractor in its entirety;
- Alternatively, if practical (and subject to favourable outcome of stakeholder consultation exercise), undertake ex situ bioremediation on a proportion of the hydrocarbon impacted soil;
- Assess whether an 80 m x 14 m size remediation pad (adjacent to the southern boundary) is practical given the Shires proposed design and sequencing of the remediation earthworks e.g. battered side slopes to the windrows will take up space, timeframes for remediation of the site etc.;
- Local government authority planning approval for undertaking bioremediation works onsite.
- Community consultation and notification will be required for surrounding residential properties prior to remediation site works;
- Upon removal of the full extent of the Uncontrolled Fill and the Natural Topsoil (Buried), samples of the natural soils should be collected and tested to demonstrate that the underlying soils are validated and structurally suitable for residential use;
- Actual waste classification is to be confirmed and agreed with the receiving landfill in advance of disposal;
- Replace deficit of fill with importation of certifiable clean fill, as per DER (2014) requirements, to provide a structurally sound site suitable for development of residential dwellings;
- Undertake all works, both on- and off-site, so as to minimise impact on the surrounding sensitive receptors including residences and the environment;
- If during the remediation earthworks, the ground conditions differ significantly from those encountered during the course of the investigations to date, including the discovery of any other odorous or visible contaminants, then this should be sampled, tested and dealt with appropriately;
- Undertaken pre, during and post site remediation groundwater quality monitoring;
- Proposed timeframes for remediation of the site is from August to December 2016; and
- On completion of the remediation earthworks a Site Remediation and Validation (SRV) report shall be prepared detailing the extent and effectiveness of the clean-up;
- The RAP and SRV are to be submitted to DER at completion of remedial works for reclassification of the site.

## 10 References

- ANZECC & ARMCANZ. 2000. *National Water Quality Management Strategy. Australian Guidelines for Water Quality Monitoring and Reporting*. Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand.
- ANZECC & ARMCANZ. 2000. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand.
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- Department of Environment and Conservation (DEC). 2011. *A guideline for managing the impacts of dust and associated contaminants from land development sites, contaminated sites remediation and other related activities*. Government of Western Australia, Perth.
- DEC. 2009. *Landfill Waste Classification and Waste Definitions 1996 (As amended December 2009)*. Government of Western Australia, Perth.
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- DER. 2014. *Material guideline: Clean fill*. Government of Western Australia, Perth.
- Department of Health (DoH) 2009. *Guidelines for the Assessment, Remediation and Management of Asbestos – Contaminated Sites in Western Australia – May 2009*, Government of Western Australia, Perth.
- Environment Agency (UK). *Remedial Treatment Action Data Sheet on Windrow Turning*. DS-02, V1.0.
- Johnston, C.D. 2010. *Selecting and Assessing Strategies for Remediating LNAPL in Soil and Aquifers*, CRC CARE Technical Report no. 18, CRC for Contamination Assessment and Remediation of the Environment, Adelaide, Australia.
- National Environment Protection (Assessment of Site Contamination) Measure (NEPM) 1999.
- New South Wales Environment Protection Authority. 2014. *Best Practice Note: Landfarming State of NSW and EPA*, Sydney.
- Shire of Denmark. 2012. *Ordinary Meeting of Council 12 June 2012, 8.5.1 Reserve 34209 Hardy Street, Denmark*. Shire of Denmark, Denmark.
- Opus International Consultants Limited Pty Ltd (Opus). 2011. *Detailed Site Investigation Lot 3002 Hardy Street, Denmark*. Unpublished document prepared for Lionsville Denmark Inc. and Amaroo Care Services Inc.
- Opus. 2015. *Revised Detailed Site Investigation Lot 3002 Hardy Street, Denmark*. Unpublished document prepared for the Shire of Denmark.
- Standards Australia. 2010. *Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites*. AS 2436-2010.

## Appendix A

Report of a Known or Suspected Contaminated Site Form 1[r.6] and  
DEC/ DER Correspondence

# REPORT OF A KNOWN or SUSPECTED CONTAMINATED SITE

## Form 1 [r. 6]

### Contaminated Sites Act 2003, section 11



Department of  
Environment and  
Conservation

Our environment, our future

**PERSON REPORTING THE SITE:**

Family Name:	Given Name(s):
Company (if applicable):	<i>LIONSVILLE DENMARK INC (W. FAIRPOLLANSON Preside)</i>
Address:	Suburb/Town:
<i>P.O. Box 259</i>	<i>DENMARK.</i>
Postcode:	Phone:
<i>9548 DENMARK 6333.</i>	<i>98481500.</i>
Fax:	Email:
<i>98481017</i>	

Are you:

- an owner of the site;
- an occupier of the site;
- an Accredited Contaminated Sites Auditor engaged to audit the site;
- a person who knows, or suspects, that he or she has caused, or contributed to the contamination of the
- none of the above - please specify your relationship with the site (below):

Relationship with the site: \_\_\_\_\_

**SITE DETAILS / DESCRIPTION OF LAND TO WHICH REPORT RELATES:**

Lot No. <i>3002</i> and/or Street No. _____	Street Name: <i>HARDY ST.</i>
Certificate of Title Reference No. / Volume & Folio: _____	Suburb / Town: <i>DENMARK.</i>
	Postcode: <i>6333.</i>
(incl. copy of current Certificate of Title)*	Local Government: <i>DENMARK.</i>

\*Not required unless this form is submitted by a person under a duty to report the site under the Contaminated Sites Act 2003 section 11(4e).

# REPORT OF A KNOWN or SUSPECTED CONTAMINATED SITE

## Form 1 [r. 6]

Contaminated Sites Act 2003, section 11



Department of Environment and Conservation

Our environment, our future

### PART A (complete either PART A or PART B overleaf)

#### SUSPECTED CONTAMINATION:

Date on which you first suspected that the site was contaminated:

Type of contamination you suspect: Rubble & old trees & hydrocarbons.

Suspected source of contamination:

Ex Depot of the Denmark Shire. Mid 64-65 closed after that.

Where is the suspected contamination? (i.e. soil, groundwater, surface water): of Building Site.

Reason(s) why contamination is suspected: -

during site works to build 6 residential units for Ours 55 in conjunction with Dept of Housing. Holes were dug which revealed - Rubbish, old trees tim etc + smell of Diesel.

Previous activity, or activities and/or land use, or uses (if known): SHIRE DEPOT

Current activity, or activities and/or land use, or uses (if known): BUILDING SITE.

Future activity, or activities and/or land use, or uses (if known): RESIDENTIAL

Is a licence under the Environmental Protection Act 1986 Part V in force, or ever been in force, in respect of any part of the site?

Yes

No

Licence No. (if known): NO.

# REPORT OF A KNOWN or SUSPECTED CONTAMINATED SITE

## Form 1 [r. 6]

Contaminated Sites Act 2003, section 11



Department of Environment and Conservation

Our environment, our future

### PART B (complete either PART A or PART B)

#### KNOWN CONTAMINATION:

Date on which you first knew that the site was contaminated: about 30/11/2010.

Known contaminant(s): OLD TILES, DRUMS, LITTER, PLATES etc.

Suspected source of contamination: SHIRE DEPOT WASTE FROM WORKSHOP.

Where is the contamination? (i.e. soil, groundwater, surface water): SOILS TO 3 METRES.

Previous activity, or activities and/or land use, or uses (if known): SHIRE DEPOT.

Current activity, or activities and/or land use, or uses (if known): VACANT LAND.

Future activity, or activities and/or land use, or uses (if known): RESIDENTIAL.

Is a licence under the *Environmental Protection Act 1986* Part V in force, or ever been in force, in respect of any part of the site?

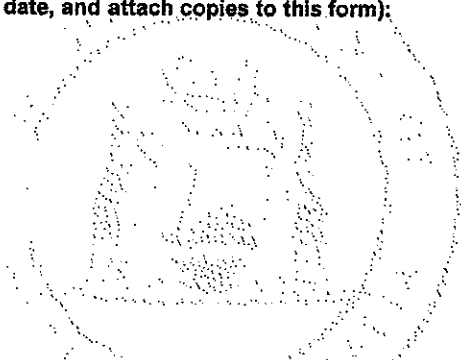
Yes

No

Licence No. (if known):

Details of investigations undertaken to confirm the presence of contamination (where investigations have been reported, list report title, author and date, and attach copies to this form):

NONE.



Details of any remediation undertaken or planned:

NONE. - However SHIRE ADVISED THAT WORK SHOULD CEASE. PRIOR TO STOPPING WORK MATERIAL THAT APPEARED TO BE CONTAMINATED WAS SET ASIDE ON SITE. AN ENVIRONMENTAL REVIEW WAS CARRIED OUT BY HARRINGTON CONSULTANTS IN ASSOCIATION WITH AYTON TAYLOR & BARRELL & WOOD & BRIEVE ENGINEERS. IN SEPTEMBER, 1997. COPY ATTACHED.



# REPORT OF A KNOWN or SUSPECTED CONTAMINATED SITE

## Form 1 [r. 6]

### Contaminated Sites Act 2003, section 11



Department of Environment and Conservation

Our environment, our future

**Note that under the Contaminated Sites Act 2003, it is an offence to:**

- Report a site maliciously and without reasonable grounds to believe or suspect that the site is contaminated (section 11(9)); or
- Make a statement in this report which you know is false or misleading in a material particular (section 94); or
- Make a statement, in making this report, which is false or misleading in a material particular, with reckless disregard as to whether the statement is false or misleading in a material particular (section 94); or
- Provide, or cause to be provided, in making this report, information that you know is false or misleading in a material particular (section 94); or
- Provide, or cause to be provided, in making this report, information that is false or misleading in a material particular, with reckless disregard as to whether or not the information is false or misleading in a material particular (section 94); or
- Fail to disclose, or cause a failure to disclose all information which you know is materially relevant in making this report (section 94).

**IF THIS REPORT IS BEING MADE BY AN INDIVIDUAL:**

Signature of person making the report: W.R. Farquharson PRESIDENT LONSVILLE DENMARK INC.  
 Date: 9/12/2010 Title and Full Name: WILLIAM FARQUHARSON  
 Address: P.O. BOX 259 DENMARK Suburb/Town: DENMARK WA 6332  
 Postcode: 6333 Phone: 98482211/0408482185  
 Fax: 98481017 Email: DENVILLE@WESTNET.AU

**IF THIS REPORT IS BEING MADE BY A BODY CORPORATE, IT MAY BE SIGNED ON BEHALF OF THE BODY CORPORATE BY AN AUTHORISED OFFICER AND NEED NOT BE MADE UNDER ITS SEAL:**

I, WILLIAM RICHARD FARQUHARSON PRESIDENT  
(Position)

am authorised by [LONSVILLE DENMARK INC.] to make this report on behalf of that body corporate.  
(Body Corporate name)

Signature: W.R. Farquharson Date: 9/12/2010  
 Title and Full Name: PRESIDENT WILLIAM RICHARD FARQUHARSON  
 Address: UNIT 3/29 BAUN Suburb/Town: DENMARK WA  
 Postcode: 6333 Phone: 98481500  
 Fax: 98481017 Email: WILL.FARQUHARSON@GMAIL.COM

**Mail the completed form to:**

Department of Environment and Conservation  
Contaminated Sites Branch  
Locked Bag 104  
Bentley DC WA 6983



Government of Western Australia  
Department of Environment and Conservation

Your ref:  
Our ref: 2010/10654  
Enquiries: Registrar  
Phone: 1300 762982  
Fax:  
Email:

William Farquharson  
Lionsville Denmark Inc  
PO Box 259  
Denmark WA 6333

Dear Sir/Madam

New legislation is in place to record and manage contaminated sites in Western Australia, in order to protect people's health and the environment. Please note that contamination does not necessarily mean that an area is unsafe to live or work in – for example, it may be limited to groundwater, and only becomes an issue to be managed if a groundwater bore was being considered.

The *Contaminated Sites Act 2003*, which came into effect on 1 December 2006, requires the Department of Environment and Conservation (DEC) to classify sites reported to it and inform a number of people, including owners and occupiers, so they can make informed decisions about the site.

Set out below in this letter is the formal notice of a classification of a known or suspected contaminated site in which you have an interest. The notice explains why the site received the classification, any restrictions on the use of the site, and how you can appeal the classification if you believe it is incorrect. In some cases, this notice may include a list of lots in addition to the one in which you have an interest.

Also attached is a copy of the brochure *Contaminated sites: New laws for Western Australia*, which has more information about the new Act. If you have any queries, please contact DEC's Contaminated Sites Section on 1300 762 982.

**NOTICE OF A CLASSIFICATION OF A KNOWN OR SUSPECTED CONTAMINATED SITE GIVEN UNDER SECTION 15 OF THE *CONTAMINATED SITES ACT 2003***

The site detailed below, consisting of 1 parcel(s) of land, was reported to the CEO of DEC as a known or suspected contaminated site and has been classified under the Act:

- LOT 3002 ON PLAN 45104 as shown on certificate of title LR3151/703 known as 26 Hardy St, Denmark WA 6333 (the Site)

This notification is being sent to you in accordance with section 15(1) of the Act on the grounds that you, as the recipient, are one or more of the following:

DIRECTOR GENERAL AND ENVIRONMENTAL SERVICES DIVISIONS: The Atrium, 168 St Georges Terrace, Perth, Western Australia 6000  
Phone: (08) 6467 5000 Fax: (08) 6467 5562

PARKS AND CONSERVATION SERVICES DIVISIONS: Executive: Corner of Australia II Drive and Hackett Drive, Crawley, Western Australia 6009  
Phone: (08) 9442 0300 Fax: (08) 9386 1578 Operations: 17 Dick Perry Avenue, Technology Park, Kensington, Western Australia 6151  
Phone: (08) 9219 8000 Fax: (08) 9334 0498

POSTAL ADDRESS FOR ALL DIVISIONS: Locked Bag 104, Bentley Delivery Centre, Western Australia 6983

[www.dec.wa.gov.au](http://www.dec.wa.gov.au)  
[wa.gov.au](http://wa.gov.au)

- (a) owner of the site;
- (b) occupier of the site;
- (c) relevant public authority;
- (d) person in the CEO's opinion there is particular reason to notify;
- (e) person who made the report under section 11 or 12; and
- (f) person in the CEO's opinion who may be responsible for remediation of the site classified as *contaminated – remediation required*.

### Site Classification

The Site is classified as the following category:

**Category of Site classification:** Possibly contaminated - investigation required

**Date of site classification:** 24/01/2011

**Reasons for classification:** This site was reported to the Department of Environment and Conservation (DEC) as per reporting obligations under section 11 of the 'Contaminated Sites Act 2003', which commenced on 1 December 2006. The site classification is based on information submitted to DEC by December 2010.

The site was historically used as a Shire Council Depot, a land use which has the potential to cause contamination as detailed in the DEC guideline "Potentially Contaminating Activities, Industries and Land Uses" (Department of Environment, October 2004).

The site was reported because recent soil excavations, conducted during residential redevelopment works at the site, uncovered potential hydrocarbon-impacted soils (such as from diesel and oil) and evidence of historical waste burial activities. Items uncovered included: building rubble; sleepers; trees; drums; licence plates; and general rubbish.

In 1997, test pit and bore hole inspections of soils were conducted at the site and detected evidence of assorted timber, textiles and scrap metals at the site. However, limited soil testing undertaken at the time did not identify any potential contaminants of concern above relevant assessment levels.

A limited engineering assessment conducted at the site in December 2010 similarly detected evidence of uncontrolled fill, rubble and miscellaneous wastes (including metal, wire ropes, organic materials) and strong petroleum hydrocarbon odours within stockpiled soils.

Soil and groundwater quality investigations undertaken at the site to date are limited and do not meet the requirements of DEC's current Contaminated Sites Management Series of guidelines. The quality of soils and groundwater across the site has not been thoroughly assessed.

Based on information submitted to DEC to date, further investigations are required to determine the nature and extent of possible contamination at the site and the suitability of the site for the proposed redevelopment for residential use.

As there are grounds to indicate possible contamination of the site, and since a suitable investigation of soil and groundwater and a risk assessment to determine the risk to human health, the environment, or any environmental value, has not been carried out, further works are required to determine the contamination status of the site and suitability for proposed residential land use. The site has therefore been classified as "possibly contaminated - investigation required".

When the results of soil and groundwater investigations are submitted to DEC, these will be reviewed, and the site may be re-classified.

DEC, in consultation with the Department of Health, has classified the site based on the information available at the time of classification. It is acknowledged that the contamination status may have changed since this time, and as such the usefulness of this information may be limited.

In accordance with Department of Health advice if groundwater is being, or is proposed to be, abstracted DEC recommends that analytical testing should be carried out to determine whether the groundwater is suitable for its intended use.

The nature and extent of contamination and any restrictions on the use of the land, if applicable, are listed in Attachment A.

Information in relation to the classification of the site will be available to the public through a request for a summary of records on written application and payment of a prescribed fee from the Reported Sites Register.

In some instances DEC has had to classify sites based on historical information. It should be noted that a site may be re-classified at any stage to better reflect the current status when additional information becomes available, for example where a new investigation or remediation report completed in accordance with DEC's *Contaminated Sites Management Series* of guidelines, is submitted to DEC. The current site classification is the classification most recently conferred on the site.

#### Memorials

In accordance with section 58(1) of the Act, DEC will lodge a memorial against the Certificate of Title(s) LR3151/703 relating to the site, with Registrar of Landgate, which will record the site classification. The parcel(s) that do not have a registration number or certificate of title will not have a memorial lodged against them until a certificate of title has been created. Confirmation of the lodgement of the memorial(s) will be forwarded to the following people once completed:

- (a) each owner,
- (b) the Western Australian Planning Commission;
- (c) the CEO of the Department of Health;
- (d) the Local Government Authority;
- (e) the relevant scheme authority.

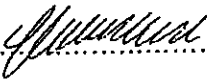
Given that memorial(s) will be lodged against the site, the Western Australian Planning Commission (WAPC) may not approve the subdivision of the land under Section 135 of the *Planning and Development Act 2005*, or the amalgamation of that land with any other land without seeking, and taking into account, the advice of DEC as to the suitability of the land for subdivision or amalgamation. Furthermore, a responsible authority (e.g. Local Government Authorities) may not grant approval under a scheme for any proposed development of the land without seeking, and taking into account, advice from DEC as to the suitability of the proposed development.

#### Appealing the Site classification

All site classifications given by DEC are appealable. However, only certain people can lodge a valid appeal depending on the classification category as detailed in the attached Fact Sheet. Appeals need to be lodged in writing with the Contaminated Sites Committee at Level 22, Forrest Centre, 221 St Georges Tce, Perth WA 6000, within 30 days of being given this notification. The appeal should set out the appellant's relationship to the site, and must include the grounds and facts upon which it is based.

For further information on all aspects of site classification, please refer to the *Site Classifications – What do they Mean?* Fact Sheet (enclosed) and *Site Classification Scheme 2006* (guideline) which are available from DEC's website [www.dec.wa.gov.au/contaminatedsites](http://www.dec.wa.gov.au/contaminatedsites) or by contacting the Registrar on 1300 762 982.

Yours sincerely



Sally Dodds, A/SECTION MANAGER

CONTAMINATED SITES BRANCH  
Delegated Officer under section 91  
of the *Contaminated Sites Act 2003*

24/01/2011

Enc. Attachment A – Nature and Extent and Restrictions on Use.

Rights of Appeal under the *Contaminated Sites Act 2003* Fact Sheet  
Site Classifications – “What do they mean” Fact Sheet

**ATTACHMENT A – Nature and Extent and Restrictions on Use**

- **LOT 3002 ON PLAN 45104**

**Nature and Extent:** Fill material, potentially including hydrocarbon impacted soil, (such as from diesel and oil); building rubble; sleepers; trees; drums; licence plates; and general rubbish has been identified in soils at the site.

**Restriction on Use:** DEC recommends that further investigations and, if necessary, remedial works are completed before the site is redeveloped for residential use.



RECEIVED  
7 SEP 2011

Vickie Laurie  
Opus International Consultants Limited  
PO Box 5236  
Albany WA 6330

Dear Sir/Madam

**NOTICE OF A CLASSIFICATION OF A KNOWN OR SUSPECTED CONTAMINATED SITE GIVEN UNDER SECTION 15 OF THE *CONTAMINATED SITES ACT 2003***

The site detailed below, consisting of 1 parcel(s) of land, was classified by the Department of Environment and Conservation (DEC) under the *Contaminated Sites Act 2003* (the Act) on 24 January 2011 as '*Possibly contaminated - investigation required*':

- LOT 3002 ON PLAN 45104 as shown on certificate of title LR3151/703 known as 26 Hardy St, Denmark WA 6333

As a result of additional information submitted to the DEC in relation to the contamination status of the site, the site has been re-classified to '*Contaminated - remediation required*'.

This notification is being sent to you in accordance with section 15(1) of the Act on the grounds that you, as the recipient, are one or more of the following:

- (a) owner of the site (contact details sourced from the current certificate of title);
- (b) occupier of the site;
- (c) relevant public authority;
- (d) person who, in the CEO's opinion, there is particular reason to notify;
- (e) person who made the report under section 11 or 12; and
- (f) person who, in the CEO's opinion, may be responsible for remediation of a site classified as *contaminated - remediation required*.

**Re-classification of the site**

**Former Site Classification**

**Former site Classification:** Possibly contaminated - investigation required

**Date of Former site Classification:** 24/01/2011

**New Site Classification**

**New site Classification:** Contaminated - remediation required

**DIRECTOR GENERAL AND ENVIRONMENTAL SERVICES DIVISIONS:** The Atrium, 168 St Georges Terrace, Perth, Western Australia 6000  
Phone: (08) 6467 5000 Fax: (08) 6467 5562

**PARKS AND CONSERVATION SERVICES DIVISIONS:** Executive: Corner of Australia II Drive and Hackett Drive, Crawley, Western Australia 6009  
Phone: (08) 9442 0300 Fax: (08) 9386 1578 Operations: 17 Dick Perry Avenue, Technology Park, Kensington, Western Australia 6151  
Phone: (08) 9219 8000 Fax: (08) 9334 0498

**POSTAL ADDRESS FOR ALL DIVISIONS:** Locked Bag 104, Bentley Delivery Centre, Western Australia 6983

www.dec.wa.gov.au  
wa.gov.au

**Date of New site Classification:** 29/08/2011

**Reasons for classification:** This site was reported to the Department of Environment and Conservation (DEC) as per reporting obligations under section 11 of the 'Contaminated Sites Act 2003', which commenced on 1 December 2006. The site classification is based on information submitted to DEC by July 2011.

The site was historically used as a Shire Council Depot, a land use which has the potential to cause contamination as detailed in the DEC guideline "Potentially Contaminating Activities, Industries and Land Uses" (Department of Environment, October 2004).

The site was reported because soil excavations conducted during residential redevelopment works at the site during December 2010, uncovered potential hydrocarbon-impacted soils (such as from diesel and oil) and evidence of historical waste burial activities. Items uncovered included: building rubble; sleepers; trees; drums; licence plates; and general rubbish.

In 1997, test pit and bore hole inspections of soils were conducted at the site and detected evidence of assorted timber, textiles and scrap metals at the site. A limited engineering assessment conducted at the site in December 2010 similarly detected evidence of uncontrolled fill, rubble and miscellaneous wastes (including metal, wire ropes, organic materials) and strong petroleum hydrocarbon odours within stockpiled soils.

Further detailed site investigations conducted in April 2011 again identified evidence of the burial of assorted materials. Soil sampling and analysis detected petroleum hydrocarbon (such as from diesel and oil) contamination within isolated areas of soil, at concentrations potentially exceeding Health Investigation Levels for residential land uses as published in 'Assessment Levels for Soil, Sediment and Water' (DEC, 2010). Further laboratory analysis would be required to determine whether Health Investigations Levels for residential land use are exceeded. DEC notes, however, that a strong hydrocarbon odour was reported from some of the impacted soil

Limited opportunistic sampling of groundwater conducted as part of the April 2011 investigations, did not detect contaminants at concentrations exceeding relevant guideline values. Groundwater appears to be perched upon a clay layer beneath the site and further investigations are required to determine the contamination status of groundwater beneath the site.

Based on information submitted to DEC to date, the site is contaminated and remediation is required to ensure the site is suitable for the proposed residential development. DEC understands that earthworks are planned to render the site geotechnically suitable for residential development and further contamination investigations and remediation activities are also planned to ensure the site is suitable for the proposed residential redevelopment.

As the site in its current condition has been demonstrated to be unsuitable for residential land use and remediation is required to reduce unacceptable risks to human health, the environment or any environmental value to acceptable levels, the site is classified as 'contaminated - remediation required'.

When the results of further investigations and/or remediation activities are submitted to DEC, these will be reviewed, and the site may be re-classified.



DEC, in consultation with the Department of Health, has classified the site based on the information available at the time of classification. It is acknowledged that the contamination status may have changed since this time, and as such the usefulness of this information may be limited.

In accordance with Department of Health advice if groundwater is being, or is proposed to be, abstracted DEC recommends that analytical testing should be carried out to determine whether the groundwater is suitable for its intended use.

### General Information

The nature and extent of contamination and any restrictions on the use of the land, if applicable, are listed in Attachment A.

Information in relation to the classification of the site is available free of charge as a summary of records via the Contaminated Sites Database at [www.dec.wa.gov.au/contaminatedsites](http://www.dec.wa.gov.au/contaminatedsites).

In some instances DEC has had to classify sites based on historical information. A site may be re-classified at any stage when additional information becomes available, for example where a new investigation or remediation report completed in accordance with DEC's *Contaminated Sites Management Series* guidelines, is submitted to DEC. The current site classification is the classification most recently conferred on the site.

### Memorials

In accordance with sections 58 (1) and (3) of the Act, DEC will give notice to Landgate to withdraw the current memorial(s) lodged against the Certificate of Title LR3151/703 relating to the site, and subsequently lodge a new memorial against the Certificate(s) of Title, which will record the new site classification.

### Disclosure upon sale / lease / mortgage of the site

Where the land is part of a transaction – sale, mortgage or lease agreement – and is classified as

- *contaminated – remediation required;*
- *contaminated – restricted use; or*
- *remediated for restricted use;*

land owners MUST PROVIDE WRITTEN DISCLOSURE (on the prescribed Form 6 enclosed) of the site's status to any potential owner, mortgagee (e.g. financial institutions) or lessee at least 14 days before the completion of the transaction. A copy of the disclosure must also be forwarded to DEC.

**Important note:** Failure to provide written notice is an offence and carries a penalty of up to \$125,000 and a daily penalty of \$25,000.

### Transferring responsibility for remediation

This site has been classified '*contaminated – remediation required*'. Where transfer of responsibility for remediation is proposed, the person responsible for remediation must obtain written agreement from the person to whom the whole or part of that responsibility will transfer, and seek written approval of that agreement from DEC in accordance with section 30 of the Act. If

it is proposed to transfer responsibility for remediation to the State, then written approval from the Minister for Environment must be obtained.

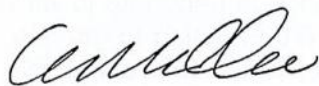
### Appealing the Site Classification

All site classifications given by DEC are appealable. However, only certain people can lodge a valid appeal. The people who can lodge a valid appeal varies, depending on the classification category, as detailed in Fact Sheet 11: *Rights of appeal under the Contaminated Sites Act 2003* (enclosed). Appeals need to be lodged in writing with the Contaminated Sites Committee at Forrest Centre, Level 22, 221 St Georges Terrace, Perth WA 6000, within **30 days** of being given this notification. The appeal should set out the appellant's relationship to the site, and must include the grounds and facts upon which it is based. An appeal fee (currently \$45) applies.

To find out more about the appeal process, see the Contaminated Sites Committee website at [www.consitescommittee.wa.gov.au](http://www.consitescommittee.wa.gov.au) or contact the office of the Committee on (08) 6467 5201.

For further information on all aspects of site classification, please refer to Fact Sheet 9: *Site classifications – What do they mean?* (enclosed) and *Site Classification Scheme 2006* (guideline) which are available from DEC's website [www.dec.wa.gov.au/contaminatedsites](http://www.dec.wa.gov.au/contaminatedsites) or by contacting the Registrar on 1300 762 982.

Yours sincerely



Andrew Miller  
SECTION MANAGER

CONTAMINATED SITES BRANCH  
Delegated Officer under section 91  
of the *Contaminated Sites Act 2003*

01/09/2011

Enc. Attachment A – Nature and Extent and Restrictions on Use.

Fact Sheet 9: Site classifications – what do they mean?  
Fact Sheet 11: Rights of appeal under the *Contaminated Sites Act 2003*  
Fact Sheet 14: Buying, selling or occupying contaminated land

## ATTACHMENT A – Nature and Extent and Restrictions on Use

- LOT 3002 ON PLAN 45104

**Nature and Extent:** Uncontrolled fill material, petroleum hydrocarbon (such as from diesel and oil) impacted soil, building rubble, drums, licence plates and general rubbish has been identified in soils at the site.

**Restriction on Use:** Further investigations and, remedial works are required before the site is redeveloped for residential use.



## Rights of appeal under the *Contaminated Sites Act 2003*

Under the Contaminated Sites Act 2003 (Act), all decisions regarding the assessment, management and remediation of contaminated sites are made by qualified, experienced Department of Environment and Conservation (DEC) environmental officers and DEC's chief executive officer (or his/her delegate).

All decisions are based on a thorough review and assessment of all available information. Under the Act, you may be able to appeal a decision you are not happy with. Depending on the nature of the case, your appeal will be heard by either the Contaminated Sites Committee or the Supreme Court.

The **Contaminated Sites Committee** (Committee) is a statutory committee appointed by the Minister for the Environment. It comprises three to five people with suitable expertise to make decisions for the purposes of the Act. The Committee is fully independent of DEC and has separate offices.

In making a decision under the Act, the Committee is required to consult DEC's chief executive officer and may consult any other person it considers necessary. The Committee is required to act according to equity, good conscience and the substantial merits of the case, without regard to technicalities or legal forms. It is not bound by the rules of evidence and may conduct its inquiries in any manner it considers appropriate.

The Committee's website is available at:  
[www.consitescommittee.wa.gov.au](http://www.consitescommittee.wa.gov.au)  
Telephone (08) 6467 5201

### What decisions can I appeal?

There are five types of decisions against which appeals can be made:

1. Site classifications assigned by DEC
2. Investigation or clean up notices issued by DEC
3. Responsibility for remediation determined by the Committee
4. Exemption certificates issued by the Committee
5. A notice relating to the recovery of costs incurred by the State on an orphan site - given to the person who would have been responsible for remediation

The disputed decision, classification, notice relating to cost recovery or certificate, applies while you are waiting for the outcome of the appeal, unless the appeal body decides otherwise.

**There is no avenue for appeal against receiving a hazard abatement notice.** The purpose of this notice is to address an immediate and serious risk to human health or the environment.

Appeal fees apply - currently the prescribed fee is \$45 for appeals against site classifications and investigation or clean up notices (see the Committee's information sheets at [www.consitescommittee.wa.gov.au](http://www.consitescommittee.wa.gov.au) for more details).

### How do I lodge an appeal?

There is a specific format for lodging appeals with the Committee. For exact details on this process refer to the Committee's information sheets at:  
[www.consitescommittee.wa.gov.au](http://www.consitescommittee.wa.gov.au)

## Appeals against site classification

Site classification decisions are made by DEC's chief executive officer or his/her delegate. Dependent upon the nature of the classification, certain people can appeal against the classification to the Contaminated Sites Committee (see table below). An appeal must include the reasons why the person lodging the appeal disagrees with the site classification assigned, and include any relevant supporting information.

Classifications	Eligible Appellants		
	Owner/ occupier	Person responsible for remediation	Third party who reported a suspected contaminated site
Possibly contaminated, investigation required	✓		
Not contaminated – unrestricted use	✓		
Contaminated – restricted use	✓	✓	
Remediated for restricted use	✓	✓	
Contaminated – remediation required	✓	✓	
Decontaminated	✓		
Report not substantiated			✓

The timeframe for lodging an appeal will be specified in the formal written notice of classification. The appeal must be received by the Committee within the specified timeframe to be valid (the Act provides a minimum 21-day appeal period, however the notice of classification may specify a longer period).

The Committee's decision in relation to appeals against site classifications is final and without further appeal.

## Appeals against the requirements of an investigation or clean up notice issued by DEC

The recipient of an investigation or clean up notice may appeal to the Committee against the requirements of the notice if they have good reason to dispute them.

To lodge an appeal, details of the case, including the grounds for appeal, must be submitted in writing to the Committee. Notice of an appeal must be lodged with the Committee within 21 days after the day on which the notice was received, or such later time as specified in the notice.

The Committee's decision in relation to the appeal is final, with no further appeal allowed to either the Committee or a court of law.

## Appeals against responsibility for remediation

If the responsibility for remediation of a contaminated site is in question, the Committee may, if requested or on its own initiative, determine who is responsible for cleaning up the site and the extent of that responsibility.

Appeals against a decision regarding responsibility for remediation may be made to the Supreme Court on a point of law only. An appeal to the Supreme Court is to be made in accordance with the rules of court and must be made within 21 days of receiving the Committee's decision.

## Appeals against issuing exemption certificates

The Committee decides if an exemption certificate should be issued when a disclosure statement has been submitted to the Committee. If the Committee refuses to issue an exemption certificate, the person who submitted the disclosure statement is entitled to appeal to the Supreme Court. The extent of exemption or cancellation or amendment of an exemption certificate can also be appealed - but only on a point of law.

An appeal to the Supreme Court is to be made in accordance with the rules of court and must be made within 21 days of receiving the Committee's decision.

## NEED MORE INFORMATION?

DEC has published a series of fact sheets and guidelines to assist with the assessment, management and remediation of contaminated sites in Western Australia. They are available at [www.dec.wa.gov.au/contaminatedsites](http://www.dec.wa.gov.au/contaminatedsites)

Alternatively, information is available by mail from the address below, or by calling the Contaminated Sites Hotline on 1300 762 982.

Contaminated Sites Branch

Department of Environment and Conservation  
Locked Bag 104  
Bentley Delivery Centre WA 6983

## Site classifications - what do they mean?

### What is a site classification?

A site classification is a description assigned to an area of land that has been reported to the Department of Environment and Conservation (DEC) as a site that is known or suspected to be contaminated. Under the *Contaminated Sites Act 2003* (Act), DEC can allocate any one of seven possible classifications to sites:

- 1. Report not substantiated** – there is not enough information to indicate that the site could be contaminated.
- 2. Possibly contaminated - investigation required** – there are grounds to indicate soil, groundwater and/or surface water at the site may be contaminated, however, more information is required to confirm or dismiss the possibility of contamination.
- 3. Not contaminated - unrestricted use** – after investigation, no contamination was found at the site.
- 4. Contaminated - restricted use** – the site is contaminated but suitable for limited uses (e.g. the site may be suitable for commercial use only, or for residential use provided groundwater bores are not used).
- 5. Remediated for restricted use** – the site was contaminated but has been cleaned up to a standard where it is suitable for limited uses (e.g. the site may be suitable for an apartment block, but not for a kindergarten).
- 6. Contaminated - remediation required** – the site is contaminated and needs to be cleaned up to ensure it does not present a risk to human health or the environment. This classification will remain until remediation is complete.
- 7. Decontaminated** – the site has been remediated and is suitable for all uses. It does not pose a risk to the environment or human health.

**Remediation** means 'cleaning' or removing contamination. It includes action taken to remove, destroy, reduce or contain any contaminant or its negative effects on the environment or human health, or to restore the site to the condition it was in before the contamination occurred. Remediation may involve restricting public access to an area or removing material for suitable waste disposal.

Some classifications have more serious ramifications than others. For example, sites classified as:

- *contaminated - remediation required*
- *contaminated - restricted use*
- *remediated for restricted use*
- *possibly contaminated - investigation required*

require DEC to place a memorial on the Certificate of Title. This alerts potential buyers and interested parties to the site's contamination status. For further information refer to Fact Sheet 14, *Buying, Selling or Occupying Contaminated Land*.

The Contaminated Sites Database on DEC's website has information on sites classified as:

- *contaminated - remediation required*
- *contaminated - restricted use*
- *remediated for restricted use*

Members of the public can access the database by going to [www.dec.wa.gov.au/contaminatedsites](http://www.dec.wa.gov.au/contaminatedsites)

Information on all **other reported sites**, including those awaiting classification, is available by submitting a Form 2 to DEC. Forms are available for download on DEC's website [www.dec.wa.gov.au/contaminatedsites](http://www.dec.wa.gov.au/contaminatedsites). For further information refer to Fact Sheet 1, *How to Access Information on Contaminated Sites in Western Australia*.

## How are sites classified?

Contamination, as defined by the Act, means having a substance on land, water or site above background concentrations and at high enough levels to present, or potentially present, a risk of harm to human health, the environment or any environmental value.

**Background concentrations** - substances that occur naturally due to the geology (rock formations and soil types) at a site. Establishing background concentrations will determine if any chemical substances detected are due to human activities at or near a site, or are representative of natural conditions in the area.

To classify a site, DEC is required to assess the levels of substances present in soil, groundwater and/or surface water at the site against accepted criteria. Contamination is generally deemed present or potentially present if there are specific substances recorded above concentrations listed in DEC's guideline, *Assessment Levels for Soil, Sediment and Water* which is available on DEC's website:

[www.dec.wa.gov.au/contaminatedsites](http://www.dec.wa.gov.au/contaminatedsites)

All classifications are based on information available to DEC at the time of classification and take into account the relevant guidelines for site investigations and management.

The classification of a site may influence:

- the intended use of the land
- whether a memorial is registered on the Certificate of Title
- who is notified of the classification
- who may appeal against a site classification
- how information on the site can be accessed
- whether further work to investigate or clean up the site is required.

## Notification of classification

The Act requires DEC to notify the following people of a reported site's classification:

- each owner of the site
- an occupier of the site
- any relevant public authority
- the person who reported the site
- those responsible for remediating the site where it is classified *contaminated – remediation required*
- any other person DEC has a particular reason to notify.

## Changing a Classification

The classification of a site may be changed if:

- a site investigation is conducted in accordance with DEC guidelines supporting a different classification
- a new area or type of contamination is discovered
- contamination has been removed or cleaned up and a subsequent validation report has been reviewed and accepted by DEC
- the owner or occupier of a site successfully appeals against a classification.

## Disclosure of Contaminated Sites Classification

Under the Act, owners of contaminated sites are required to inform any potential new owner, lessee or mortgagee at least 14 days before the completion of a transaction when a site is classified:

- *contaminated – remediation required*
- *contaminated – restricted use*
- *remediated for restricted use*

Disclosure is also required where an investigation, clean up or hazard abatement notice has been issued for a site.

The appropriate form (Form 6 – *Land Owner's Disclosure Before Completion of Land Transaction*) is available for download from DEC's website:

[www.dec.wa.gov.au/contaminatedsites](http://www.dec.wa.gov.au/contaminatedsites)

A completed copy must also be submitted to DEC.

## NEED MORE INFORMATION?

DEC has published a series of fact sheets and guidelines to assist with the assessment, management and remediation of contaminated sites in Western Australia. These are available on DEC's website:

[www.dec.wa.gov.au/contaminatedsites](http://www.dec.wa.gov.au/contaminatedsites)

Further information is available by mail from the address below or by calling the Contaminated Sites Hotline on 1300 762 982.

Contaminated Sites Branch  
Department of Environment and Conservation  
Locked Bag 104  
Bentley Delivery Centre WA 6983

## Buying, selling or occupying contaminated land

If you are considering buying, selling or occupying land that is, or has the potential to be, contaminated from previous land uses, the Department of Environment and Conservation (DEC) recommends you seek professional advice from an environmental consultant experienced in contaminated site assessments who can undertake an environmental investigation of your property. If you don't establish prior to purchase what contamination is present, you may be held responsible for the remediation of the contamination in the future. You should refer to Fact Sheet 5, *How to hire a contaminated sites consultant or an Accredited Auditor* for more information or go to [www.dec.wa.gov.au/contaminatedsites](http://www.dec.wa.gov.au/contaminatedsites).

You must provide written disclosure to any new or potential owners if you are selling or transferring land that has been classified by DEC as:

- *contaminated – restricted use*
- *contaminated – remediation required*<sup>1</sup>
- *remediated for restricted use, or*
- where the land is subject to a regulatory notice under Part 4 of the *Contaminated Sites Act 2003* (Act), and a memorial has been registered on the title of the land.

You should refer to Form 6 - *Land Owner's Disclosure Before Completion of Land Transaction*, which can be found at [www.dec.wa.gov.au/contaminatedsites](http://www.dec.wa.gov.au/contaminatedsites), or in Schedule 1, Form 6 of the Regulations. When completed, the form should detail information about the contamination status of the site and it must be submitted to each person who is considering becoming an owner, mortgagee or lessee of the property. Failing to do this at least 14 days before the completion of a potential transaction could result in a penalty of \$125,000, and an additional daily penalty of \$25,000.

In relation to Crown land, *owner* means, for the purposes of the Act:

- A management body that is responsible for the care, management and control of a site.
- A person who is responsible for the administration of the land, which is reserved, set apart or vested for, or dedicated to, the purposes of another written law.
- The Minister for the Environment where the site is an 'orphan site' taken into State ownership.
- If not any of the above, the Minister for Lands.

More information on disclosure statements, including what information is required in a disclosure statement, is available in the DEC Guideline, *Disclosure statements*.

### Need more information?

DEC has published a series of fact sheets and administrative and technical guidelines to assist with the assessment, management and remediation of contaminated sites in Western Australia; these are available by going to [www.dec.wa.gov.au/contaminatedsites](http://www.dec.wa.gov.au/contaminatedsites).

Further information is available by mail from the address below or by calling the Contaminated Sites Section on 1300 762 982.

Contaminated Sites Section  
Department of Environment and Conservation  
Locked Bag 104  
Bentley Delivery Centre WA 6983

<sup>1</sup> If you are selling or transferring ownership of a site that is classified as *Contaminated - Remediation Required*, then in addition to completing the Land Owner's Disclosure Form you must also seek approval from DEC, prior to settlement. This is to ensure that the potential purchaser of the property has the financial capabilities to undertake the remediation of the site.





**Contaminated Sites Act 2003**  
**Basic Summary of Records Search Response**

Report Generated at: 11:29:00AM, 20/07/2016

**Search Results**

This response relates to a search request received for:

26 Hardy St  
Denmark WA 6333

This parcel belongs to a site that contains 1 parcel(s).

According to Department of Environment Regulation records, this land has been reported as a known or suspected contaminated site.

Address	26 Hardy St Denmark WA 6333
Lot on Plan Address	Lot 3002 On Plan 45104
Parcel Status	<p><b>Classification:</b> 05/05/2016 - Contaminated - remediation required</p> <p><b>Nature and Extent of Contamination:</b></p> <p>Buried waste, including granite boulders, building rubble, wire rope, car number plates, drums, tree stumps and logs, are buried beneath the site. Additionally, soil beneath the site is impacted by zinc and hydrocarbons (such as from diesel and oil).</p> <p><b>Restrictions on Use:</b></p> <p>Further investigations and remedial works are required before the site is redeveloped for residential land use.</p> <p><b>Reason for Classification:</b></p> <p>This site was reported to the Department of Environment Regulation (DER) as per reporting obligations under section 11 of the 'Contaminated Sites Act 2003' (the Act), which commenced on 1 December 2006. The site was classified under section 13 of the Act based on information submitted to DER by August 2011. These reasons for classification have been updated to reflect additional technical information submitted to DER by March 2016.</p> <p>The site was reported because residential redevelopment earthworks in December 2010 found waste buried beneath the site. Materials found included granite boulders, building rubble, wire rope, car number plates, drums, tree stumps and logs.</p> <p>This site was used as a depot, for approximately 20 years, from circa 1964 to 1984. Depot activities included automotive repair, chemical (pesticide) storage and bulk fuel storage,</p>

**Disclaimer**

This Summary of Records has been prepared by Department of Environment Regulation (DER) as a requirement of the *Contaminated Sites Act 2003*. DER makes every effort to ensure the accuracy, currency and reliability of this information at the time it was prepared, however advises that due to the ability of contamination to potentially change in nature and extent over time, circumstances may have changed since the information was originally provided. Users must exercise their own skill and care when interpreting the information contained within this Summary of Records and, where applicable, obtain independent professional advice appropriate to their circumstances. In no event will DER, its agents or employees be held responsible for any loss or damage arising from any use of or reliance on this information. Additionally, the Summary of Records must not be reproduced or supplied to third parties except in full and unabridged form.



## **Contaminated Sites Act 2003**

### **Basic Summary of Records Search Response**

Report Generated at: 11:29:00AM, 20/07/2016

land uses that have the potential to cause contamination, as specified in the guideline 'Assessment and management of contaminated sites' (DER, 2014).

Contamination assessments were carried out in 1997, 2011 and 2015 to determine the quality of soil beneath the site and to characterise the nature and extent of uncontrolled fill material buried.

A soil investigation, carried out in April 2011, found that hydrocarbons (such as from diesel and oil) were present in soil at concentrations potentially exceeding Health-based Investigation Levels for residential with accessible soils, as published in 'Assessment Levels for Soil, Sediment and Water' (Department of Environment and Conservation, 2010), which were the relevant assessment criteria at the time.

Further soil investigations, carried out in July 2015, found that hydrocarbons (such as from diesel and oil) remain present in soil at concentrations exceeding Ecological Screening Levels for urban residential land and public open space and the relevant soil Health Screening Levels for vapour intrusion on residential land, as published in Schedule B1 of the 'National Environment Protection (Assessment of Site Contamination) Measure 1999' (the NEPM). Zinc was also present in soil within the fill material at concentrations exceeding the relevant Ecological Investigation Levels for urban residential land and public open space, as specified in the NEPM. These impacted soils were found in the central, northern and eastern portion of the site.

A groundwater investigation, carried out in April 2011, found no potential contaminants were detected above Australian Drinking Water Guidelines or Aquatic Ecosystems - Freshwater guidelines, as published in 'Assessment Levels for Soil, Sediment and Water' (Department of Environment and Conservation, 2010), which were the relevant assessment criteria at the time. The groundwater investigation was limited and did not meet the required DER standards at the time of the investigation.

The site is not suitable for residential redevelopment until further investigations and remedial measures have been undertaken.

As the site has been shown to be contaminated, and remediation is required to reduce unacceptable risks to human health, the environment or any environmental value to acceptable levels, the site is classified as 'contaminated - remediation required'.

DER, in consultation with the Department of Health, has classified this site based on the information available to DER at the time of classification. It is acknowledged that the contamination status of the site may have changed since the information was collated and/or submitted to DER, and as such, the usefulness of this information may be limited.

In accordance with Department of Health advice, if groundwater is being, or is proposed to be abstracted, DER recommends that analytical testing should be carried out to determine whether the groundwater is suitable for its intended use.

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**Contaminated Sites Act 2003  
Basic Summary of Records Search Response**

Report Generated at: 11:29:00AM, 20/07/2016

Certificate of Title Memorial
Current Regulatory Notice Issued
General

**Other Relevant Information:**

Where the land is part of a transaction - sale, mortgagee or lease agreement, the land owners MUST PROVIDE WRITTEN DISCLOSURE (on the prescribed Form 6) of the site's status to any potential owner, mortgagee (e.g financial institutions) or lessee at least 14 days before the completion of the transaction. A copy of the disclosure must also be forwarded to DER.

**Action Required:**

As soil remediation of the site is required, remedial options must be assessed and a remediation action plan developed for the site.

Further soil investigations are required beneath the existing soil stockpile in the centre of the site to determine the soil quality in this area. Additionally, further groundwater investigations are required to adequately determine the quality of groundwater beneath the site.

Investigations and remedial works should be carried out prior to residential development and should meet the standards outlined in DER's 'Contaminated Sites Guidelines' (2014) and the NEPM.

Under the Contaminated Sites Act 2003, this site has been classified as "contaminated - remediation required". For further information on the contamination status of this site, please contact the Contaminated Sites Branch of the Department of Environment & Conservation.

**Type of Regulatory Notice:** Nil

**Date Issued:** Nil

No other information relating to this parcel.

**Disclaimer**

This Summary of Records has been prepared by Department of Environment Regulation (DER) as a requirement of the *Contaminated Sites Act 2003*. DER makes every effort to ensure the accuracy, currency and reliability of this information at the time it was prepared, however advises that due to the ability of contamination to potentially change in nature and extent over time, circumstances may have changed since the information was originally provided. Users must exercise their own skill and care when interpreting the information contained within this Summary of Records and, where applicable, obtain independent professional advice appropriate to their circumstances. In no event will DER, its agents or employees be held responsible for any loss or damage arising from any use of or reliance on this information. Additionally, the Summary of Records must not be reproduced or supplied to third parties except in full and unabridged form.

# Appendix B

## Certificate of Title

WESTERN



AUSTRALIA

REGISTER NUMBER <b>3002/DP45104</b>	
DUPLICATE EDITION <b>N/A</b>	DATE DUPLICATE ISSUED <b>N/A</b>

RECORD OF QUALIFIED CERTIFICATE  
OF  
CROWN LAND TITLE

VOLUME **LR3151** FOLIO **703**

UNDER THE TRANSFER OF LAND ACT 1893  
AND THE LAND ADMINISTRATION ACT 1997

**NO DUPLICATE CREATED**

The undermentioned land is Crown land in the name of the STATE of WESTERN AUSTRALIA, subject to the interests and Status Orders shown in the first schedule which are in turn subject to the limitations, interests, encumbrances and notifications shown in the second schedule.



REGISTRAR OF TITLES

**LAND DESCRIPTION:**

LOT 3002 ON DEPOSITED PLAN 45104

**STATUS ORDER AND PRIMARY INTEREST HOLDER:  
(FIRST SCHEDULE)**

**STATUS ORDER/INTEREST:** RESERVE WITHOUT MANAGEMENT ORDER

**PRIMARY INTEREST HOLDER:** STATE OF WESTERN AUSTRALIA

**LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:  
(SECOND SCHEDULE)**

1. L737271 MEMORIAL. CONTAMINATED SITES ACT 2003 REGISTERED 20.9.2011.
2. N269971 RESERVE 52384 FOR THE PURPOSE OF FUTURE HOUSING DEVELOPMENT SITE REGISTERED 8.3.2016.

- Warning: (1) A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required. Lot as described in the land description may be a lot or location.
- (2) The land and interests etc. shown hereon may be affected by interests etc. that can be, but are not, shown on the register.
- (3) The interests etc. shown hereon may have a different priority than shown.

-----END OF CERTIFICATE OF CROWN LAND TITLE-----

**STATEMENTS:**

The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for local government, legal, surveying or other professional advice.

SKETCH OF LAND: DP45104.  
PREVIOUS TITLE: LR3119-390.  
PROPERTY STREET ADDRESS: 26 HARDY ST, DENMARK.  
LOCAL GOVERNMENT AREA: SHIRE OF DENMARK.  
RESPONSIBLE AGENCY: DEPARTMENT OF LANDS (SLSD).

NOTE 1: N269971 CORRESPONDENCE FILE 00046-2016-01RO

# Appendix C

## Locality Map

117°20'55"E

117°21'0"E

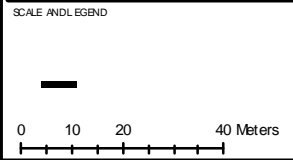
117°21'5"E

34°57'35"S

34°57'35"S

HARDY ST

WELSH



- Legend**
- IRIS\_Roads
  - Lot 3002 Hardy Street
  - cadastre

Client  
**Lionsville Denmark Inc. & Amaroo Village Denmark**



TITLE <b>Lot 3002 Hardy Street, Denmark</b>	
LOCALITY MAP	
STATUS Final	FILE W-04925.00
SCALE 1:1,250	PLOT DATE 01/10/2015

117°20'55"E

117°21'0"E

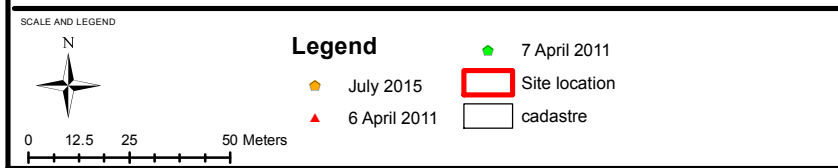
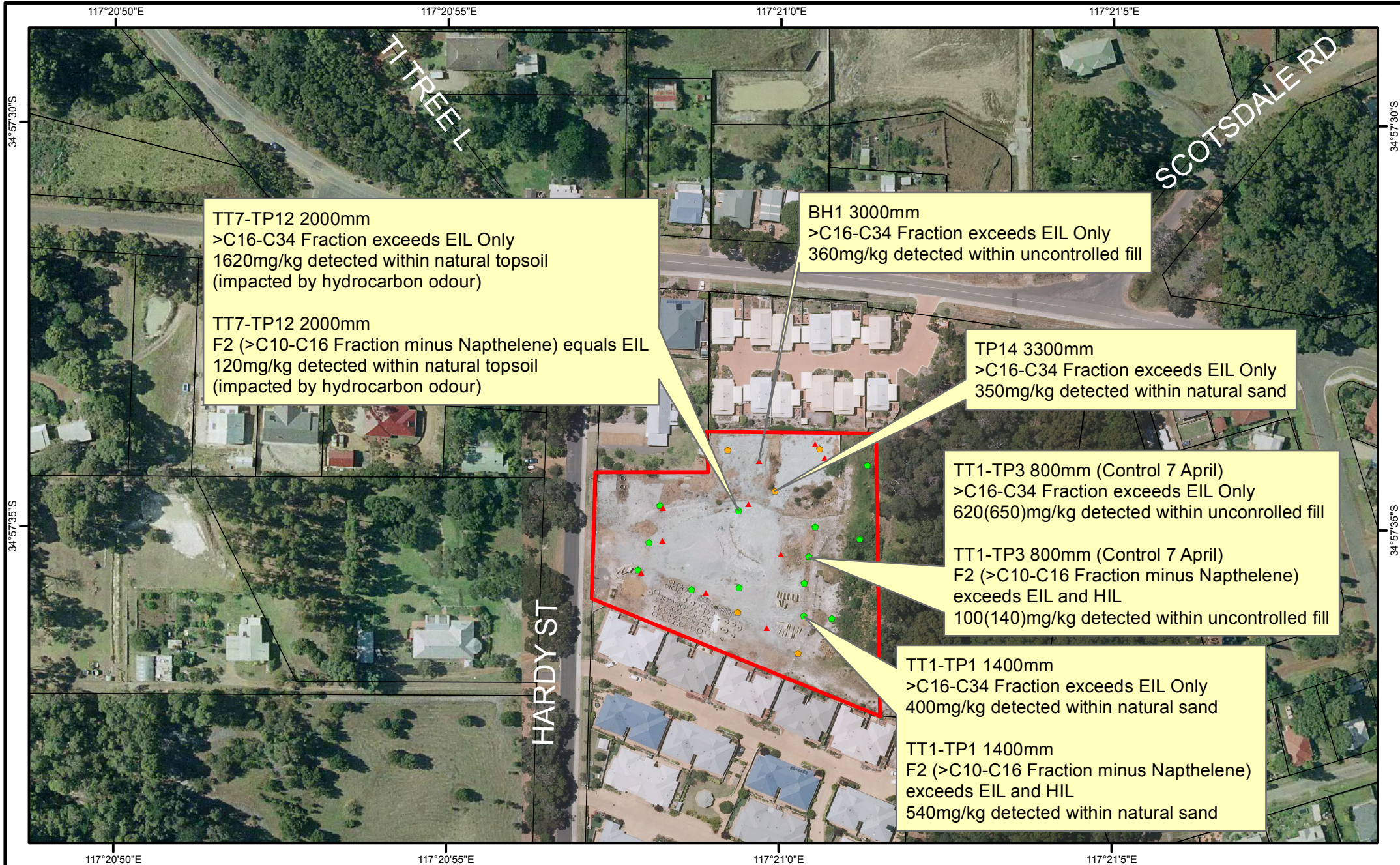
117°21'5"E

## Appendix D

Extent of Contamination

Approximate Location of Hydrocarbon Impacted Uncontrolled Fill

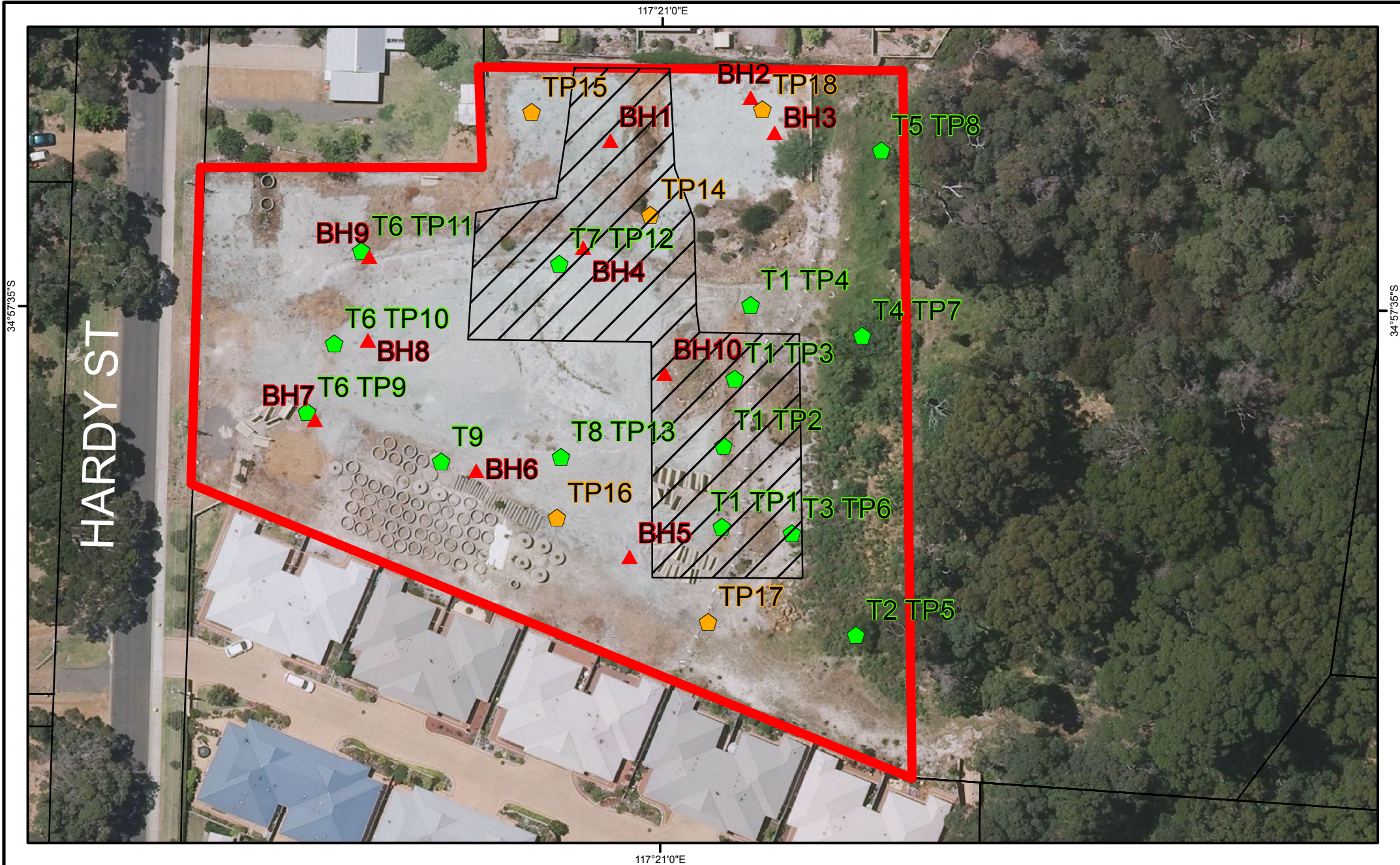




Client  
**Shire of Denmark**

**OPUS**  
Albany Office  
PO Box 5236  
Albany, WA 6330, Australia  
Tel: +61 8 9892 9600

TITLE <b>Lot 3002 Hardy Street, Denmark</b>	
Extent of Contamination	
STATUS <b>Final</b>	FILE <b>W-04925.00</b>
SCALE <b>1:1,878</b>	PLOT DATE <b>15/10/2015</b>



SCALE AND LEGEND

**Legend**

Approx. Location Hydrocarbon Impacted Uncontrolled Fill Site location

0 5 10 20 Meters

Client

**Shire of Denmark**

**OPUS**

Albany Office

PO Box 5236  
Albany, WA 6330, Australia  
Tel: +61 8 9892 9600

TITLE <b>Lot 3002 Hardy Street, Denmark</b>	
Approximate Location of Hydrocarbon Impacted Uncontrolled Fill	
STATUS <b>Final</b>	FILE <b>W-04925.01</b>
SCALE <b>1:751</b>	PLOT DATE <b>22/07/2016</b>

# Appendix E

## Further Investigation Sampling and Analysis Quality Plan

## **E.1 Further Soil Investigation Sampling and Analysis Quality Plan (SAQP)**

### **E.1.1 Purpose**

The purpose of the supplementary site investigation to be undertaken are as follows:

- Conduct additional test pits to further define the extent of contaminated materials;

This information will be included in the SRV at completion of remediation works.

### **E.1.2 Data Quality Objectives**

The following data quality objectives (DQOs) were developed in order to satisfy the intended purpose of further investigation required:

- Characterise the soil beneath the stockpile (location of two underground petrol and diesel storage tanks and bowsers) and stored materials adjacent to the southern boundary (former maintenance shed and workshop) and western boundary as these areas were obstructed during the previous site investigations.

### E.1.3 Sampling Design and Justification

Table E-1 outlines proposed soil sampling and field and laboratory analysis proposed to undertaken prior to remediation works to further characterise the site.

**Table E-1: Proposed Sampling and Analysis of Soil Samples from Test Pits**

Media	Analyte Selection		Sample Locations / Depth / Frequency	
Soil – test pits	Field	PID	<ul style="list-style-type: none"> <li>• Test Pits are proposed at 9 locations identified in Figure E-1 and will be sampled:                             <ul style="list-style-type: none"> <li>• At each and every change in the fill or natural soil strata;</li> <li>• Where material is homogenous samples will be collected at a minimum depth of every 0.5 m;</li> <li>• Additional samples will be collected should visual or olfactory evidence of contamination be observed;</li> <li>• In the capillary zone immediately above the water table (if encountered)</li> <li>• The first sample of natural soil will be collected at the boundary with the fill;</li> </ul> </li> <li>• Where suspected asbestos containing material (ACM) is encountered as a bulk item in fill it should be sampled and surrounding soil collected as a separate sample to assess whether asbestos is present in the fill as free fibres</li> </ul>	
	Laboratory	Asbestos (all forms)		
		Metals		Arsenic Cadmium Chromium (total) Chromium (hexavalent) Copper Lead Nickel Zinc Mercury
		PCB		
		OC/OP Pesticides		Aldrin Dieldrin DDT+DDD+DDE Trans Chlordane
		Phenols		
	PAHs	Total PAHs Anthracene Benzo(a)pyrene Fluoranthene Naphthalene Phenanthrene		

**Remedial Action Plan**

<b>Media</b>	<b>Analyte Selection</b>		<b>Sample Locations / Depth / Frequency</b>	
		Pyrene  Total Recoverable Hydrocarbons NEPM 2013 Fractions		C6-C10 Fraction minus BTEX (F1) >C10-C16 Fraction minus Naphthalene (F2) >C16-C34 Fraction (F3) >C34-C40 Fraction (F4) >C10-C40 Fraction (Sum)
		BTEX		Benzene Toluene Ethylbenzene Total Xylenes

### E.1.3.1 Sampling Locations

Figure E-1 below identifies locations within Lot 3002 Hardy Street previously investigated. Additional locations are proposed on the western and southern boundaries and in the centre of the site where materials being stored onsite previously obstructed investigations.



**Legend**

- Approximate Locations for further Testing
- 2015
- ▲ 6 April 2011
- 7 April 2011
- Site location



**Figure E-1: Previous and Proposed Soil Sample Locations within the Site (Not to scale) (Source Landgate)**

## E.1.3.2 Sampling Methods and Procedures

### E.1.3.2.1 Soil

#### (a) Test Pit Excavation

The test pits are to be excavated using a backhoe excavator. Typically the dimensions of the test pits will be rectangular pits of around 3.0 m length, 1.0 m breadth and 3.0–4.0 m depth. The maximum volume of soil excavated from each test pit should not exceed 12 m<sup>3</sup>. The test pit size will depend on stability of the pit, strata, bucket size, and reach of the backhoe. Test pit excavation will stop if groundwater is encountered and proven.

It is anticipated that the test pits will be excavated through the full depth of the Uncontrolled Fill terminating in the natural sand. The test pits are not expected to penetrate the full depth of the natural sand.

No person should enter an excavation if the depth is greater than 1.0 m depth. Further safety guidance is provided in the Code of Practice Excavation (Government of Western Australia Commission for Occupational Safety and Health 2005). Care should be taken when standing close to the edge of the open excavations in case the side walls collapse during excavation, particularly below the water table.

During excavation of the test pits, the excavated material should be laid out at the side of the pit in the order of excavation. When reinstating test pits, the spoil excavated must be replaced in the same order that it was excavated (ensuring material from the base of the pit is returned to the base etc.).

If encountered, no visible fragments of suspected asbestos will be left at ground surface. If required, asbestos containing materials should be covered at surface with non-asbestos containing fill from the excavation.

#### (b) Avoidance of Contamination during Sampling

It is aimed to collect samples for analysis that are as representative as possible of the area or material being sampled at the location and depth being sampled, therefore care shall be taken to ensure that:

- Equipment and sample containers do not cause contamination or loss of contaminants due to adsorption or volatilization;
- Cross-contamination does not occur.

Soil samples collected via mechanical excavation shall be sampled away from any surfaces such as the edges of the excavator bucket or spade or any surfaces created by the investigation technique.

When taking samples below surface level at a site, care shall be taken to avoid samples being affected by debris (soil or water) falling from more shallow depths. Thus, the base of each test pit shall be cleared of debris before obtaining a sample of the material at the base.

Soil samples shall be transferred to appropriate sample containers by hand using clean suitable disposable gloves which shall, as a minimum, be changed in between each sample. Where appropriate / necessary, an inert tool may be used to place samples into sample containers, such as a clean hand trowel of stainless steel. However, prior to taking a sample, the sampling tool should be cleaned using wet wipes to avoid cross-contamination.



## **(c) Collection of Soil Samples**

### **(i) Sample Containers**

Samples of the soils shall be collected and sealed in sampling vessels immediately upon excavation and exposure to minimise the potential loss of contaminants, such as volatiles. The sample containers are to be provided by ALS Environmental's Perth Laboratory.

Each soil sample shall be collected and placed in the following combination of sample containers:

- Glass jar 150ml for the analysis of inorganic & organic contaminants – 1No.
- Plastic bag 500ml for asbestos in soil analysis – 1No.
- Plastic bag small size for headspace testing – 1No.

For the surface soil samples only, the glass jars and plastic freezer bags can be omitted as volatiles are readily lost from the surface layers of the soil.

The sample jars should be filled to the top, particularly the glass jars to minimise any headspace.

A duplicate set of soil samples should be taken at a frequency of 1 in every 10 samples taken. This field duplicate will be analysed in the laboratory for QC purposes.

### **(ii) Field Testing**

All soil samples analysed will be subject to on-site testing to screen the soil samples for the presence of volatile organic compounds (VOCs) using a hand-held photo-ionization detector (PID).

This will take the form of headspace testing for volatiles (e.g. testing a small air pocket within a soil sample container) using a PID instrument in the field to assist with the selection of subsequent TPH and VOC analysis at the laboratory.

Headspace testing for VOCs shall be undertaken on the soil samples collected into small plastic bags. The plastic bags shall be filled half full and sealed intentionally leaving a headspace of air in the top of the bag. The plastic bags should be allowed to equilibrate to the ambient temperature for a period of at least 15 minutes prior to testing.

Once the temperature has equilibrated, the plastic shall be punctured with the probe of the PID instrument which should be inserted into the headspace. A sample of the headspace vapour is then drawn into the PID instrument for analysis via an internal pump. The maximum response of the PID instrument shall be recorded with the results expressed in parts per million (ppm).

## **(d) Sample Labelling, Handling and Transport**

### **(i) Sample Labelling**

Once a sample is obtained, it shall be clearly and uniquely labelled, using a permanent marker pen on the side of the container.

One of the following labelling methods shall be used:

1. Adhesive labels (providing there is adequate adhesion of the label under field conditions), or;
2. Writing directly on the sample container.

Before samples are dispatched from the site (and also upon receipt at the laboratory), the details on the container should be checked against the sample report and chain of custody documents.

As a minimum, all environmental samples shall be labelled with the following which should together form a unique and traceable sample:

- Company name: *Opus*
- Project name: *Lot 3002 Hardy Street*
- Exploratory hole reference: *e.g. TP14*
- Depth from which sample is taken in metres below ground surface:
- Date of sampling:

Details provided on the label of each sample should be recorded on a chain of custody sheet that provides a traceable record of sample collection and movement between site and the laboratory.

The field duplicate soil samples, which are to be collected at a frequency of every one in 10 samples, shall be labelled with a unique sample reference so that the laboratory does not know that the sample is a duplicate.

Samples suspected of containing asbestos collected into 500 ml plastic bags shall be placed and sealed in a plastic bag and clearly labelled as such in order to provide a warning to the laboratory.

### **E.1.3.3 Sampling Records**

The ground strata should be described in the field during the formation of the test pits. Location within the site should be recorded as the samples are taken. The descriptions of ground used for recording the strata should conform to the categories used in AS 1726 Geotechnical Site Investigations, but should also include any additional observations that are relevant to the contamination investigation.

If additional or special samples are taken, the reasons should be recorded. A description of each sample taken should also be recorded.

Where a scheduled or pre-arranged sampling location could not be used, and an alternative location was used, the actual location should be noted and the reason for the relocation stated.

Any other field observations should also be included in the report (such as visual or olfactory evidence of contamination), as these can be useful in the subsequent interpretation of analytical data.

The following information should be included, as appropriate, in the sampling report:

- Location and name of the sampling site with coordinates and other relevant locational information, including ground levels;
- Details of the actual sampling locations, including coordinates and depth;
- Date of collection;
- Method of collection;
- Name of collector;
- Weather conditions;
- Nature of any pre-treatment;
- Any other data or observations gathered during the sampling process.

Standard forms for soil sampling are included in Appendix J.

### **E.1.4 Field Quality Assurance/ Quality Control (QA/QC)**

The following field QA/QC procedures will be undertaken for sampling as per DER (2015) guidelines:

- Collection of field duplicates (blind replicates) as quality control samples;
- Use of standard field sampling forms and methods (Appendix J);
- Use of standard Chain of Custody forms (Appendix J);
- Documentation of field instrument calibration;
- Use of trip blanks during transport of samples.

Field duplicate samples will be collected as per DER collection rates. The field duplicate sample (labelled as “Control”) and investigative sample, from the same location, will be submitted to the laboratory as two individual samples without indication to the laboratory that they have been duplicated (DER, 2015).

### **E.1.5 Laboratory Quality Assurance/ Quality Control (QA/QC)**

The selected laboratory for this project is the ALS Laboratory Group’s Perth Environmental testing facility. The Perth environmental testing facility operates under ALS Laboratory Group's Global Quality Management System and has been accredited to ISO 17025 standards by the National Association of Testing Authorities (NATA) for the chemical testing of a wide range of parameters (Accreditation number 825).

Preservation and handling of soil and groundwater samples should generally be dealt with on a method-specific basis. Samples for organic analysis shall be stored on site and transported to the laboratory in cool boxes containing ice packs.

Samples should be transported to the laboratory and scheduled for analysis as quickly as possible to minimize any potential for chemical and biological changes before examination, and with consideration of holding times recommended by ALS Environmental Perth Laboratory.

Each chain of custody form shall be signed (along with a record of the time and date) by site personnel when samples are dispatched to the laboratory from site. The chain of custody form shall also be signed (along with a record of the time and date) upon receipt of the samples at the receiving laboratory.

One copy of the chain of custody form should be dispatched with the samples to the laboratory and a duplicate copy shall be retained by the sampling personnel.

When the laboratory receives the samples a copy of the Chain of Custody is returned along with a Sample Receipt Notification.

ALS then detail and report on all Quality Assurance and Quality Control processes.

The ALS Quality Control Report contains the following information:

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

The ALS Interpretive Quality Control Report contains the following information:

- Analysis Holding Time Compliance;
- Quality Control Parameter Frequency Compliance;
- Brief Method Summaries; and
- Summary of Outliers.

Duplicate soil and groundwater samples will be collected at a rates as per DER guidance. These samples will be marked as ‘Control’ samples with internal notes recorded as to their corresponding primary sample.

#### **E.1.5.1 Data Review**

The assessment of duplicate samples will be undertaken by calculating the Relative Percent Difference (RPD) of the duplicate result compared with the primary sample result. The RPD is defined as:

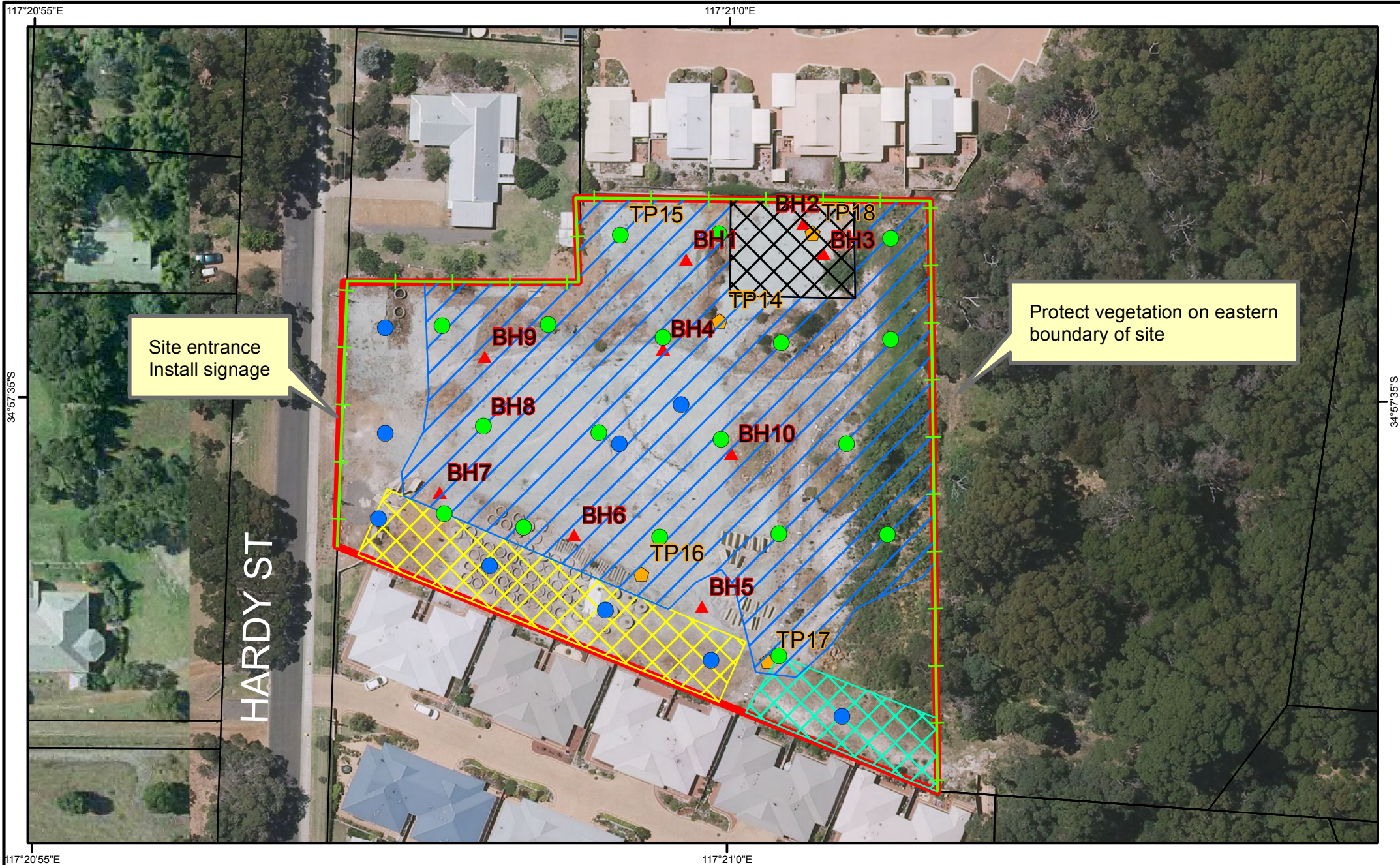
$$RPD = 100 \times \frac{(X1 - X2)}{Average}$$

Where ‘X1’ is equal to the result of the primary sample and ‘X2’ is the result of the blind replicate. The ‘Average’ is the average of all results within that analyte (i.e. Arsenic) (AS 4482.1–2005).

The acceptance criterion for quality control samples is an RPD of 30% – 50% of the mean concentration of a particular analyte. This variation can be expected to be higher for organic analysis than for inorganics and for low concentrations of analytes (AS 4482.1–2005).

# Appendix F

## Remedial Works Site Plan



SCALE AND LEGEND

	<b>Legend</b>		Validate Removal of Unsuitable Materials		Previously excavated and partially filled		Area to store stormwater and retaining wall materials
	Further Testing Required		Approximate area of uncontrolled fill		Site location		
	Install silt fence		Area to stockpile materials				

0 5 10 20 Meters

Client  
**Shire of Denmark**

**OPUS**  
 Albany Office  
 PO Box 5236  
 Albany, WA 6330, Australia  
 Tel: +61 8 9892 9600

TITLE <b>Lot 3002 Hardy Street, Denmark Remedial Works Site Plan</b>	
STATUS Final	FILE W-04925.01
SCALE 1:900	PLOT DATE 21/07/2016

# Appendix G

## Stakeholder Correspondence

## Vicki Davies

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**From:** Gregg Harwood <dcrs@denmark.wa.gov.au>  
**Sent:** Thursday, 7 April 2016 8:08 p.m.  
**To:** Vicki Davies  
**Subject:** FW: Class 1 Landfill material (sand Possibly some gravel/ clay) from former Shire Depot at Hardy Rd to Shire of Plantagenet Landfill site

---

**From:** Dominic Le Cerf [mailto:mws@sop.wa.gov.au]  
**Sent:** Wednesday, 6 April 2016 7:03 PM  
**To:** Gregg Harwood  
**Cc:** Rob Stewart  
**Subject:** Re: Class 1 Landfill material (sand Possibly some gravel/ clay) from former Shire Depot at Hardy Rd to Shire of Plantagenet Landfill site

Hi Greg,  
thanks for your email.

I am keen to take the class 1 material for landfill cover and yes there would be no charge for this at the site. In terms of the other material that you may need to dispose of, can I make suggestion of putting the material into bulk bag and seal them. Once sealed these bags could be freighted to our site and buried in our asbestos area. We have done this previously for a contractor that were cleaning up an area at the Albany hospital site and it ended up creating savings for them. This could be the case for Denmark as you would not need to engage opus could just pay freight, tipping fees and your staff or contractors to load the bulk bags.

I will be on leave until 27/4/16 so I will be happy to discuss this on my return. I will also get contractor details with compaction sand for you then.

Cheers,  
Dom.

Dominic Le Cerf  
Manager Works and Services  
Shire of Plantagenet.

Sent from my iPhone.

On 5 Apr 2016, at 11:23 AM, Gregg Harwood <[dcrs@denmark.wa.gov.au](mailto:dcrs@denmark.wa.gov.au)> wrote:

Dominic as discussed on the phone yesterday I am seeking a preliminary commitment that the Shire of Plantagenet would accept Class 1 Landfill material (sand Possibly some gravel/ clay) being carted from former Shire Depot at Hardy Rd to the Shire of Plantagenet Landfill site for usage as cover material at no cost if it is suitable to be easily for that purpose.

There is a possibility that small amounts of the material may be of a higher classification and we would also seek to bring this material to your site and perform further work there under the direction of Vicky Davis from Opus to get it down to class 1 standards. We would also undertake to remove that same material at our own full cost again under Vicky's supervision if it cannot be remediated to a class1 standard within a period of time which is acceptable to yourself.

I would also appreciate some contacts for back loading compaction sand.

*Gregg Harwood*  
Director of Community & Regulatory Services



Shire of Denmark  
953 South Coast Highway  
PO Box 183  
Denmark WA 6333

Phone: (08) 9848 0300

Mobile: 0418 732 197

Fax: (08) 9848 1985

Email: [dcrs@denmark.wa.gov.au](mailto:dcrs@denmark.wa.gov.au)

website: [www.denmark.wa.gov.au](http://www.denmark.wa.gov.au)

# Appendix H

## Summary Results of Soil and Groundwater Sampling 2016

	Field Measurements					Metals								PCB	OC/OP Pesticides			Phenol	PAH		TPH						BTEX				
	Dissolved Oxygen	Electrical Conductivity	Total Dissolved Salts	pH	Temperature	Arsenic	Cadmium	Chromium (Unspeciated)	Copper	Nickel	Lead	Zinc	Mercury (Total)	Total Polychlorinated biphenyls	Aldrin	Dieldrin	DDT	Phenols	Naphthalene	Benzo(a)pyrene	C6-C9 Fraction	>C10-C14 Fraction	>C15-C28 Fraction	>C29-C36 Fraction	>C10-C36 Fraction (Sum)	Benzene	Toluene	Ethylbenzene	Xylenes		
WATER ASSESSMENT CRITERIA	%Sat	µS/cm	ppM		C	mg/L								µg/L	µg/L			µg/L	µg/L		µg/L										
<sup>1</sup> Drinking water				6.5-8.5		0.01	0.002	0.05	2	0.02	0.01	3	0.001		*0.3	9	NV	NV	0.01							1	800	300	600		
Freshwater				6.5-8.5		0.013	0.0002	0.001	0.0014	0.011	0.0034	0.008	0.00006	*0.3	NV	0.006	320	16	NV							950	NV	NV	200		
Non-Potable Groundwater Use				NV		0.1	0.02	NV	20	0.2	0.1	3	0.01		3	90	NV	NV	0.1							10	25	3	20		
Sample ID	Sample Date																														
MB1	9/05/2016	25	1225	713	5.75	17.6	<0.001	<0.0001	<0.001	0.016	0.049	<0.001	0.132	<0.0001	<1	<0.5	<0.5	<2	<1.0	<1.0	<0.5	<20	<50	<100	<50	<50	<1	<2	<2	<2	
MB2	9/05/2016	46.3	845	488	6.44	20.2	<0.001	<0.0001	<0.001	0.009	0.049	<0.001	0.098	<0.0001	<1	<0.5	<0.5	<2	<1.0	<1.0	<0.5	<20	<50	<100	<50	<50	<1	<2	<2	<2	
MB3	9/05/2016	35.1	911	525	6.8	18.5	0.002	<0.0001	0.002	0.001	0.017	<0.001	0.01	<0.0001	<1	<0.5	<0.5	<2	<1.0	<1.0	<0.5	<20	<50	<100	<50	<50	<1	<2	<2	<2	
Control = MB3	9/05/2016						0.001	<0.0001	0.002	0.002	0.018	<0.001	0.009	<0.0001	<1	<0.5	<0.5	<2	<1.0	<1.0	<0.5	<20	<50	<100	<150	<50	<1	<2	<2	<2	
QA/QC																															
RPD (%)							80%	0%	0%	-14%	-3%	0%	2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

<sup>1</sup> Health Value (HV) unless absent then Aesthetic Vaule (AV) guideline used

\* LOR greater than Drinking Water Guideline concentration

NV = No value

Source:

Drinking Water (ADWG 2011)

Fresh Water (ANZECC & ARMCANZ 2000)

Non-Potable Groundwater Use (DoH 2014)





### Acid Sulfate Soils Field Test

<b>Job: W-04925.02</b>	<b>Location: Hardy St, Denmark</b>
<b>Date: 9/5/16</b>	<b>Collected By: Will White</b>

Sample No/ID	Soil Texture	Field pH			Sample Depth (mm)
		pH <sub>f</sub>	pH <sub>fox</sub>	Reaction	
SP1	Light brown/grey fine sand	6.8	6.1	None	500
SP2	Light brown/grey fine sand	6.5	6.0	None	500
SP4	Grey/brown medium sand with shells	8.9	7.6	Slight	500
SP8	Grey/brown medium sand with shells	8.9	7.4	Slight	500
Control (SP8)	Grey/brown medium sand with shells	8.9	7.4	Slight	500

Reaction Rating: None, Slight, Moderate, High, Extreme



# ALBANY SOIL & CONCRETE TESTING

No 2 Charles Street, Milpara WA  
 Phone : 08 98415309 Fax :08 98415309  
 Mobile : 0427 2777 97 Email : albsoil@omninet.net .au



ASCT

page 1 of 1

## DRY DENSITY/MOISTURE CONTENT RELATIONSHIP REPORT ( AS 1289 Method 5.2.1 )

## TEST REPORT

Soil compaction & density tests - Determination of the dry density/moisture content relation of a soil using Modified compactive effort

Job No/Sample ID                      17680/MDD-1    Test Request Number                      N/a

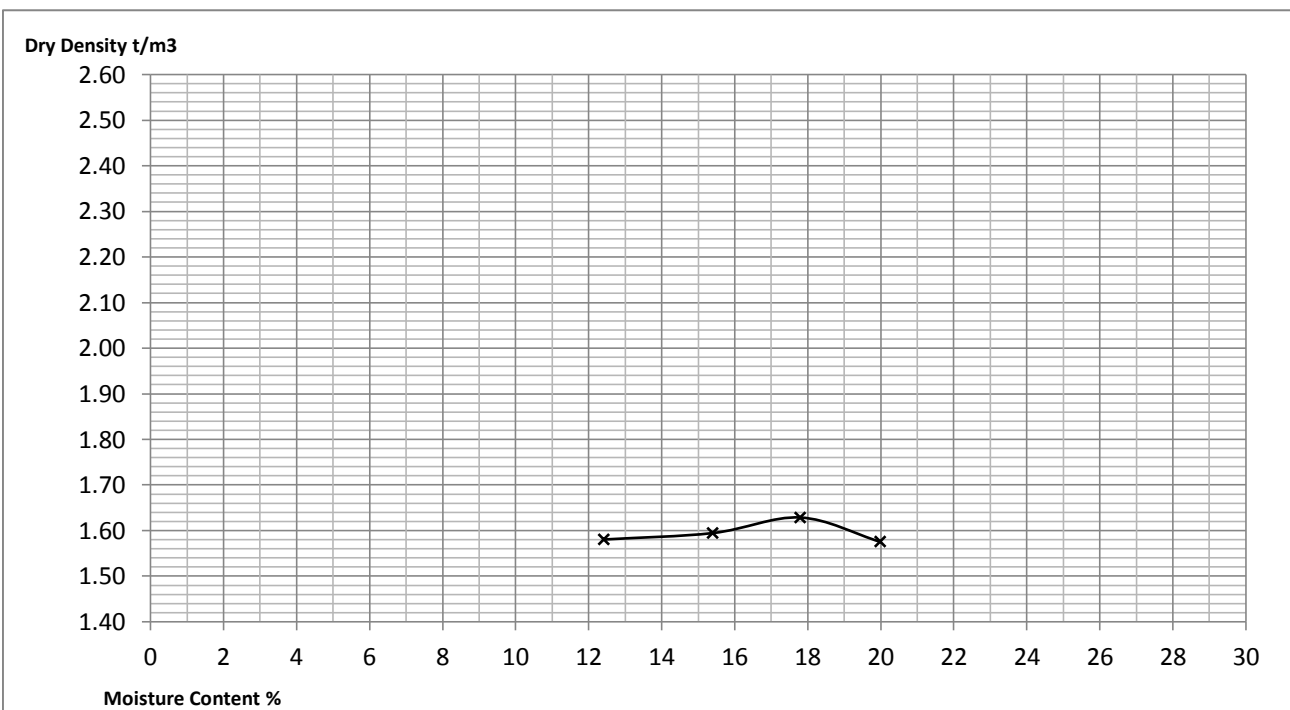
Client    Opus International Consultants Pty Ltd

Project    Denmark Site - Proposed Fill

Sample Location                              Sample 1

Date & time Tested                              4/04/2016

Tested By    S.Gough



<b>Optimum Moisture Content %</b>	17.5	<b>Maximum Dry Density t/m3</b>	1.63	<b>Retained 19.0 mm sieve %</b>	0.0
<b>Corrected OMC %</b>	-	<b>Corrected MDD t/m3</b>	-	<b>Corrected 19.0 mm sieve %</b>	-

Soil Description (visual)                      Grey, SAND

Depth    N/a Denotes " Not Applicable "

Method of Sampling                              Sampled by client

Method of Preparation                              AS 1289.1.1

Comments    N/a Denotes " Not Applicable "

Date Reported                                      5/05/2016

Authorised Signatory                              M.Coffey

Signature 

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ASCT

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## DRY DENSITY/MOISTURE CONTENT RELATIONSHIP REPORT ( AS 1289 Method 5.2.1 )

## TEST REPORT

Soil compaction & density tests - Determination of the dry density/moisture content relation of a soil using Modified compactive effort

Job No/Sample ID                      17680/MDD-2    Test Request Number                      N/a

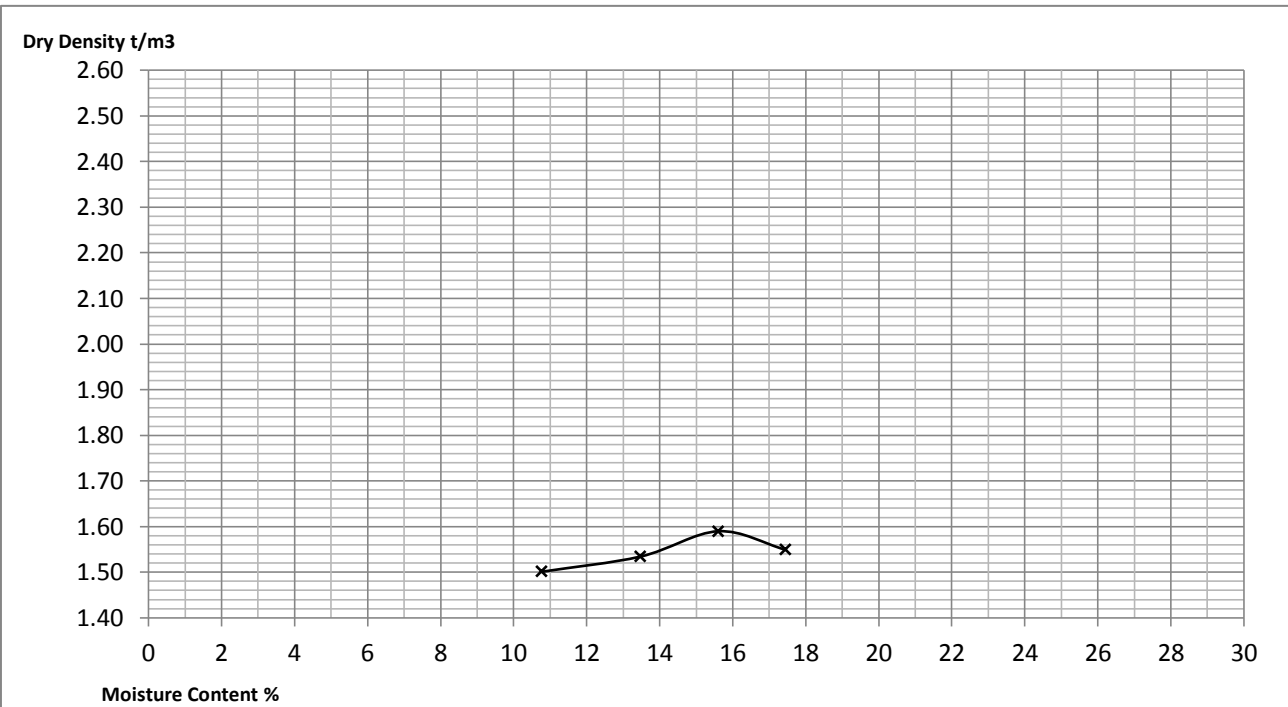
Client    Opus International Consultants Pty Ltd

Project    Denmark Site - Proposed Fill

Sample Location                              Sample 2

Date & time Tested                              4/05/2016

Tested By    J.Gray



<b>Optimum Moisture Content %</b>	15.5	<b>Maximum Dry Density t/m3</b>	1.59	<b>Retained 19.0 mm sieve %</b>	0.0
<b>Corrected OMC %</b>	-	<b>Corrected MDD t/m3</b>	-	<b>Corrected 19.0 mm sieve %</b>	-

Soil Description (visual)                      White SAND

Depth    N/a Denotes " Not Applicable "

Method of Sampling                              Sampled by client

Method of Preparation                              AS 1289.1.1

Comments    N/a Denotes " Not Applicable "

Date Reported    5/05/2016

Authorised Signatory                              M.Coffey

Signature

# ALBANY SOIL & CONCRETE TESTING

No 2 Charles Street, Milpara WA  
Phone : 08 98415309 Fax :08 98415309  
Mobile : 0427 2777 97 Email : Lab@albanysoiltesting.com.au



# ASCT

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## PLASTIC PROPERTIES ( AS 1289 Method 3.1.1 )

## TEST REPORT

Soil classification tests - Determination of the Liquid Limit of a soil - Four Point Casagrande Method

Job No/Sample ID 17680/PILS-2 Test Request Number N/a

Client Opus International Consultants Pty Ltd

Project Denmark Site - Proposed Fill

Sample Location Sample 2

Time & Date Tested 4/4/16 pm

Tested By J.Gray

**LIQUID LIMIT** 'Unattainable' % ( AS 1289 Method 3.1.1 )

**PLASTIC LIMIT** 'Unattainable' % ( AS 1289 Method 3.2.1 )

**PLASTICITY INDEX** 'Non Plastic' % ( AS 1289 Method 3.3.1 )

**LINEAR SHRINKAGE** 0.0 % ( AS 1289 Method 3.4.1 ) **Moisture Content** 13.2 %

Soil Description : White, SAND with silt

Depth: N/a

Method of Sampling : sampled by client

History of Sample : Air Dried

Method of Preparation: Dry Sieved ( AS 1289 Method 1.1 )

Length of Linear Shrinkage Mould : 255

Nature of Shrinkage : Normal

Comments N/a

Date Reported 5/05/2016

Authorised Signatory M.Coffey

Signature



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No 2 Charles Street, Milpara WA  
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Mobile : 0427 2777 97 Email : Lab@albanysoiltesting.com.au



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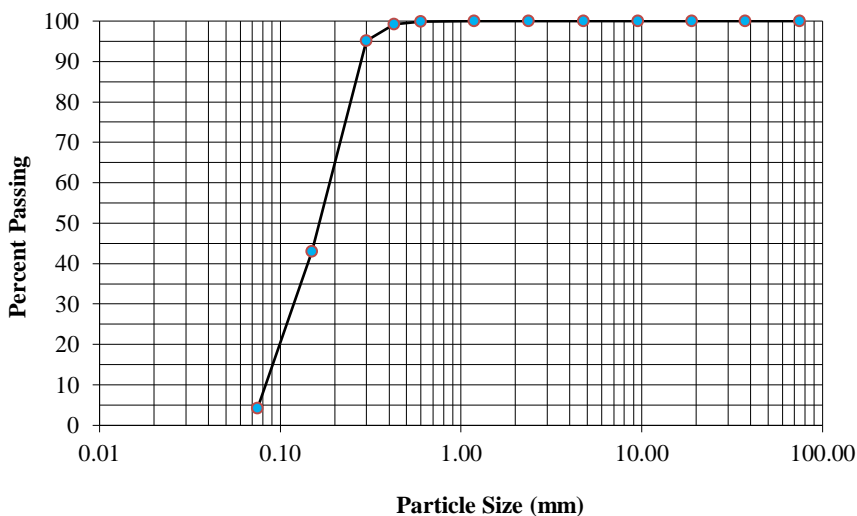
## PARTICLE SIZE DISTRIBUTION ( AS 1289 Method 3.6.1 )

## TEST REPORT

Soil classification tests - Determination of the particle size distribution of a soil - Standard Method of analysis by sieving

Job No/Sample ID	17680/PSD-2	Test Request Number	N/a
Client	Opus International Consultants Pty Ltd		
Project	Denmark Site - Proposed Fill		
Sample Location	Sample 2		
Date & Time Tested	4/5/16 3.00pm		
Tested By	J.Gray		

### Particle Size Distribution



Sieve Size	Passing	Retained
75.0 mm	100 %	0 %
37.5 mm	100 %	0 %
19.0 mm	100 %	0 %
9.5 mm	100 %	0 %
4.75 mm	100 %	0 %
2.36 mm	100 %	0 %
1.18 mm	100 %	0 %
0.600 mm	100 %	0 %
0.425 mm	99 %	1 %
0.300 mm	95 %	5 %
0.150 mm	43 %	57 %
0.075 mm	4 %	96 %

Soil Description	White, SAND
Depth	N/a

Method of Sampling	Sampled by client
Method of Preparation	AS 1289.1.1

Comments N/a

Date Reported 5/05/2016

Authorised Signatory M.Coffey

Signature

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Phone : 08 98415309 Fax :08 98415309  
Mobile : 0427 2777 97 Email : Lab@albanysoiltesting.com.au



## ASCT

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### PLASTIC PROPERTIES ( AS 1289 Method 3.1.1 )

### TEST REPORT

Soil classification tests - Determination of the Liquid Limit of a soil - Four Point Casagrande Method

Job No/Sample ID 17680/PILS-1 Test Request Number N/a

Client Opus International Consultants Pty Ltd

Project Denmark Site - Proposed Fill

Sample Location Sample 1

Time & Date Tested 4/4/16 PM

Tested By S.Gough

**LIQUID LIMIT** 'Unattainable' % ( AS 1289 Method 3.1.1 )

**PLASTIC LIMIT** 'Unattainable' % ( AS 1289 Method 3.2.1 )

**PLASTICITY INDEX** 'Non Plastic' % ( AS 1289 Method 3.3.1 )

**LINEAR SHRINKAGE** 0.0 % ( AS 1289 Method 3.4.1 ) **Moisture Content** 18.0 %

Soil Description : Grey, SAND

Depth: N/a

Method of Sampling : sampled by client

History of Sample : Air Dried

Method of Preparation: Dry Sieved ( AS 1289 Method 1.1 )

Length of Linear Shrinkage Mould : 254

Nature of Shrinkage : Normal

Comments N/a

Date Reported 5/05/2016

Authorised Signatory M.Coffey

Signature

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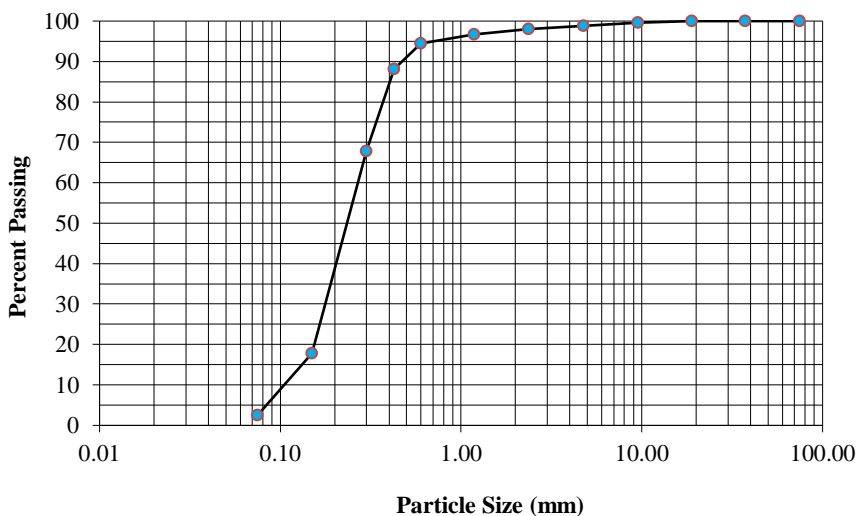
## PARTICLE SIZE DISTRIBUTION ( AS 1289 Method 3.6.1 )

## TEST REPORT

Soil classification tests - Determination of the particle size distribution of a soil - Standard Method of analysis by sieving

Job No/Sample ID	17680/PSD-1	Test Request Number	N/a
Client	Opus International Consultants Pty Ltd		
Project	Denmark Site - Proposed Fill		
Sample Location	Sample 1		
Date & Time Tested	4/4/16 pm		
Tested By	S.Gough		

### Particle Size Distribution



Sieve Size	Passing	Retained
75.0 mm	100 %	0 %
37.5 mm	100 %	0 %
19.0 mm	100 %	0 %
9.5 mm	100 %	0 %
4.75 mm	99 %	1 %
2.36 mm	98 %	2 %
1.18 mm	97 %	3 %
0.600 mm	94 %	6 %
0.425 mm	88 %	12 %
0.300 mm	68 %	32 %
0.150 mm	18 %	82 %
0.075 mm	3 %	97 %

Soil Description	Grey, SAND
Depth	N/a

Method of Sampling	Sampled by client
Method of Preparation	AS 1289.1.1

Comments N/a

Date Reported 5/05/2016

Authorised Signatory M.Coffey

Signature

# Appendix I

## Site Validation Sampling and Analysis Quality Plan

## **I.1 Validation Sampling and Analysis Quality Plan (SAQP)**

### **I.1.1 Purpose**

The purpose of the supplementary site investigation to be undertaken are as follows:

- Validate soils for onsite retention and classify soils for waste disposal to landfill;
- Monitor groundwater quality to investigate impact of remediation works;

This information will be included in the SRV at completion of remediation works.

### **I.1.2 Data Quality Objectives**

The following data quality objectives (DQOs) were developed in order to satisfy the intended purpose of further investigation required and validation of remediation works:

- Determine waste classification of Uncontrolled Fill, buried Natural Topsoil and Natural Sand (where hydrocarbon impacted) prior to disposal to landfill;
- Validate remaining natural soil, once contaminated material has been removed, to determine if Remedial Targets have been achieved;
- Certify replacement material as suitable “clean” fill;
- Groundwater monitoring prior to, during and post remediation works to determine background levels and impact of undertaking proposed remediation works;

## Remedial Action Plan

### I.1.3 Sampling Design and Justification

Table I-1 outlines proposed soil and groundwater sampling during and post remediation works.

**Table I-1: Proposed Sampling and Analysis of Soil and Groundwater**

Media		Analyte Selection		Sample Locations / Depth / Frequency		
Soil	In situ natural soil	Field	PID		<ul style="list-style-type: none"> <li>In situ natural soil in a grid pattern at a rate of 1/20 m<sup>2</sup> following excavation of contaminated material (Appendix F)</li> <li>Analyse all samples using a PID in the field as per Appendix E</li> <li>Soil samples should be laboratory analysed for TRH only</li> <li>If Remedial Targets are not met contaminated material shall be further excavated and retested until Remedial Targets are met</li> </ul>	
		Laboratory	Total Recoverable Hydrocarbons (TRH) NEPM 2013 Fractions	C6-C10 Fraction minus BTEX (F1) >C10-C16 Fraction minus Naphthalene (F2) >C16-C34 Fraction (F3) >C34-C40 Fraction (F4) >C10-C40 Fraction (Sum)		
	Site derived Recent Fill	Field	PID			<ul style="list-style-type: none"> <li>Analyse all samples using a PID in the field as per Appendix E</li> <li>Analyse 18 samples based on approximately 3,600 m<sup>3</sup> of Recent Fill for TRH only to meet Remedial Targets (Table 3-2) and check for possible cross contamination during excavation and stockpiling</li> </ul>
		Laboratory	TRH NEPM 2013 Fractions	C6-C10 Fraction minus BTEX (F1) >C10-C16 Fraction minus Naphthalene (F2) >C16-C34 Fraction (F3) >C34-C40 Fraction (F4) >C10-C40 Fraction (Sum)		
	Site derived screened Uncontrolled Fill, Buried Natural Topsoil (where hydrocarbon impacted) and bioremediated soil	Field	PID			<ul style="list-style-type: none"> <li>Sample Stockpile locations as required with collection of representative of material encountered</li> <li>Sample “hotspots” observed where there is visual and/ or olfactory evidence of contamination</li> <li>Collection of samples should be taken at various depths towards the centre of the stockpile to 300 mm below the surface to avoid the higher risk of weathering on the outside of the stockpile (Section 7.5 of Schedule B2 of the NEPM 1999)</li> <li>Analyse all samples using a PID in the field as per Appendix E</li> </ul>
		Laboratory	Asbestos (all forms)			
	TRH NEPM 2013 Fractions		C6-C10 Fraction minus BTEX (F1) >C10-C16 Fraction minus Naphthalene (F2) >C16-C34 Fraction (F3) >C34-C40 Fraction (F4) >C10-C40 Fraction (Sum)			

**Remedial Action Plan**

Media		Analyte Selection		Sample Locations / Depth / Frequency
				<ul style="list-style-type: none"> <li>Analyse samples based on approximately 8,400 m<sup>3</sup> of Uncontrolled Fill for TRH only to meet Remedial Targets as per rates of sampling in DEC (2009) guidelines for stockpiles</li> <li>Stockpile screened fines in approximately 100 m<sup>3</sup> piles and collect a composite sample from 4 locations within the stockpile</li> <li>Where suspected asbestos containing material (ACM) is encountered as a bulk item in fill it should be sampled and surrounding soil collected as a separate sample to assess whether asbestos is present in the fill as free fibres</li> <li>If screened fines do not meet Remedial Targets for TRH retest for classification for disposal to landfill as per DEC (2009) guidelines</li> </ul>
		Testing for structural suitability	To be determined by Supervising Engineer	<ul style="list-style-type: none"> <li>Shire of Denmark Supervising Engineer to ensure that the fill and compaction meets requirements for construction of buildings</li> </ul>
Imported clean fill	Laboratory	Asbestos (all forms)		<ul style="list-style-type: none"> <li>Clean Fill shall be obtained from an undisturbed natural source</li> <li>Three representative samples will be collected and all analytes for Remedial Targets will be laboratory tested (Table 3-1)</li> <li>Where suspected asbestos containing material (ACM) is encountered as a bulk item in fill it should be sampled and surrounding soil collected as a separate sample to assess whether asbestos is present in the fill as free fibres</li> </ul>
		Metals	Arsenic Cadmium Chromium (total) Chromium (hexavalent) Copper Lead Nickel Zinc Mercury	
		PCB		
		OC/OP Pesticides	Aldrin Dieldrin DDT+DDD+DDE Trans Chlordane	

**Remedial Action Plan**

Media		Analyte Selection		Sample Locations / Depth / Frequency	
			Phenols		
		PAHs	Total PAHs Anthracene Benzo(a)pyrene Fluoranthene Naphthalene Phenanthrene Pyrene		
		Total Recoverable Hydrocarbons NEPM 2013 Fractions	C6-C10 Fraction minus BTEX (F1) >C10-C16 Fraction minus Naphthalene (F2) >C16-C34 Fraction (F3) >C34-C40 Fraction (F4) >C10-C40 Fraction (Sum)		
		BTEX	Benzene Toluene Ethylbenzene Total Xylenes		
		Laboratory	Testing for structural suitability	To be determined by Supervising Engineer	Shire of Denmark Supervising Engineer to ensure that the fill and compaction meets requirements for construction of buildings
Groundwater	Field	pH Dissolved Oxygen Total Dissolved Salts Temperature Groundwater level			<ul style="list-style-type: none"> <li>Sampling will be undertaken at MB1, MB2, MB3 (Figure 8-1) for pre remediation monitoring (completed), during and post remediation on a quarterly (or more frequent) basis dependent on timeframes of works</li> </ul>



### Remedial Action Plan

Media	Analyte Selection		Sample Locations / Depth / Frequency	
	Laboratory	Dissolved Metals (Field filtered 45 µm)	Arsenic Cadmium Chromium (unspeciated) Copper Nickel Lead Zinc	<ul style="list-style-type: none"> <li>• Groundwater will be sampled from the bore locations using a low flow pump</li> <li>• Samples will be collected when three times the bore volume has been purged and water quality parameters, measured in the field, have stabilised</li> <li>• Samples will be collected as per the bottles for each suite of analytes provided by the laboratory and filled with zero head space.</li> </ul>
		Total Metals	Mercury	
		PCB		
		OC/OP Pesticides	Aldrin Dieldrin DDT	
		Phenols		
		PAH	Naphthalene Benzo(a)pyrene	
		TPH	C6-C9 Fraction >C10-C14 Fraction >C15-C28 Fraction >C29-C36 Fraction >C10-C36 Fraction (Sum)	
		BTEX	Benzene Toluene Ethylbenzene Xylenes	

## **I.1.4 Sampling Methods and Procedures**

### **I.1.4.1 Soil**

Refer to sampling methods and procedures as per Appendix E.

### **I.1.4.2 Groundwater**

Three groundwater bores (MB1, MB2, MB3) were installed at the Site on 26 April 2016 to obtain baseline groundwater samples. The results of the baseline sampling undertaken on 9 May 2016 and bore logs have been included in Appendix H.

It is proposed to undertake further groundwater investigation during and post remediation of the site and timeframes for monitoring will be dependent on the works schedule.

It should be noted that groundwater monitoring borehole MB2 is located with the area of the remediation excavation and will be destroyed during the remediation works. It is therefore proposed that the groundwater sampling is undertaken at an early stage during the remediation works, before such a time that MB2 is destroyed.

Groundwater sampling will be undertaken by Opus using a Micropurge®/ Low Flow Sampling Kit supplied by ThermoFisher Scientific at MB1, MB2 and MB3. This includes a QED MP10 controller, 47mm QED Sample Pro pump (with disposable Polyethylene Bladders) and is powered by a 12V Compressor. In situ groundwater quality measurements will be recorded using either a TPS 90FLMV or Aquaread Water Quality instrument.

Prior to purging the bore casing a water level reading will be taken using an AquaDipper Pro water level meter to determine the top level of groundwater and the base of the bore casing so as to calculate an appropriate volume of water to purge. Three times the bore case volume will be purged from the bore casing until pH, Electrical Conductivity (EC) and Total Dissolved Solids (TDS) are in equilibrium. Sampling and preservation of samples will be undertaken as per AS/NZS 5667:1998 Part 1 and 11.

Standard forms for groundwater monitoring are included in Appendix J.

## **I.1.5 Field Quality Assurance/ Quality Control (QA/QC)**


Refer to Field QA/QC as per Appendix E.


## **I.1.6 Laboratory Quality Assurance/ Quality Control (QA/ QC)**

Refer to Laboratory QA/QC as Appendix E.

# Appendix J

## Field Sampling and Chain of Custody Forms

Exploratory Hole ID:	Client:		 <a href="http://www.opus.com.au">www.opus.com.au</a>			
	Site:					
Project No:			Start Date:	End Date:		
Drilling Equipment/ Excavation Method:	Co-ords:		Backfill Date:	Field Records:		
	Ground Level (mAHD):		Logged:	Checked:	Appr:	
Strata Description	Depth (m)	Legend	Sample Type	Sample Depth (m)	Tests	GW (m)
Remarks			<b>Sample Type Key</b> D - Disturbed Representative B - Bulk Representative S - Spot Non-Representative W - Water U - Undisturbed Representative J - Jar Sample		<b>Test Type Key</b> (C) - Cone SPT (S) - Spoon SPT P - Pocket Pentrometer Reading PID - PID Reading V - Hand Shear Vane Reading	
			Sheet:			

Groundwater Bore ID:	Client:	 <a href="http://www.opus.com.au">www.opus.com.au</a>	
	Site:		
Project No:		Start Date:	End Date:

Measured Total Depth (T.D.) (m)		
Measured Water Level (W.L.) (m)		
Casing Height (m)		
Radius of Bore (m)		
Slots/ Screen @ (m)		
Pump Depth (m)		
Pump time on		
Pump time off		
Pumping time (min)		
Average Flow rate (L/min)		
Reduced T.D. (m)		Measured T.D. - Casing Height
Reduced W.L. (m)		Measured W.L. - Casing Height
Water Column (m)		Reduced T.D. - Reduced W.L.
Approx. Casing volume (L)		$3.1416 \times \text{radius}^2 \times \text{water column} \times 1000$
Approx. Volume removed (L)		Pumping time x Average Flow Rate
Sample collected for lab analysis?		
Sample field filtered?		

**Field Analyses:**

Time	Flow rate (L/min)	pH	Temp °C	D.O. (% Sat)	D.O. (mg/L)	EC (uS/cm)	TDS (mg/L)	Redox (MV)

**Comments**  
Flow rate conversion: Measure in seconds how long it takes to fill a 10L container  
Convert to L/min - (60 divided by seconds taken to fill 10L container) x 10 = L/min  
Record all measurements until pH, EC, TDS stabilise  
Purge a minimum of three bore case volumes prior to collecting sample for laboratory analysis



# CHAIN OF CUSTODY

ALS Laboratory: *please tick* →

Sydney: 277 Woodpark Rd, Smithfield NSW 2176  
Ph: 02 8784 8555 E:samples.sydney@alsenviro.com

Brisbane: 32 Shand St, Stafford QLD 4053  
Ph:07 3243 7222 E:samples.brisbane@alsenviro.com

Melbourne: 2-4 Westall Rd, Springvale VIC 3171  
Ph:03 8549 9600 E: samples.melbourne@alsenviro.com

Perth: 10 Hod Way, Malaga WA 6090  
Ph: 08 9209 7655 E: samples.perth@alsenviro.com

Newcastle: 5 Rosegum Rd, Warabrook NSW 2304  
Ph:02 4968 9433 E:samples.newcastle@alsenviro.com

Townsville: 14-15 Desma Ct, Bohle QLD 4818  
Ph:07 4796 0600 E:townsville.environmental@alsenviro.com

Adelaide: 2-1 Burma Rd, Pooraka SA 5095  
Ph: 08 8359 0890 E:adelaide@alsenviro.com

<b>CLIENT:</b>		<b>TURNAROUND REQUIREMENTS :</b> <input type="checkbox"/> Standard TAT ( <b>List due date</b> ):					<b>FOR LABORATORY USE ONLY (Circle)</b> Custody Seal Intact? Yes No N/A Free ice / frozen ice bricks present upon receipt? Yes No N/A Random Sample Temperature on Receipt: °C Other comment:					
<b>OFFICE:</b>		(Standard TAT may be longer for some tests e.g., Ultra Trace Organics) <input type="checkbox"/> Non Standard or urgent TAT ( <b>List due date</b> ):										
<b>PROJECT:</b>		<b>ALS QUOTE NO.:</b>										
<b>ORDER NUMBER:</b>		<b>COC SEQUENCE NUMBER (Circle)</b>										
<b>PROJECT MANAGER:</b>		<b>CONTACT PH:</b>										
<b>SAMPLER:</b>		<b>SAMPLER MOBILE:</b>			<b>RELINQUISHED BY:</b>			<b>RECEIVED BY:</b>		<b>RELINQUISHED BY:</b>		<b>RECEIVED BY:</b>
<b>COC emailed to ALS? ( YES / NO)</b>		<b>EDD FORMAT (or default):</b>			<b>DATE/TIME:</b>			<b>DATE/TIME:</b>		<b>DATE/TIME:</b>		<b>DATE/TIME:</b>
<b>Email Reports to</b> (will default to PM if no other addresses are listed):												
<b>Email Invoice to</b> (will default to PM if no other addresses are listed):												

**COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:**

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where <b>Metals</b> are required, specify <b>Total</b> (unfiltered bottle required) or <b>Dissolved</b> (field filtered bottle required).								Additional Information		
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE <i>(refer to codes below)</i>	TOTAL BOTTLES											Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
<b>TOTAL</b>																

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



**Opus International Consultants  
(Australia) Pty Ltd**  
Frederick House, 70 - 74 Frederick Street  
PO Box 5236, Albany WA 6332  
Australia

t: +61 8 9892 9600

w: [www.opus.com.au](http://www.opus.com.au)